# CHAPTER 3
# GROUNDWATER MONITORING

## Groundwater Monitoring Program Overview

**Groundwater** at the West Valley Demonstration Project (WVDP) is monitored according to a comprehensive program developed to comply with all applicable state and federal regulations and to meet the following requirements of Department of Energy (DOE) Order 5400.1:

• obtain data for determining baseline conditions of groundwater quality and quantity

• provide data that will allow the early detection of groundwater contamination

• identify existing and potential groundwater contamination sources and maintain surveillance of these sources

• provide data upon which decisions can be made concerning the integrity of existing disposal areas and the management and protection of groundwater resources.

Current groundwater monitoring activities at the WVDP are summarized in two primary documents, the Groundwater Monitoring Plan (West Valley Nuclear Services Co., Inc. December 1998) and the Groundwater Protection Plan (West Valley Nuclear Services Co., Inc. April 1997). The Groundwater Monitoring Plan outlines the WVDP's plans for groundwater characterization, current groundwater monitoring, and support of long-term monitoring requirements identified in the Resource Conservation and Recovery Act (RCRA) facilities investigation (RFI) and DOE programs. The Groundwater Protection Plan provides additional information regarding protection of groundwater from on-site activities.

## Geologic History of the West Valley Site

**The** Western New York Nuclear Service Center (WNYNSC) is located on the Allegheny Plateau near the northern border of Cattaraugus County in Western New York. Underneath the WNYNSC site is a sequence of Holocene (recent age) and Pleistocene (ice age) sediments in a steep-sided valley of bedrock. The bedrock is composed of shales and interbedded siltstones of the upper Devonian Canadaway and Conneaut Groups and dips southward at about 5 m/km (Rickard 1975).

The Holocene and Pleistocene sediments overlying the bedrock typically consist of a sequence of three glacial tills of Lavery, Kent, and possibly Olean age. The tills are separated by stratified fluvio-lacustrine deposits. In the northern part of the site the till is capped by alluvial-fluvial coarse-grained deposits.

Glaciation of the ancestral valley occurred between 24,000 and 15,000 years ago (Albanese et al. 1984), ending with the deposition of up to 40 meters (130 ft) of Lavery till. Post-Lavery outwash and alluvial fans, including the sand and gravel unit that covers the northern portion of the WVDP site, were deposited on the Lavery till between 15,000 and 14,200 years ago (La Fleur 1979).

## Surface Water Hydrology of the West Valley Site

**The** WNYNSC lies within the Cattaraugus Creek watershed, which empties into Lake Erie about 43 kilometers (27 mi) southwest of Buffalo. Buttermilk Creek, a tributary of Cattaraugus Creek, drains most of the WNYNSC and all of the WVDP site.

The 80-hectare (200-acre) WVDP site, located on the WNYNSC, is contained within the smaller Frank's Creek watershed. Frank's Creek, a tributary of Buttermilk Creek, forms the eastern and southern boundary of the WVDP, and Quarry Creek, a tributary of Frank's Creek, forms the northern boundary. (See Fig.A-6 (p.A-8].)

Another tributary of Frank's Creek, Erdman Brook, bisects the WVDP into a north and south plateau. The main plant, waste tanks, and lagoons are located on the north plateau. The drum cell, the U.S. Nuclear Regulatory Commission (NRC)-licensed disposal area (NDA), and the New York State-licensed disposal area (SDA) are located on the south plateau.

## Hydrogeology of the West Valley Site

**Glacial deposits.** As noted above, the WVDP site area is underlain by a sequence of glacial tills comprised primarily of clays and silts separated by coarser-grained interstadial layers. The bottommost layer, the Kent till, is less permeable than the other geological units and does not provide a pathway for contaminant movement from the WVDP and so it is not discussed here. The sediments above the Kent till — the Kent recessional sequence, the Lavery till and the intra-Lavery till-sand, and the surficial sand and gravel — are generally regarded as containing all of the potential routes for the migration of contaminants (via groundwater) from the WVDP site. (See Figs.3-1 and 3-2 [*facing page*], which show the relative locations of these sediments on the north and south plateaus.) The Kent recessional sequence and the Lavery till are common to both the north and south plateaus.

**Kent recessional sequence.** The Kent recessional sequence consists of a fine-grained lacustrine unit of interbedded clay and silty clay layers locally overlain by coarse-grained glacial sands and gravels. These deposits underlie the Lavery till beneath most of the site, pinching out along the southwestern margin of the site where the walls of the bedrock valley intersect the sequence.

Groundwater flow in the Kent recessional sequence is predominantly to the northeast, towards Buttermilk Creek. The mean hydraulic conductivity generally ranges from $10^{-6}$ cm/sec ($10^{-3}$ ft/day) to $10^{-5}$ cm/sec ($10^{-2}$ ft/day). Recharge comes from the overlying Lavery till and the bedrock in the southwest, and discharge is to Buttermilk Creek.

**Lavery till.** The Lavery till is predominantly an olive-gray, silty clay glacial till with scattered lenses of silt and sand. The Lavery till underlies both the north and south plateaus and ranges up to 40 meters (130 ft) in thickness beneath the active areas of the site, generally increasing northeastward towards Buttermilk Creek and the center of the bedrock valley. (On the south plateau the upper zone of the Lavery till is weathered and fractured. See description of the south plateau below.)

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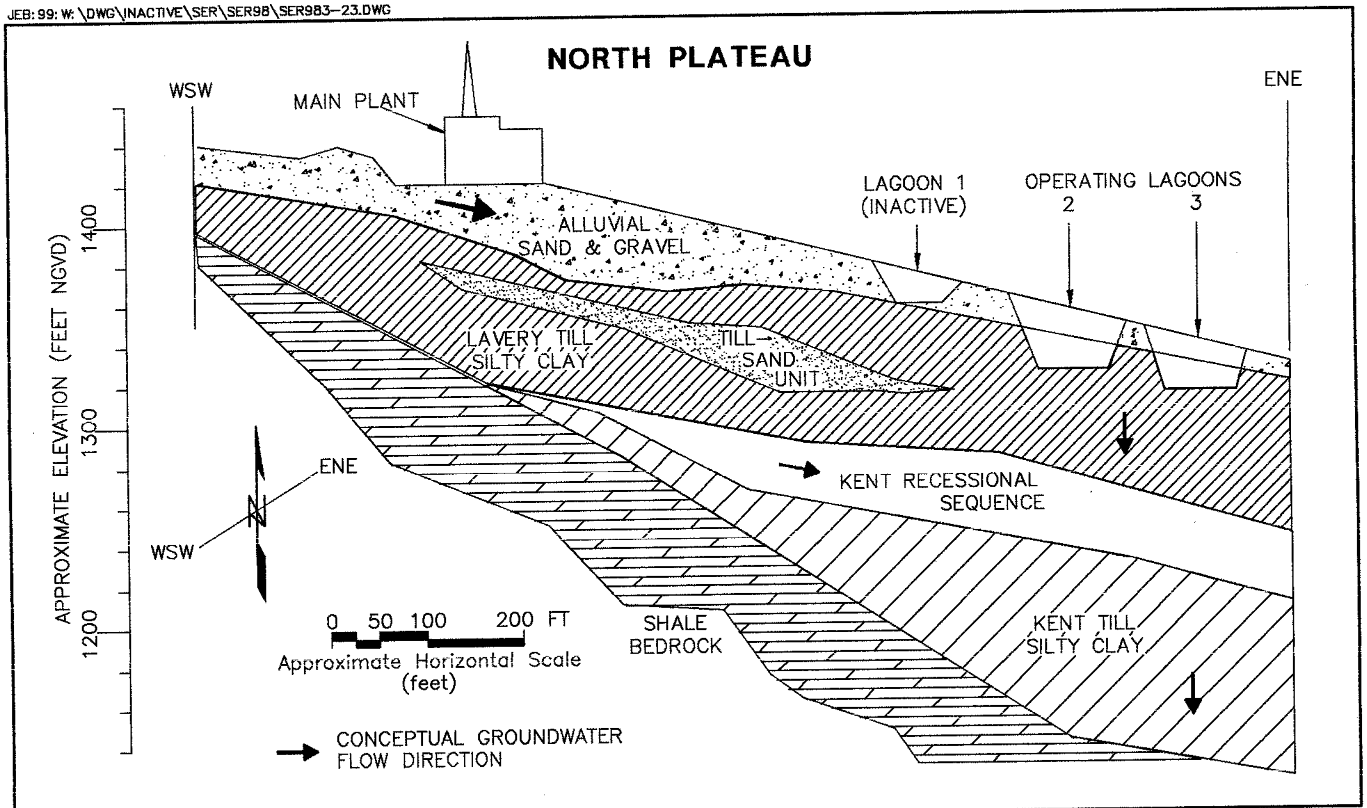


*Figure 3-1. Geologic Cross Section through the North Plateau*

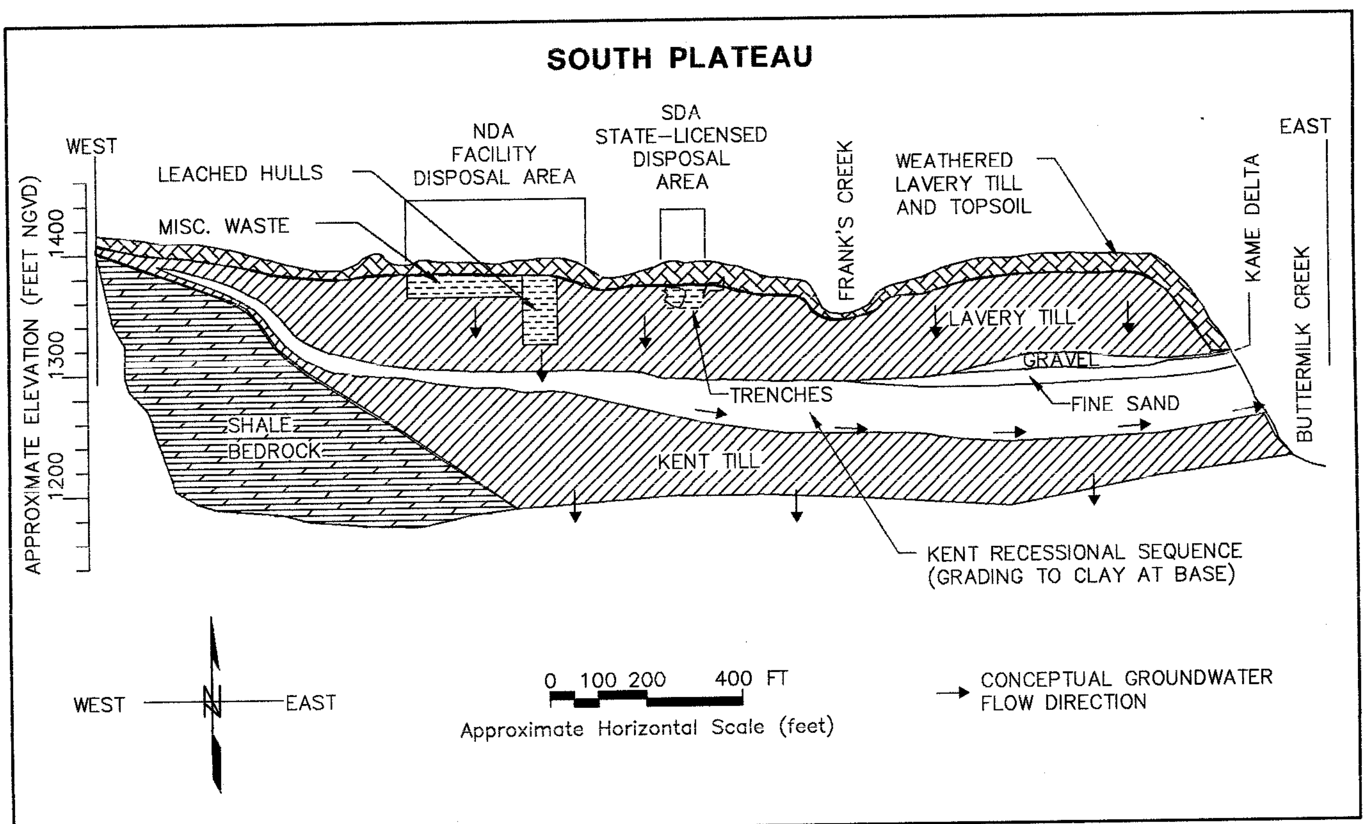


*Figure 3-2. Geologic Cross Section through the South Plateau*

Hydraulic head distributions in the *unweathered* Lavery till indicate that groundwater flow is predominantly vertically downward at a relatively slow rate, towards the underlying Kent recessional sequence. The mean hydraulic conductivity of this unweathered till generally ranges from $10^{-8}$ cm/sec ($10^{-5}$ ft/day) to $10^{-7}$ cm/sec ($10^{-4}$ ft/day).

**South Plateau.** On the south plateau the upper portion of the Lavery till is exposed at the ground surface and is weathered and fractured to a depth of 0.9 meters to 4.9 meters (3 to 16 ft). This layer is referred to as the *weathered* Lavery till and is unique to the south plateau. The weathered Lavery till has been oxidized to a brown color and contains numerous fractures and root tubes.

Groundwater flow in the weathered till has both horizontal and vertical components. This enables the groundwater to move laterally across the south plateau before moving downward into the unweathered Lavery till or discharging to nearby incised stream channels. The hydraulic conductivity of the weathered till generally ranges from $10^{-7}$ cm/sec ($10^{-4}$ ft/day) to $10^{-5}$ cm/sec ($10^{-2}$ ft/day). The highest conductivities are associated with the dense fracture zones found within the upper 2 meters (7 ft) of the unit.

**North Plateau.** On the north plateau, where the main plant, waste tanks, and lagoons are located, the weathered till layer is much thinner or nonexistent and the *unweathered* Lavery till is immediately overlain by the sand and gravel unit.

The sand and gravel unit and the Lavery till-sand are unique to the north plateau. The sand and gravel unit is a silty sand and gravel layer composed of younger Holocene alluvial deposits that overlie older Pleistocene-age glaciofluvial deposits. Together these two layers range up to 12.5 meters (41 ft) in thickness near the center of the plateau and pinch out along the northern, eastern, and southern edges of the plateau, where they have been truncated by the downward erosion of stream channels. Depth to groundwater within the sand and gravel unit varies from 0 meters to 5 meters (0 ft to 16 ft), being deepest generally beneath the central north plateau (beneath the main plant facilities) and intersecting the ground surface farther north towards the security fence. Groundwater in this unit generally flows northeastward across the north plateau towards Frank's Creek. Groundwater near the northwestern and southeastern margins of the sand and gravel layer also flows radially outward toward Quarry Creek and Erdman Brook, respectively. There is minimal groundwater flow downward into the underlying Lavery till. The mean hydraulic conductivity generally is from $10^{-6}$ cm/sec ($10^{-3}$ ft/day) to $10^{-3}$ cm/sec (3 ft/day).

Within the unweathered Lavery till on the north plateau is another unit, the *till-sand*. On-site investigations from 1989 through 1990 identified this lenticular sandy unit of limited areal extent and variable thickness within the Lavery till, primarily beneath the southeastern portion of the north plateau. Groundwater flow through this unit is in an east-southeast direction. Surface discharge locations have not been observed. Results of the most recent hydraulic testing in 1996 and 1998 of eight wells monitoring this unit indicate a mean hydraulic conductivity of $10^{-3}$ cm/sec (3 ft/day).

## Routine Groundwater Monitoring Program

The purpose of groundwater monitoring is to detect changes in groundwater quality within the five different hydrogeologic units described above: the sand and gravel, the weathered Lavery till, the unweathered Lavery till, the Lavery till-sand, and the Kent recessional sequence.

**Monitoring Well Network.** Table E-1 (Appendix E [p.E-3]) lists the eleven super solid waste management units (SSWMUs) monitored by the well network; the hydraulic position of each well relative to the waste management unit; the geologic unit monitored; and the analytes measured in 1998. Note that monitoring of certain wells, marked by an asterisk, is required by the RCRA 3008(h) Administrative Order on Consent for the WVDP. (See the Environmental Compliance Summary: Calendar Year 1998, RCRA Facility Investigation [RFI] Program [p. ECS-4].)

Figure A-6 (p.A-8) shows the boundaries of the eleven super solid waste management units at the WVDP. (Twenty-one additional wells monitor the SDA and are the responsibility of the New York State Energy Research and Development Authority [NYSERDA]. Locations of NYSERDA wells are shown on Fig.A-8 [p.A-10] in Appendix A.) Although the SDA, a closed radioactive waste landfill, is contiguous with the Project premises, the WVDP is not responsible for the facilities or activities relating to it. Under a joint agreement with the DOE, NYSERDA contracts with the Project to obtain specifically requested technical support in SDA-related matters. The 1998 groundwater monitoring results from the SDA are reported in this document in Appendix L (pp.L-3 through L-14) but are not discussed here.

*Four designations can be used to indicate the function of a monitoring well in the WVDP groundwater monitoring program:*

*Upgradient well. A well installed hydraulically upgradient of a SSWMU that is capable of yielding groundwater samples that are representative of local conditions and that are not affected by the SSWMU being monitored.*

*Downgradient well. A well installed hydraulically downgradient of a SSWMU that is capable of detecting the migration of contaminants from the SSWMU.*

*Background well. A well installed hydraulically upgradient of all SWMUs and SSWMUs that is capable of yielding groundwater samples that are representative of conditions not affected by site activities. In some cases upgradient wells may be downgradient of other SSMWUs or SWMUs, which makes them unsuitable for use as true background wells.*

*Crossgradient well. A well installed to the side of the major downgradient flow path such that the well is neither upgradient nor downgradient of the monitored SSWMU.*

Table E-1 (pp.E-3 through E-6) identifies the positions of monitoring locations relative to the SSWMUs. The wells monitoring a given hydrogeologic unit (e.g., sand and gravel, weathered Lavery till) also are arranged in a generalized upgradient to downgradient order based upon their location within the entire hydrogeologic unit. The hydraulic position of a well relative to a SSWMU, i.e., upgradient or downgradient, does not necessarily match that same well's position within a hydrogeologic unit. For example, a well that is upgradient in relation to a SSWMU may be located at any position within a hydrogeologic unit within the boundaries of the WVDP, depending on the geographic position of the SSWMU relative to the hydrogeologic unit. In general, the following text and graphics refer to the hydraulic position of monitoring wells within their respective hydrogeologic units, thus providing a site-wide perspective rather than a perspective centered on SSWMUs.

Potentiometric (water level) measurements also are collected from the wells listed in Table E-1 in conjunction with the quarterly analytical sampling schedule. (See Table 3-1, p.3-6.) Groundwater elevation data are used to produce groundwater contour maps (which delineate flow directions and gradients) and long-term trend graphs (which illustrate seasonal fluctuations and identify changes in the groundwater system).

## *Table 3-1*
## *1998 Groundwater Sampling and Analysis Agenda*

| *Analyte Group* | *Description of Parameters* [1] | *Location of Sampling Results in Appendix E* |
|---|---|---|
| Contamination Indicator Parameters (I) | pH, specific conductance (field measurement) | Tables E-2 through E-8 (pp. E-7 through E-15) |
| Radiological Indicator Parameters (RI) | Gross alpha, gross beta, tritium | Tables E-2 through E-8 (pp. E-7 through E-15) |
| Volatile Organic Compounds (V) | Appendix 33 VOCs (See Table E-15 [p. E-23]) | Table E-9 (p. E-16) |
| Semivolatile Organic Compounds (SV) | Appendix 33 SVOCs (See Table E-15 [p. E-24]) | Table E-10 (p. E-16) |
| Appendix 33 Metals (M33) | Antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, mercury, nickel, selenium, silver, thallium, tin, vanadium, zinc | Table E-11 (pp. E-17 and E-18) |
| Pilot Program for Investigating Chromium and Nickel Concentrations (M) | Chromium, nickel | Table E-12 (p. E-19) |
| Special Monitoring Parameters for Early Warning Wells (SM) | Aluminum, iron, manganese | Table E-13 (p. E-20) |
| Radioisotopic Analyses: alpha- , beta- , and gamma-emitters (R) | C-14, Cs-137, I-129, Ra-226, Ra- 228, Sr-90, Tc-99, U-232, U-233/234, U-235/236, U-238, total uranium | Table E-14 (pp. E-20 through E-22) |
| Strontium-90 (S) | Sr-90 | Table E-14 (pp. E-20 through E-22) |

*1998 Quarterly Sampling Schedule:*
*1st Qtr - December 1, 1997 to December 22, 1997*
*2nd Qtr - March 2, 1998 to March 13, 1998*
*3rd Qtr - June 1, 1998 to June 12, 1998*
*4th Qtr - September 1, 1998 to September 14, 1998*

[1]*Analysis performed at selected active monitoring locations only. See Table E-1 (pp. E-3 through E-6) for the analytes sampled at each monitoring location.*

## *Groundwater Sampling Methodology*

*Groundwater samples are collected from monitoring wells using either dedicated Teflon® well bailers or bladder pumps. (Dedicated bailers are equipped with Teflon®-coated stainless steel leaders.)*

*The method of collection depends on well construction, water depth, and the water-yielding characteristics of the well. Bailers are used in low-yield wells; bladder pumps are used in wells with good water-yielding characteristics.*

*To ensure that only representative groundwater is sampled, three well volumes are removed (purged) from the well before the actual samples are collected. If three well volumes cannot be removed because of limited recharge, purging the well to dryness provides sufficient purging. Conductivity and pH are measured before sampling and after sampling, if sufficient water is still available, to confirm the geochemical stability of the groundwater during sampling.*

*The bailer, a tube with a check valve at the bottom, is lowered into the well until it reaches the desired point in the water column. The bailer is lowered slowly to minimize agitation of the water column and is then withdrawn from the well with a sample and emptied into a sample container. The bailer, bailer line, and bottom-emptying device used to drain the bailer are dedicated to the well, i.e., are not used for any other well.*

*Bladder pumps use compressed air to gently squeeze a Teflon® bladder that is encased in a stainless steel tube located near the bottom of the well. When the pressure is released, new groundwater flows into the bladder. A series of check valves ensures that the water flows only in one direction. The operating air is always separated from the sample and is expelled to the surface by a separate line.*

*Bladder pumps reduce mixing and agitation of the water in the well. Each bladder pump system is dedicated to an individual well to reduce the likelihood of sample contamination from external materials or cross contamination. The air compressor and pump control box can be used from well to well because they do not contact the sample.*

*Immediately after the samples are collected they are put into a cooler and returned to the Project's Environmental Laboratory. The samples are preserved with chemicals, if necessary, and stored under controlled conditions to minimize chemical and/or biological changes after sample collection. The samples are then either packaged for expedited delivery to an off-site contract laboratory or kept in controlled storage to await on-site testing. A strict chain-of-custody protocol is followed for all samples.*

Eleven surface water elevation stakes were installed in August 1998 in areas of the north plateau where groundwater in the sand and gravel unit is believed to intersect the ground surface. Surface water elevation measurements taken at these locations will be evaluated to determine how well they correlate with groundwater elevation measurements taken at monitoring wells. If the correlation is acceptable, then the surface water elevations will be used to improve the definition of groundwater flow-direction and gradients in the sand and gravel unit.

**Groundwater Monitoring Program Highlights 1982 to 1998.** The groundwater monitoring program is designed to support DOE Order 5400.1 requirements and the RCRA 3008(h) Administrative Order on Consent for the WVDP. In general, the content of the program is dictated by these requirements in conjunction with current operating practices and historical knowledge of previous site activities.

- WVDP groundwater monitoring activities began in 1982 with the monitoring of tritium in the sand and gravel unit in the area of the lagoon system.

- By 1984 twenty wells in the vicinity of the main plant and the NDA provided monitoring coverage.

- Fourteen new wells, a groundwater seep location, and the french drain outfall were added in 1986 to monitor additional site facilities.

- Ninety-six new wells were installed in 1990 to support data collection for the environmental impact statement and RCRA facility investigations.

- A RCRA facility investigation expanded-characterization program was conducted during 1993 and 1994 to fully assess potential releases of hazardous wastes or constituents from on-site SSWMUs. This investigation, which consisted of two rounds of sampling for a wide range of radiological and chemical parameters, yielded valuable information regarding the presence or absence of groundwater contamination near each SSWMU and was also used to guide later monitoring program modifications.

***Measuring Water Levels in a Groundwater Monitoring Well***

- In 1993 monitoring results indicated elevated gross beta activity in groundwater in the sand and gravel unit on the north plateau. Subsequent investigation of this area delineated a plume of contamination with a southwest to northeast orientation. (See Special Groundwater Monitoring, p. 3-15, for more detail.)

- Long-term monitoring needs were the focus of a 1995 groundwater monitoring program evaluation. After a comprehensive assessment the number of sampling locations was reduced from ninety-one to sixty-five and analytical parameters were tailored for each sampling location, for a more focused, efficient, and cost-effective program.

- From 1996 through 1998, in response to current sampling results and to DOE and RCRA monitoring requirements, wells, analytes, and sampling frequencies were modified. In 1996 other sampling locations, the seeps on the north plateau, were added to the program.

**Annual Analytical Trigger Limit Review.** A computerized data evaluation program using "trigger limits" for chemical and radiological analytes was instituted in 1995. These pre-set limits — conservative values for chemical or radiological concentrations — were developed to expedite a prompt focus on any monitoring anomalies. Trigger limits are recalculated and updated every year, if necessary, using all pre-existing data as well as data collected during the year. The trigger limits were updated in early 1998. Initially, only upper trigger limits had been used, but in early 1998 lower trigger limits for selected wells and analytes also were instituted.

In addition, upper and lower trigger limits for groundwater elevation measurements were introduced this year. These limits are used to identify field measurement anomalies, allowing prompt investigation and remeasurement, if necessary.

## Results of Routine Groundwater Monitoring

**Groundwater** monitoring program components are completed in accordance with regulatory protocols. These components include placing and installing wells properly, collecting groundwater samples appropriately, incorporating quality assurance methods, and evaluating data appropriately.

The tables in Appendix E (pp.E-7 through E-22) present the results of groundwater monitoring grouped according to the five hydrogeologic units monitored: the sand and gravel unit, the Lavery till-sand unit, the weathered Lavery till unit, the unweathered Lavery till unit, and the Kent recessional sequence. These tables contain the results of 1998 sampling for the radiological and nonradiological analyte groups noted on Table 3-1 (p.3-6). Table E-15 (pp.E-23 through E-25) lists the practical quantitation limits (PQLs) for individual NYCRR [New York Official Compilation of Codes, Rules, and Regulations] Title 6, Appendix 33 analytes.

Appendix E tables also display each well's hydraulic position relative to other wells within the same hydrogeologic unit. Wells identified as UP refer to either background or upgradient wells that are upgradient of all other wells in the same hydrogeologic unit. Downgradient locations are designated B, C, or D to indicate their positions along the groundwater flow path relative to each other. Wells denoted as DOWN - B are closest to the UP wells. Wells denoted as DOWN - C are downgradient of DOWN - B wells but are upgradient of DOWN - D wells. DOWN - D wells are downgradient of all other wells in that hydrogeologic unit. Grouping the wells by hydraulic position provides a logical basis for presenting the groundwater monitoring data in the tables and figures in this report.

The Appendix E tables also list the sample collection periods. The 1998 sampling year covers the period from December 1997 (the first quarter of 1998) through September 1998 (the fourth quarter of 1998).

Graphs showing the highest and lowest measurements of contamination and radiological indicator parameters (pH, conductivity, gross alpha, gross beta, and tritium) have been prepared for all active monitoring locations in each geologic unit. (See Appendix E [pp.E-26 through E-35].) These *high-low* graphs allow results for all wells within a given hydrogeologic unit to be compared to each other. All the high-low graphs present the upgradient wells on the left side of the figure. Downgradient locations are plotted to the right according to their relative position along the groundwater flow path.

On the high-low graphs depicting nonradiological results (pH and conductivity), the upper and lower tick marks on the vertical bar indicate the highest and lowest measurements recorded during 1998. The middle tick represents the arithmetic mean of all 1998 results. The vertical bar thus represents the total range of the data set for each monitoring location during the year.

On the high-low graphs depicting radiological results (gross alpha, gross beta, and tritium), the middle tick is again used to represent the arithmetic mean of all 1998 results. However, the upper and lower tick marks on the vertical bar indicate the upper and lower ranges of the pooled error terms for all 1998 results. This format illustrates the relative amount of uncertainty associated with the radiological measurements. By displaying the uncertainty together with the mean, a more realistic perspective is obtained. (See also Data Reporting [p.1-4] in Chapter 1, Environmental Monitoring Program Information.)

The sample counting results for gross alpha, gross beta, and tritium, even if below the minimum detectable concentrations, were used to generate the high-low graphs. Thus, negative values were included. This is most common for the gross alpha analyses, where sample radiological counting results may be lower than the associated instrument background.

The wells used to provide background values are noted on each graph. All the geologic units except the sand and gravel unit use a single well for background, and in previous years well NB1S was used as the single background reference well for the sand and gravel unit. However, in 1997 the collective monitoring results from three upgradient wells (301, 401, and 706) were substituted for comparison with other sand and gravel wells as a way of better representing the natural spatial variability within the geologic unit. Both the DOE and NYSDEC have accepted the use of this collective background reference instead of well NB1S.

*Trend-line* graphs have been used to show concentrations of a particular parameter over time at monitoring locations that have historically shown radiological concentrations above background values or volatile organic compound (VOC) concentrations above practical quantitation limits. Graphs are included for gross beta and tritium at selected groundwater monitoring locations (104, 111, 408, 501, 502, 801, 8603, 8604, 8605, and GSEEP) and for the VOCs 1,1-dichloroethane (1,1-DCA) at wells 8609 and 8612; dichlorodifluoromethane (DCDFMeth) at wells 803 and 8612; 1,2-dichloroethylene (1,2-DCE) and 1,1,1-trichloroethane (1,1,1-TCA) at well 8612. (See Volatile and Semivolatile Organic Compounds Sampling [p.3-14].)

**Long-term Trends of Gross Beta and Tritium at Selected Groundwater Monitoring Locations.** Figures 3-5 through 3-8 (pp.3-19 through 3-20) show the trends of gross beta activity and tritium at selected monitoring locations in the sand and gravel unit. These specific groundwater monitoring locations were selected for trending because they have shown elevated or rising levels of gross beta activity or steady or falling levels of tritium. Results are presented on a logarithmic scale to adequately represent locations of differing concentrations and can be compared to the average background concentrations plotted on each graph.

***Gross Beta.*** The groundwater plume of gross beta activity in the sand and gravel unit on the north plateau (Fig.3-3 [p.3-12]) continues to be monitored closely. The source of the plume's activity can be traced to the subsurface beneath the southwest corner of the former process building. Nine wells (104, 111, 408, 501, 502, 801, 8603, 8604, and 8605) contain elevated levels of gross beta activity, i.e., activity that exceeds the DOE DCG for strontium-90, 1.0E-06 $\mu$Ci/mL. Gross beta results for wells 804 and 105 were one order of magnitude less than the DOE DCG, thereby indicating the downgradient limits of the plume.

• Figure 3-5 (p.3-19) shows gross beta concentrations in wells 104, 111, 408, 501, 502, and 801 over the eight-year period that the WVDP's current groundwater monitoring program has been in place.

As in previous years, samples from well 408 continued to show the highest gross beta levels of all the wells within the north plateau gross beta plume area. The yearly average gross beta concentration at well 408 increased slightly in 1998 after showing a small decrease in 1997. The gross beta concentrations in wells 501 and 502 have remained relatively consistent over the last several years. Concentrations in well 104 continued to increase but at a slower rate than in previous years.

Gross beta concentrations in well 801 decreased slightly this year. Gross beta concentrations in well 111 increased slightly after showing decreases during the past two years.

• Figure 3-6 (p.3-19) is a graph of gross beta activity at sand and gravel unit monitoring locations 8603, 8604, 8605, and GSEEP. After several years of steep increases in gross beta concentrations in well 8604, the trend leveled off in 1997 and in 1998 showed a slight decrease. Results from well 8603 have continued to show a steady upward trend, apparently due to migration of the eastern lobe of the north plateau plume.

Lagoon 1, formerly part of the low-level waste treatment facility, has been identified as a source of the gross beta activity at wells 8605 and 111. The gross beta concentrations at well 8605 have been slowly but steadily decreasing over the past several years.

***Tritium***. Tritium in sand and gravel wells also is monitored under the routine monitoring program.

• Figure 3-7 (p. 3-20) shows the tritium concentrations in wells 104, 111, 408, 501, 502, and 801 over the eight-year period that the WVDP's current groundwater monitoring program has been in place. The figure shows that tritium concentrations in well 111 apparently have decreased over recent years. Other monitoring points show slight decreases or relatively steady concentration trends.

• Figure 3-8 (p.3-20) shows the thirteen-year trend of tritium concentrations at monitoring locations 8603, 8604, 8605, and GSEEP. Wells 8603 and 8604 indicate gradually declining trends in tritium, and 8605 shows a significant decrease over time.

**North Plateau Seeps.** Five of the nine seep sampling points were repaired and upgraded in August 1998 by clearing the sampling pipe interiors of accumulated sediment and roots and inserting the pipes into new holes to optimize water flow. Flow from the pipes was improved, ensuring the collection of high-quality samples and minimizing sample time.

Analytical results for radiological parameters from semiannual sampling of the sand and gravel unit seepage locations were compared to the results from GSEEP, a seep monitored since 1991 that apparently is not influenced by the gross beta plume. (See Fig.A-7 [p.A-9].) Results thus far appear to indicate that gross beta activity from the north plateau plume has not migrated to these seepage areas. Gross alpha and gross beta concentrations at most of the seep sampling locations were generally similar to results from GSEEP. Gross beta concentrations from SP02

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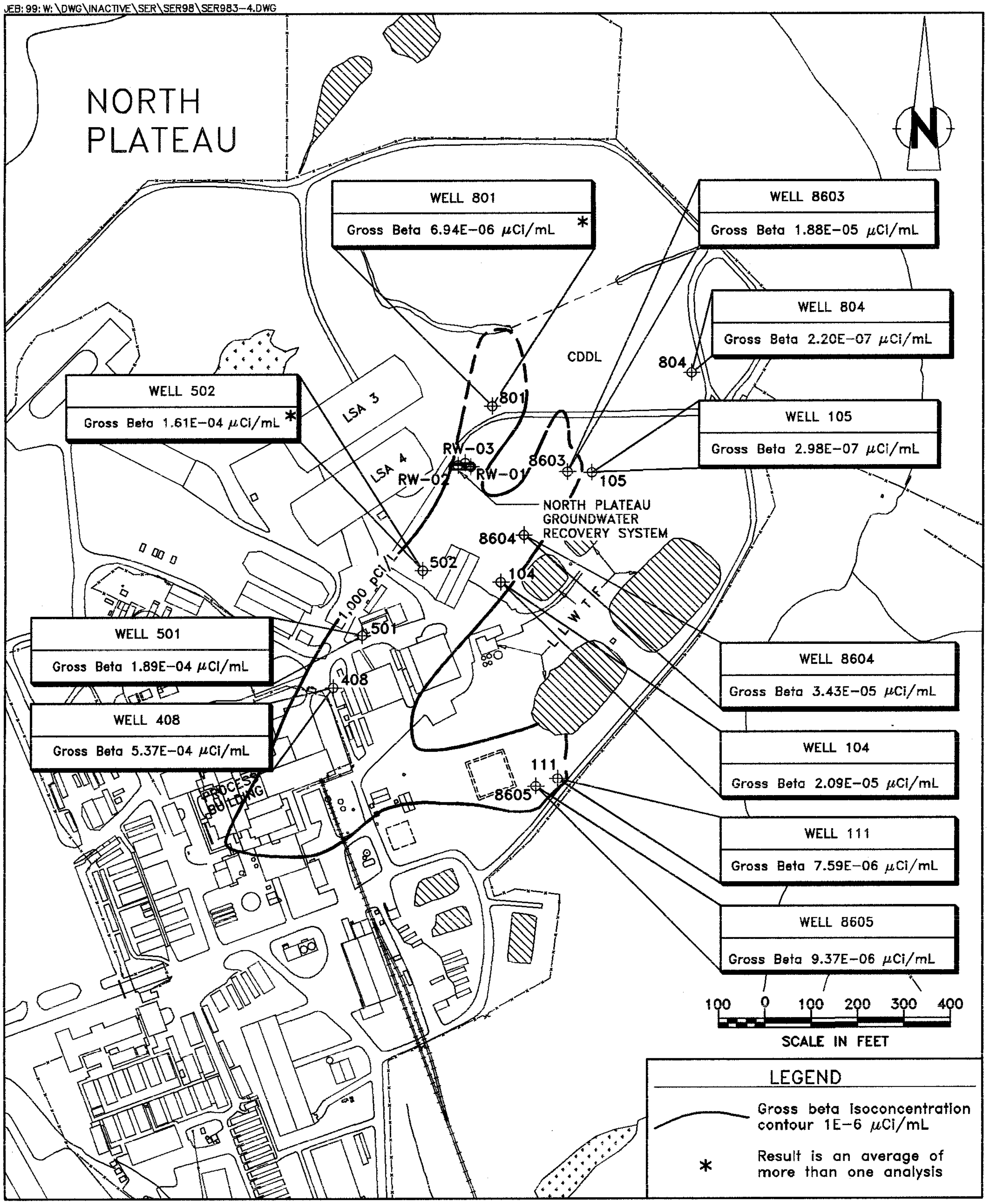


*Figure 3-3. North Plateau Gross Beta Plume Area: Fourth-Quarter 1998 Results.*

and gross alpha and gross beta results from SP04 were slightly above GSEEP concentrations during 1998 but still were well below the DCGs. (See Table E-7 [p.E-15].)

Tritium concentrations at the seeps remained similar in magnitude or were less than concentrations at GSEEP. Minor seasonal fluctuations over time also are apparent. Concentrations at all the seeps were slightly above background but were generally consistent with tritium levels seen in sand and gravel wells on the north plateau.

**North Plateau Well Points.** Seven well points were installed in 1990 downgradient of the process building and were sampled annually between 1993 and 1998 for radiological indicator parameters. Data from these well points were used to supplement data collected from groundwater monitoring wells.

Well points A, C, and H (Fig.A-6 [p.A-8]) have yielded samples with concentrations of tritium that are elevated with respect to historical monitoring of wells in the area. However, the tritium concentrations are well below the DOE derived concentration guide of 2.0E-03 $\mu$Ci/mL. Data from downgradient monitoring wells have not indicated similarly elevated levels of tritium. (See Table E-8 [p.E-15].)

This area east of the process building and west of inactive lagoon 1 may be an area of localized contamination, and it will continue to be monitored annually for contamination indicator and radiological indicator parameters. Sampling will continue at well points A, C, and H to further evaluate the presence of tritium in this localized area.

**Results of Monitoring at the NDA.** Gross beta and tritium concentrations in samples from well 909 and location NDATR (Fig.A-6 [p.A-8]) continued to be elevated with respect to other locations monitoring the NDA but remained well below the DCGs. Radiological indicator results have historically fluctuated at these locations but, in general, upward trends in gross beta and tritium are discernible at well 909. Gross beta concentrations from well 909 are considerably higher than at NDATR; residual soil contamination near this well is the suspected source.

A trench was constructed around two sides of the NDA to collect groundwater that may contain a mixture of n-dodecane and tributyl phosphate (TBP). (For more information see Chapter 1, Environmental Monitoring Program Information, NRC-licensed Disposal Area [NDA] Interceptor Trench and Pretreatment System [p.1-8].) There were no monitoring results in 1998 that indicated the presence of TBP or n-dodecane.

Procedures for collecting water samples from location NDATR (the NDA interceptor trench manhole sump) were recently modified. Previously, the water in the manhole had been sampled anywhere from immediately after it was pumped out to up to nineteen days after being pumped out. Because the manhole is not purged before sampling, the varying age of the water may have induced occasional variability in analytical results from this location. The modified procedures include sampling the water within forty-eight hours after pumping is completed. This approach is expected to minimize potential variability in future analytical results (Dames & Moore May 1998). An evaluation of the effectiveness of this strategy will be made after a minimum of four quarterly sampling rounds have been completed.

**Results of Radioisotopic Sampling.** Groundwater samples for radioisotopic analyses are collected regularly from sixteen monitoring points in the sand and gravel unit and the weathered Lavery till. (See Table E-14 [pp.E-20 through E-22]. Results from 1998 generally confirmed historical findings. Strontium-90 remained the major contributor to elevated gross beta activity in the plume on the north plateau.

Technetium-99, iodine-129, and carbon-14 radionuclides, which have been noted at several monitoring locations at concentrations above background levels (in specific wells within the gross beta plume and downgradient of inactive lagoon 1 and the NDA), have been demonstrated to contribute very small percentages to total gross beta concentrations. None of these concentrations have been above DCGs, and gross beta analyses continue to provide surveillance on a quarterly basis.

# Volatile and Semivolatile Organic Compounds Sampling

V**olatile** and semivolatile organic compounds were sampled at specific locations (wells 8612, 8609, 803, and SP12 [Fig.A-6, p.A-8]) that have shown historical results above their respective practical quantitation levels (PQLs). (The PQL is the lowest level of an analyte that can be measured within specified limits of precision during routine laboratory operations [New York State Department of Environmental Conservation 1991]. See Table E-15 [pp.E-23 through E-25] for a list of PQLs.) Other monitoring locations are sampled for volatile and semivolatile organic compounds because they are downgradient of locations showing positive results.

***1,1-dichloroethane***. Trends in concentrations of the compound 1,1-dichloroethane (1,1-DCA) from 1991 through 1998 are illustrated in Figure 3-9 (p.3-21). Concentrations of 1,1-DCA at well 8612 remained consistent with results from previous years but were not detected at wells 8609, 803, or groundwater seep SP-12 during 1998. (See Table E-9 [p. E-16].)

***Dichlorodifluoromethane***. Trends of dichlorodifluoromethane (DCDFMeth) concentrations are shown in Figure 3-10 (p.3-21). The concentrations of DCDFMeth at well 8612 remained at low levels in 1998 — near the detection limit. DCDFMeth was identified at well 803 at concentrations below the PQL. DCDFMeth was not detected at SP-12 during 1998.

***1,2-dichloroethylene.*** Another positive VOC detection (Fig.3-11 [p.3-22]) was 1,2-dichloroethylene (1,2-DCE) at well 8612, which showed an increasing trend during 1998. (This compound was first detected in 1995.)

***1,1,1-trichloroethane.*** Concentrations of the compound 1,1,1-trichloroethane (1,1,1-TCA) also were detected at well 8612 below the PQL.

The VOCs 1,1-DCA, DCDFMeth, and 1,1,1-TCA are often found in combination with each other and with 1,2-DCE. In well 8612 each of these three compounds first exhibited an increasing trend that, over the past few years, was then followed by a decreasing trend. It is expected that 1,2-DCE will exhibit similar behavior, and continued routine monitoring will evaluate future trends.

***Tributyl phosphate.*** Aqueous concentrations of tributyl phosphate (TBP) were detected at well 8605, near lagoon 1, at concentrations similar to those in 1997. TBP was detected once in well 111 during 1998 at levels below the PQL. (See Table E-10 [p.E-16].) This well is next to and downgradient of well 8605, and positive detections of TBP have been reported in the past.

The ongoing detection of TBP in this localized area may be related to previously detected low, positive concentrations of iodine-129 and uranium-232 in wells 111 and 8605, as noted in previous annual Site Environmental Reports. The presence of all three contaminants indicates that these results reflect residual contamination from previous waste disposal activities in the former lagoon 1 area during historical fuel reprocessing. Future trends of TBP will be evaluated as part of the routine groundwater monitoring program.

# Special Groundwater Monitoring

**Gross Beta Plume on the North Plateau.** Elevated gross beta activity has been detected in groundwater from the surficial sand and gravel unit in localized areas north and east of the building where NFS reprocessed nuclear fuel (Fig. 3-3 [p.3-12]). In December 1993 elevated gross beta concentrations were detected in surface water at former sampling location WNDMPNE, located at the edge of the plateau. This detection initiated a subsurface investigation in 1994. Groundwater and soil were sampled using the Geoprobe®, a mobile sampling system. The investigation was used to define the extent of the gross beta plume beneath and downgradient of the process building. The gross beta plume delineated was approximately 300 feet wide and 800 feet long.

The highest gross beta concentrations in groundwater and soil were near the southeast corner of the process building. The maximum activity in groundwater was 3.6E-03 $\mu$Ci/mL, and the maximum activity in soil reached 2.4E-02 $\mu$Ci/g. Strontium-90 and its daughter product, yttrium-90, were determined to be the isotopes responsible for most of this elevated gross beta activity. (West Valley Nuclear Services Co., Inc. 1995). In 1995 the north plateau groundwater recovery system (NPGRS) was installed to minimize the spread of the gross beta plume.

The NPGRS was located near the leading edge of the main lobe of the plume where groundwater flows preferentially towards the edge of the plateau. The NPGRS initially consisted of two extraction wells (RW-01 and RW-02) to recover the contaminated groundwater. In September 1996 a third well (RW-03) was added to the NPGRS along with other system upgrades. The upgraded recovery system more effectively captures the contaminant plume in this area.

Water recovered by the NPGRS is treated by ion exchange to remove strontium-90. Treated water is transferred to lagoon 4 or 5 and then to lagoon 3 for ultimate discharge to Erdman Brook.

The north plateau groundwater recovery system operated successfully throughout 1998, processing more than 4.4 million gallons, and has recovered and processed more than 14 million gallons since November 1995.

**Northeast Swamp Drainage Monitoring.** Routine surface water sampling during 1998 continued to monitor radiological discharges through the northeast swamp drainage at location WNSWAMP. (See Appendix C, Table C-7 [p.C-8].) Gross beta and strontium-90 concentrations continued to fluctuate due to seasonal effects. The annualized average strontium-90 concentrations trended upward to some extent during 1998. (Fig. 3-4 [p.3-16].) This increase was expected and is attributable to groundwater downgradient of the influence of the NPGRS.

Although the annualized averaged concentration of strontium-90 in surface water exceeded the DOE DCG at sampling location WNSWAMP (on the WVDP premises), monitoring downstream at the first point of public access (WFFELBR) continued to show strontium-90 concentrations to be nearly indistinguishable from background (WFBIGBR) concentrations. (See also Off-site Surface Water, p.2-8, in Chapter 2, Environmental Monitoring.)

**1998 Geoprobe® Investigation in the Core Area of the North Plateau Plume.** As a result of recommendations from a 1997 external review of WVDP response actions on the north plateau, more attention was given in 1998 to the core area of the plume. (The core area is the portion of the gross beta plume beneath or immediately downgradient of the former process building suspected to be the source of the plume.) A Geoprobe® sampling program subsequently was developed to further characterize the core area. The program's goals were as follows:

- characterize the soil and groundwater in the strontium-90 plume core and compare the results with 1994 data

- collect data for a geochemical evaluation of the core and for strontium-90-transport modeling

- collect data to be used to evaluate the feasibility of various treatment and mitigative technologies for groundwater and saturated soil within the strontium-90 plume core

- collect soil grain-size distribution data

- evaluate the potential for strontium-90 to migrate into the Lavery till within the strontium-90 plume core.

The 1998 Geoprobe® field program began in June 1998 and was completed in September 1998. Geoprobe® groundwater and soil samples also were collected downgradient of the north plateau groundwater recovery system (NPGRS) to provide further characterization of this area. A summary report will be completed in 1999.

**North Plateau Groundwater Quality Early Warning Sampling.** An early warning evaluation of selected monitoring well data was devised to identify possible changes in the quality of the groundwater recovered by the NPGRS that might affect compliance with site effluent limitations on pollutants specified in the SPDES permit for outfall 001. This monitoring is important because water recovered by the NPGRS ultimately is discharged through outfall 001.

The early warning system compares quarterly monitoring results from three wells (116, 602, and 502) in the vicinity of the NPGRS to early warning levels (multiples of the SPDES permit levels) in order to identify concentrations that may affect compliance with SPDES effluent limits. Two of the wells, 116 and 602, are used to monitor groundwater in the area affected by NPGRS drawdown. The third well, 502, is directly upgradient of the NPGRS and is sampled for additional metals not routinely analyzed under the groundwater monitoring program. Analytical re-

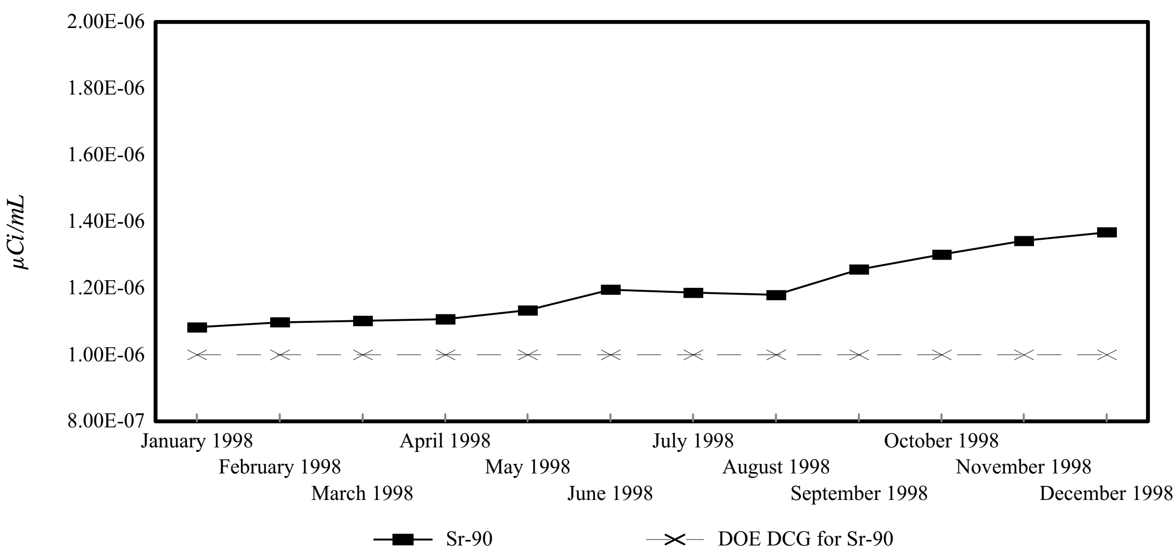


***Figure 3-4. Annualized Average Strontium-90 Concentrations at WNSWAMP***

sults from the early warning sampling can be found in Tables E-11 through E-13 (pp.E-17 through E-20 in Appendix E).

**Pilot Program Investigating Chromium and Nickel in the Sand and Gravel Unit**. Long-term groundwater monitoring results have shown a wide spatial and temporal range of chromium and nickel concentrations in the sand and gravel unit. The randomness of these elevated concentrations indicated that the source probably was not related to a release from an on-site facility.

However, a possible source of elevated metals in groundwater samples is corrosion of stainless steel monitoring well screens and casings: Metals leached from the well materials can adsorb to sediment particles within the well and these particles can then become entrained in the groundwater sample by vigorous purging and sampling.

A study was initiated in 1997 to determine the effect of modifying sampling equipment and methodology on the concentrations of chromium and nickel in the groundwater. Twelve sand and gravel wells were selected for the investigation. The equipment and sampling methods for six of the wells were left unchanged and these wells were sampled according to routine procedures. The sampling equipment and methodology of the other six wells were modified in order to minimize the amount of solids collected during sampling.

The final report of this study, completed in June 1998, noted that modifications to sampling equipment and methodology produced decreases in chromium and nickel concentrations. This supported the hypothesis that the elevated concentrations were not representative of actual groundwater conditions but presumably were caused by the release of metals from subsurface corrosion of stainless steel well materials, which is well-documented in the technical literature.

To ensure continued well integrity, WVNS currently is evaluating the extent of corrosion of stainless steel wells in the sand and gravel unit. The evaluation will include a review of historical information and well performance data, downhole video inspections, and well redevelopment and/or cleaning, and will determine recommendations for continued well monitoring, maintenance, or replacement, as necessary, to maintain well integrity and sample quality.

**NYSDEC Sample-splitting Program**. During the fourth quarter of 1998 groundwater sampling, NYSDEC collected split samples, which were independently analyzed for selected metals and radiological indicator parameters by WVDP and NYSDEC laboratories. Overall, agreement between the split sample results was favorable.

# Summary of Site Groundwater Monitoring

**One** of the primary functions of routine groundwater monitoring at the WVDP is to provide timely detection of contaminant release, if any, from SSWMUs to site groundwater. Program specifications such as monitoring well locations and selection of analytes were designed for this purpose. Groundwater monitoring data collected during 1998 did not indicate new releases from SSWMUs or any other new groundwater concerns.

Groundwater seep samples from the sand and gravel unit are collected semiannually from several points near the northeast corner of the north plateau. These points are hydraulically downgradient of the site. Analytical results from seep samples obtained during 1998 indicated no concentrations of radiological or chemical parameters above regulatory guidelines.

The 1998 groundwater monitoring program reflects continuous refinements of a systematic routine based on historic groundwater data, site-use information, and recent trends. These data and information are also used to make responsible, proactive decisions such as the Geoprobe® investigations to better define the core area of the north plateau gross beta plume, installation and operation of the NPGRS, and the pilot study to investigate chromium and nickel in groundwater.

Groundwater monitoring will continue on a quarterly basis during 1999. If items of concern are discovered, they will be addressed promptly in order to protect groundwater resources in the vicinity of the WVDP.

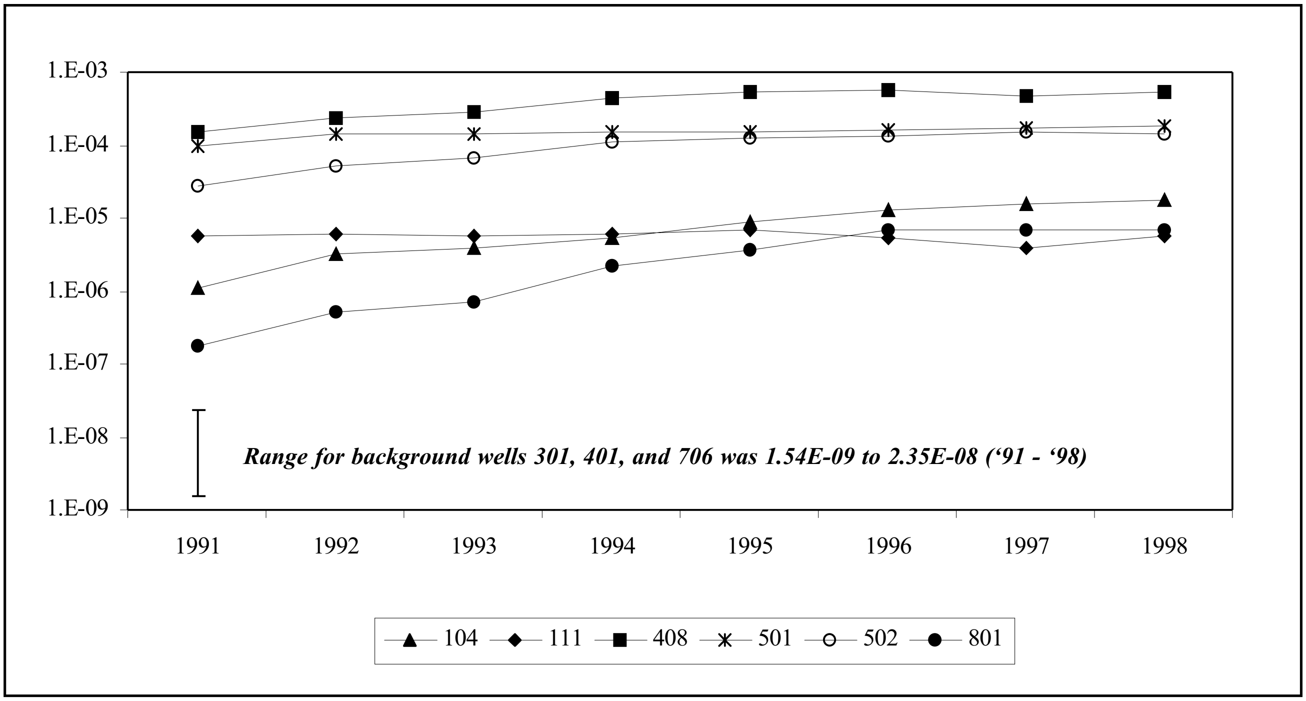


***Figure 3-5. Eight-Year Trends of Averaged Gross Beta Activity (µCi/mL) at Selected Locations in the Sand and Gravel Unit***

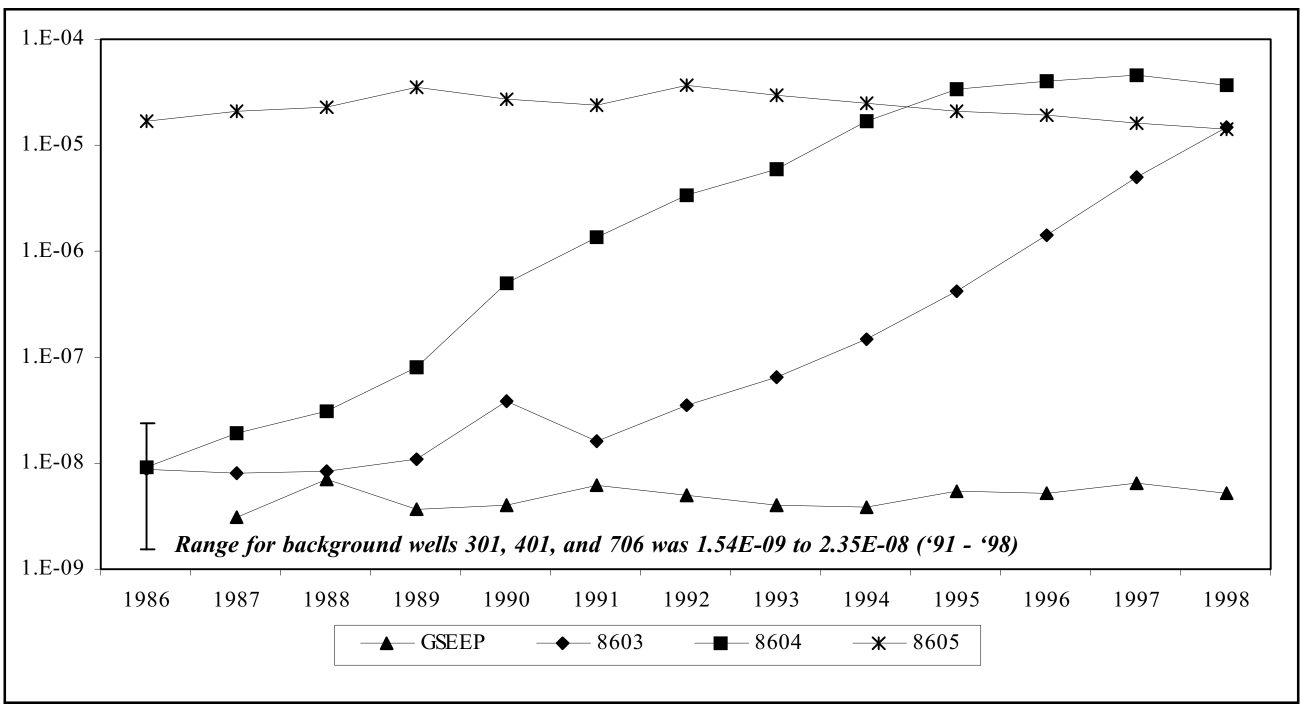


***Figure 3-6. Thirteen-Year Trends of Averaged Gross Beta Activity (µCi/mL) at Selected Locations in the Sand and Gravel Unit***

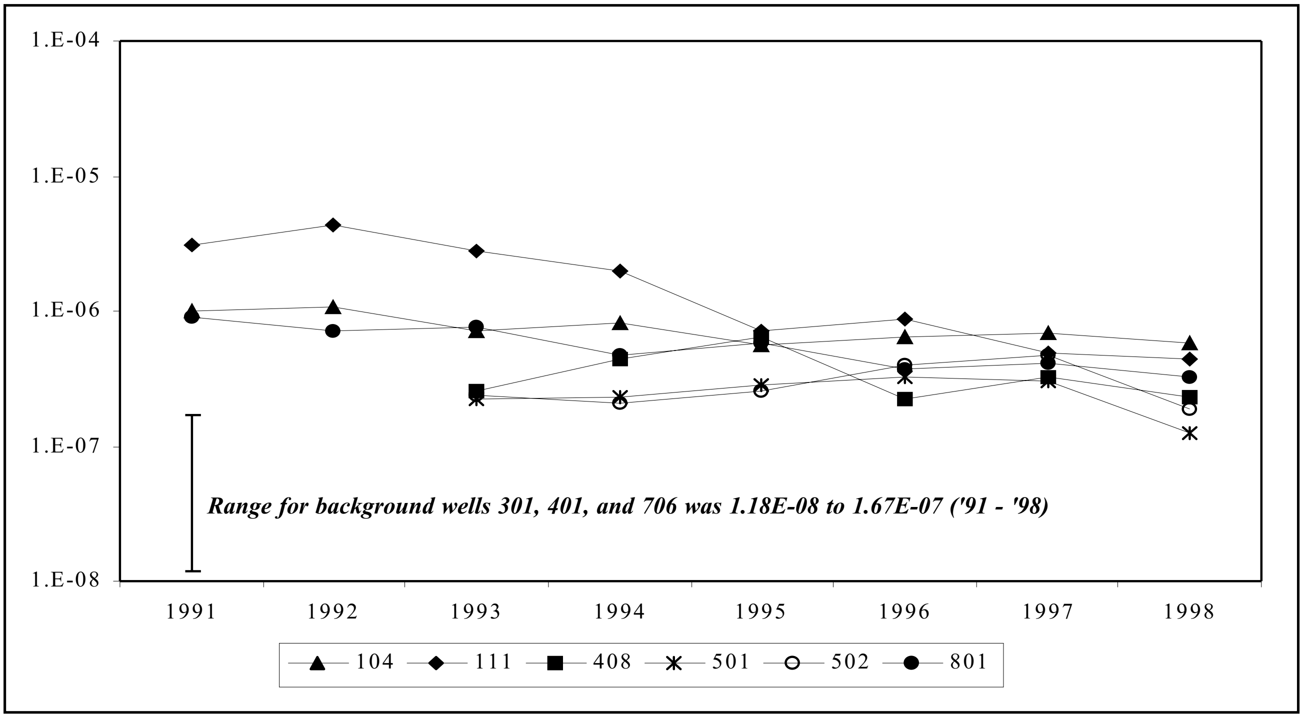


***Figure 3-7. Eight-Year Trends of Averaged Tritium Activity (µCi/mL) at Selected Locations in the Sand and Gravel Unit***

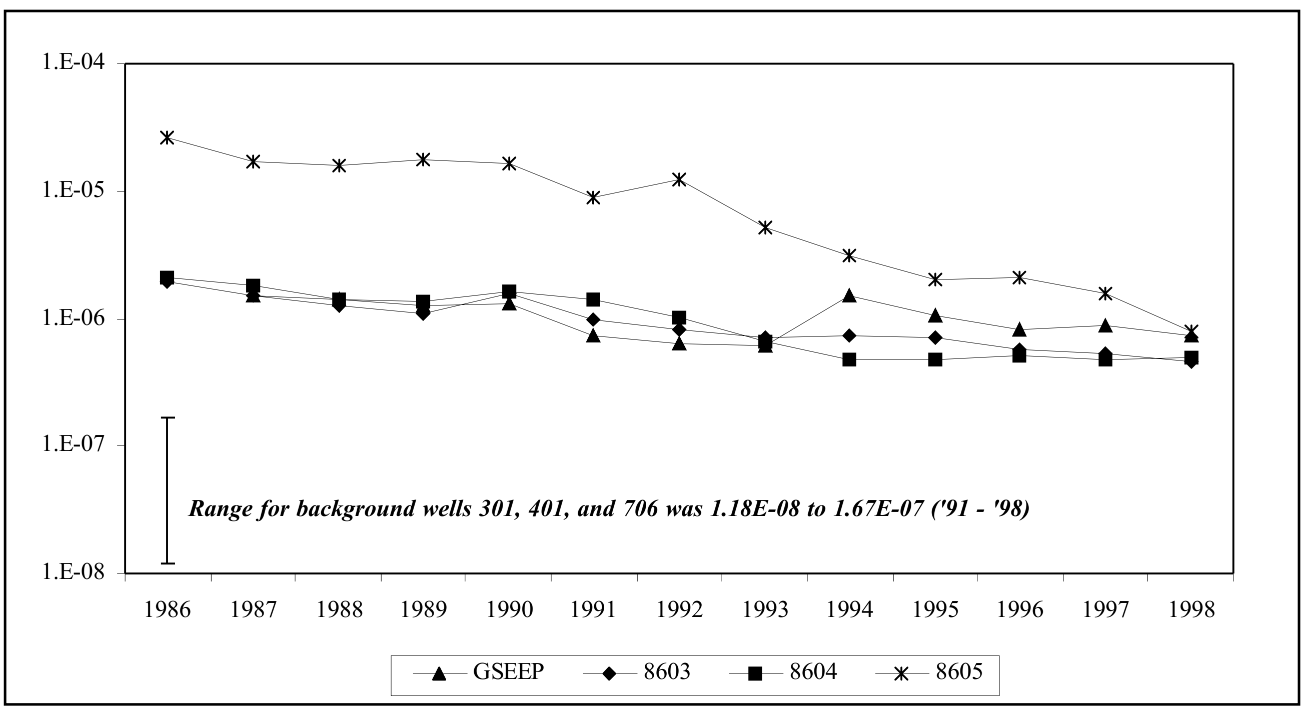


***Figure 3-8. Thirteen-Year Trends of Averaged Tritium Activity (µCi/mL) at Selected Locations in the Sand and Gravel Unit***

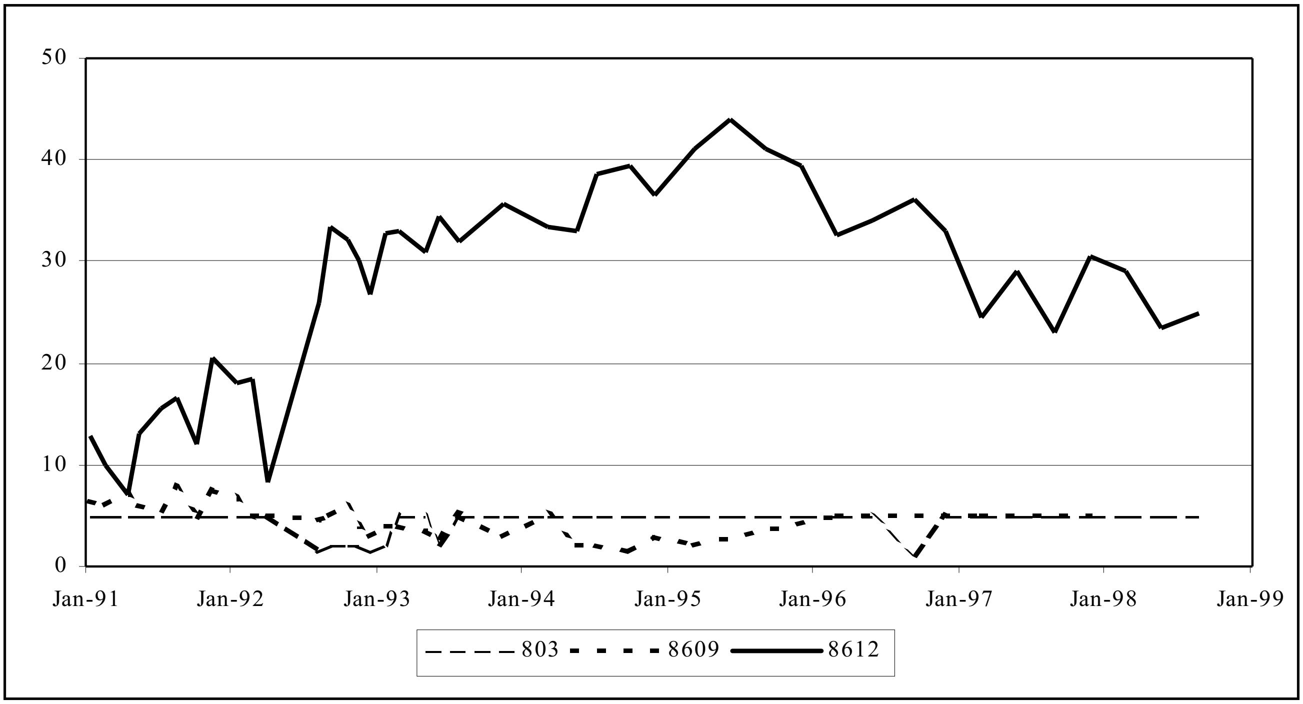


***Figure 3-9. Eight-Year Trends (1991 through 1998) of 1,1-DCA (µg/L) at Selected Monitoring Locations***

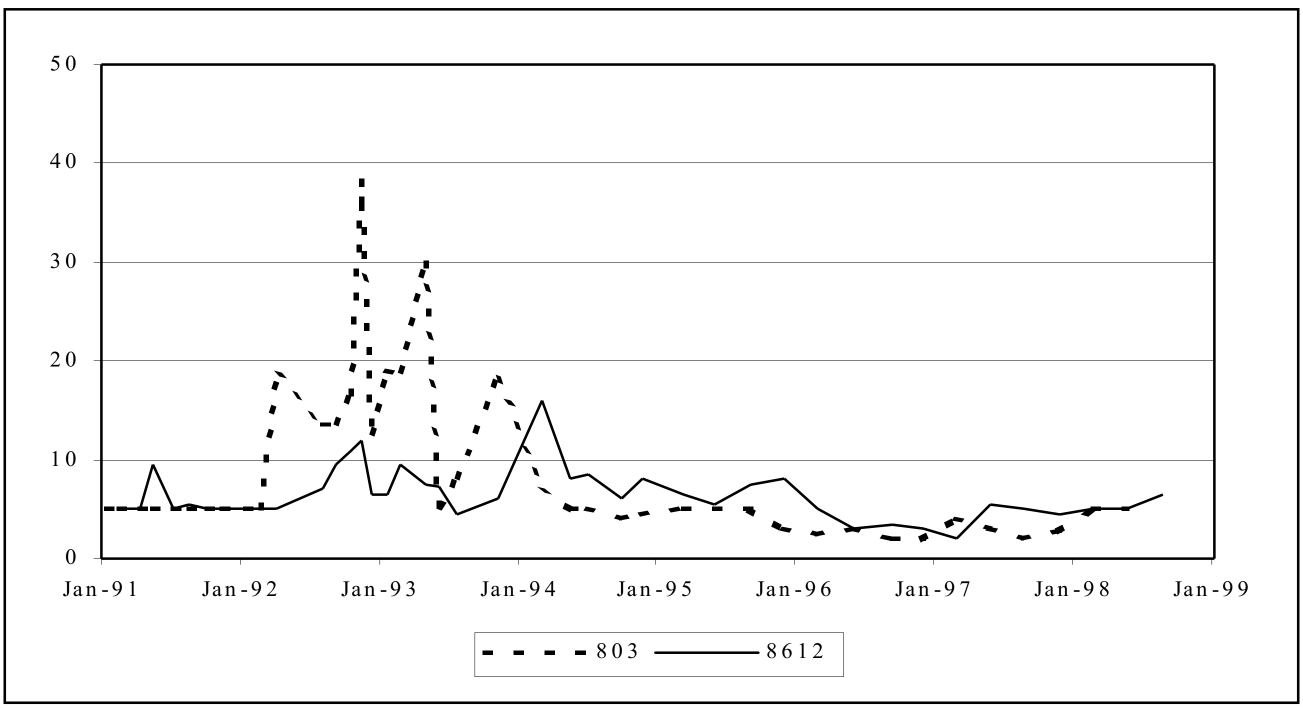


***Figure 3-10. Eight-Year Trends (1991 through 1998) of Dichlorodifluoromethane (DCDFMeth) (µg/L) at Selected Groundwater Locations***

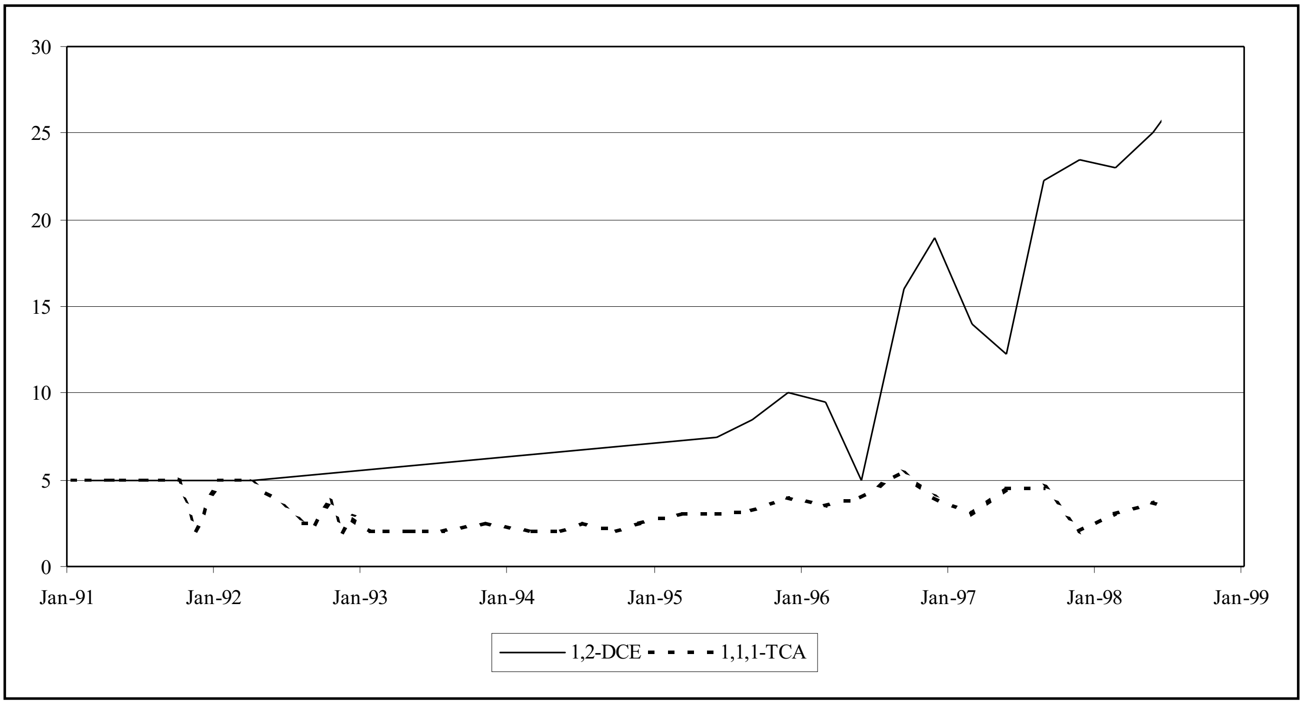


***Figure 3-11. Eight-Year Trends (1991 through 1998) of 1,2-DCE and 1,1,1-TCA (µg/L) at Well 8612***