3.0 GROUNDWATER MONITORING PROGRAM

3.1 Hydrology of the Site

The WVDP site lies within the Glaciated Allegheny Plateau section of the Appalachian Plateau Physiographic Province. The section is a maturely dissected plateau with surficial bedrock units of Devonian shales and sandstones. Bedding dips gently (4 to 7.5 m/km) and uniformly to the south. The plateau has been subjected to erosion and deposits of repeated glaciations, resulting in accumulations of till, outwash, and lacustrine deposits over the area.

The site is underlain by a thick sequence of silty clay tills and more granular deposits overlying a bedrock valley that has been carved through Devonian shales by Cattaraugus Creek and its tributaries. Figure 3-1 shows a generalized east-west cross section through the site. The uppermost till unit is the Lavery, a very compact gray silty clay. The Lavery is approximately 6 m thick at the western boundary of the WVDP and thickens to the east. At the western edge of the developed portion of the WVDP, the Lavery is approximately 30 m thick. *In situ* measurements of the hydraulic conductivity in the Lavery have generally ranged between 10^{-9} and 10^{-7} cm/s.

The upper 3 m (approximately) of the Lavery have been chemically weathered by leaching and oxidation and mechanically weathered by bioturbation. The hydraulic conductivity of the weathered till is much higher than that of the underlying unweathered parent material, probably as a result of increased fracture flow.

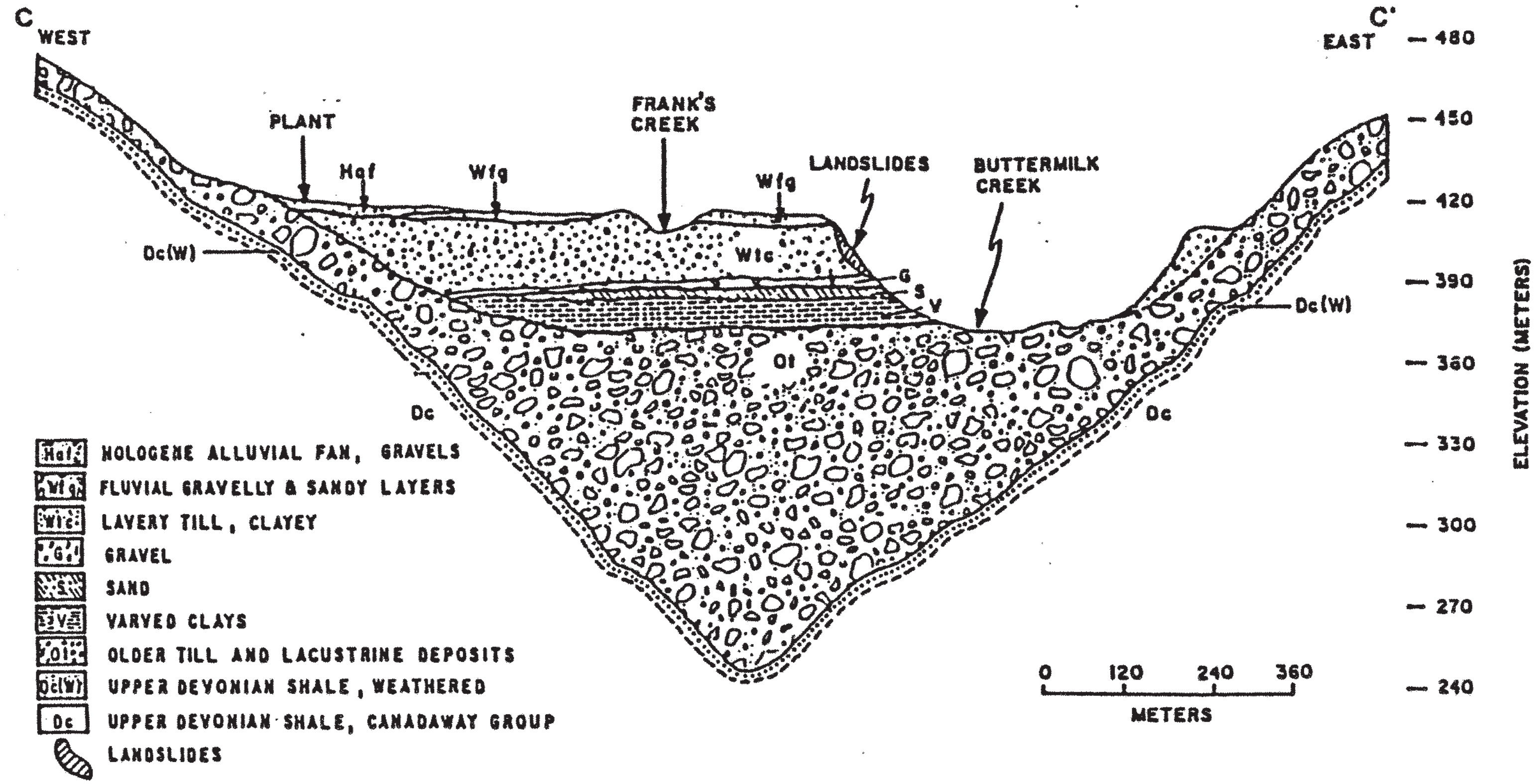
The northern portion of the WVDP site is blanketed by a layer of alluvial gravels up to 6 m thick. These gravels extend from the plant area northward.

Below the Lavery till is a more granular unit referred to locally as the Lacustrine Unit. It comprises silts, sands and, in some areas, gravels which overlie a varved clay. The Lacustrine is believed to be more permeable than the Lavery, but little permeability testing has been performed in this unit. Hydraulic conductivities on the order of 10^{-5} to 10^{-4} cm/s are assumed for this unit which are conservative in consideration of the gradation of the Lacustrine Unit materials.

Free field groundwater flow through the described geosystem occurs in two aquifers and to a considerably lesser extent in the aquiclude between them. The upper aquifer is a transient water table aquifer in the weathered till and, where it is encountered, the alluvial gravels. To a lesser extent, the highly fractured upper metre of the unweathered till is also part of this aquifer. This unit is generally unsaturated, but immediately after periods of intensive runoff, such as a spring thaw, significant quantities of groundwater are believed to flow through this unit. The primary flow occurs through the extensive system of fractures which dissects this unit.

The lower aquifer is an unconfined aquifer in the Lacustrine Unit. The piezometers embedded in this unit all exhibit phreatic heads below the top of this unit. The total recharge mechanism for the unit is not well defined because of limited data, but available data suggest that the unit is recharged from the fractured bedrock and downward seepage through the overlying Lavery till. The bedrock recharge zone to the west is recharged at outcrops in the uplands to the west of the site. Flow through this unit appears to be to the east toward Buttermilk Creek.

The aquiclude that separates these two aquifers is the Lavery. Its mass permeability is extremely low but it does permit seepage. When the weathered till is acting as a transient aquifer, a vertical gradient of unity exists in the



NOTE:
Vertical scale = 1/4 horizontal scale.
Adapted from Dana et al. (1979a).

Figure 3-1. Generalized Geologic Cross Section at the West Valley Demonstration Project.

till and causes water to move downward, but at a very low rate.

3.2 Groundwater Monitoring

The 1987 groundwater program sampled wells both on the Project site and on residential properties around its perimeter. The shallow wells in this program fall into five groups:

1. A group of dug shallow wells installed north of and immediately surrounding the main plant building which were monitored for several years before Project start-up and are therefore used for reference to examine long-term trends. These wells were not sampled in 1987.

2. The USGS series 80 wells which form an outer ring around the facility dug wells.

3. The USGS series 82 wells that are grouped around the former NRC-Licensed Disposal Area. Selected series 75 wells also fall into this category.

4. The 86 series monitoring wells which were installed by WVNS to supplement the existing groundwater monitoring network around specifically identified waste management areas.

5. Private wells around the perimeter used for drinking water by site neighbors (half of these are sampled each year).

A system of 14 wells has been designated to monitor three waste management areas. In addition, a groundwater seep and an existing monitoring station at the french drain outlet in the lagoon area are included in the monitoring program. Of the 14 wells, five were existing wells installed by the USGS as observation wells, and the remaining nine wells were installed in the summer of 1986. The locations of these wells and monitoring points are shown on Figure 3-2.

The locations of the upgradient and downgradient monitoring wells were based on known groundwater flow patterns in the given area and the presence and proximity of other potential contamination sources close to the waste management area. Wells were located so that no other possible contamination source would lie between the well (downgradient or upgradient) and the waste management area which it is to monitor.

As shown on Figure 3-2, six monitoring wells are used to assess the Low-Level Waste Lagoon System. Wells 80-5, 80-6, 86-3, and 86-4 are all downgradient wells and Well 86-6 is upgradient of the lagoon system. Two locations are existing USGS wells (80-5 and 80-6). Well 86-5 is designed to monitor the quality of groundwater flowing beneath old Lagoon 1 in the direction of Erdman Brook.

The outlet for the french drain (WNSP008) and a groundwater seep along the western bank of Frank's Creek are included in the monitoring system for this area. The outlet for the french drain is currently also a sampling point (008) under the New York State SPDES permit. This drain serves as a sink for a major portion of the surface groundwater flowing in the immediate vicinity of the lagoon system, and provides an indication of the change in the local groundwater quality over time.

The groundwater seep located on the upper western bank of Frank's Creek provides an indication of the groundwater quality in the surficial deposits, along with monitoring wells 80-5 and 80-6. It is not clear just how much groundwater flowing beneath the lagoon system escapes discharge to the french drain. However, it is believed that some of the deeper surficial groundwater, particularly on the northern sides of Lagoons 4 and 5, tends to flow eastward or northeastward toward Frank's Creek.

Four wells monitor the High-Level Waste Tank Complex. Wells 86-7, 86-8 and 86-9 are downgradient wells, while well 80-2 serves as the upgradient well. Wells 86-7 through 86-9 are located along the major flow paths passing through the tank complex as determined by Yager (1985). At the same time, they were

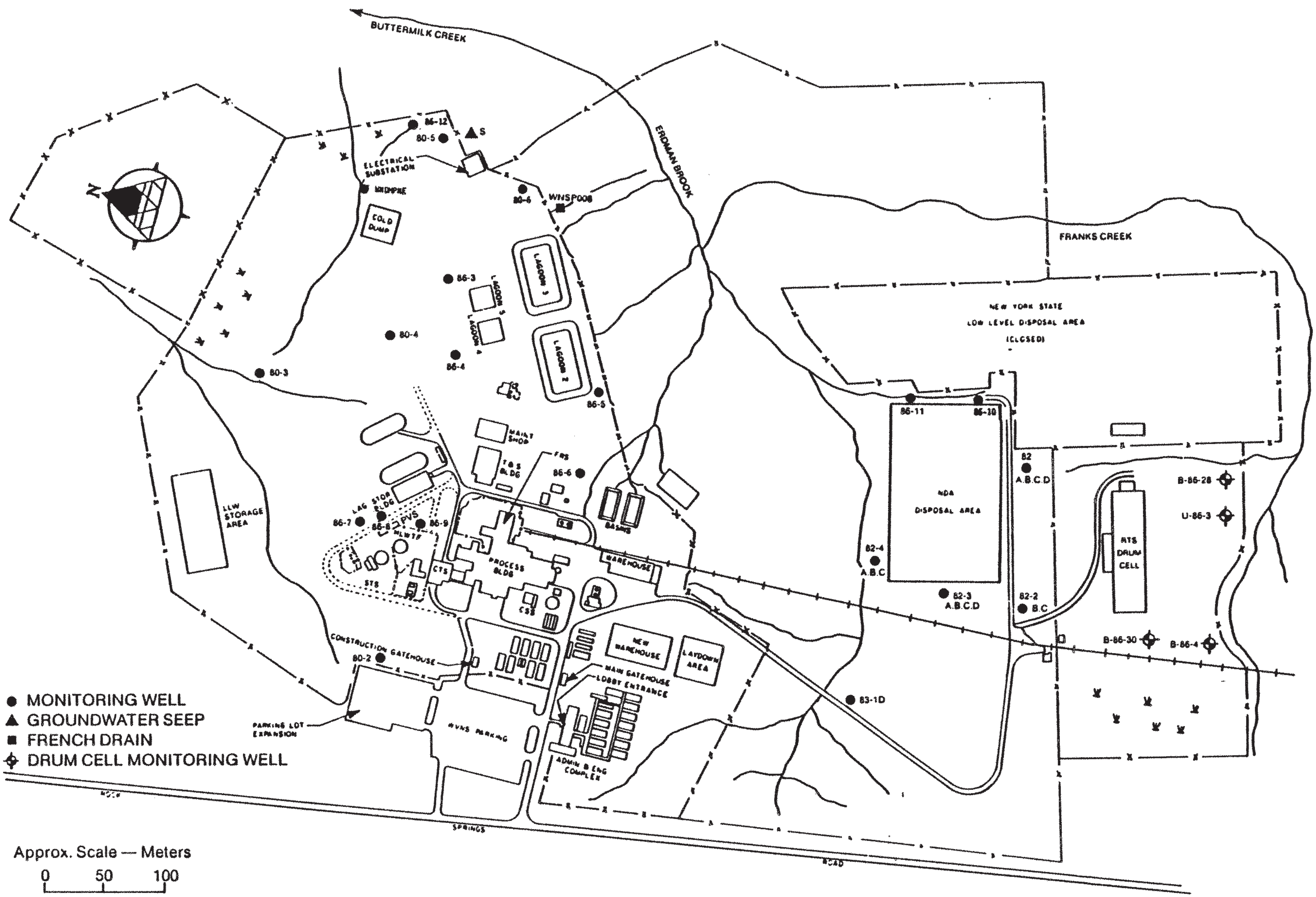


Figure 3-2. Location of Groundwater Monitoring Area Sample Points.

placed clearly upgradient of the hardstand and salvage areas.

Two groundwater monitoring locations are used to assess the former on-site nonradioactive construction and demolition debris landfill (cold dump) which was closed in 1986. Well 86-12 and a screened standpipe (WNDMPNE) were sampled along with other waste management wells. Results for these two sampling locations are included with results from the High-Level Waste Tank Complex wells to allow comparison with a representative upgradient well (80-2).

Four wells were selected to monitor the disposal unit within the NRC Licensed Disposal Area. All four tap the Lacustrine Unit. Wells 86-10 and 86-11 are downgradient wells located along the northeastern boundary of the area, and just upgradient of the New York State commercial disposal area. Well 82-1D is located downgradient of the western one-third of the NDA. Well 83-2D is located clearly upgradient of the disposal unit. However, due to difficulties in properly purging and sampling this well because of an apparently bent casing, well 83-1D was substituted as a new upgradient well for this disposal unit beginning with the second quarter of 1987.

The parameters and sampling schedule shown in Table 3-1 are used for the groundwater monitoring program. Category III parameters, Groundwater Contamination Indicators, were selected after considering the type, quantities and concentrations of constituents in the wastes of the three waste management areas, in addition to their mobility, persistence and detectability. These parameters are sensitive indicators and at the same time are representative of the wastes existing at the three areas.

At each sampling, sufficient liquid is obtained (if possible) from each well for four replicate analyses of each groundwater monitoring parameter. At each sampling event, the depth to the static water level from a leveled reference point (generally top of the well casing) is measured and recorded prior to purging the well and taking the necessary water sample.

Sampling and analysis are performed in accordance with accepted practice formalized in approved procedures to ensure the reliability and retrievability of water quality data.

Well 86-13 serves to monitor the WVDP below-ground fuel storage area for evidence of volatile organic compounds as well as selected water quality parameters and radioactivity.

In addition to monitoring the wells described above, a number of existing wells (the WNW80- and 82- series) were sampled routinely. These samples were analyzed for a variety of water quality parameters (see Appendix E) as well as for radioactivity. The location of these existing wells is shown on Figure A-2. Note that several of the wells are also included in Figure 3-2 because they were incorporated into the revised groundwater monitoring plan.

Private wells around the perimeter of the restricted area represent the nearest unrestricted use of groundwater near the Project. These potable water wells between 1.5 and 4 km away are monitored primarily for radioactivity on a biennial schedule.

3.3 Groundwater Monitoring Results

Table E-1 shows results for supporting groundwater monitoring stations sampled during the first quarter of 1987. Of greatest significance is the repeated detection of tritium in well WNW82-4A1 at levels of 2.29 E-5 to 2.48 E-5 μCi/mL. However, adjacent wells WNW82-4A2 and WNW82-4A3 which are at approximately the same depth exhibit tritium levels of 1.0 E-7 to 3.83 E-7 μCi/mL.

Table E-2 shows results of quarterly sampling of well 86-13 which monitors groundwater in the vicinity of the fuel storage area. Analyses of selected volatile organic constituents resulted in less-than-detectable concentrations

TABLE 3-1
SCHEDULE OF GROUNDWATER SAMPLING AND ANALYSIS

Category	Parameter	Frequency	Comment
I. EPA Interim Drinking Water Standards	Arsenic Barium Cadmium Chromium Fluoride Lead Mercury Nitrate (as N) Selenium Silver Radium Gross Alpha Gross Beta	Quarterly for 1st year	Annually after 1st year except coliform and pesticides
	Coliform Bacteria Endrin Lindane Methoxychlor Toxaphene 2,4-D 2,4,5-TP Silvex		These were omitted because site history does not indicate past usage
II. Groundwater Quality Indicators	Chloride Iron Manganese Phenols Sodium Sulphate	Quarterly for 1st year, annually thereafter	
III. Groundwater Contamination Indicators	Nitrate pH Conductivity Total Organic Carbon Total Organic Halogens Specific Metals Tritium Gross Alpha Gross Beta Specific Gamma Emitters	Quarterly for 1st year, semiannually thereafter	All parameters are measured in 4 replicates of each sample. Parameters selected by WVNS as indicators of waste treatment/disposal at WVDP.
IV. Groundwater Elevations		Once before collecting each well sample	

(0.2 μg/L) for all parameters of interest. Other selected parameters were not indicative of any problems in this area.

The results of groundwater monitoring for the three waste management units discussed above (including the former cold dump as a fourth unit reported with results from the High-Level Radioactive Waste Tank unit) are shown in Tables E-3 through E-14, and Figures E-2 through E-40. For the most part, values reported in tabular format represent the average of the four replicate measurements taken per quarter per parameter. Notable exceptions include data for well 83-2D from which the sample volume required for four replicates could not be obtained (Well 83-2D was replaced as the upgradient well for the NRC-Licensed Disposal Area by well 83-1D which provides adequate sample volume), and tritium results for the fourth quarter of 1987.

Non-radiological results exhibiting a mixture of detectable and less-than-detectable values were averaged using Cohen's method from "RCRA Groundwater Monitoring Technical Enforcement Guidance Document" (USEPA, 1986). All radiological averaging was performed on the actual counting results.

For aid in data interpretation, selected parameters are also shown in separate multiple Box-and-Whisker plots which allow direct visual comparison of yearly results for wells within the same waste management unit. Figure E-1 illustrates the multiple Box-and-Whisker plot for those who may be unfamiliar with this presentation format. In all cases upgradient wells are positioned to the left in the plots and at the top in tables.

Tables E-3 through E-6 and Figures E-2 through E-9 show results for wells within the High-Level Radioactive Waste Tank Complex unit (including two cold dump monitoring points). Differences between upgradient and downgradient locations do exist throughout the year (Figures E-3, E-7, E-13, and E-14). However, trends of increasing concentrations for these parameters are not evident indicating that the measured differences are fairly stable.

Data for wells monitoring the Low-Level Radioactive Waste Lagoon System are shown in Tables E-7 through E-10 and Figures E-15 through E-27.

Notable findings within this unit are elevated levels of gross beta and tritium activity in well 86-5 compared to upgradient well 86-6 (see Table E-10, and Figures E-23 and E-25). These elevated levels may be directly attributed to this well's position at the immediate downgradient edge of former Lagoon 1.

An analysis of Sr-90 on a fourth quarter sample collected from well 86-5 (7.75 E-6 μCi/mL) indicates that almost all the gross beta activity (1.61 E-5 μCi/mL) for this fourth quarter sample is accounted for by Sr-90, if it is assumed to be in equilibrium with Y-90 (total activity Sr-90 and Y-90 = 1.55 E-5 μCi/mL). The areal extent of tritium and beta contamination at this location is unknown; however, its detection here is not surprising given this area's history as Lagoon 1.

Data for wells monitoring the NRC-Licensed Disposal Area are shown in Tables E-11 through E-14 and Figures E-28 through E-40. Positive differences between upgradient and downgradient wells were noted for sulfate (Table E-11, Figure E-33) with an apparently widening trend occurring at location 86-11. However, levels of radioactivity at downgradient locations either remained approximately the same or decreased during the year (see Table E-14).

Data for the private offsite wells is given in Table C-1.6. With the exception of tritium in one well at 0.02 percent of the DCG, no fuel-cycle isotopes were detected.