
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. The monitoring program also meets requirements of Department of Energy (DOE) Order 5400.1 to obtain data for determining baseline conditions of groundwater quality and quantity, to provide data that will allow the early detection of groundwater contamination, to identify existing and potential groundwater contamination sources and maintain surveillance of these sources, and to 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 Management Program Plan (West Valley Nuclear Services Co. May 2, 2000). The Groundwater Monitoring Plan outlines the

WVDP's plans for groundwater characterization, current groundwater sampling requirements, 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 Management Program 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. Beneath the WNYNSC site is a sequence of Holocene (recent age) and Pleistocene (ice age) sediments filling a steep-sided valley incised in the bedrock. The bedrock is composed of shales and interbedded siltstones of the upper Devonian Canadaway and Conneaut Groups that dip southward at about 5 m/km (Rickard 1975).

The 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 Lavery till is capped by coarse-grained alluvial-fluvial deposits.

Repeated glaciations of the ancestral bedrock 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).

A summary of the site hydrology is below. Hydrologic conditions of the site are more fully described in Environmental Information Document Volume III, Part 4 (West Valley Nuclear Services Co., Inc. March 1996) and in the RCRA Facility Investigation Report: Introduction and General Site Overview (West Valley Nuclear Services Co., Inc. July 1997).

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; 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

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 sediments. Because 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, 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. (Figs. 3-1 and 3-2 [facing page] 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.

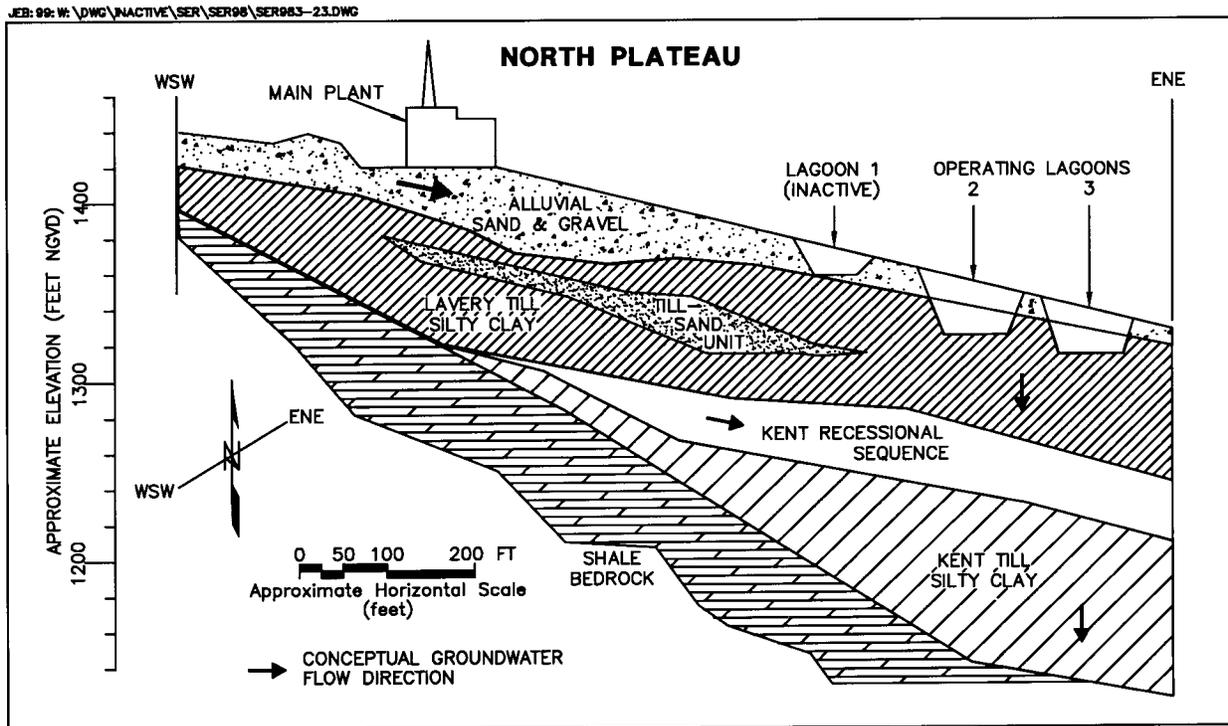


Figure 3-1. Geologic Cross Section through the North Plateau

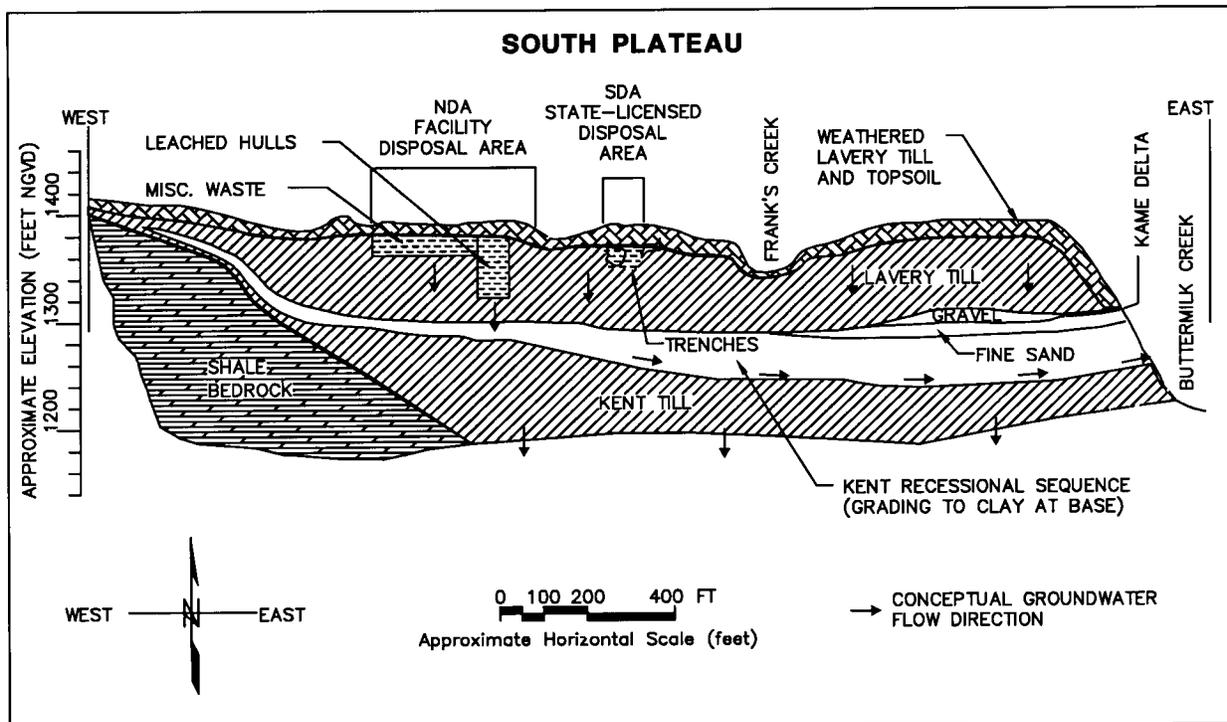


Figure 3-2. Geologic Cross Section through the South Plateau

Groundwater flow in the Kent recessional sequence is predominantly to the northeast, toward Buttermilk Creek. Hydraulic conductivity testing completed during the last several years indicates a mean value of $1\text{E-}06$ cm/sec ($1\text{E-}03$ ft/day) or 0.01 in/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. It 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 north-eastward towards Buttermilk Creek and the center of the bedrock valley.

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. Hydraulic conductivity testing in the Lavery till during the last several years indicates a mean value of $1\text{E-}07$ cm/sec ($1\text{E-}04$ ft/day) or 0.001 in/day.

On the south plateau the upper zone 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 ft 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. Hydraulic conductivity testing in the weathered Lavery till

completed during the last several years indicates a mean value of $1\text{E-}05$ cm/sec ($1\text{E-}02$ ft/day) or 0.1 in/day. The highest conductivities are associated with the dense fracture zones found within the upper 2 meters (7 ft) of the unit.

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.

Sand and Gravel and Till-sand Units. 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 north-eastward across the 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 is $1\text{E-}04$ cm/sec ($1\text{E-}01$ ft/day) or 1.2 in/day, based on testing completed during the last several years.

Within the unweathered Lavery till on the north plateau is another unit, the Lavery till-sand. On-site investigations from 1989 through 1990 identified this thin 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. The mean hydraulic conductivity of 1E-04 cm/sec (1E-01 ft/day) or 1.2 in/day for this unit is based on testing completed during the last several years.

Routine Groundwater Monitoring Program

The purpose of groundwater monitoring at the WVDP 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 through E-6]) 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 2000. Note that monitoring of certain wells, marked by an asterisk, is required by the RCRA §3008(h) Administrative Order on Consent for the WVDP.

Figures A-7 and A-8 (pp.A-9 and A-10) show the boundaries of ten of the SSWMUs at the WVDP. (Twenty-one additional wells in an eleventh SSWMU 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. The SDA, a closed radioactive waste landfill, is contiguous with the Project premises, but 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. Groundwater monitoring results from the SDA are reported in this document in Appendix L [pp.L-3 through L-10] but are not discussed here.)

Table E-1 (pp.E-3 through E-6) identifies the hydraulic 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 its 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. Information provided in Appendix E (pp.E-7 through E-19) also follows this convention.

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

Table 3-1
2000 Groundwater Sampling and Analysis Agenda

Analyte Group	Description of Parameters¹	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 (Volatile Organic Compounds) (See Table E-14 [p. E-20].)	Table E-9 (p. E-15)
Semivolatile Organic Compounds (SV)	Appendix 33 SVOCs (Semi-volatile Organic Compounds) and tributyl phosphate (See Table E-14 [p. E-20].)	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-16 through E-17)
Special Monitoring Parameters for Early Warning Wells (SM)	Aluminum, iron, manganese	Table E-12 (p. E-17)
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-13 (pp. E-18 through E-19)
Strontium-90 (S)	Sr-90	Table E-13 (pp. E-18 through E-19)

2000 Quarterly Monitoring Schedule:
1st Qtr - December 1, 1999 to February 29, 2000
2nd Qtr - March 1, 2000 to May 31, 2000
3rd Qtr - June 1, 2000 to August 31, 2000
4th Qtr - September 1, 2000 to November 30, 2000

¹*Analysis completed for selected active monitoring locations only. See Table E-1 (pp. E-3 through E-6) for the analytes assigned to 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 collected by the WVDP.

flow directions and gradients, and long-term trend graphs, which illustrate seasonal fluctuations and other changes in the groundwater system.

Measurements are also collected at eleven surface water elevation stakes located on the north plateau where the water table in the sand and gravel unit intersects the ground surface, forming pools or puddles of standing water. Surface water elevation measurements taken at these locations were found to correlate with groundwater elevation measurements taken at monitoring wells and are used routinely to help define groundwater flow-direction and gradients in the sand and gravel unit in areas where monitoring well coverage is sparse or nonexistent.

Groundwater Monitoring Program Highlights 1982 to 2000. 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.

- Groundwater monitoring at the WVDP 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.
- In 1990 ninety-six new wells were installed for 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.

- 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. 3-16, 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.

- In 1996 several groundwater seep monitoring locations on the northeast edge of the north plateau were added to the monitoring program.

- From 1996 through 2000, in response to current sampling results and DOE and RCRA monitoring requirements, wells, analytes, and sampling frequencies were modified.

Annual Analytical Trigger Level Review. A computerized data-evaluation program using “trigger levels” for chemical and radiological analytes was instituted in 1995. These pre-set

levels — conservative values for chemical or radiological concentrations — were developed to identify and expedite a prompt focus on any anomalies in monitoring results. These values are based on regulatory limits, detection limits, or statistically derived levels. Trigger levels are reviewed and updated every year, if necessary, using all pre-existing data as well as data collected during the year. The trigger levels were updated before the start of the first-quarter 2000 groundwater monitoring.

Upper and lower trigger levels for groundwater elevation measurements were introduced in 1999. These levels are used to identify field measurement anomalies, allowing prompt investigation and remeasurement, if necessary. Groundwater-elevation trigger levels were updated before the start of the first-quarter 2000 groundwater monitoring.

Results of Routine Groundwater Monitoring

Each component of the groundwater monitoring program is completed in accordance with regulatory protocols. These components include locating and installing wells, collecting groundwater samples, incorporating quality assurance methods, and evaluating data.

The tables in Appendix E (pp.E-7 through E-19) group the results of groundwater monitoring 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 sampling for the radiological and nonradiological analyte groups noted on Table 3-1 (p.3-6). In addition, Table E-14 (pp.E-20 through E-22) lists the practical quantitation limits (PQLs) for individual NYCRR [New York



Using a Datalogger to Record Hydraulic Conductivity Data from an On-site Monitoring Well

Official Compilation of Codes, Rules, and Regulations] Title 6, Appendix 33 analytes. (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].)

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 wells or wells that are upgradient of 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 the basis for presenting the groundwater monitoring data in the tables and figures in this report.

Sample collection periods also are noted. The 2000 sampling year covers the period from December 1999 (the beginning of the first quarter of 2000) through September 2000 (the beginning of the fourth quarter of 2000).

High-low graphs. Graphs showing the range of values for 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-23 through E-31].) These high-low graphs allow results for all wells within a given hydrogeologic unit to be compared to each other. All of 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 contamination indicator nonradiological results (pH and conductivity), the upper and lower tick marks on the vertical bar indicate the highest and lowest measurements recorded during 2000 for a particular well. The middle tick represents the arithmetic mean of all 2000 results for that well. The vertical bar indicates the total range of the data set for each monitoring location during the year.

On the high-low graphs depicting radiological indicator results (gross alpha, gross beta, and tritium), the middle tick is again used to repre-

sent the arithmetic mean of all 2000 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 2000 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.1-5] in Chapter 1, Environmental Program Information.) On magnified-scale graphs, markers for some locations can not be shown because the magnitude of the concentration is larger than the upper range of the graph.

The analytical 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 background.

The wells used to provide background values are noted on each graph. All of the geologic units except the sand and gravel unit use a single well for background. 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 NB1S to use for comparison with other sand and gravel wells as a way of better representing the natural spatial variability within this geologic unit. Both the DOE and NYSDEC have accepted the use of this collective background reference instead of well NB1S.

Trend-line graphs. Trend-line graphs have been used to show concentrations of a particular parameter over time at monitoring locations that have historically shown radiological concentra-

tions 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, 105, 111, 408, 501, 502, 801, 8603, 8604, and 8605) and for the VOCs 1,1-dichloroethane (1,1-DCA) at wells 803, 8609, and 8612; dichlorodifluoromethane (DCDFMeth) at wells 803 and 8612; 1,2-dichloroethylene (1,2-DCE-t) and 1,1,1-trichloroethane (1,1,1-TCA) at well 8612; and tributyl phosphate (TBP) at wells 111 and 8605. (See Volatile and Semivolatile Organic Compounds Sampling [p.3-15].)

Long-term Trends of Gross Beta and Tritium at Selected Groundwater Monitoring Locations. Figures 3-5 through 3-10 (pp.3-19 through 3-21) show the trends of gross beta and tritium concentrations 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 concentrations, with some also showing elevated levels of tritium concentrations. Results are presented on a logarithmic scale to allow locations of widely differing concentrations to 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. In 2000 ten wells (104, 105, 111, 408, 501, 502, 801, 8603, 8604, and 8605) showed elevated levels of gross beta concentrations, i.e., concentrations that exceeded the DOE derived concentration guide (DCG) for strontium-90, $1.0E-06 \mu\text{Ci/mL}$.

- Figures 3-5 and 3-6 (p.3-19) show gross beta concentrations in wells 104, 105, 111, 408, 501, 502, and 801 over the last ten years. As in previous years, samples from well 408 continued to show the highest gross beta concentrations of all the wells within the north plateau gross beta plume area: Gross beta results for well 408 were approximately the same in 2000 as in 1999.

Gross beta at well 111 was about the same in 2000 as in 1999. Wells 501, 502, and 801 showed slight increases relative to 1999, and wells 104 and 105 showed somewhat greater increases relative to 1999 values.

- Figure 3-7 (p.3-20) is a graph of gross beta concentrations at sand and gravel unit monitoring locations 8603, 8604, and 8605. After several years of increases in gross beta concentrations in well 8604, the trend showed slight decreases during 1997 and 1998 and leveled off during 1999 and 2000. Results from well 8603 showed a steady upward trend until early 2000, apparently due to migration of strontium-90 within the eastern lobe of the north plateau plume. Moderate decreases were reported later during 2000.

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 while concentrations at 111 continued to fluctuate within historical levels.

Tritium. Tritium in sand and gravel wells also is routinely monitored under the groundwater monitoring program.

- Figure 3-8 (p.3-20) shows the tritium concentrations in wells 111, 408, 501, and 502

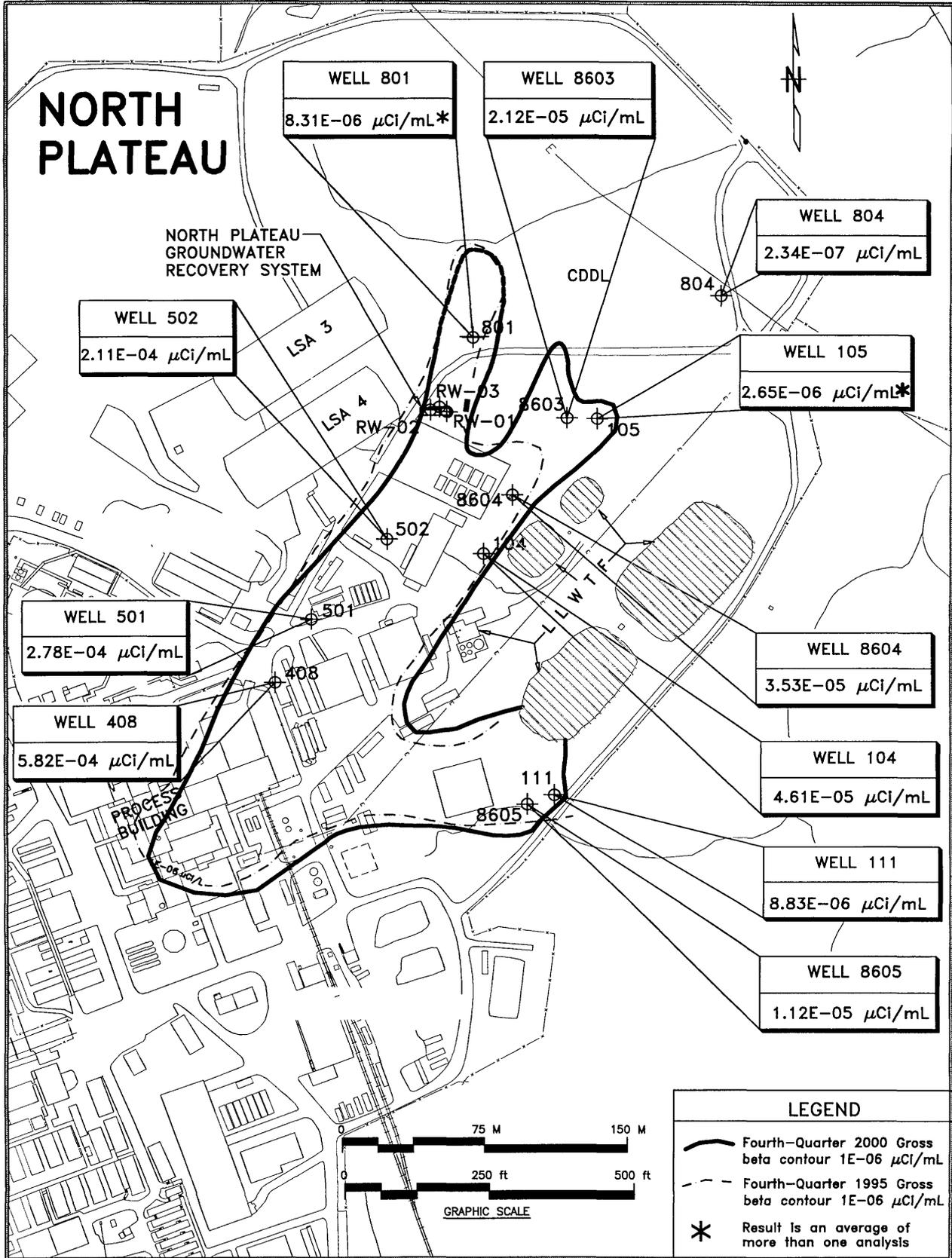


Figure 3-3. North Plateau Gross Beta Plume Area: Fourth-Quarter 2000 Results.

over the ten-year period that the WVDP's current groundwater monitoring program has been in place. The figure indicates that tritium concentrations in these wells show slight decreases or relatively steady concentration trends.

- Figure 3-9 (p. 3-21) shows tritium concentrations in wells 104, 105 and 801 over the past ten years. Well 801 shows a general decrease over the entire monitoring period; wells 104 and 105 show a slight decrease over the past three years.

- Figure 3-10 (p. 3-21) shows fifteen-year trends of tritium concentrations at monitoring locations 8603, 8604, and 8605. Wells 8603 and 8604 indicate gradually declining trends in tritium; 8605 shows a significant decrease over time.

North Plateau Seeps. Analytical results of sampling for radiological parameters from the sand and gravel unit seepage monitoring locations were compared with the results from GSEEP, a seep monitored since 1991 that has not been affected by the gross beta plume. (Seep monitoring locations are noted on Fig. A-7 [p. A-9].)

Gross beta. Radiological monitoring results continue to indicate that the gross beta plume has not migrated to these seepage areas. With the exception of SP11, gross beta concentrations from all seep monitoring locations were less than or similar to GSEEP concentrations during 2000. The gross beta concentration at SP11 shows a slightly increasing trend since early 1999; although somewhat greater than values typically obtained at GSEEP, it is still well below the gross beta DCG. (See Table E-7 [p. E-14].)

Gross alpha. Gross alpha concentrations at all of the seep sampling locations were very low — generally below the associated uncertainty or less than the detection limit.

Tritium. Tritium concentrations at the seeps remained similar in magnitude or were less than concentrations at GSEEP. Tritium concentrations in the north plateau seeps, including GSEEP, are slightly above the levels reported in background wells of the sand and gravel unit. The concentrations are similar to those seen in sand and gravel unit wells monitoring the lagoon areas of the north plateau but are still far below the DCG for tritium.

Historical sampling results at the seep monitoring locations were evaluated to determine the most efficient and effective monitoring program with respect to locations, analytical parameters, and frequency. Six of the eight active seeps showed either gross beta concentrations similar to or less than GSEEP or were consistently dry. It was recommended that monitoring at four of the seeps (SP02, SP05, SP18, and SP23) be discontinued and that monitoring at all other active seeps be continued according to the current protocol (West Valley Nuclear Services Co. and Dames & Moore March 1999). These recommendations were reviewed and approved by the DOE and NYSDEC and were instituted with the first-quarter 2000 sampling round.

The north plateau seep monitoring locations are inspected periodically and repaired as necessary to maintain optimum seepage flow. This ensures the quality, quantity, and representativeness of the groundwater samples. Minor repairs were required during 1999 at seep monitoring locations SP04 and SP11, including some repositioning of the sampling pipes and clearing of root growth within the pipes. The conditions at all seep monitoring locations are checked during routine sampling and during the annual inspection.

North Plateau Well Points. Seven well points were installed in 1990 downgradient of the process building and were sampled annually be-

tween 1993 and 1996 for radiological indicator parameters. This area east of the process building and west of inactive lagoon 1 appears to be an area of localized contamination and is routinely monitored for contamination indicator and radiological indicator parameters. Data from these seven well points were used to supplement data collected from groundwater monitoring wells. Four well points were removed from the sampling program in 1997 because sufficient coverage was provided by active monitoring wells.

Sampling at well points A, C, and H (Fig. A-6 [p.A-8]) monitors tritium concentrations in the area east of the process building and west of inactive lagoon 1. Samples from these three locations have yielded concentrations of tritium that, while elevated with respect to historical monitoring of wells in the area, are well below the DCG of $2.0E-03 \mu\text{Ci/mL}$. (See Table E-8 [p.E-15].) Data from downgradient monitoring wells have not indicated similarly elevated levels of tritium.

Results of Radioisotopic Sampling. Groundwater samples for radioisotopic analyses are collected regularly from selected monitoring points in the sand and gravel unit and the weathered Lavery till. (See Table E-13 [pp.E-18 through E-19].) Results in 2000 were generally similar to historical findings. Strontium-90 remained the major contributor to elevated gross beta activity in the plume on the north plateau, as indicated by the similarity between strontium-90 trends and gross beta trends in wells showing elevated gross beta results.

Technetium-99, iodine-129, and carbon-14, which have been detected 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 NRC-licensed Disposal Area [NDA]), contribute very small percentages to total gross beta concentrations. None of the concentrations of technetium-99, iodine-129, or carbon-14 have been above DCGs, and gross beta analyses continue to provide surveillance on a quarterly basis.

Results of Monitoring at the NDA. 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). (See also Chapter 1, Environmental Program Information, NRC-licensed Disposal Area [NDA] Interceptor Trench and Pretreatment System [p.1-11].) There were no monitoring results in 2000 that indicated the presence of TBP or n-dodecane in groundwater in the vicinity of the NDA. Groundwater levels are monitored quarterly in and around the trench to ensure that an inward gradient is maintained, thereby minimizing the likelihood for outward migration of potentially contaminated groundwater.

Gross beta and tritium concentrations in samples from location NDATR, a sump at the bottom of the interceptor trench, and from well 909 (Fig.A-6 [p.A-8]), which is downgradient of NDATR, were elevated with respect to background monitoring locations on the south plateau but were still well below the DCGs.

NDATR. During 2000 gross beta concentrations at NDATR remained similar to those seen during 1999, but tritium, while still higher than at other NDA monitoring locations, declined and then leveled off during 1999 and 2000.

Well 909. Radiological indicator results have historically fluctuated at this location but, in general, upward long-term trends in both gross beta and tritium are discernible at well 909,

although the trends show a decrease and then a leveling off during 2000. Gross beta concentrations from well 909 are considerably higher than at NDATR. Residual soil contamination near well 909 is the suspected source of elevated gross beta concentrations at well 909.

Volatile and Semivolatile Organic Compounds Sampling

Volatile and semivolatile organic compounds were sampled at specific locations (wells 8612, 8609, 803, and seep sampling location SP12 [Fig.A-6, p.A-8]) that have shown historical results above their respective practical quantitation limits (PQLs). (See Table E-14 [pp.E-20 through E-22] for a list of PQLs.) Other monitoring locations are sampled for volatile and/or semivolatile organic compounds because they are downgradient of locations that have shown positive results or to comply with the RCRA §3008(h) Administrative Order on Consent.

1,1-dichloroethane. Trends in concentrations of the compound 1,1-dichloroethane (1,1-DCA) from 1991 through 2000 are illustrated in Figure 3-11 (p.3-22). Concentrations of 1,1-DCA at well 8612 have decreased somewhat over the past five years. The compound was not detected at wells 8609, 803, or groundwater seep SP12 during 2000. (See Table E-9 [p. E-15].)

Dichlorodifluoromethane. Trends of dichlorodifluoromethane (DCDFMeth) concentrations are shown in Figure 3-12 (p.3-22). DCDFMeth was not detected at wells 803 or 8612 during 2000.

1,2-dichloroethylene. Positive detections of 1,2-dichloroethylene (1,2-DCE-t) were first noticed at well 8612 (Fig. 3-13 [p.3-23]) in 1995.

Concentrations of 1,2-DCE-t during 2000 were similar to those of 1999 and somewhat lower than concentrations measured during 1998.

1,1,1-trichloroethane. The compound 1,1,1-trichloroethane (1,1,1-TCA) was not detected above the PQL of 5 µg/L in 8612 (Fig. 3-13 [p. 3-23]) or wells 803, 8609, and seep SP12 (Table E-9 [p. E-15]).

The VOCs 1,1-DCA, DCDFMeth, and 1,1,1-TCA are often found in combination with each other and with 1,2-DCE-t. 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-t will exhibit similar behavior, and routine monitoring will evaluate future trends.

Tributyl phosphate. Aqueous concentrations of tributyl phosphate (TBP) were detected in 2000 at well 8605, near former lagoon 1, at concentrations similar to or less than those in 1999. During 1999 TBP also was detected in well 111, which is next to and downgradient of well 8605, but at levels much lower than those at well 8605. (See Fig. 3-14 [p. 3-23] and Table E-10 [p.E-16].) TBP was not detected above the PQL in well 111 during 2000.

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 these three contaminants reflects residual contamination from waste disposal activities in the former lagoon 1 area during earlier 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 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 a Geoprobe®, a mobile sampling system. The investigation was used to estimate the extent of the gross beta plume beneath and downgradient of the process building. The gross beta plume delineated in 1994 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 concentration in groundwater was $3.6E-03$ $\mu\text{Ci/mL}$, and the maximum concentration in soil reached $2.4E-02$ $\mu\text{Ci/g}$. 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 is located near the leading edge of the main lobe of the plume where groundwater flows preferentially towards the edge of the plateau. The NPGRS consists of three extraction wells (RW-01, RW-02, and RW-03) that recover the contaminated groundwater and then treat it by ion exchange to remove strontium-90. Treated water is transferred to lagoon 4 or

5 and then to lagoon 3 and ultimately is discharged to Erdman Brook.

The north plateau groundwater recovery system operated successfully throughout 2000, processing about 16 million liters (4.2 million gal). The system has recovered and processed approximately 83 million liters (22.0 million gal) since November 1995.

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. A summary report, 1998 Geoprobe® Investigation in the Core Area of the North Plateau Groundwater Plume (West Valley Nuclear Services Co., Inc. June 1999) discusses groundwater and soil sampling data in the core area and compares radiological sampling results with a 1994 sampling. The 1998 study verified that strontium-90 continues to be the predominant beta-emitter in groundwater and saturated soil within the north plateau groundwater plume. The report also noted that while the overall distribution of strontium-90 in groundwater within the plume was similar to 1994, concentrations detected in 1998 Geoprobe® samples were generally lower than in the 1994 Geoprobe® samples due to radioactive decay and continuing migration and dispersion of the plume.

Permeable Treatment Wall. A pilot-scale permeable treatment wall (PTW) was completed in the fall of 1999 in the eastern lobe of the north plateau strontium-90 groundwater plume in order to test this passive, in situ remediation technology. The PTW is a trench constructed in the subsurface and backfilled with clinoptilolite, a medium selected for its ability to adsorb strontium-90 ions from groundwater. The PTW extends vertically downward through the sand and gravel unit to the top of the underlying Lavery

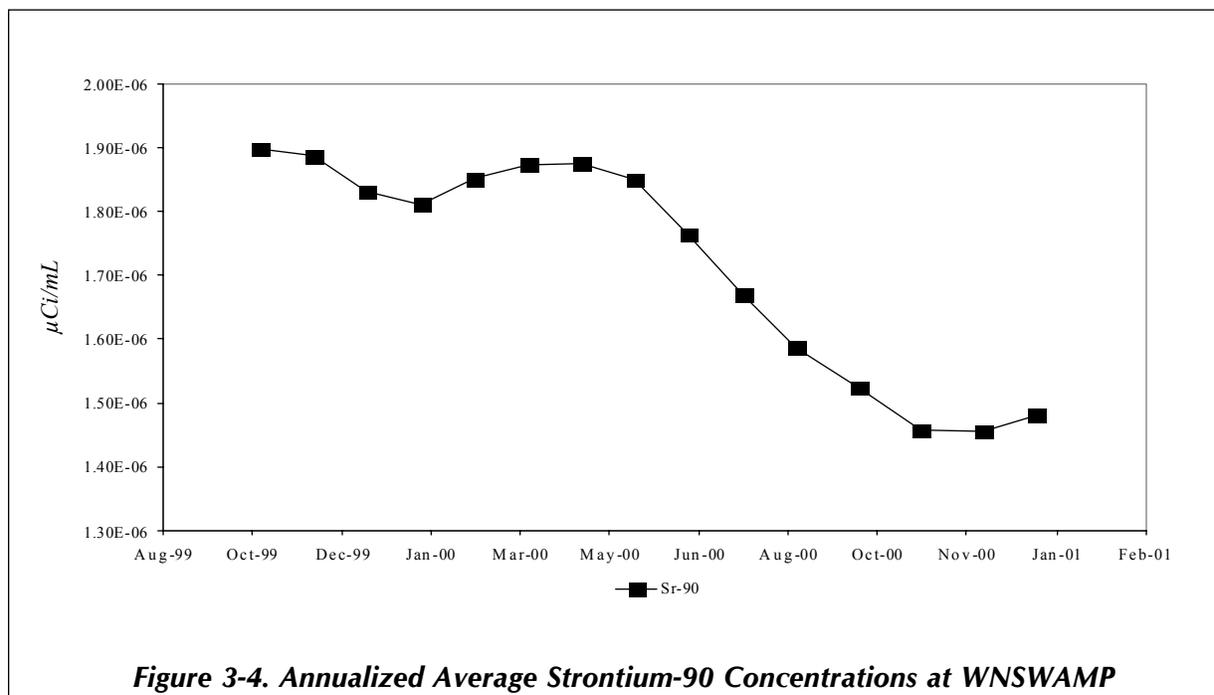


Figure 3-4. Annualized Average Strontium-90 Concentrations at WNSWAMP

till and is approximately 30 feet long and 10 feet wide.

Monitoring and evaluation of water levels and radiological concentrations upgradient, within, and downgradient of the PTW continued during 2000 in order to assess its effectiveness. During a short-term study groundwater was pumped out of the PTW in order to evaluate hydraulic response in the immediate vicinity of the wall. During 2001 additional evaluation of PTW effectiveness will continue. This evaluation is expected to provide data relevant to development of a full-scale treatment wall.

Northeast Swamp Drainage Monitoring. Routine surface water sampling during 2000 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 were generally consistent through mid-2000 and then steadily decreased until leveling off late in the year. (See Fig. 3-4 [above].)

Although the annualized averaged concentration of strontium-90 in surface water was elevated at sampling location WNSWAMP (on the WVDP premises), monitoring downstream at the first point of public access (WFFELBR) continued to show strontium-90 concentrations that were not significantly different from background (WFBIGBR) concentrations. (See also Off-site Surface Water Sampling Locations, p.2-9, in Chapter 2, Environmental Monitoring.)

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 (Dames & Moore May 1995). 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, 602A, 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. Routine results for two of the wells, 116 and 602A, are used to monitor groundwater in the area affected by NPGRS drawdown. The third well, 502, is directly up-gradient of the NPGRS and is sampled for additional metals not routinely analyzed under the current groundwater monitoring program. Analytical results of sampling of well 502 for additional metals can be found in Table E-12 (pp.E-17 in Appendix E).

Investigation of Chromium and Nickel in the Sand and Gravel Unit and Evaluation of Corrosion in Groundwater Monitoring Wells. A 1997 and 1998 study of the effect of modifying sampling equipment and methodology on the concentrations of chromium and nickel in samples of groundwater from the sand and gravel unit noted that such modifications did produce decreases in chromium and nickel concentrations. This supported the hypothesis (which is well documented in the technical literature) that the apparently elevated concentrations were not representative of actual groundwater conditions but were caused by the release of metals from subsurface corrosion of stainless steel well materials (West Valley Nuclear Services, Inc. and Dames & Moore June 1998b).

To ensure continued monitoring well integrity and the collection of high-quality samples representative of actual groundwater conditions,

in 1999 and 2000 the WVDP evaluated current corrosion and corrosion-removal methods by inspecting the inside of the wells with a down-hole video camera, documenting the observed conditions, and attempting to remove corrosion, where present. A second video inspection was made after cleaning to evaluate the effectiveness of the work. Simple brushing and well-purging proved to be successful in removing corrosion from all wells. No degradation of the well casings or screens was evident after corrosion was removed.

Long-term corrosion management will begin during 2001 and will include annual video inspections and corrosion removal, where appropriate (West Valley Nuclear Services Co. January 2001).

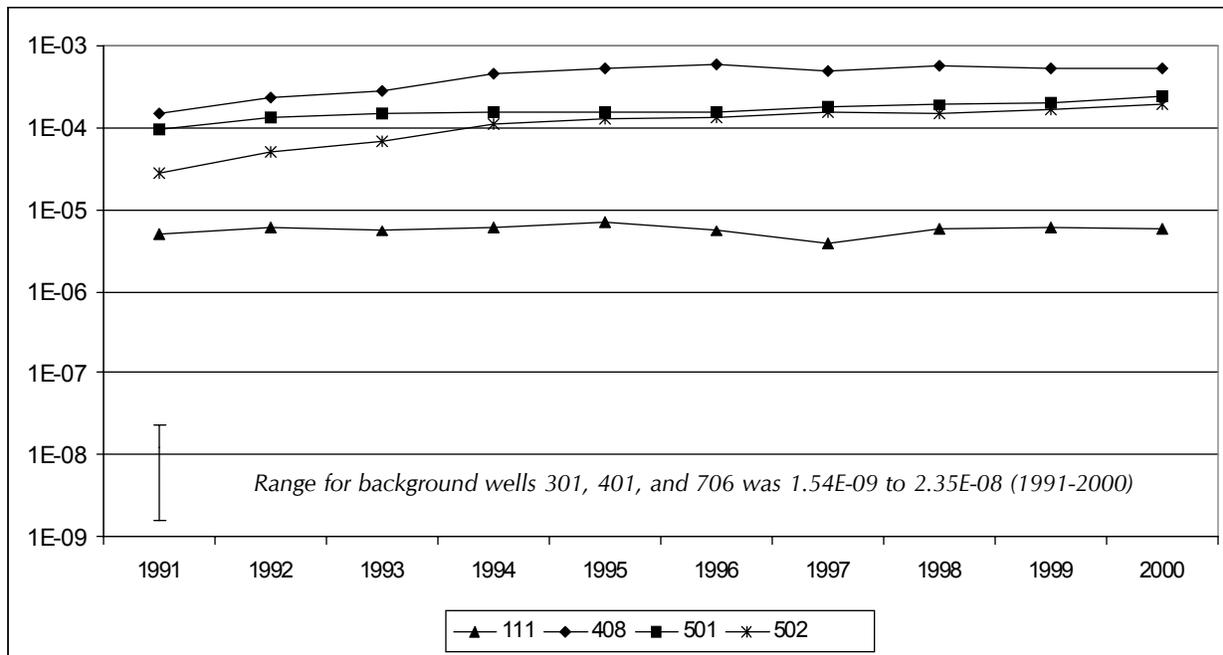


Figure 3-5. Ten-year Trends of Averaged Gross Beta Concentrations ($\mu\text{Ci/mL}$) at Selected Locations in the Sand and Gravel Unit

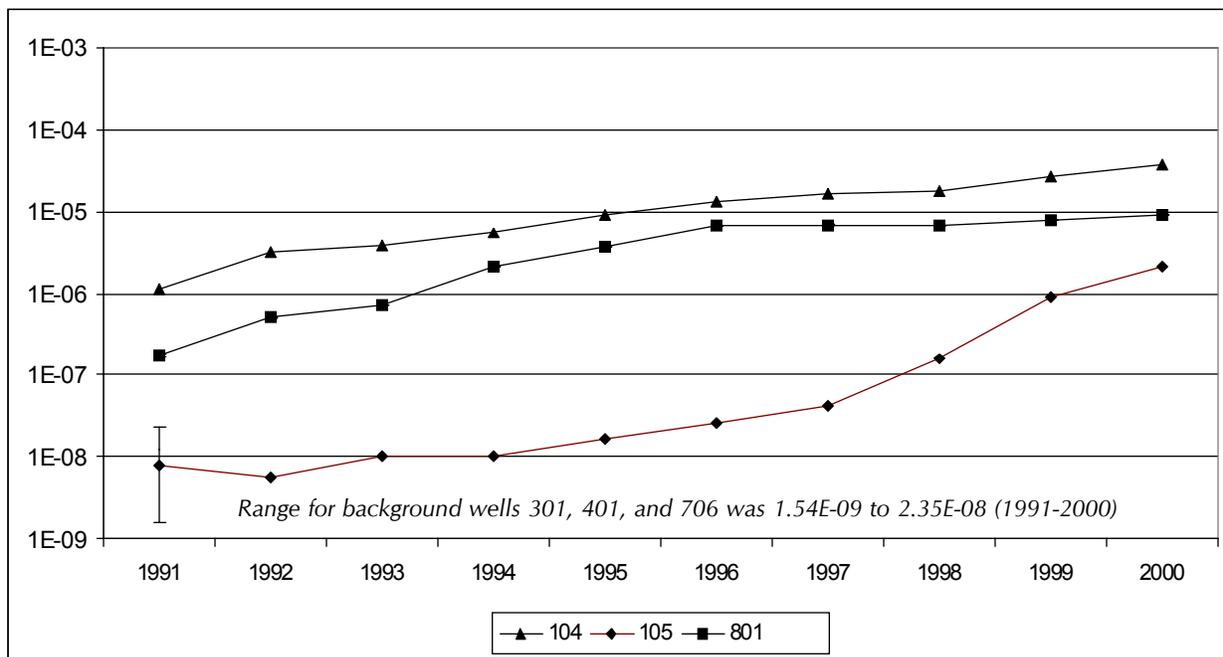


Figure 3-6. Ten-year Trends of Averaged Gross Beta Concentrations ($\mu\text{Ci/mL}$) at Selected Locations in the Sand and Gravel Unit

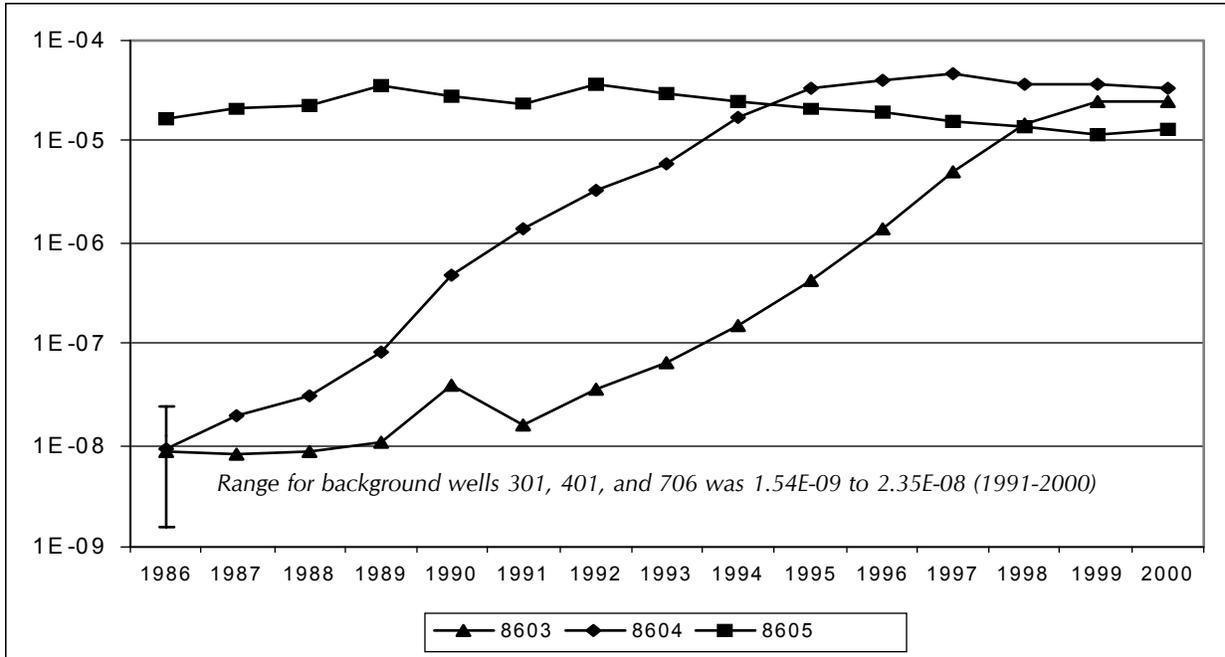


Figure 3-7. Fifteen-year Trends of Averaged Gross Beta Concentrations (µCi/mL) at Selected Locations in the Sand and Gravel Unit

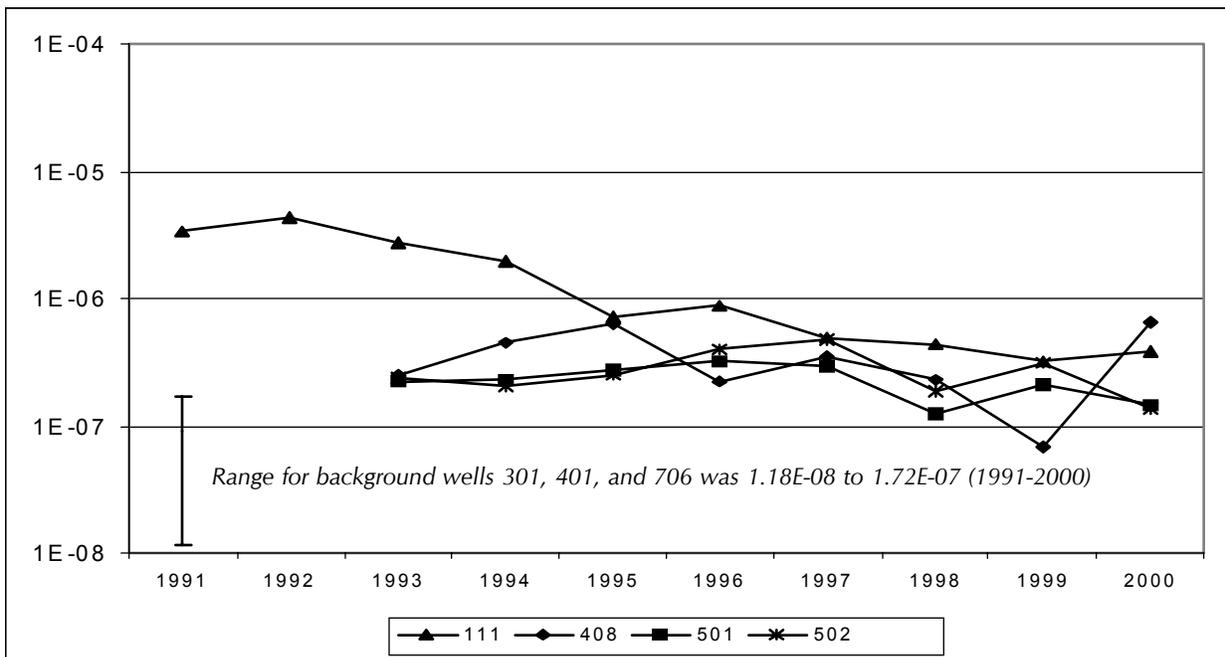


Figure 3-8. Ten-year Trends of Averaged Tritium Concentrations (µCi/mL) at Selected Locations in the Sand and Gravel Unit

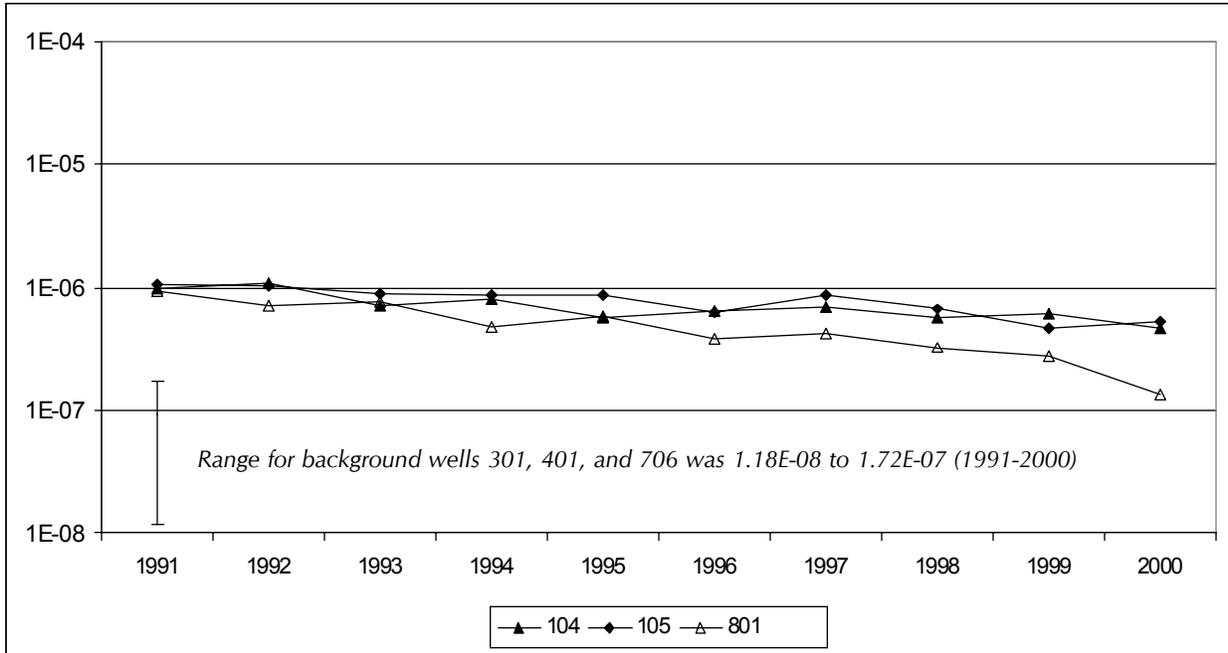


Figure 3-9. Ten-year Trends of Averaged Tritium Concentrations ($\mu\text{Ci/mL}$) at Selected Locations in the Sand and Gravel Unit

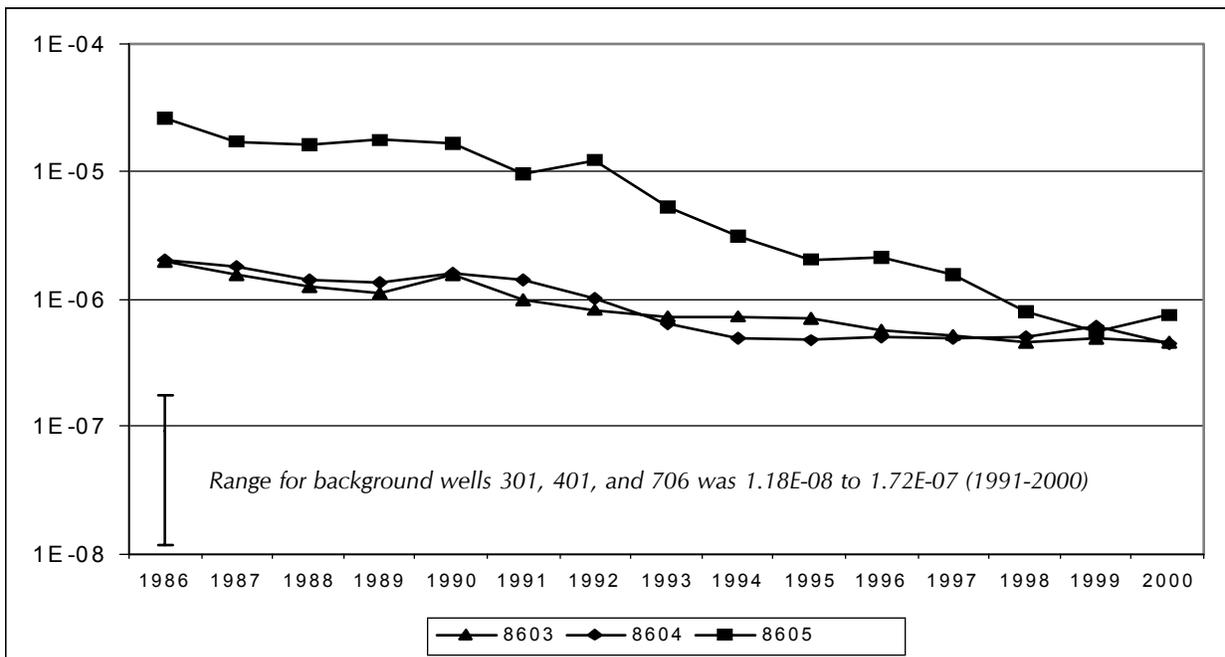


Figure 3-10. Fifteen-year Trends of Averaged Tritium Concentrations ($\mu\text{Ci/mL}$) at Selected Locations in the Sand and Gravel Unit

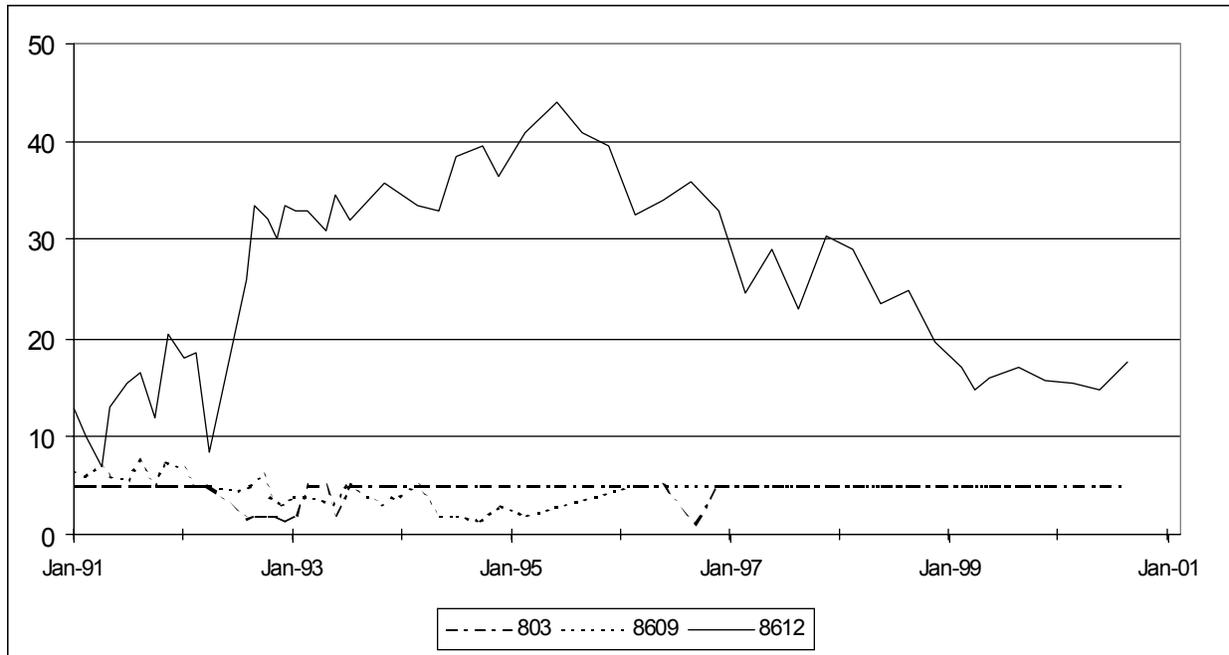


Figure 3-11. Ten-year Trends of 1,1-DCA (µg/L) at Selected Locations in the Sand and Gravel Unit

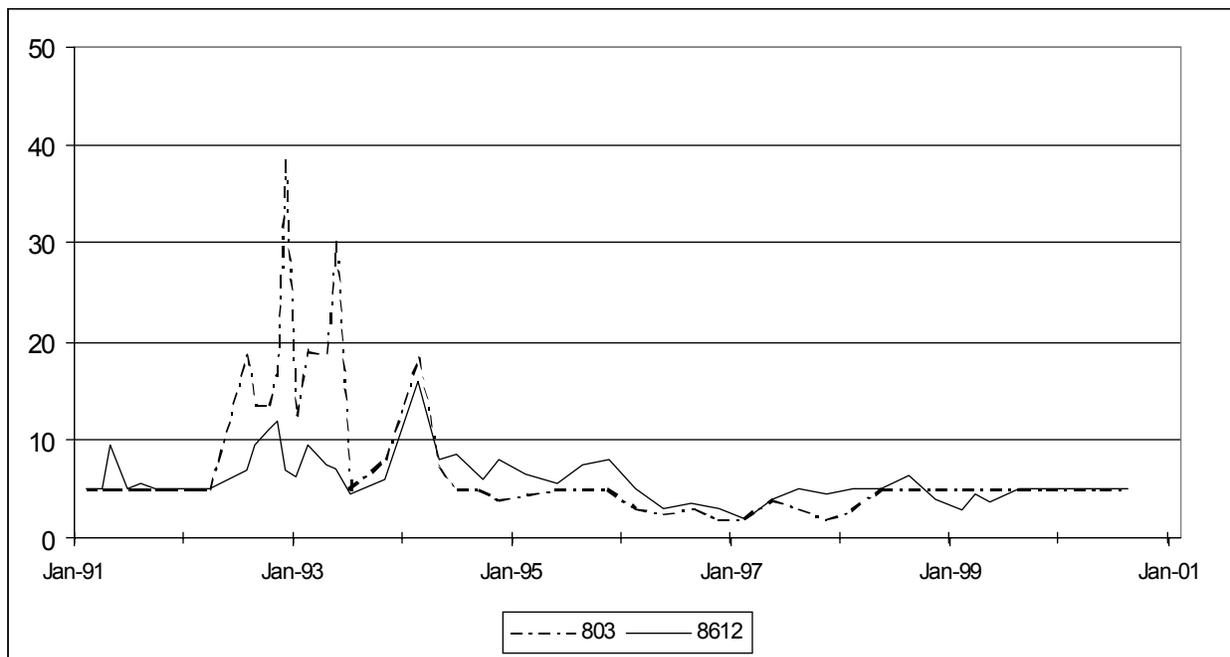


Figure 3-12. Ten-year Trends of Dichlorodifluoromethane (µg/L) at Selected Locations in the Sand and Gravel Unit

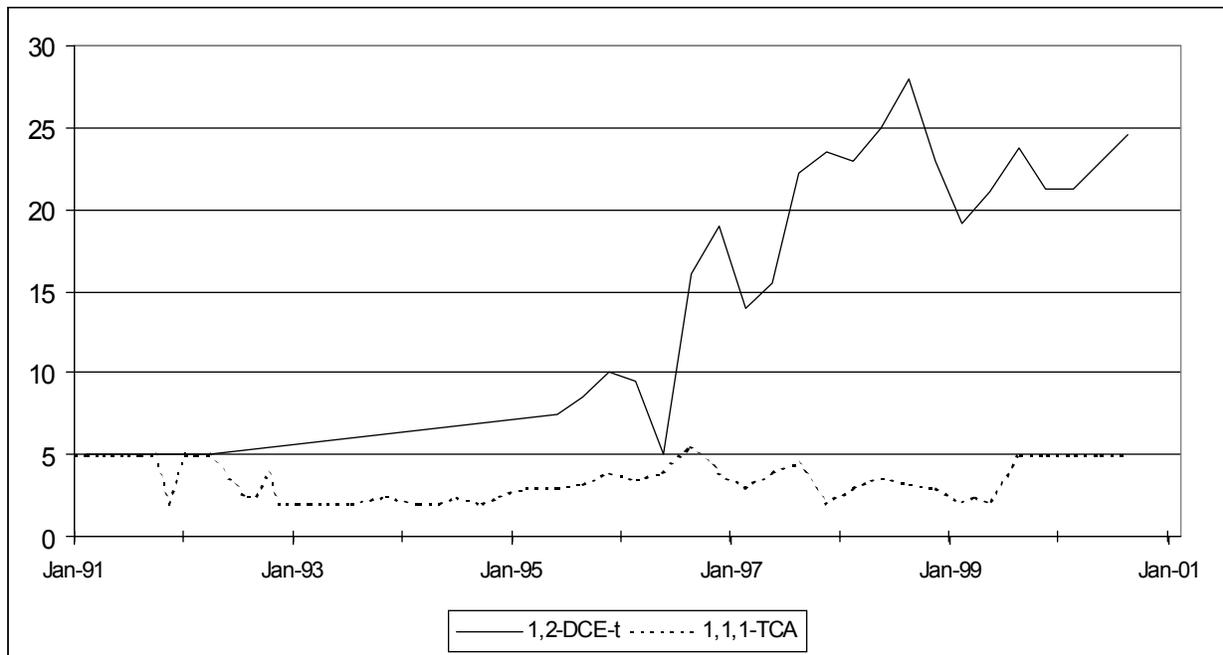


Figure 3-13. Ten-year Trends of 1,2-DCE-t and 1,1,1-TCA (µg/L) at Well 8612 in the Sand and Gravel Unit

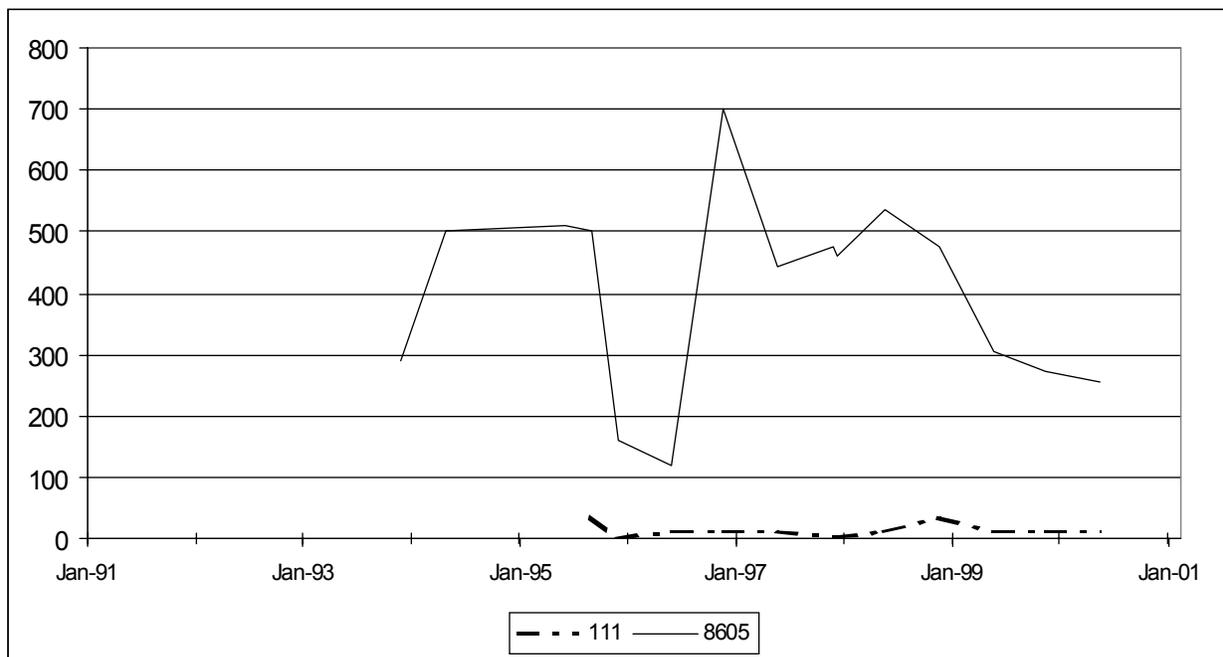


Figure 3-14. Trends of Tributyl Phosphate (µg/L) at Selected Locations in the Sand and Gravel Unit