

6. GROUNDWATER PROTECTION



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The groundwater below the ANL-E site is monitored through the collection and analysis of samples obtained from the former on-site water supply wells and from a series of groundwater monitoring wells located near several sites that have the potential for affecting groundwater. Regulations establishing comprehensive water quality standards for the protection of groundwater have been enacted — IEPA Groundwater Quality Standards, 35 IAC, Subtitle F, Part 620.²⁶ In addition, demonstration of compliance with the groundwater protection requirements in DOE Order 5400.1,¹ as related to sitewide characterization studies and monitoring well requirements, is presented in this chapter. The permit for the 800 Area Landfill requires a groundwater monitoring program; the program was initiated in July 1992.

6.1. Former Potable Water System

Domestic water for ANL-E was supplied by four wells (see Section 1.7 and Table 6.1) until early 1997, when Lake Michigan water was obtained. The well locations are shown in Figure 1.1. Lake Michigan water was obtained to provide better quality drinking water. The dolomite water from the on-site wells had deteriorated in quality to where the TDS content of the supply water was approaching 800 mg/L, which made it difficult to consistently meet the 1,000-mg/L TDS discharge limit at NPDES Outfall 001. Lake Michigan water has a TDS of approximately 200 mg/L. In addition, Lake Michigan water is lower in bicarbonate, which makes it less corrosive on the piping system.

6.1.1. Regulatory Required Monitoring

The supplier of the domestic water is responsible for conducting any regulatory required monitoring. Because ANL-E water is provided by the DuPage Water Commission, it is responsible for any monitoring. Therefore, ANL-E did not conduct any required monitoring in 1999.

6.1.2. Informational Monitoring

Samples were collected quarterly at the wellhead, except for Well 2, which is no longer operational, and were analyzed to determine the presence of several types of radioactive constituents and VOCs in ANL-E groundwater. Samples from each well were tested for total alpha, total beta, hydrogen-3, and strontium-90. Samples also were analyzed annually for radium-226, radium-228, and isotopic uranium. Alpha and beta radioactivity were determined by a gas-flow-proportional counting technique. Hydrogen-3 was determined by distillation followed by a beta liquid scintillation counting technique. Strontium-90 was determined by ion-exchange separations followed by proportional counting. The results are presented in Table 6.2. If these wells constituted the ANL-E

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TABLE 6.1

ANL-E Former Water Supply Wells

Well No.	Location	Well Elevation (m AMSL) ^a	Bedrock Elevation (m AMSL)	Well Depth (m bgs) ^b	Inner Diameter (m)	Year Drilled
1	Building 31	204.5	184.4	86.6	0.30	1948
2	Building 32	202.4	183.2	91.4	0.30	1948
3	Building 163	210.0	182.9	96.9	0.30	1955
4	Building 264	218.2	181.4	103.6	0.36	1959

^a AMSL = above mean sea level.

^b bgs = below ground surface.

drinking water source, the following EPA limits established for the nuclides measured in Table 6.2 would apply:

Gross alpha particle activity	=	15 pCi/L
Gross beta particle activity	=	50 pCi/L
Hydrogen-3	=	2×10^4 pCi/L
Strontium-90	=	8 pCi/L

VOC samples were collected quarterly. Samples were analyzed for SDWA volatile compounds and quantified by EPA Method 524.2²⁷, which includes purge and trap pretreatment, followed by gas chromatography-mass spectroscopy detection. The detection limit is the Practical Quantification Limit (PQL), which is defined as 10 times the method detection limit. The lack of measurable concentrations of VOCs supports the determination that no VOCs have migrated from remediation sites.

6.1.3. Dolomite Well Monitoring

Past analytical data were used to track the presence of hydrogen-3 in ANL-E domestic Well 1 and at a lower concentration in Well 2. It is speculated that the source of the hydrogen-3 was liquid waste placed in an unlined holding pond in the wastewater treatment area (location 10M in Figure 1.1) in the 1950s. The tritiated water appears to have migrated through the glacial till to the dolomite aquifer and was drawn into the wells. Well 1, which is about 200 m (650 ft) north of the

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TABLE 6.2

Radioactivity in ANL-E Former Water Supply Wells, 1999
(concentrations in pCi/L)

Type of Activity	Location	No. of Samples	Average	Minimum	Maximum
Alpha (nonvolatile)	Well 1	4	3.6	2.5	4.7
	Well 3	4	2.6	1.6	3.2
	Well 4	4	3.2	2.1	4.8
Beta (nonvolatile)	Well 1	4	10.5	10.1	11.4
	Well 3	4	11.5	10.9	12.4
	Well 4	4	12.4	11.5	12.9
Hydrogen-3	Well 1	4	<100	<100	<100
	Well 3	4	<100	<100	<100
	Well 4	4	<100	<100	<100
Strontium-90	Well 1	4	<0.25	<0.25	<0.25
	Well 3	4	<0.25	<0.25	<0.25
	Well 4	4	<0.25	<0.25	<0.25
Radium-226	Well 1	1	- ^a	-	0.90
	Well 3	1	-	-	2.24
	Well 4	1	-	-	1.76
Radium-228	Well 1	1	-	-	0.40
	Well 3	1	-	-	1.15
	Well 4	1	-	-	0.32
Uranium-234	Well 1	1	-	-	1.00
	Well 3	1	-	-	0.23
	Well 4	1	-	-	0.23
Uranium-235	Well 1	1	-	-	0.03
	Well 3	1	-	-	<0.01
	Well 4	1	-	-	<0.01
Uranium-238	Well 1	1	-	-	0.68
	Well 3	1	-	-	0.11
	Well 4	1	-	-	0.10

^a A hyphen indicates that for a single result, the value is placed in the maximum column.

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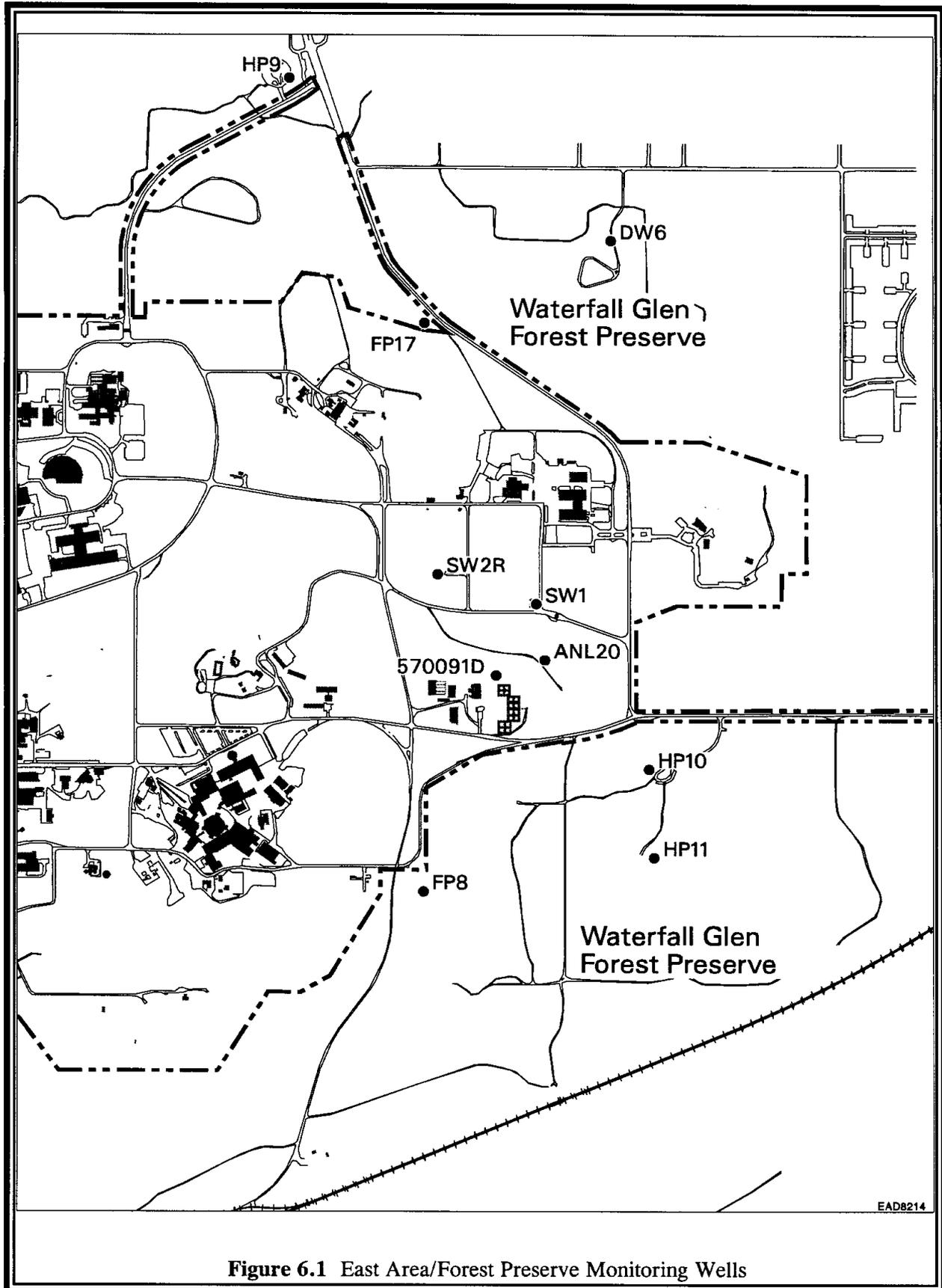


Figure 6.1 East Area/Forest Preserve Monitoring Wells

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wastewater treatment area, had higher hydrogen-3 concentrations than Well 2, which is about 300 m (1,000 ft) from the treatment area. Although the normal subsurface water flow gradient is toward the south-southeast, the cone of depression created by pumping these wells would overpower the normal flow pattern.

With the conversion of local well water to Lake Michigan water in early 1997, the water table elevations began to recover. A concern was raised that potentially the subsurface migration of radionuclides, particularly hydrogen-3, could change direction because of the lack of the influence of pumping. Since hydrogen-3 from the 570 Area Pond was already known to have migrated to the dolomite, a monitoring network of three ANL-E and six forest preserve wells was established to monitor the magnitude and direction of any hydrogen-3 movement. The well locations are shown in Figure 6.1. Samples were collected quarterly and analyzed for hydrogen-3. Table 6.3 shows the results for 1999. Hydrogen-3 results from Well 570091D, which is directly below the 570 Pond, continue to show low concentrations of hydrogen-3. The results from HP No. 11 are just above the detection limit and will require continued surveillance. This sampling network is now part of the monitoring program.

6.2. Groundwater Monitoring at Waste Management Sites

ANL-E has occupied its current site since 1948. Since that time, waste generated by ANL-E was placed in a number of on-site disposal units; these ranged from ditches filled with construction

TABLE 6.3
Hydrogen-3 in Dolomite Wells, 1999
(concentrations in pCi/L)

Well	Date Collected			
	February 24	April 22	July 13	October 19
Waterfall Glen				
DW No. 6	<100	<100	<100	<100
HP No. 9	<100	<100	<100	<100
HP No. 10	<100	<100	<100	<100
HP No. 11	157	127	<100	<100
FP No. 8	<100	<100	<100	<100
FP No. 17	<100	<100	<100	<100
Ranger House	^a	-	<100	<100
ANL-E				
570091D	186	160	<100	<100
ANL-20	<100	<100	<100	<100
SW2R	<100	<100	<100	<100

^a A hyphen indicates that no samples were collected.

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and demolition debris during the 1950s, to a modern sanitary landfill used for nonhazardous solid waste disposal until September 1992. Several of these units contain significant amounts of hazardous materials and, therefore, represent a potential threat to the environment. Groundwater below these sites is monitored routinely to assess the amount and nature of hazardous chemical releases from these units. Routinely monitored sites include the sanitary landfill in the 800 Area and the 317/319 Area, which consists of seven separate waste management units located within a small geographical area. The site of the CP-5 reactor is also monitored periodically to determine whether any radionuclides are being released from this unit.

6.2.1. 317 and 319 Areas

The 317 and 319 Areas contain seven separate current or former units that have been used in the past for handling or disposal of various types of waste. The 317 Area is currently an active radioactive waste processing and storage area. It consists of a series of in-ground and aboveground concrete structures used for storage of containers of dry radioactive or mixed (radioactive and chemically hazardous) waste. It also contains a small building used for decontamination of metal objects, such as lead bricks, tools, metal objects, etc. In the past, the 317 Area was used for disposal of various liquid chemical wastes in a unit known as a French drain. The drain consisted of a shallow trench filled with gravel into which an unknown quantity of liquid wastes was poured. This unit was operational during the late 1950s. Because of these past disposal practices, there is a region of contaminated soil in the northern half of the 317 Area. The contaminants are primarily VOCs such as cleaning solvents. The groundwater below this area also contains low concentrations of these chemicals. General features in the 317/319 Area are identified in Figure 6.2.

The 319 Area contains an inactive landfill that was used for disposal of a variety of solid wastes generated on site prior to 1969. It was not intended for disposal of radioactive waste; however, a small amount of radioactive material was detected during sampling activities completed several years ago. The only radionuclide found to be migrating from the landfill is hydrogen-3, a radioactive isotope of hydrogen. The 319 waste burial area consists of two distinct segments: the waste mound, where the bulk of the waste was buried, and an adjacent burial trench, which contains a much smaller amount of mostly inert waste. This landfill also contains a French drain that was used for several years after the French drain in the 317 Area was closed. The presence of liquid chemical wastes from the French drain, as well as hydrogen-3 in the waste mound, have resulted in the generation of a plume of contaminated groundwater extending from the waste mound to the south, toward the Des Plaines River.

During late 1996, a series of small natural groundwater discharge points (groundwater seeps) was discovered approximately 183 m (600 ft) south of the 319 Area. Two of these seeps were found to contain very low levels of three VOCs. These two seeps and one additional seep, which normally does not contain VOCs, were found to contain hydrogen-3 at concentrations below all

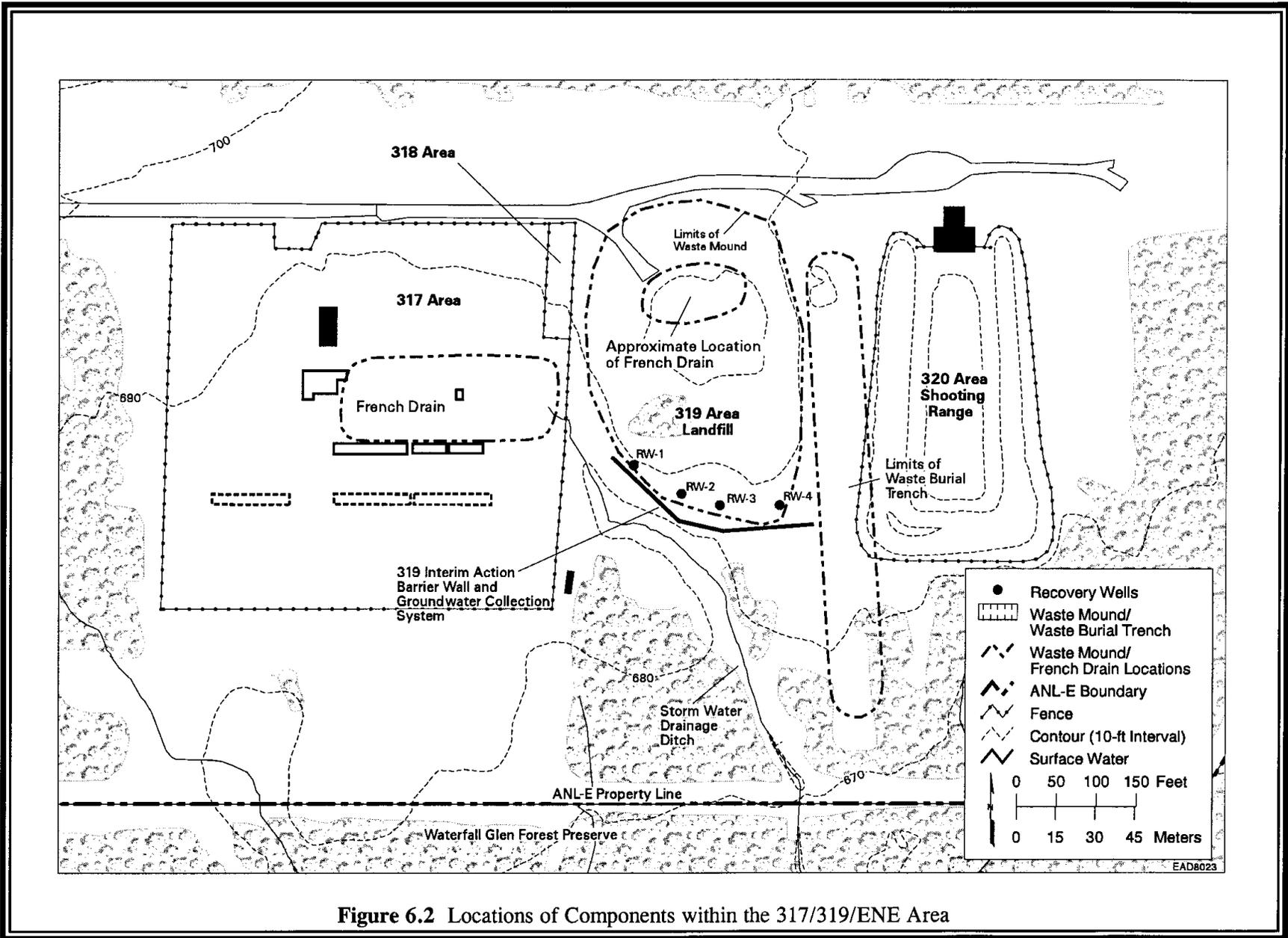


Figure 6.2 Locations of Components within the 317/319/ENE Area

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applicable standards. Since their discovery, these seeps have been monitored on a regular basis (see Section 6.5). A characterization study was completed in 1998 to identify the source and migration pathways for the hydrogen-3 and VOCs. The hydrogen-3 appears to be emanating from the 319 Landfill and is likely an extension of the on-site hydrogen-3 plume, albeit at much lower concentrations than measured on site. The source of VOCs was not clearly discerned, though it is likely that they also emanated from some past waste disposal activities in the 319 or 317 Area. The current region of VOC-contaminated groundwater is limited to a small area immediately northeast of the contaminated seeps.

Cleanup of the 317 and 319 Areas has been underway since the late 1980s. It is being carried out as a series of interrelated actions that will ultimately remove or contain the contaminants so that they will no longer migrate away from the waste disposal units. Several remedial actions are already in place and functioning as designed. These actions include a leachate and groundwater collection system for the 319 Landfill, removal of four waste storage vaults contaminated with radioactive materials, sealing of an underground drainage sewer, installation of 13 groundwater extraction wells south of the 317 Area, and construction of a concrete cover over a region containing buried compressed gas cylinders (318 Area). In addition, routine sampling and analysis of groundwater and surface water have continued. These actions have been discussed in previous annual reports. The remedial actions continued during 1999. A project to remove VOCs from the soil in the 317 French Drain area was completed. This project utilized innovative remedial technologies to remove approximately 80% of the VOCs from several locations within the French drain area.

The IEPA approved the design of a phytoremediation system in the 317 Area. Phytoremediation involves the use of green plants (trees, grasses, and flowering plants) to remove by evapotranspiration or to degrade contaminants in soil and groundwater. A dense planting of willow trees in the vicinity of the 317 French Drain and a larger planting of hybrid poplar trees downstream of the 317 French Drain and the former 319 Landfill took place during 1999.

Construction activities for the upgrade of the existing leachate and groundwater collection system at the 319 Landfill took place during 1999. Four additional wells were installed and equipment was purchased for converting the aboveground piping system to a belowground system. A composite cap was installed over the landfill mound.

The results of the routine O&M of the groundwater collection systems in the 317 and 319 Areas and the monitoring of the off-site groundwater seeps were transmitted to the IEPA on a quarterly basis through the submittal of Quarterly Progress Reports. The results of this monitoring are also summarized in this report.

6.2.2. Groundwater Monitoring at the 317 and 319 Areas

Ten active monitoring wells (some of which are clustered or nested) were installed at the locations shown in Figure 6.3. Well data are listed in Table 6.4. The wide range in water level elevations shown in Table 6.4 is not unusual and results from some of the wells being screened at different depths. This variation in water level also may be indicative of “perched” (i.e., discontinuous) groundwater conditions within the glacial till. Samples are collected quarterly following EPA sampling protocols listed in the *RCRA Ground-Water Monitoring Technical Enforcement Guidance Document*.²⁸

Groundwater monitoring in the 317 and 319 Areas has been conducted since 1986. Wells 319011, 317021, and 319031 were installed in September 1986; Well 317061 in August 1987; Wells 317101 and 317111 in September 1988; and Wells 319032 and 317052 were installed in June 1989. These wells were all completed in the glacial till. Well 317061 was sampled only two quarters due to construction damage to the well casing. In addition, Wells 317121D and 319131D were installed in November 1989 and reach the dolomite aquifer at about 25 m (80 ft) below the surface.

Wells 317101 and 317111 are upgradient of the 317 storage area, and Well 319011 is upgradient of the 319 Area Landfill. A sand lens present at 5 to 8 m (15 to 25 ft) is monitored by Well 317052 and 319032. This layer is also intercepted by Well 317101.

In addition to wells in this area, two manholes associated with the vault sewer system were monitored on a monthly basis. Figure 6.3 shows the locations of the manholes.

6.2.2.1. Sample Collection

The monitoring wells are sampled using the protocol listed in the *RCRA Ground-Water Monitoring Technical Enforcement Guidance Document*.²⁸ The volume of the water in the casing is determined by measuring the water depth from the surface and the depth to the bottom of the well. This latter measurement also determines whether siltation has occurred, which might restrict water movement in the screened area. For those wells in the glacial till that do not recharge rapidly, the well is emptied and the volume of water removed is compared with the calculated volume. In most cases, these volumes are nearly identical. The well is then sampled by bailing with a dedicated Teflon bailer. The field parameters for these samples (pH, specific conductance, redox potential, and temperature) are measured statically. For those samples in the porous, saturated zone that recharges rapidly, three well volumes are purged using dedicated submersible pumps, while the field parameters are measured continuously. These parameters stabilize quickly in these wells. In the case of the dolomite wells, samples are collected as soon as these readings stabilize. Samples for VOCs,

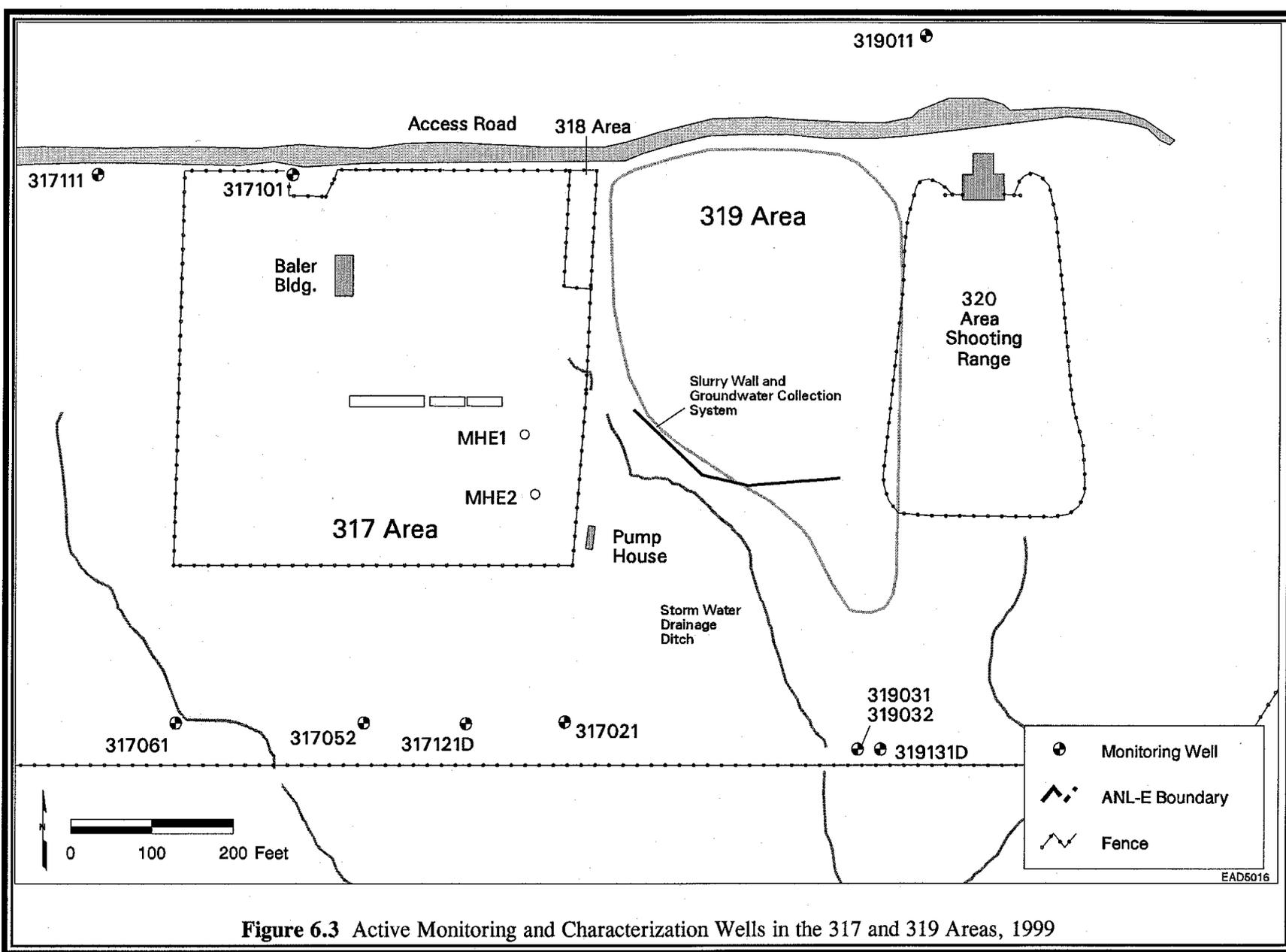


Figure 6.3 Active Monitoring and Characterization Wells in the 317 and 319 Areas, 1999

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TABLE 6.4

Groundwater Monitoring Wells: 317 and 319 Areas

ID Number	Well Depth (m bgs)	Ground Elevation (m AMSL)	Monitoring Zone (m AMSL)	Well Type ^a	Date Drilled
319011	12.19	209.8	199.1 – 197.6	0.05/PVC	9/86
317021	12.19	209.2	198.5 – 197.0	0.05/PVC	9/86
319031	12.50	204.3	194.8 – 191.8	0.05/PVC	9/86
319032	7.62	204.3	198.2 – 196.7	0.05/PVC	8/89
317051	6.10	208.3	205.3 – 202.2	0.05/PVC	7/87
317053	6.71	208.3	203.1 – 201.6	0.05/PVC	8/89
317052	4.27	208.3	207.1 – 204.0	0.05/PVC	8/89
317061	12.19	207.5	196.9 – 195.3	0.05/PVC	7/87
317101	11.89	211.0	202.2 – 199.1	0.05/PVC	8/89
317111	11.89	210.3	201.4 – 198.4	0.05/PVC	8/89
317121D ^b	24.08	207.6	185.0 – 183.5	0.15/CS	9/88
319131D	21.03	203.5	184.0 – 182.5	0.15/CS	9/88

^a Inner diameter (m)/well material (PVC = polyvinyl chloride, CS = carbon steel).

^b Wells identified by a “D” are deeper wells monitoring the dolomite bedrock aquifer.

SVOCs, PCBs and pesticides, metals, nonmetals, and radioactivity are collected in that order. The samples are placed in precleaned bottles, labeled, and preserved.

During each sampling event, one well is selected for replicate sampling. An effort is made to vary this selection so that replicates are obtained at every well over time. In addition, a field blank is also obtained.

6.2.2.2. Sample Analyses - 317 and 319 Areas

The 317 and 319 Area groundwater chemical analyses were performed using SOPs written, reviewed, and issued as controlled documents by members of ESH-Analytical Services, Chemistry Laboratory (ESH-ASCH). These SOPs reference protocols in SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods*.⁸ Fifteen metals were routinely determined and were

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measured using flame atomic absorption spectroscopy, inductively coupled plasma atomic emission spectrometry, and graphite furnace atomic absorption spectroscopy. Mercury was determined by cold vapor atomic absorption spectroscopy. Chloride was determined by titrimetry. VOCs were determined by using a purge and trap sample pretreatment followed by gas chromatography-mass spectrometry detection. SVOCs were determined by solvent extraction followed by gas chromatography-mass spectrometry detection. PCBs and pesticides were determined by solvent extraction followed by gas chromatography-electron capture detection. In the case of organic compound analyses, efforts were made to identify compounds that were present but not included on the method list. This was accomplished, and standard solutions of these compounds were prepared and analyzed.

The 317 and 319 Area groundwater radiological analyses were performed using SOPs written, reviewed, and issued as controlled documents by members of ESH-Analytical Services, Radiochemistry Laboratory (ESH-ASRL). Cesium-137 was determined by gamma-ray spectrometry. Hydrogen-3 was determined by distillation followed by a beta liquid scintillation counting technique. Strontium-90 was determined by an ion-exchange separation followed by a proportional counting technique.

6.2.2.3. Results of Analyses

Descriptions of each well, the field parameters measured during sample collection, and the results of chemical and radiological analyses of samples from the wells in the 317 and 319 Areas are contained in Tables 6.5 through 6.14. All radiological and inorganic analytical results are shown in these tables. The analytical methods used for organic compounds could identify and quantify all the compounds contained in the CLP Target Compound List. However, the vast majority of these compounds were not detected in the samples. To simplify the format of these tables, those results less than the detection limit are not included. Only those constituents that were present in amounts great enough to quantify are shown. The detection limits for the organic compounds listed were typically 1 to 5 µg/L.

Field Parameters. The purging of wells to produce water representative of the groundwater being studied was followed by measuring the field parameters. For the wells reported in this study, temperature, pH, redox potential, and specific conductance remained fairly constant after two well volumes were removed. On the basis of this information, sampling was conducted after the removal of three well volumes. The field parameters listed in the tables are the final readings obtained at the time of sampling. Wells 319011, 317021, 317061, 317111, and 319031 usually dry up after one well volume is removed. Therefore, field parameters were measured on one well volume. As in past years, Well 319031 was dry during the third and fourth quarters. It is unlikely that any nearby residents use water from the measured aquifers for domestic use.

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TABLE 6.5

Groundwater Monitoring Results, 300 Area Well 317021, 1999

Parameter	Unit	Date of Sampling				
		03/23/99	06/10/99	09/02/99	11/15/99	11/15/99
Water elevation ^a	m	200.24	202.38	200.33	198.94	198.94
Temperature	°C	11.1	11.8	13.9	12.6	12.6
pH	pH	7.92	7.58	7.94	7.40	7.40
Redox	mV	-45	-30	-37	-12	-12
Conductivity	µmhos/c	906	749	613	823	823
Chloride ^b	mg/L	32	13	17	32	32
Arsenic ^b	mg/L	< 0.0025	< 0.0025	< 0.0025	< 0.0025	< 0.0025
Barium ^b	mg/L	0.0370	0.0322	0.0338	0.0366	0.0405
Beryllium ^b	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Cadmium ^b	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium ^b	mg/L	< 0.044	< 0.044	< 0.044	< 0.044	< 0.044
Cobalt ^b	mg/L	< 0.026	< 0.026	< 0.026	< 0.026	< 0.026
Copper ^b	mg/L	< 0.017	< 0.017	< 0.017	< 0.017	< 0.017
Iron ^b	mg/L	< 0.037	< 0.037	< 0.037	< 0.037	< 0.037
Lead ^b	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Manganese ^b	mg/L	< 0.017	< 0.017	< 0.017	< 0.017	< 0.017
Mercury ^b	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel ^b	mg/L	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04
Silver ^b	mg/L	< 0.0005	< 0.0005	0.0007	< 0.0005	0.0005
Thallium ^b	mg/L	< 0.0015	< 0.0015	< 0.0015	< 0.0015	< 0.0015
Vanadium ^b	mg/L	< 0.024	< 0.024	< 0.024	< 0.024	< 0.024
Zinc ^b	mg/L	0.0575	0.0284	< 0.011	0.0169	0.0118
Cesium-137	pCi/L	< 1.0	1.1	< 1.0	< 1.0	< 1.0
Hydrogen-3	pCi/L	101	< 100	125	109	< 100
Strontium-90	pCi/L	< 0.25	1.055	< 0.25	< 0.25	< 0.25
1,1,1-Trichloroethane	µg/L	8	5	7	9	8
1,1-Dichloroethane	µg/L	2	2	2	5	4
Methylene chloride	µg/L	< 1	< 1	1	< 1	< 1

^a Well point elevation = 197.27 m mean sea level (MSL); Ground surface elevation = 209.17 m (MSL); casing material = PVC.

^b Filtered sample.

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TABLE 6.6

Groundwater Monitoring Results, 300 Area Well 317052, 1999

Parameter	Unit	Date of Sampling			
		03/23/99	06/10/99	09/03/99	11/15/99
Water elevation ^a	m	205.85	205.29	204.69	204.16
Temperature	°C	8.1	11.0	14.7	13.0
pH	pH	7.51	7.79	7.87	7.32
Redox	mV	-21	-42	-34	-8
Conductivity	µmhos/cm	733	745	606	778
Chloride ^b	mg/L	3	4	3	5
Arsenic ^b	mg/L	< 0.0025	< 0.0025	< 0.0025	< 0.0025
Barium ^b	mg/L	0.0199	0.0260	0.0372	0.0410
Beryllium ^b	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Cadmium ^b	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium ^b	mg/L	< 0.044	< 0.044	< 0.044	< 0.044
Cobalt ^b	mg/L	< 0.026	< 0.026	< 0.026	< 0.026
Copper ^b	mg/L	< 0.017	< 0.017	< 0.017	< 0.017
Iron ^b	mg/L	< 0.037	< 0.037	< 0.037	0.0402
Lead ^b	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Manganese ^b	mg/L	< 0.017	< 0.017	< 0.017	< 0.017
Mercury ^b	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel ^b	mg/L	< 0.04	< 0.04	< 0.04	< 0.04
Silver ^b	mg/L	< 0.0005	< 0.0005	0.001	0.0005
Thallium ^b	mg/L	< 0.0015	< 0.0015	< 0.0015	< 0.0015
Vanadium ^b	mg/L	< 0.024	< 0.024	< 0.024	< 0.024
Zinc ^b	mg/L	0.0554	0.0235	< 0.011	< 0.011
Cesium-137	pCi/L	< 1.0	< 1.0	< 1.0	< 1.0
Hydrogen-3	pCi/L	< 100	< 100	100	< 100
Strontium-90	pCi/L	< 0.25	< 0.25	< 0.25	< 0.25

^a Well point elevation = 204.04 m (MSL); ground surface elevation = 208.32 m (MSL); casing material = PVC.

^b Filtered sample.

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TABLE 6.7

Groundwater Monitoring Results,
300 Area Well 317061, 1999

Parameter	Unit	Date of Sampling	
		03/23/99	06/10/99
Water elevation ^a	m	199.86	200.63
Temperature	°C	10.9	12.3
pH	pH	7.27	7.51
Redox	mV	-10	-26
Conductivity	µmhos/cm	1,115	1,115
Chloride ^b	mg/L	76	81
Arsenic ^b	mg/L	< 0.0025	< 0.0025
Barium ^b	mg/L	0.0477	0.0514
Beryllium ^b	mg/L	< 0.0002	< 0.0002
Cadmium ^b	mg/L	< 0.0002	< 0.0002
Chromium ^b	mg/L	< 0.044	< 0.044
Cobalt ^b	mg/L	< 0.026	< 0.026
Copper ^b	mg/L	< 0.017	< 0.017
Iron ^b	mg/L	0.0463	0.0592
Lead ^b	mg/L	< 0.002	< 0.002
Manganese ^b	mg/L	< 0.017	< 0.017
Mercury ^b	mg/L	< 0.0001	< 0.0001
Nickel ^b	mg/L	< 0.04	< 0.04
Silver ^b	mg/L	< 0.0005	< 0.0005
Thallium ^b	mg/L	0.0016	< 0.0015
Vanadium ^b	mg/L	< 0.024	< 0.024
Zinc ^b	mg/L	0.0190	0.0244
Cesium-137	pCi/L	< 1.0	< 1.0
Hydrogen-3	pCi/L	124	116
Strontium-90	pCi/L	< 0.25	< 0.25

^a Well point elevation = 195.35 m (MSL); ground surface elevation = 207.54 m (MSL); casing material = PVC

^b Filtered sample.

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TABLE 6.8

Groundwater Monitoring Results, 300 Area Well 317101, 1999

Parameter	Unit	Date of Sampling			
		03/22/99	06/09/99	09/02/99	11/15/99
Water elevation ^a	m	203.89	204.81	202.93	202.29
Temperature	°C	11.9	12.1	12.1	11.7
pH	pH	7.07	7.13	7.14	7.19
Redox	mV	-2	-6	7	0
Conductivity	µmhos/cm	3,190	2,740	1,558	1,358
Chloride ^b	mg/L	725	606	369	162
Arsenic ^b	mg/L	< 0.0025	< 0.0025	< 0.0025	< 0.0025
Barium ^b	mg/L	0.0897	0.0750	0.0659	0.0406
Beryllium ^b	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Cadmium ^b	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium ^b	mg/L	< 0.044	< 0.044	< 0.044	< 0.044
Cobalt ^b	mg/L	< 0.026	< 0.026	< 0.026	< 0.026
Copper ^b	mg/L	< 0.017	< 0.017	< 0.017	< 0.017
Iron ^b	mg/L	< 0.037	< 0.037	< 0.037	< 0.037
Lead ^b	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Manganese ^b	mg/L	0.0197	0.0202	0.0259	0.0372
Mercury ^b	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel ^b	mg/L	< 0.04	< 0.04	< 0.04	< 0.04
Silver ^b	mg/L	0.0006	< 0.0005	0.0007	< 0.0005
Thallium ^b	mg/L	< 0.0015	< 0.0015	< 0.0015	< 0.0015
Vanadium ^b	mg/L	< 0.024	< 0.024	< 0.024	< 0.024
Zinc ^b	mg/L	0.0496	< 0.011	< 0.011	< 0.011
Cesium-137	pCi/L	< 1.0	< 1.0	< 1.0	1.9
Hydrogen-3	pCi/L	< 100	112	< 100	< 100
Strontium-90	pCi/L	< 0.25	< 0.25	< 0.25	< 0.25

^a Well point elevation = 198.66 m (MSL); ground surface elevation = 211.04 m (MSL); casing material = PVC.

^b Filtered sample.

6. GROUNDWATER PROTECTION

TABLE 6.9

Groundwater Monitoring Results, 300 Area Well 317111, 1999

Parameter	Unit	Date of Sampling			
		03/22/99	06/10/99	09/02/99	11/15/99
Water elevation ^a	m	204.27	205.24	203.22	202.46
Temperature	°C	11.4	13.1	12.3	12.2
pH	pH	7.16	7.39	6.82	7.20
Redox	mV	-6	-25	36	-5
Conductivity	µmhos/cm	1,601	1,454	1,059	1,411
Chloride ^b	mg/L	312	244	269	244
Arsenic ^b	mg/L	< 0.0025	< 0.0025	< 0.0025	< 0.0025
Barium ^b	mg/L	0.0758	0.0845	0.0833	0.0817
Beryllium ^b	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Cadmium ^b	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium ^b	mg/L	< 0.044	< 0.044	< 0.044	< 0.044
Cobalt ^b	mg/L	< 0.026	< 0.026	< 0.026	< 0.026
Copper ^b	mg/L	< 0.017	< 0.017	< 0.017	< 0.017
Iron ^b	mg/L	< 0.037	< 0.037	< 0.037	< 0.037
Lead ^b	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Manganese ^b	mg/L	0.0297	0.0335	0.0345	0.0723
Mercury ^b	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel ^b	mg/L	< 0.04	< 0.04	< 0.04	< 0.04
Silver ^b	mg/L	0.0005	< 0.0005	0.0010	< 0.0005
Thallium ^b	mg/L	< 0.0015	< 0.0015	< 0.0015	< 0.0015
Vanadium ^b	mg/L	< 0.024	< 0.024	< 0.024	< 0.024
Zinc ^b	mg/L	< 0.011	< 0.011	< 0.011	< 0.011
Cesium-137	pCi/L	< 1.0	< 1.0	< 1.0	< 1.0
Hydrogen-3	pCi/L	< 100	< 100	< 100	< 100
Strontium-90	pCi/L	< 0.25	< 0.25	< 0.25	< 0.25

^a Well point elevation = 198.37 m (MSL); ground surface elevation = 210.25 m (MSL); casing material = PVC.

^b Filtered sample.

6. GROUNDWATER PROTECTION

TABLE 6.10

Groundwater Monitoring Results, 300 Area Well 317121D, 1999

Parameter	Unit	Date of Sampling				
		03/23/99	03/23/99	06/10/99	09/03/99	11/15/99
Water elevation ^a	m	186.42	186.42	186.41	186.38	186.38
Temperature	°C	11.3	11.3	12.0	12.1	11.0
pH	pH	11.85	11.85	11.49	10.70	10.65
Redox	mV	-255	-255	-242	-187	-199
Conductivity	µmhos/cm	892	892	676	368	497
Chloride ^b	mg/L	35	39	41	36	42
Arsenic ^b	mg/L	< 0.0025	< 0.0025	< 0.0025	< 0.0025	< 0.0025
Barium ^b	mg/L	0.1419	0.1081	0.1149	0.1113	0.0481
Beryllium ^b	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Cadmium ^b	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium ^b	mg/L	< 0.044	< 0.044	< 0.044	< 0.044	< 0.044
Cobalt ^b	mg/L	< 0.026	< 0.026	< 0.026	< 0.026	< 0.026
Copper ^b	mg/L	< 0.017	< 0.017	< 0.017	< 0.017	< 0.017
Iron ^b	mg/L	< 0.037	0.1458	< 0.037	< 0.037	< 0.037
Lead ^b	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Manganese ^b	mg/L	< 0.017	< 0.017	< 0.017	< 0.017	< 0.017
Mercury ^b	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel ^b	mg/L	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04
Silver ^b	mg/L	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Thallium ^b	mg/L	0.0018	< 0.0015	< 0.0015	< 0.0015	< 0.0015
Vanadium ^b	mg/L	< 0.024	< 0.024	< 0.024	< 0.024	< 0.024
Zinc ^b	mg/L	< 0.011	< 0.011	< 0.011	< 0.011	< 0.011
Cesium-137	pCi/L	< 1.0	< 1.0	< 1.0	< 1.0	1.2
Hydrogen-3	pCi/L	144	127	144	154	138
Strontium-90	pCi/L	< 0.25	< 0.25	< 0.25	< 0.25	< 0.25

^a Well point elevation = 183.49 m (MSL); ground surface elevation = 207.57 m (MSL); casing material = steel.

^b Filtered sample.

6. GROUNDWATER PROTECTION

TABLE 6.11

Groundwater Monitoring Results, 300 Area Well 319011, 1999

Parameter	Unit	Date of Sampling				
		03/22/99	06/09/99	09/02/99	09/02/99	11/15/99
Water elevation ^a	m	200.13	202.75	200.06	200.06	198.83
Temperature	°C	10.8	13.0	13.4	13.4	11.5
pH	pH	7.12	7.33	7.45	7.45	7.21
Redox	mV	-2	-19	-10	-10	-1
Conductivity	µmhos/cm	1,154	1,109	815	815	1,066
Chloride ^b	mg/L	44	40	38	36	34
Arsenic ^b	mg/L	< 0.0025	< 0.0025	< 0.0025	< 0.0025	< 0.0025
Barium ^b	mg/L	0.0369	0.0381	0.0379	0.0372	0.038
Beryllium ^b	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Cadmium ^b	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium ^b	mg/L	< 0.044	< 0.044	< 0.044	< 0.044	< 0.044
Cobalt ^b	mg/L	< 0.026	< 0.026	< 0.026	< 0.026	< 0.026
Copper ^b	mg/L	< 0.017	< 0.017	< 0.017	< 0.017	< 0.017
Iron ^b	mg/L	< 0.037	< 0.037	< 0.037	< 0.037	< 0.037
Lead ^b	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Manganese ^b	mg/L	0.0204	0.0234	0.0355	0.0243	0.0209
Mercury ^b	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel ^b	mg/L	< 0.04	0.0415	< 0.04	< 0.04	< 0.04
Silver ^b	mg/L	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Thallium ^b	mg/L	< 0.0015	< 0.0015	< 0.0015	< 0.0015	< 0.0015
Vanadium ^b	mg/L	< 0.024	< 0.024	< 0.024	< 0.024	< 0.024
Zinc ^b	mg/L	0.0906	0.0384	< 0.0110	< 0.0110	0.0114
Cesium-137	pCi/L	< 1.0	< 1.0	< 1.0	< 1.0	1.05
Hydrogen-3	pCi/L	< 100	107	< 100	134	117
Strontium-90	pCi/L	< 0.25	< 0.25	< 0.25	< 0.25	< 0.25
Methylene chloride	µg/L	< 1	< 1	1	1	< 1

^a Well point elevation = 197.60 m (MSL); ground surface elevation = 209.81 m (MSL); casing material = PVC.

^b Filtered sample.

6. GROUNDWATER PROTECTION

TABLE 6.12

Groundwater Monitoring Results,
300 Area Well 319031, 1999

Parameter	Unit	Date of Sampling	
		03/22/99	06/10/99
Water elevation ^a	m	193.14	193.12
Temperature	°C	11.3	11.8
pH	pH	7.26	7.39
Redox	mV	-9	-21
Conductivity	µmhos/cm	983	979
Chloride ^b	mg/L	31	27
Arsenic ^b	mg/L	< 0.0025	< 0.0025
Barium ^b	mg/L	0.0503	0.0526
Beryllium ^b	mg/L	< 0.0002	< 0.0002
Cadmium ^b	mg/L	< 0.0002	< 0.0002
Chromium ^b	mg/L	< 0.044	< 0.044
Cobalt ^b	mg/L	< 0.026	< 0.026
Copper ^b	mg/L	< 0.017	< 0.017
Iron ^b	mg/L	< 0.037	< 0.037
Lead ^b	mg/L	< 0.002	< 0.002
Manganese ^b	mg/L	< 0.017	< 0.017
Mercury ^b	mg/L	< 0.0001	< 0.0001
Nickel ^b	mg/L	0.0448	< 0.04
Silver ^b	mg/L	< 0.0005	< 0.0005
Thallium ^b	mg/L	< 0.0015	< 0.0015
Vanadium ^b	mg/L	< 0.024	< 0.024
Zinc ^b	mg/L	0.0231	0.2129
Cesium-137	pCi/L	< 1.0	< 1.0
Hydrogen-3	pCi/L	877	685
Strontium-90	pCi/L	0.36	0.40
1,1,1-Trichloroethane	µg/L	2	2
4-Methyl-2-pentanone	µg/L	< 1	2
Acetone	µg/L	< 1	5
Trichloroethene	µg/L	3	4

^a Well point elevation = 191.78 m (MSL); ground surface elevation = 204.28 m (MSL); casing material = PVC.

^b Filtered sample.

6. GROUNDWATER PROTECTION

TABLE 6.13

Groundwater Monitoring Results, 300 Area Well 319032, 1999

Parameter	Unit	Date of Sampling			
		03/22/99	06/10/99	09/02/99	11/15/99
Water elevation ^a	m	198.42	198.53	197.59	197.05
Temperature	°C	10.7	11.4	11.4	11.0
pH	pH	7.24	7.39	7.53	7.15
Redox	mV	-7	-20	-13	0
Conductivity	µmhos/cm	1,053	1,067	745	1,023
Chloride ^b	mg/L	16	27	17	17
Arsenic ^b	mg/L	< 0.0025	< 0.0025	< 0.0025	< 0.0025
Barium ^b	mg/L	0.0642	0.0740	0.0702	0.0692
Beryllium ^b	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Cadmium ^b	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium ^b	mg/L	< 0.044	< 0.044	< 0.044	< 0.044
Cobalt ^b	mg/L	< 0.026	< 0.026	< 0.026	< 0.026
Copper ^b	mg/L	< 0.017	< 0.017	< 0.017	< 0.017
Iron ^b	mg/L	< 0.037	< 0.037	< 0.037	< 0.037
Lead ^b	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Manganese ^b	mg/L	< 0.017	< 0.017	< 0.017	< 0.017
Mercury ^b	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel ^b	mg/L	< 0.04	< 0.04	< 0.04	< 0.04
Silver ^b	mg/L	< 0.0005	< 0.0005	0.0008	< 0.0005
Thallium ^b	mg/L	< 0.0015	< 0.0015	< 0.0015	< 0.0015
Vanadium ^b	mg/L	< 0.024	< 0.024	< 0.024	< 0.024
Zinc ^b	mg/L	0.0157	0.028	0.0115	< 0.011
Americium-241	fCi/L	- ^c	-	< 1.0	-
Curium-244	fCi/L	-	-	< 1.0	-
Cesium-137	pCi/L	< 1.0	< 1.0	< 1.0	1.0
Hydrogen-3	pCi/L	373	770	487	456
Neptunium-237	fCi/L	-	-	2.2	-
Plutonium-238	fCi/L	-	-	< 1.0	-
Plutonium-239	fCi/L	-	-	5.4	-
Strontium-90	pCi/L	< 0.25	< 0.25	< 0.25	0.27
1,1,1-Trichloroethane	µg/L	< 1.0	1.0	1.0	< 1.0
1,1-Dichloroethane	µg/L	< 1.0	1.0	< 1.0	< 1.0

^a Well point elevation = 196.66 m (MSL); ground surface elevation = 204.28 m (MSL); casing material = PVC.

^b Filtered samples.

^c A hyphen indicates that no samples were collected.

6. GROUNDWATER PROTECTION

TABLE 6.14

Groundwater Monitoring Results, 300 Area Well 319131D, 1999

Parameter	Unit	Date of Sampling				
		03/22/99	06/10/99	06/10/99	09/02/99	11/15/99
Water elevation ^a	m	184.70	184.84	184.84	184.43	184.28
Temperature	°C	11.1	13.8	13.8	14.2	10.7
pH	pH	7.15	7.31	7.31	7.76	7.27
Redox	mV	-6	-21	-21	-30	-6
Conductivity	µmhos/cm	1,116	1,026	1,026	840	1,092
Chloride ^b	mg/L	49	43	49	49	51
Arsenic ^b	mg/L	< 0.0025	< 0.0025	< 0.0025	< 0.0025	< 0.0025
Barium ^b	mg/L	0.0656	0.0669	0.0694	0.0733	0.0702
Beryllium ^b	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Cadmium ^b	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium ^b	mg/L	< 0.044	< 0.044	< 0.044	< 0.044	< 0.044
Cobalt ^b	mg/L	< 0.026	< 0.026	< 0.026	< 0.026	< 0.026
Copper ^b	mg/L	< 0.017	< 0.017	< 0.017	< 0.017	< 0.017
Iron ^b	mg/L	< 0.037	< 0.037	< 0.037	< 0.037	< 0.037
Lead ^b	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Manganese ^b	mg/L	< 0.0170	0.0621	0.0485	< 0.0170	< 0.0170
Mercury ^b	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel ^b	mg/L	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04
Silver ^b	mg/L	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Thallium ^b	mg/L	< 0.0015	< 0.0015	< 0.0015	< 0.0015	< 0.0015
Vanadium ^b	mg/L	< 0.024	< 0.024	< 0.024	< 0.024	< 0.024
Zinc ^b	mg/L	< 0.0110	0.0415	0.0388	< 0.0110	< 0.0110
Americium-241	fCi/L	- ^c	< 1	-	-	-
Curium-242	fCi/L	-	< 1	-	-	-
Curium-244	fCi/L	-	< 1	-	-	-
Cesium-137	pCi/L	< 1.0	< 1.0	< 1.0	< 1.0	1.2
Hydrogen-3	pCi/L	1,227	1,250	986	1,398	1,358
Neptunium-237	fCi/L	-	< 1	-	-	-
Plutonium-238	fCi/L	-	< 1	-	-	-
Plutonium-239	fCi/L	-	< 1	-	-	-
Strontium-90	pCi/L	< 0.25	< 0.25	< 0.25	< 0.25	< 0.25
Carbon tetrachloride	µg/L	< 1	1	1	< 1	< 1
Methylene chloride	µg/L	< 1	< 1	< 1	1	< 1

^a Well point elevation = 182.88 m (MSL); ground surface elevation = 203.56 m (MSL); casing material = steel.

^b Filtered samples.

^c A hyphen indicates that no samples were collected.

6. GROUNDWATER PROTECTION

Inorganic Parameters. ANL-E chose a conservative approach for evaluating the monitoring results by selecting as the standard of comparison the Illinois Groundwater Quality Standards for Class I: Potable Resource Groundwater, 31 IAC, Section 620.410. The standards are presented in Tables 6.15 and 6.16. In 1999, all samples for metals analyses were field-filtered prior to preservation with acid (an IEPA requirement for the IEPA-approved groundwater monitoring program at the 800 Area Landfill, Section 6.3.2.3).

As noted in previous years, no elevated levels, with respect to the WQS for inorganics, were noted with the exception of pH at dolomite Well 317121D and chloride at Wells 317101 and 317111. Historically, elevated pH values at Well 317121D have been reported. The pH changes drastically between the purging of two to five volumes of water. In each case, the last value obtained was recorded. Well 317111 exceeded the WQS for chloride each quarter, and Well 317101 exceeded the chloride WQS three quarters. Chloride levels ranged from 162 to 725 mg/L. Several wells had elevated levels of barium and manganese, but they were considerably below the WQS. Barium concentrations ranged from 0.02 to 0.14 mg/L, and manganese concentrations ranged from less than 0.017 to 0.072 mg/L. The source of the elevated barium and manganese levels is unknown. Elevated levels of barium and manganese have been reported in previous annual reports.¹⁶

Organic Parameters. Each well was sampled quarterly and analyzed for VOCs. In 1996 and 1997, VOCs were noted in nine wells. In 1998, VOCs were detected in three wells — 317021, 317061, and 319031 — and in 1999, VOCs were detected in five wells — 317021, 319011, 319031, 319032, and 319131D. Except for Well 319011, these wells are located south of the 317 Area and the 319 Area, near the south perimeter fence. The

TABLE 6.15

Illinois Class I Groundwater Quality Standards: Inorganics
(Concentrations in mg/L, except radionuclides and pH)

Constituent	Standard
Antimony	0.006
Arsenic	0.05
Barium	2
Beryllium	0.004
Boron	2
Cadmium	0.005
Chloride	200
Chromium	0.1
Cobalt	1
Copper	0.65
Cyanide	0.2
Fluoride	4
Iron	5
Lead	0.0075
Manganese	0.15
Mercury	0.002
Nickel	0.1
Nitrate, as N	10
Radium-226	20 pCi/L
Radium-228	20 pCi/L
Selenium	0.05
Silver	0.05
Sulfate	400
Thallium	0.002
TDS	1,200
Zinc	5
pH	6.5 – 9.0

6. GROUNDWATER PROTECTION

TABLE 6.16

Illinois Class I Groundwater Quality Standards: Organics
(concentrations in mg/L)

Constituent	Standard	Constituent	Standard
Alachlor	0.002	1,1-Dichloroethene	0.007
Aldicarb	0.003	cis-1,2-Dichloroethylene	0.07
Atrazine	0.003	trans-1,2-Dichloroethylene	0.1
Benzene	0.005	1,2-Dichloropropane	0.005
Benzo(a)pyrene	0.0002	Ethylbenzene	0.7
Carbofuran	0.04	Methoxychlor	0.04
Carbon tetrachloride	0.005	Monochlorobenzene	0.1
Chlordane	0.002	Pentachlorophenol	0.001
Dalapon	0.2	Phenols	0.1
Dichloromethane	0.005	Picloram	0.5
Di(2-ethylhexyl)phthalate	0.006	PCBs (decachlorobiphenyl)	0.0005
Dinoseb	0.007	Simazine	0.004
Endothall	0.1	Styrene	0.1
Endrin	0.002	2,4-5-TP (Silvex)	0.05
Ethylene dibromide	0.00005	Tetrachloroethylene	0.005
Heptachlor	0.0004	Toluene	1
Heptachlor epoxide	0.0002	Toxaphene	0.003
Hexachlorocyclopentadiene	0.05	1,1,1-Trichloroethane	0.2
Lindane	0.0002	1,1,2-Trichloroethane	0.005
2,4-D	0.07	1,2,4-Trichlorobenzene	0.07
o-Dichlorobenzene	0.6	Trichloroethylene	0.005
p-Dichlorobenzene	0.075	Vinyl chloride	0.002
1,2-Dibromo-3-Chloropropane	0.0002	Xylenes	10
1,2-Dichloroethane	0.005		

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concentrations of VOCs in the wells were very low. Well 317021 showed persistent VOC levels, as in the past. Well 319031 is frequently dry but contains organic constituents when water is present. Well 319031 was dry during the third and fourth quarters. VOCs were detected in 319011 only during the third quarter at the detection limit. No organic WQSs were exceeded. The reduction in the frequency and concentration of VOCs may be due to the extensive Soil Treatment Project in the 317 Area completed during 1998 as well as the 319 Landfill expanded groundwater collection system. Over 6,500 m³ (8,500 yd³) of VOC-contaminated soil was treated using an innovative treatment approach developed by ANL-E for reduction of VOCs. The 319 Landfill leachate and groundwater collection system was upgraded and expanded with four additional wells for pumping contaminated groundwater to the wastewater treatment system.

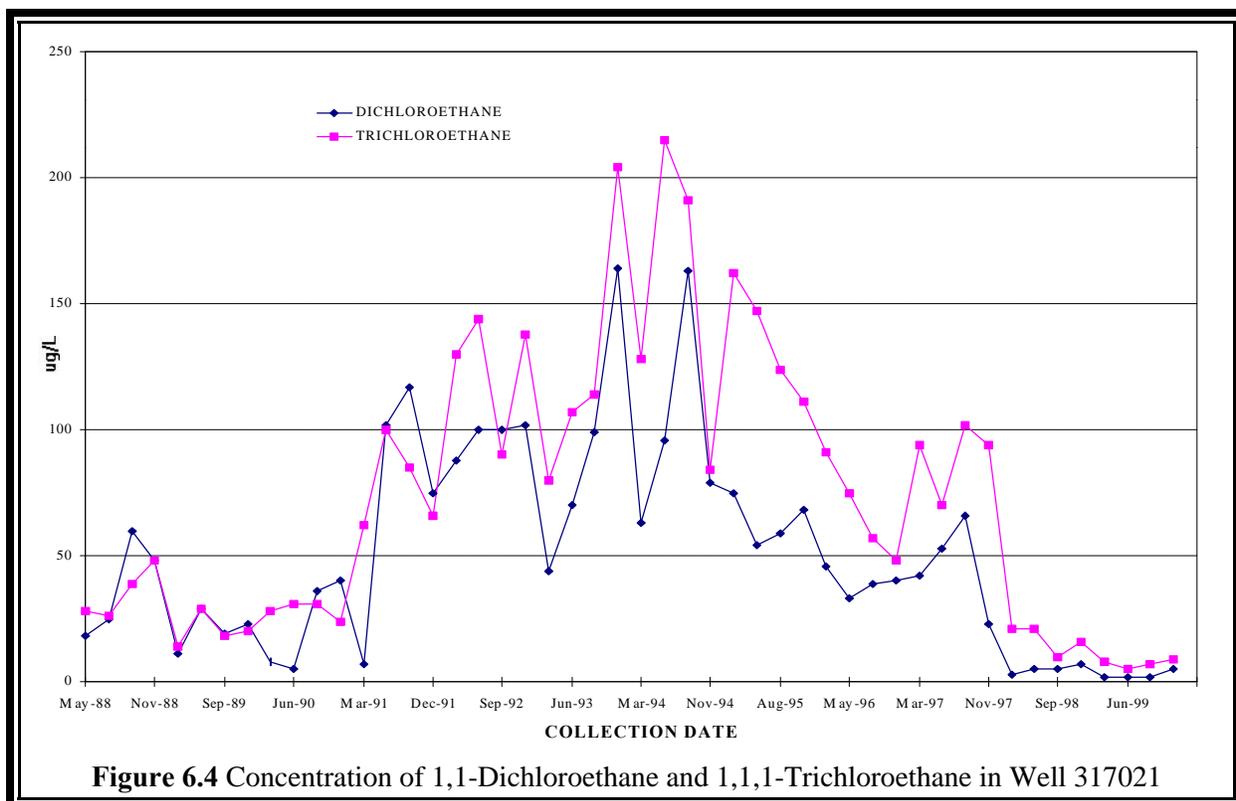
Once during the year, the wells were sampled and analyzed for SVOCs, PCBs, pesticides, and herbicides. None of these parameters were found in 1999.

Figure 6.4 shows the results for Well 317021. The major components are 1,1,1-trichloroethane (TCA) and 1,1-dichloroethane; the latter can be a decomposition product of TCA. As shown in Figure 6.4, the concentrations roughly parallel each other, and the levels are remarkably consistent until 1991, at which time a substantial increase is seen. The consistent levels prior to 1991 would indicate that this well is sampling a large area of contaminated water that is unaffected by seasonal water level changes. The large increase in the summer and fall of 1991 is clearly related to a period of intense drought and also could be related to restricted flow of normal dilution water. In 1999, a trace level of methylene chloride was also found in this well but at levels well below the WQS and only during one quarter. The well is immediately below a former sewer line that was known to be contaminated. The sewer line was permanently closed in 1986 and sealed in 1997.

Manholes E1 and E2, in the 317 Area were sampled monthly and analyzed for VOCs. The results are presented in Table 6.17. Contributors of groundwater into Manholes E1 and E2 include an average of 3,529 L/day (932 gal/day) from the 319 Area groundwater collection system, an average of 29,840 L/day (7,880 gal/day) from the 317 Area groundwater collection system, and groundwater from existing foundation drains around storage vaults. This represents a substantial increase in flow from 1997 and 1998. In May 1997, grouting and sealing a footing drain system in the southeastern portion of the 317 Area to prevent the migration of contaminated groundwater off site was completed. Approximately 183 m (600 ft) of underground pipe and bedding material was sealed in the 317 Area south of the deactivated South Vault system. At a future date, all underground piping immediately south of the Deep Vault, Map Tube Vault, and North Vault will be grouted and sealed.

In general, volatile constituent concentrations decreased from levels noted in previous years (see Figure 6.5). In addition, the ratios of the decreases in concentrations between Manhole E1 and

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Manhole E2 (see Figure 6.6 and Table 6.17) have changed significantly since 1998; most likely these changes can be attributed to the dilution of Manhole E2 water. Remediation activities in the 317 and 319 Areas has resulted in Manhole E2 receiving increased groundwater flows from these areas. Starting in October 1997, as part of the 317 Area remediation project, 317 Area groundwater was pumped at a rate of over 4,542 L/day (1,200 gal/day) to Manhole E2, increasing to 29,840 L/day (7,880 gal/day) in 1999.

Chloroform is a degradation product of carbon tetrachloride. Cis-1,2-dichloroethene (1,2-DCE) is a degradation product of TCE. The fact that both the original and breakdown products are present in most samples indicates an ongoing release of these compounds into the groundwater, such as from highly contaminated soils. Trace levels of acetone, dichlorofluoromethane, methylene chloride, trans-1,2-DCE, tribromoethene, 1,2-dibromoethene, 1,2-dichloroethane, vinyl chloride, tetrahydrofuran, and 4-methyl-2-pentanone have been detected, but at low levels and not on a consistent basis. The source of these compounds is believed to be the French drains previously described in Section 6.2.1. Extensive characterization activities continue to better define the nature, rate, and extent of contamination at this location.

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TABLE 6.17

Volatile Organic Compounds in the 317 Area: Manholes E1 and E2, 1999
(concentrations in µg/L)

Date Collected	Chloroform		Tetra-chloroethene		Trichloro-ethene		cis-1,2-Dichloro-ethene		1,1-Dichloro-ethane		Carbon Tetrachloride		1,1,1-Trichloro-ethane	
	E1	E2	E1	E2	E1	E2	E1	E2	E1	E2	E1	E2	E1	E2
January 13	5	5	< 1	2	2	3	5	6	22	24	7	4	13	14
February 11	53	7	27	5	12	13	32	33	3	4	153	14	3	14
March 9	38	9	7	5	7	7	10	12	31	16	43	16	29	18
April 16	188	114	34	28	46	34	14	15	14	25	169	101	13	23
May 10	99	9	19	3	38	57	30	8	38	142	93	13	51	261
June 3	343	19	57	8	54	10	18	4	31	50	342	22	25	37
July 8	610	2	57	< 1	41	10	38	27	30	4	463	< 1	33	1
August 8	216	8	26	2	33	22	26	24	76	100	123	5	58	99
September 14	196	1	26	< 1	21	10	18	14	17	26	235	2	23	43
October 14	171	1	23	1	23	8	22	7	33	33	157	2	47	50
November 10	116	3	18	2	23	25	20	84	53	43	127	4	113	88
December 9	206	39	42	10	40	34	27	25	68	111	261	35	141	248

Radioactive Constituents. Samples collected quarterly from the monitoring wells in the 317 and 319 Areas were analyzed for hydrogen-3, strontium-90, and gamma-ray emitters. An annual sample for alpha-emitters was collected from Wells 317021, 319031, 319032, and 319131D. The results are presented in Tables 6.5 to 6.14. Evidence of possible off-site migration of radionuclides is noted by the low concentrations of hydrogen-3, cesium-137, strontium-90, and alpha-emitters in wells located near the south perimeter fence in the 317 and 319 Areas. Hydrogen-3 was detected in Wells 317021, 317052, 317061, and 317121D, located south of the 317 Area. It was detected during one quarter in upgradient Well 317101. Hydrogen-3 was also detected in Wells 319011, 319031, 319032, and 319131D, which (except for Well 319011) are located near the south 319 Area perimeter fence. Cesium-137 was detected in Wells 317021, 317052, 317061, and 317121D located south of the 317 Area near the south perimeter fence. Cesium-137 was also detected in Wells 317101 and 317111, which are upgradient of the 317 Area. A small amount of cesium-137 was also detected in Well 319131D, which is south of the 319 Area near the south perimeter fence. It was also detected one quarter in upgradient Well 319011. Strontium-90 was detected in Wells 319031 and 319032, which are near the south perimeter fence. Alpha-emitters were monitored and detected in Well 319032. Wells 319031, 319032, and 319131D are directly below a small drainage swale from the 319 Area that has contained water intermittently with measurable concentrations of hydrogen-3 and strontium-90. All concentrations are well below any applicable standards.

Water from the 317 Area and 319 Area groundwater collection systems is pumped to Manhole 2E. Manhole 1E is connected to the footing drain system around the operating vaults. In

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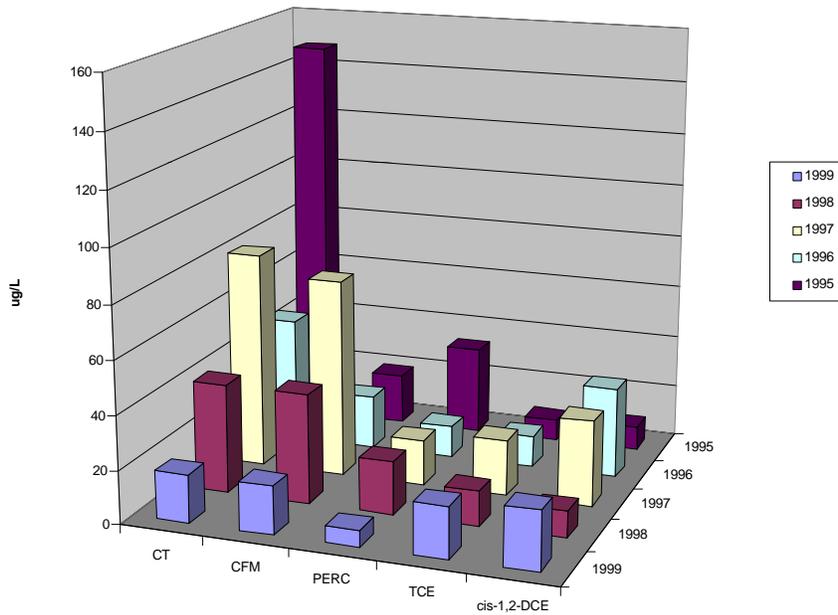
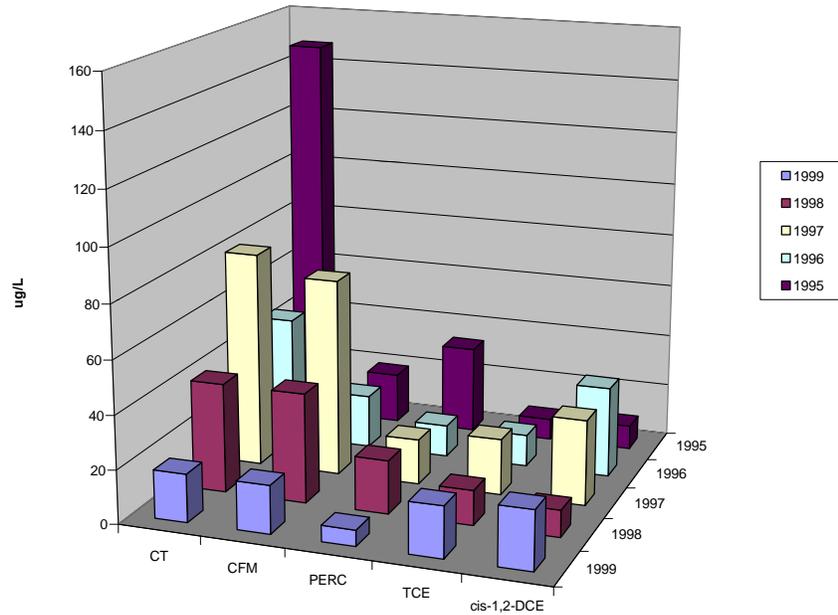
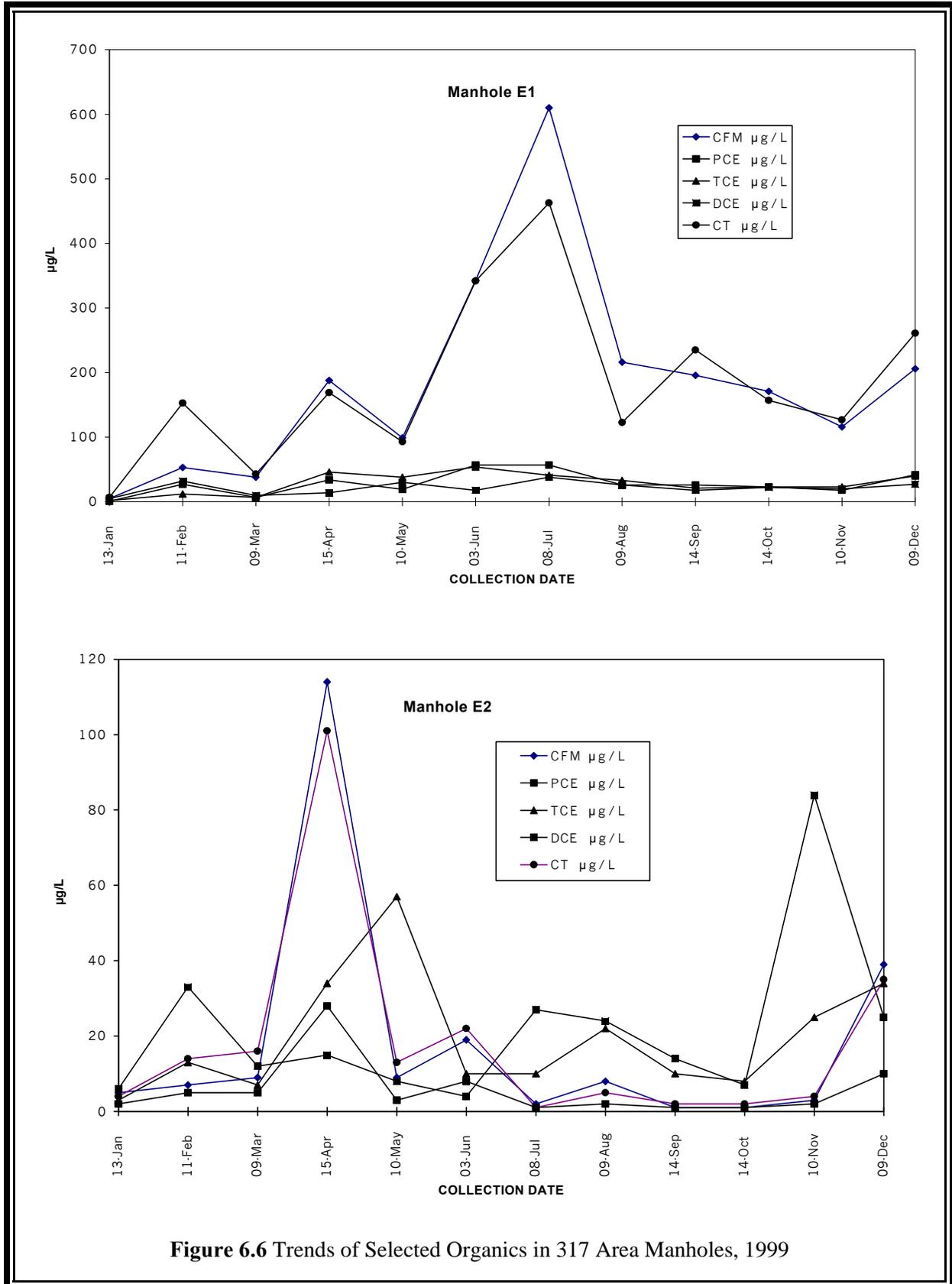


Figure 6.5 Manhole E1 and Manhole E2 Average Groundwater Concentrations, 1995 to 1999

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In addition to VOCs, the manhole water is analyzed for hydrogen-3 and gamma-ray-emitting radionuclides. Table 6.18 gives the hydrogen-3 results. Although the hydrogen-3 concentrations are relatively high, the volume is fairly low. Since hydrogen-3 concentrations are generally higher in Manhole 2E, the source of the hydrogen-3 appears to be from the groundwater pumping system. In contrast, the VOCs, see Table 6.17, are generally higher in Manhole 1E, which implies that the main source of the VOCs is the 317 Area French Drain. No gamma-ray-emitting radionuclides were detected in any samples.

Monitoring was also conducted quarterly at an artesian well located about 2,000 m (6,000 ft) southwest of the 317 Area (location 3E in Figure 1.1). All hydrogen-3 concentrations were less than the detection limit of 100 pCi/L. This indicates that any subsurface contaminant movement has not extended to this location and indicates a western limit to movement.

TABLE 6.18

Hydrogen-3 Concentrations in Manhole Water Samples, 1999
(Concentrations in pCi/L)

Date Collected	Manhole 1E	Manhole 2E
January 13	13,710	14,190
February 11	76,190	85,370
March 9	14,870	16,730
April 16	4,441	11,190
May 10	103,100	14,780
June 3	873	3,366
July 8	75,960	63,000
August 9	27,070	22,430
September 14	20,660	14,950
October 14	26,960	8,636
November 10	19,000	56,880
December 9	11,620	16,230

6.3. Sanitary Landfill

The 800 Area is the site of the ANL-E sanitary landfill. The 8.8-ha (21.8-acre) landfill is located on the western edge of ANL-E property (Figure 1.1). The landfill has received waste since 1966 and was operated under IEPA Permit No. 1981-29-OP, which was issued on September 18, 1981. The landfill received general refuse, construction debris, boiler house ash, and other nonradioactive solid waste until September 1992. The landfill is now being closed pursuant to Permit No. 1992-002-SP and Supplemental Permit Nos. 1994-506-SP, 1997-295-SP, 1998-017-SP, and 1999-107-SP.

6.3.1. French Drain

The landfill area was used for the disposal of certain types of liquid wastes from 1969 to 1978. The wastes were poured into a French drain that consisted of a corrugated steel pipe placed in a gravel-filled pit dug into an area previously filled with waste. The liquid waste was poured into the drain and allowed to permeate into the gravel, and thence into the soil and fill material.

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Available documentation indicates that 109,000 L (29,000 gal) of liquid waste was placed in this drain. Some of the wastes disposed of in this manner are now defined as hazardous wastes. The presence of volatile and other toxic organic compounds has been confirmed by soil gas surveys and leachate sampling conducted at the landfill. Measurable amounts of these materials were identified in soil vapor leachate but not groundwater near the landfill.

6.3.2. Monitoring Studies

During October 1992, 15 stainless-steel wells, 800161 through 800203D, were installed around the landfill as part of the IEPA-approved closure plan. Wells 800172 and 800182 are consistently dry. The 13 active wells are required to be monitored as part of the IEPA-approved groundwater monitoring program, effective January 1995. These wells are set in five clusters; each cluster consists of a shallow, medium, and deep well (see Figure 6.7 and Table 6.19). Wells 800241 and 800243D, installed during 1995, were formally incorporated into the 800 Area Landfill Groundwater Monitoring Program by IEPA Supplemental Permit No. 1998-017-SP, effective August 25, 1998. The analytical data collected from these wells is being evaluated in order to determine their appropriateness for use as upgradient wells for the shallow and deep series wells. Informational monitoring of these wells commenced during July 1998.

IEPA Supplemental Permit No. 1999-107-SP, effective June 16, 1999, provided for (1) the installation and addition of three new upgradient groundwater monitoring wells, Nos. 800271, 800272, and 800273D; and (2) the addition of 10 new downgradient groundwater monitoring wells (800281, 800291, 800301, 800311, 800321, 800331, 800341, 800351, 800361, and 800371). Sampling of these wells commenced in October 1999. Table 6.19 provides information on these wells, and Figure 6.7 shows their locations. Wells 800272, 800311, and 800321 have been dry since installation.

In late spring of 1999, an environmental remediation project was completed that resulted in the extension of the north portion of the landfill to cover some recently identified waste material. As part of this project, the fence was moved 15 m (50 ft) north, and monitoring wells Nos. 800161, 800162, and 800163D were also relocated. During the first two quarters of 1999, results are for Wells 800161, 800162, and 800163D, while for the last quarters, the replacement wells, Nos. 800381, 800382, and 800383D, were sampled.

6.3.2.1. Sample Collection

The same procedure for well water sample collection previously described for the 300 Area was used for this area. Each well is sampled annually for semivolatiles, PCBs, pesticides, and

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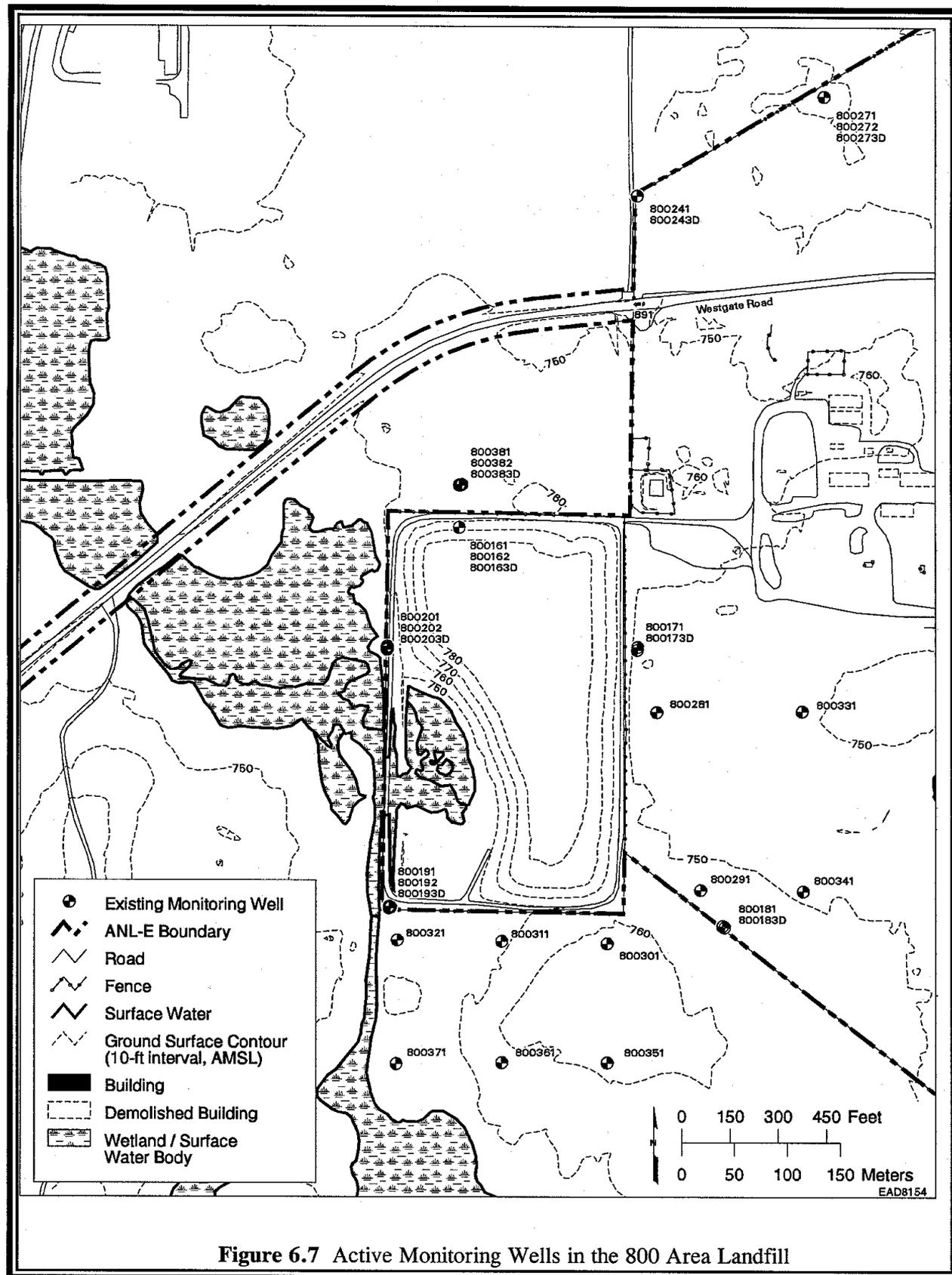


Figure 6.7 Active Monitoring Wells in the 800 Area Landfill

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TABLE 6.19

Groundwater Monitoring Wells: 800 Area Landfill

ID Number ^a	Well Depth (m bgs)	Ground Elevation (m AMSL)	Monitoring Zone (m AMSL)	Well Type ^b	Date Drilled
800161	7.94	230.8	224.3 – 222.8	0.05/SS	10/92
800162	20.76	230.7	211.5 – 210.0	0.05/SS	10/92
800163D	47.00	230.8	186.8 – 183.8	0.05/SS	9/92
800171	7.71	228.4	222.2 – 220.7	0.05/SS	10/92
800173D	39.08	228.4	192.4 – 189.3	0.05/SS	10/92
800181	11.01	230.5	221.0 – 219.5	0.05/SS	10/92
800183D	49.68	230.4	183.7 – 180.7	0.05/SS	10/92
800191	4.62	227.4	224.3 – 222.8	0.05/SS	10/92
800192	18.67	227.4	210.2 – 208.7	0.05/SS	10/92
800193D	45.48	227.4	185.0 – 181.9	0.05/SS	10/92
800201	10.74	227.9	218.7 – 217.2	0.05/SS	10/92
800202	18.52	227.9	210.9 – 209.4	0.05/SS	10/92
800203D	38.47	227.9	192.5 – 189.5	0.05/SS	9/92
800241	4.90	226.1	224.3 – 221.3	0.05/SS	3/95
800243D	35.50	226.1	193.9 – 190.8	0.05/SS	4/95
800271	3.98	225.7	193.4 – 222.5	0.05/SS	8/99
800272	13.77	225.7	214.2 – 212.7	0.05/SS	8/99
800273D	36.72	225.7	192.8 – 189.7	0.05/SS	8/99
800281	3.98	227.7	226.2 – 224.6	0.05/SS	9/99
800291	7.34	230.5	225.5 – 224.0	0.05/SS	9/99
800301	7.04	232.6	227.7 – 226.2	0.05/SS	9/99
800311	12.85	227.5	218.5 – 215.4	0.05/SS	9/99
800321	3.67	228.0	227.4 – 225.9	0.05/SS	9/99
800331	5.20	228.0	225.2 – 223.7	0.05/SS	9/99
800341	3.67	230.0	228.6 – 227.1	0.05/SS	9/99
800351	11.63	232.8	225.2 – 222.2	0.05/SS	9/99
800361	7.04	227.6	222.8 – 221.3	0.05/SS	9/99
800371	9.79	227.6	220.0 – 218.5	0.05/SS	9/99
800381 ^c	7.65	231.2	226.8 – 225.2	0.05/SS	6/99
800382 ^c	19.89	231.2	214.5 – 213.0	0.05/SS	6/99
800383D ^c	44.38	231.3	190.0 – 188.5	0.05/SS	6/99

^a Wells identified by a “D” are deeper wells monitoring the dolomite bedrock aquifer.

^b Inner diameter (m)/well material (SS = stainless steel).

^c Replacement wells used after July 1, 1999.

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herbicides. Also, during the second quarter, in accordance with the IEPA-approved groundwater monitoring plan, both filtered and unfiltered samples for numerous parameters (e.g., metals, chloride, sulfate) are required. Volatile organics are monitored each quarter, although only required by permit during the second quarter.

6.3.2.2. Sample Analyses - 800 Area

The 800 Area sample analyses were performed using SOPs written, reviewed, and issued as controlled documents by members of ESH-ASCL, PFS-Utilities Laboratory, and ESH-ASRL. These SOPs reference protocols in SW-846.⁸ Fifteen metals were routinely determined and analyzed by using flame atomic absorption spectroscopy, inductively coupled plasma atomic emission spectroscopy, and graphite furnace atomic absorption spectroscopy. Mercury was determined by cold vapor atomic absorption spectroscopy. VOCs were determined by using a purge and trap sample pretreatment, followed by gas chromatography-mass spectroscopy detection. SVOCs were determined by solvent extraction followed by gas chromatography-mass spectroscopy detection. PCBs and pesticides were determined by solvent extraction followed by gas chromatography-electron capture detection. In the case of organic compound analyses, efforts were made to identify compounds that were present but not included on the method list. This was accomplished, and standard solutions of these compounds were prepared and analyzed. TDS were determined gravimetrically. Sulfate determination was performed by using a turbidimetric technique, while chloride was determined by titrimetry. Ammonia nitrogen was determined by using distillation followed by an ion-selective electrode technique.

Some analyses were performed at an off-site contractor laboratory. SW-846⁸ procedures were specified and used. Cyanide and phenol were determined by distillation followed by a spectrophotometric finish. Total organic carbon (TOC) and total organic halogen (TOX) were determined by combustion techniques followed by infrared detection and coulometric titration, respectively. Chlorinated organic compounds and carbamate pesticides were analyzed by extractions followed by gas and liquid chromatography techniques, respectively.

The 800 Area groundwater radiological analyses were performed using SOPs written, reviewed, and issued as controlled documents by members of ESH-ASRL. Hydrogen-3 was determined by distillation followed by a beta liquid scintillation counting technique.

6.3.2.3. Results of Analyses

Descriptions of each well, field parameters measured during sample collection, and the results of chemical and radiological analysis of samples from the wells in the 800 Area are presented in Tables 6.20 to 6.47. All radiological and inorganic analysis results are shown in these tables. The

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analytical methods used for organic compounds could identify and quantify all the compounds contained in the CLP Target Compound List. However, the vast majority of these compounds were not detected in the samples. Only those constituents that were present in amounts great enough to quantify are shown. The detection limits for the organic compounds listed were typically 1 to 5 µg/L. Figures 6.8 to 6.22 show the trends for exceedances of the WQS for wells monitored as part of the IEPA-approved groundwater monitoring program for the sanitary landfill. Results represent filtered samples only because filtered samples are collected each quarter for the constituents presented.

ANL-E chose a conservative approach for evaluating the inorganic monitoring results by selecting as the standard of comparison the Illinois Groundwater Quality Standards for Class I: Potable Resource Groundwater, 35 IAC Part 620.410. The most common constituents at levels above the WQS (see Table 6.15) are chloride, iron, TDS, and manganese. This is consistent with results reported in prior years using the previous well monitoring network. In general, data for the shallow wells indicate exceedances of the manganese, iron, TDS, and chloride WQSs in a number of wells. These results are consistent with results reported in prior years. The intermediate wells have fewer exceedances except for manganese, which exceeded the WQS in each intermediate well. The iron WQS was exceeded in two wells. The results for the deep wells show only manganese exceedances.

Field Parameters. Field parameters include such items as well and water depth information, pH, specific conductance, and temperature of water. These parameters are measured each quarter. No standards exist for comparative purposes, with the exception of pH. However, results are consistent from quarter to quarter and similar to results obtained in previous years.

Filtered Routine Indicator Parameters. Filtered routine indicator parameters include ammonia nitrogen, arsenic, cadmium, chloride, iron, lead, manganese, mercury, sulfate, and TDS. These parameters are measured each quarter. Ammonia, arsenic, cadmium, lead, and mercury were all less than the WQS. Sulfate exceeded the WQS (400 mg/L) in Well 800381 during one quarter. Chloride exceeded the WQS (200 mg/L) in Well 800241 during three quarters, and the chloride levels ranged from 481 to 531 mg/L. Well 800241 is considered an upgradient well. TDS exceeded the WQS (1,200 mg/L) in Well 800241 also during three quarters, and the TDS levels ranged from 1,347 to 1,499 mg/L. Chloride and TDS in Well 800241 are due to road salt runoff, since the well is located within 100 m (300 ft) of a main road and is screened only 2 m (6 ft) below the surface. The other upgradient well, 800271, had no exceedances of the WQS.

Iron concentrations exceeded the WQS (5 mg/L) at least once during the year in Wells 800191, 800192, 800201, 800202, and 800241. Iron levels in these wells ranged from 5 to 143 mg/L.

Manganese concentrations exceeded the WQS (0.15 mg/L) during at least one quarter in Wells 800161, 800381, 800162, 800163D, 800171, 800181, 800191, 800192, 800201, 800202, 800241, 800243D, 800281, 800291, 800301, 800331, and 800341. Manganese levels in these wells ranged from 0.16 to 1.78 mg/L. Manganese appears to be elevated over the entire 800 Landfill area, and

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TABLE 6.20

**Groundwater Monitoring Results, Sanitary Landfill
Well 800161, 1999**

Parameter	Unit	Date of Sampling	
		01/21/99	04/06/99
Water elevation ^a	m	227.49	228.66
Temperature	°C	11.3	9.7
pH	pH	7.37	7.04
Redox	mV	-11	-9
Conductivity	µmhos/cm	1,379	1,384
Chloride ^b	mg/L	65	135
Sulfate ^b	mg/L	142	132
TDS ^b	mg/L	858	848
Cyanide (total) ^c	mg/L	< 0.01	< 0.01
Arsenic ^c	mg/L	-d	0.0204
Barium ^c	mg/L	-	0.2726
Boron ^c	mg/L	-	0.1955
Cadmium ^c	mg/L	-	0.0006
Chromium ^c	mg/L	-	< 0.044
Cobalt ^c	mg/L	-	< 0.026
Copper ^c	mg/L	-	0.0481
Iron ^c	mg/L	-	37.78
Lead ^c	mg/L	-	0.0275
Manganese ^c	mg/L	-	1.281
Mercury ^c	mg/L	-	< 0.0001
Nickel ^c	mg/L	-	0.0435
Selenium ^c	mg/L	-	< 0.003
Silver ^c	mg/L	-	< 0.0005
Zinc ^c	mg/L	-	0.2723
Chlordane	µg/L	-	< 0.5
Ammonia nitrogen ^b	mg/L	0.1	0.2
Arsenic ^b	mg/L	< 0.0025	0.0043
Barium ^b	mg/L	0.1507	0.0552
Beryllium ^b	mg/L	< 0.0002	< 0.0002
Cadmium ^b	mg/L	< 0.0002	< 0.0002
Chromium ^b	mg/L	< 0.044	< 0.044
Cobalt ^b	mg/L	< 0.026	< 0.026
Copper ^b	mg/L	< 0.017	< 0.017
Iron ^b	mg/L	0.4142	1.817
Lead ^b	mg/L	< 0.002	< 0.002
Manganese ^b	mg/L	0.7304	0.0492
Mercury ^b	mg/L	< 0.0001	< 0.0001
Nickel ^b	mg/L	< 0.04	< 0.04
Silver ^b	mg/L	< 0.0005	< 0.0005
Thallium ^b	mg/L	< 0.0015	< 0.0015
Vanadium ^b	mg/L	< 0.024	< 0.024
Zinc ^b	mg/L	< 0.011	< 0.011
Nitrate	mg/L	-	< 0.1
Phenols	mg/L	< 0.005	0.011
Cesium-137	pCi/L	-	< 1.0
Hydrogen-3	pCi/L	325	138
Chloride	mg/L	-	81
Fluoride	mg/L	-	0.306
Sulfate	mg/L	-	129
TOCs	mg/L	13.8	4.1
TOCs	mg/L	12.0	4.0
TOCs	mg/L	13.8	4.2
TOCs	mg/L	14.0	4.2
TOXs	mg/L	0.012	0.071
TOXs	mg/L	0.011	0.079

^a Well point elevation = 222.83 m (MSL); ground surface elevation = 230.76 m (MSL); casing material = stainless steel.

^b Filtered sample.

^c Unfiltered sample.

^d A hyphen indicates that no samples were collected.

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TABLE 6.21

Groundwater Monitoring Results, Sanitary Landfill
Well 800162, 1999

Parameter	Unit	Date of Sampling	
		01/21/99	04/06/99
Water elevation ^a	m	218.63	219.06
Temperature	°C	10.5	10.6
pH	pH	7.26	6.98
Redox	mV	-5	-2
Conductivity	µmhos/cm	1,059	1,070
Chloride ^b	mg/L	54	61
Sulfate ^b	mg/L	74	34
TDS ^b	mg/L	641	645
Cyanide (total) ^c	mg/L	< 0.01	< 0.01
Arsenic ^c	mg/L	- ^d	< 0.0025
Barium ^c	mg/L	-	0.062
Boron ^c	mg/L	-	0.1362
Cadmium ^c	mg/L	-	< 0.0002
Chromium ^c	mg/L	-	< 0.044
Cobalt ^c	mg/L	-	< 0.026
Copper ^c	mg/L	-	< 0.017
Iron ^c	mg/L	-	1.438
Lead ^c	mg/L	-	< 0.002
Manganese ^c	mg/L	-	0.2584
Mercury ^c	mg/L	-	< 0.0001
Nickel ^c	mg/L	-	< 0.04
Selenium ^c	mg/L	-	< 0.003
Silver ^c	mg/L	-	< 0.0005
Zinc ^c	mg/L	-	0.0149
Ammonia nitrogen ^b	mg/L	0.3	0.2
Arsenic ^b	mg/L	0.0027	< 0.0025
Barium ^b	mg/L	0.0644	0.0593
Beryllium ^b	mg/L	< 0.0002	< 0.0002
Cadmium ^b	mg/L	< 0.0002	< 0.0002
Chromium ^b	mg/L	< 0.044	< 0.044
Cobalt ^b	mg/L	< 0.026	< 0.026
Copper ^b	mg/L	< 0.017	< 0.017
Iron ^b	mg/L	1.249	1.149
Lead ^b	mg/L	< 0.002	< 0.002
Manganese ^b	mg/L	0.27	0.254
Mercury ^b	mg/L	< 0.0001	< 0.0001
Nickel ^b	mg/L	< 0.04	< 0.04
Silver ^b	mg/L	< 0.0005	< 0.0005
Thallium ^b	mg/L	< 0.0015	< 0.0015
Vanadium ^b	mg/L	< 0.024	< 0.024
Zinc ^b	mg/L	< 0.011	< 0.011
Nitrate	mg/L	-	< 0.1
Phenols	mg/L	< 0.005	< 0.005
Hydrogen-3	pCi/L	< 100	< 100
Chloride	mg/L	-	60
Fluoride	mg/L	-	0.252
Sulfate	mg/L	-	34
TOCs	mg/L	4.7	3.8
TOCs	mg/L	4.6	3.6
TOCs	mg/L	4.5	3.6
TOCs	mg/L	4.6	3.7
TOXs	mg/L	0.039	0.045
TOXs	mg/L	0.035	0.022

^a Well point elevation = 183.79 m (MSL); ground surface elevation = 230.76 m (MSL); casing material = stainless steel.

^b Filtered sample.

^c Unfiltered sample.

^d A hyphen indicates that no samples were collected.

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TABLE 6.22

Groundwater Monitoring Results, Sanitary Landfill
Well 800163D, 1999

Parameter	Unit	Date of Sampling	
		01/21/99	04/06/99
Water elevation ^a	m	192.97	192.77
Temperature	°C	11.2	11.1
pH	pH	7.25	7.13
Redox	mV	-4	-12
Conductivity	µmhos/cm	1,339	1,354
Chloride ^b	mg/L	134	61
Sulfate ^b	mg/L	190	187
TDS ^b	mg/L	881	871
Cyanide (total) ^c	mg/L	< 0.01	0.012
Arsenic ^c	mg/L	- ^d	0.0097
Barium ^c	mg/L	-	0.0768
Boron ^c	mg/L	-	0.1911
Cadmium ^c	mg/L	-	< 0.0002
Chromium ^c	mg/L	-	< 0.044
Cobalt ^c	mg/L	-	< 0.026
Copper ^c	mg/L	-	< 0.017
Iron ^c	mg/L	-	6.754
Lead ^c	mg/L	-	< 0.002
Manganese ^c	mg/L	-	0.0609
Mercury ^c	mg/L	-	< 0.0001
Nickel ^c	mg/L	-	< 0.04
Selenium ^c	mg/L	-	< 0.003
Silver ^c	mg/L	-	0.0008
Zinc ^c	mg/L	-	0.3128
Ammonia nitrogen ^b	mg/L	0.7	1.0
Arsenic ^b	mg/L	0.0051	< 0.0025
Barium ^b	mg/L	0.0551	0.1321
Beryllium ^b	mg/L	< 0.0002	< 0.0002
Cadmium ^b	mg/L	< 0.0002	< 0.0002
Chromium ^b	mg/L	< 0.044	< 0.044
Cobalt ^b	mg/L	< 0.026	< 0.026
Copper ^b	mg/L	< 0.017	< 0.017
Iron ^b	mg/L	1.984	0.5192
Lead ^b	mg/L	< 0.002	< 0.002
Manganese ^b	mg/L	0.0505	0.6039
Mercury ^b	mg/L	< 0.0001	< 0.0001
Nickel ^b	mg/L	< 0.04	< 0.04
Silver ^b	mg/L	< 0.0005	< 0.0005
Thallium ^b	mg/L	< 0.0015	< 0.0015
Vanadium ^b	mg/L	< 0.024	< 0.024
Zinc ^b	mg/L	< 0.011	0.0239
Nitrate	mg/L	-	< 0.1
Phenols	mg/L	< 0.005	< 0.005
Hydrogen-3	pCi/L	< 100	< 100
Chloride	mg/L	-	139
Fluoride	mg/L	-	0.376
Sulfate	mg/L	-	184
TOCs	mg/L	2.8	2.5
TOCs	mg/L	2.7	2.4
TOCs	mg/L	2.8	2.4
TOCs	mg/L	2.8	2.4
TOXs	mg/L	0.026	0.076
TOXs	mg/L	0.037	0.059

^a Well point elevation = 183.79 m (MSL); ground surface elevation = 230.76 m (MSL); casing material = stainless steel.

^b Filtered sample.

^c Unfiltered sample.

^d A hyphen indicates that no samples were collected.

6. GROUNDWATER PROTECTION

TABLE 6.23

Groundwater Monitoring Results, Sanitary Landfill
Well 800381, 1999

Parameter	Unit	Date of Sampling	
		08/10/99	10/01/99
Water elevation ^a	m	227.31	226.77
Temperature	°C	12.2	12.9
pH	pH	7.05	7.06
Redox	mV	7	10
Conductivity	µmhos/c	1,399	2,150
Chloride ^b	mg/L	37	110
Sulfate ^b	mg/L	161	456
TDS ^b	mg/L	854	959
Cyanide (total)	mg/L	< 0.01	< 0.01
Ammonia	mg/L	< 0.1	< 0.1
Arsenic ^b	mg/L	0.0136	0.0043
Barium ^b	mg/L	0.1007	0.0509
Beryllium ^b	mg/L	< 0.0002	< 0.0002
Cadmium ^b	mg/L	< 0.0002	< 0.0002
Chromium ^b	mg/L	< 0.044	< 0.044
Cobalt ^b	mg/L	< 0.026	< 0.026
Copper ^b	mg/L	< 0.017	< 0.017
Iron ^b	mg/L	0.6839	< 0.037
Lead ^b	mg/L	< 0.002	< 0.002
Manganese ^b	mg/L	0.2097	0.2293
Mercury ^b	mg/L	< 0.0001	< 0.0001
Nickel ^b	mg/L	< 0.04	< 0.04
Silver ^b	mg/L	< 0.0005	< 0.0005
Thallium ^b	mg/L	< 0.0015	< 0.0015
Vanadium ^b	mg/L	< 0.024	< 0.024
Zinc ^b	mg/L	< 0.011	< 0.011
Phenols	mg/L	0.006	0.010
Hydrogen-3	pCi/L	< 100	< 100
TOCs	mg/L	3.9	3.8
TOCs	mg/L	3.6	3.9
TOCs	mg/L	4.1	3.8
TOCs	mg/L	3.6	4.2
TOXs	mg/L	0.019	0.040
TOXs	mg/L	0.018	0.041

^a Well point elevation = 225.20 m (MSL); ground surface elevation = 232.00 m (MSL); casing material = stainless steel.

^b Filtered sample.

6. GROUNDWATER PROTECTION

TABLE 6.24

Groundwater Monitoring Results, Sanitary Landfill
Well 800382, 1999

Parameter	Unit	Date of Sampling	
		08/10/99	10/01/99
Water elevation ^a	m	219.83	219.31
Temperature	°C	11.2	13.9
pH	pH	7.14	7.54
Redox	mV	-5	-22
Conductivity	µmhos/cm	998	985
Chloride ^b	mg/L	58	80
Sulfate ^b	mg/L	52	69
TDS ^b	mg/L	665	652
Cyanide (total)	mg/L	< 0.01	< 0.01
Ammonia nitrogen ^b	mg/L	0.4	0.3
Arsenic ^b	mg/L	< 0.0025	< 0.0025
Barium ^b	mg/L	0.1160	0.1115
Beryllium ^b	mg/L	< 0.0002	< 0.0002
Cadmium ^b	mg/L	< 0.0002	< 0.0002
Chromium ^b	mg/L	< 0.044	< 0.044
Cobalt ^b	mg/L	< 0.026	< 0.026
Copper ^b	mg/L	< 0.017	< 0.017
Iron ^b	mg/L	0.1726	0.0727
Lead ^b	mg/L	< 0.002	< 0.002
Manganese ^b	mg/L	0.0837	0.0627
Mercury ^b	mg/L	< 0.0001	< 0.0001
Nickel ^b	mg/L	< 0.04	< 0.04
Silver ^b	mg/L	< 0.0005	< 0.0005
Thallium ^b	mg/L	< 0.0015	< 0.0015
Vanadium ^b	mg/L	< 0.024	< 0.024
Zinc ^b	mg/L	< 0.011	< 0.011
Phenols	mg/L	0.014	0.014
Hydrogen-3	pCi/L	< 100	< 100
TOCs	mg/L	3.5	2.8
TOCs	mg/L	3.4	3.0
TOCs	mg/L	3.5	2.5
TOCs	mg/L	3.9	2.4
TOXs	mg/L	0.019	0.037
TOXs	mg/L	0.024	0.034
Methylene chloride	µg/L	1	< 1

^a Well point elevation = 213.00 m (MSL); ground surface elevation = 232.10 m (MSL); casing material = stainless steel.

^b Filtered sample.

6. GROUNDWATER PROTECTION

TABLE 6.25

Groundwater Monitoring Results, Sanitary Landfill
Well 800383D, 1999

Parameter	Unit	Date of Sampling	
		08/10/99	10/01/99
Water elevation ^a	m	193.23	192.94
Temperature	°C	13.6	12.5
pH	pH	7.29	7.54
Redox	mV	-10	-11
Conductivity	µmhos/cm	1,267	1,302
Chloride ^b	mg/L	117	129
Sulfate ^b	mg/L	130	150
TDS ^b	mg/L	863	851
Cyanide (total)	mg/L	< 0.01	< 0.01
Ammonia nitrogen ^b	mg/L	0.7	0.6
Arsenic ^b	mg/L	< 0.0025	< 0.0025
Barium ^b	mg/L	0.0825	0.0778
Beryllium ^b	mg/L	< 0.0002	< 0.0002
Cadmium ^b	mg/L	< 0.0002	< 0.0002
Chromium ^b	mg/L	< 0.044	< 0.044
Cobalt ^b	mg/L	< 0.026	< 0.026
Copper ^b	mg/L	< 0.017	< 0.017
Iron ^b	mg/L	0.6598	0.8966
Lead ^b	mg/L	< 0.002	< 0.002
Manganese ^b	mg/L	0.1478	0.0872
Mercury ^b	mg/L	< 0.0001	< 0.0001
Nickel ^b	mg/L	< 0.04	< 0.04
Silver ^b	mg/L	< 0.0005	< 0.0005
Thallium ^b	mg/L	< 0.0015	< 0.0015
Vanadium ^b	mg/L	< 0.024	< 0.024
Zinc ^b	mg/L	< 0.011	< 0.011
Phenols	mg/L	< 0.005	0.009
Hydrogen-3	pCi/L	< 100	< 100
TOCs	mg/L	2.2	1.4
TOCs	mg/L	2.1	1.4
TOCs	mg/L	2.1	1.4
TOCs	mg/L	3.0	1.4
TOXs	mg/L	0.027	0.028
TOXs	mg/L	0.041	0.025
Dibromomethane	µg/L	1	< 1

^a Well point elevation = 188.50 m (MSL); ground surface elevation = 232.20 m (MSL); casing material = stainless steel.

^b Filtered sample.

6. GROUNDWATER PROTECTION

TABLE 6.26

Groundwater Monitoring Results, Sanitary Landfill Well 800171, 1999

Parameter	Unit	Date of Sampling				
		01/18/99	04/07/99	07/13/99	07/13/99	10/04/99
Water elevation ^a	m	226.20	226.17	225.75	225.75	225.69
Temperature	°C	11.3	11.1	13.3	13.3	12.4
pH	pH	6.97	6.73	6.67	6.67	7.21
Redox	mV	11	13	19	19	-3
Conductivity	µmhos/cm	1,516	1,420	1,414	1,414	1,398
Chloride ^b	mg/L	32	29	22	22	22
Sulfate ^b	mg/L	190	191	201	205	197
TDS ^b	mg/L	976	941	921	914	925
Cyanide (total) ^c	mg/L	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Arsenic ^c	mg/L	- ^d	< 0.0025	-	-	-
Barium ^c	mg/L	-	0.1131	-	-	-
Boron ^c	mg/L	-	0.1378	-	-	-
Cadmium ^c	mg/L	-	< 0.0002	-	-	-
Chromium ^c	mg/L	-	< 0.044	-	-	-
Cobalt ^c	mg/L	-	< 0.026	-	-	-
Copper ^c	mg/L	-	< 0.017	-	-	-
Iron ^c	mg/L	-	5.979	-	-	-
Lead ^c	mg/L	-	0.004	-	-	-
Manganese ^c	mg/L	-	0.6105	-	-	-
Mercury ^c	mg/L	-	< 0.0001	-	-	-
Nickel ^c	mg/L	-	< 0.04	-	-	-
Selenium ^c	mg/L	-	< 0.003	-	-	-
Silver ^c	mg/L	-	< 0.0005	-	-	-
Zinc ^c	mg/L	-	0.0832	-	-	-
Ammonia nitrogen ^b	mg/L	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Arsenic ^b	mg/L	< 0.0025	< 0.0025	< 0.0025	< 0.0025	0.0030
Barium ^b	mg/L	0.0702	0.0715	0.0670	0.0652	0.0690
Beryllium ^b	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Cadmium ^b	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium ^b	mg/L	< 0.044	< 0.044	< 0.044	< 0.044	< 0.044
Cobalt ^b	mg/L	< 0.026	< 0.026	< 0.026	< 0.026	< 0.026
Copper ^b	mg/L	< 0.017	< 0.017	< 0.017	< 0.017	< 0.017
Iron ^b	mg/L	< 0.037	< 0.037	< 0.037	< 0.037	< 0.037
Lead ^b	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Manganese ^b	mg/L	0.2513	0.1942	0.4032	0.4001	0.2372
Mercury ^b	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel ^b	mg/L	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04
Silver ^b	mg/L	< 0.0005	0.0005	< 0.0005	< 0.0005	0.0005
Thallium ^b	mg/L	< 0.0015	< 0.0015	< 0.0015	< 0.0015	< 0.0015
Vanadium ^b	mg/L	< 0.024	< 0.024	< 0.024	< 0.024	< 0.024
Zinc ^b	mg/L	0.0129	0.0330	< 0.0110	< 0.0110	0.0115
Nitrate	mg/L	-	< 0.1	-	-	-
Phenols	mg/L	< 0.005	0.007	< 0.005	< 0.005	0.008
Cesium-137	pCi/L	-	< 1.0	-	-	-
Hydrogen-3	pCi/L	155	108	< 100	< 100	< 100
Chloride	mg/L	-	29	-	-	-
Fluoride	mg/L	-	0.186	-	-	-
Sulfate	mg/L	-	199	-	-	-
TOCs	mg/L	3.1	2.3	3.6	3.1	2.5
TOCs	mg/L	3.4	2.4	3.6	3.1	2.5
TOCs	mg/L	3.2	2.3	3.5	3.1	2.5
TOCs	mg/L	3.2	2.4	3.3	3.1	2.6
TOXs	mg/L	0.037	0.028	0.023	0.035	0.018
TOXs	mg/L	0.030	0.025	0.029	0.038	0.014
Trichloroethene	µg/L	1	1	1	1	1

^a Well point elevation = 220.71 m (MSL); ground surface elevation = 228.42 m (MSL); casing material = stainless steel.

^b Filtered sample.

^c Unfiltered sample.

^d A hyphen indicates that no samples were collected.

6. GROUNDWATER PROTECTION

TABLE 6.27

Groundwater Monitoring Results, Sanitary Landfill Well 800173D, 1999

Parameter	Unit	Date of Sampling				
		01/18/99	01/18/99	04/07/99	07/13/99	10/04/99
Water elevation ^a	m	192.70	192.70	192.64	192.53	192.15
Temperature	°C	10.3	10.3	12.9	12.5	10.7
pH	pH	7.3	7.3	7.07	7.09	7.35
Redox	mV	-5	-5	-6	-5	-8
Conductivity	µmhos/cm	1,445	1,445	1,307	1,354	1,297
Chloride ^b	mg/L	197	181	178	159	156
Sulfate ^b	mg/L	109	90	103	100	89
TDS ^b	mg/L	897	888	857	898	826
Cyanide (total) ^c	mg/L	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Arsenic ^c	mg/L	- ^d	-	0.0055	-	-
Barium ^c	mg/L	-	-	0.0922	-	-
Boron ^c	mg/L	-	-	0.1733	-	-
Cadmium ^c	mg/L	-	-	< 0.0002	-	-
Chromium ^c	mg/L	-	-	< 0.044	-	-
Cobalt ^c	mg/L	-	-	< 0.026	-	-
Copper ^c	mg/L	-	-	< 0.017	-	-
Iron ^c	mg/L	-	-	3.656	-	-
Lead ^c	mg/L	-	-	< 0.002	-	-
Manganese ^c	mg/L	-	-	0.0754	-	-
Mercury ^c	mg/L	-	-	< 0.0001	-	-
Nickel ^c	mg/L	-	-	< 0.04	-	-
Selenium ^c	mg/L	-	-	< 0.003	-	-
Silver ^c	mg/L	-	-	< 0.0005	-	-
Zinc ^c	mg/L	-	-	< 0.011	-	-
Ammonia nitrogen ^b	mg/L	0.9	0.9	0.5	0.4	0.6
Arsenic ^b	mg/L	0.0062	0.0068	0.0054	0.0041	0.0030
Barium ^b	mg/L	0.0862	0.0824	0.0818	0.0850	0.0630
Beryllium ^b	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Cadmium ^b	mg/L	< 0.0002	0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium ^b	mg/L	< 0.044	< 0.044	< 0.044	< 0.044	< 0.044
Cobalt ^b	mg/L	< 0.026	< 0.026	< 0.026	< 0.026	< 0.026
Copper ^b	mg/L	< 0.017	< 0.017	< 0.017	< 0.017	< 0.017
Iron ^b	mg/L	3.345	3.403	3.148	2.700	1.403
Lead ^b	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Manganese ^b	mg/L	0.0720	0.0732	0.0727	0.0891	0.0826
Mercury ^b	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel ^b	mg/L	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04
Silver ^b	mg/L	< 0.0005	< 0.0005	0.0006	< 0.0005	< 0.0005
Thallium ^b	mg/L	< 0.0015	< 0.0015	< 0.0015	< 0.0015	< 0.0015
Vanadium ^b	mg/L	< 0.024	< 0.024	< 0.024	< 0.024	< 0.024
Zinc ^b	mg/L	< 0.011	< 0.011	< 0.011	< 0.011	< 0.011
Nitrate	mg/L	-	-	< 0.1	-	-
Phenols	mg/L	< 0.005	< 0.005	< 0.005	< 0.005	0.008
Hydrogen-3	pCi/L	< 100	< 100	< 100	< 100	< 100
Chloride	mg/L	-	-	175	-	-
Fluoride	mg/L	-	-	0.352	-	-
Sulfate	mg/L	-	-	107	-	-
TOCs	mg/L	5.0	5.1	3.3	3.7	3.0
TOCs	mg/L	5.0	4.9	3.2	3.4	3.1
TOCs	mg/L	4.8	4.9	3.3	3.6	3.0
TOCs	mg/L	4.8	4.9	3.3	3.8	3.1
TOXs	mg/L	0.025	0.037	0.038	0.029	0.034
TOXs	mg/L	0.049	0.039	0.051	0.025	0.030

^a Well point elevation = 189.34 m (MSL); ground surface elevation = 228.42 m (MSL); casing material = stainless steel.

^b Filtered sample.

^c Unfiltered sample.

^d A hyphen indicates that no samples were collected.

6. GROUNDWATER PROTECTION

TABLE 6.28

Groundwater Monitoring Results, Sanitary Landfill Well 800181, 1999

Parameter	Unit	Date of Sampling			
		01/18/99	04/08/99	07/13/99	10/04/99
Water elevation ^a	m	222.67	223.07	222.75	221.55
Temperature	°C	10.0	10.8	11.1	9.8
pH	pH	8.03	6.75	7.07	7.49
Redox	mV	-38	8	-4	-8
Conductivity	µmhos/cm	1,404	1,182	1,155	1,161
Chloride ^b	mg/L	4	5	6	4
Sulfate ^b	mg/L	206	215	221	205
TDS ^b	mg/L	773	773	817	749
Cyanide (total) ^c	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Arsenic ^c	mg/L	- ^d	0.0038	-	-
Barium ^c	mg/L	-	0.1605	-	-
Boron ^c	mg/L	-	0.1229	-	-
Cadmium ^c	mg/L	-	< 0.0002	-	-
Chromium ^c	mg/L	-	< 0.044	-	-
Cobalt ^c	mg/L	-	< 0.026	-	-
Copper ^c	mg/L	-	< 0.017	-	-
Iron ^c	mg/L	-	13.06	-	-
Lead ^c	mg/L	-	0.005	-	-
Manganese ^c	mg/L	-	0.216	-	-
Mercury ^c	mg/L	-	< 0.0001	-	-
Nickel ^c	mg/L	-	< 0.04	-	-
Selenium ^c	mg/L	-	< 0.003	-	-
Silver ^c	mg/L	-	< 0.0005	-	-
Zinc ^c	mg/L	-	0.0487	-	-
Ammonia nitrogen ^b	mg/L	<0.1	< 0.1	< 0.1	< 0.1
Arsenic ^b	mg/L	< 0.0025	< 0.0025	< 0.0025	< 0.0025
Barium ^b	mg/L	0.0848	0.0877	0.0737	0.0773
Beryllium ^b	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Cadmium ^b	mg/L	< 0.0002	0.0006	< 0.0002	< 0.0002
Chromium ^b	mg/L	< 0.044	< 0.044	< 0.044	< 0.044
Cobalt ^b	mg/L	< 0.026	< 0.026	< 0.026	< 0.026
Copper ^b	mg/L	< 0.017	< 0.017	< 0.017	< 0.017
Iron ^b	mg/L	< 0.037	< 0.037	< 0.037	< 0.037
Lead ^b	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Manganese ^b	mg/L	< 0.017	< 0.017	< 0.017	< 0.017
Mercury ^b	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel ^b	mg/L	< 0.04	< 0.04	< 0.04	< 0.04
Silver ^b	mg/L	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Thallium ^b	mg/L	< 0.0015	< 0.0015	< 0.0015	< 0.0015
Vanadium ^b	mg/L	< 0.024	< 0.024	< 0.024	< 0.024
Zinc ^b	mg/L	0.0309	< 0.011	0.0403	0.0331
Nitrate	mg/L	-	< 0.1	-	-
Phenols	mg/L	< 0.005	< 0.005	< 0.005	0.011
Hydrogen-3	pCi/L	< 100	< 100	< 100	< 100
Chloride	mg/L	-	5	-	-
Fluoride	mg/L	-	0.256	-	-
Sulfate	mg/L	-	211	-	-
TOCs	mg/L	1.9	1.3	1.7	1.4
TOCs	mg/L	1.9	1.3	1.9	1.3
TOCs	mg/L	2.0	1.4	1.6	1.3
TOCs	mg/L	2.0	1.3	1.7	1.7
TOXs	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
TOXs	mg/L	< 0.01	< 0.01	< 0.01	< 0.01

^a Well point elevation = 219.52 m (MSL); ground surface elevation = 230.52 m (MSL); casing material = stainless steel.

^b Filtered sample.

^c Unfiltered sample.

^d A hyphen indicates that no samples were collected.

6. GROUNDWATER PROTECTION

TABLE 6.29

Groundwater Monitoring Results, Sanitary Landfill Well 800183D, 1999

Parameter	Unit	Date of Sampling			
		01/18/99	04/08/99	07/13/99	10/04/99
Water elevation ^a	m	192.71	192.69	192.52	192.14
Temperature	°C	9.7	12.1	11.8	10.9
pH	pH	7.38	7.09	7.34	7.52
Redox	mV	-10	-5	-16	-13
Conductivity	µmhos/cm	1,285	1,278	1,269	1,253
Chloride ^b	mg/L	112	120	94	115
Sulfate ^b	mg/L	186	203	205	197
TDS ^b	mg/L	843	802	850	814
Cyanide (total) ^c	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Arsenic ^c	mg/L	- ^d	0.0028	-	-
Barium ^c	mg/L	-	0.0436	-	-
Boron ^c	mg/L	-	0.1778	-	-
Cadmium ^c	mg/L	-	< 0.0002	-	-
Chromium ^c	mg/L	-	< 0.044	-	-
Cobalt ^c	mg/L	-	< 0.026	-	-
Copper ^c	mg/L	-	< 0.017	-	-
Iron ^c	mg/L	-	1.417	-	-
Lead ^c	mg/L	-	< 0.002	-	-
Manganese ^c	mg/L	-	< 0.017	-	-
Mercury ^c	mg/L	-	< 0.0001	-	-
Nickel ^c	mg/L	-	< 0.04	-	-
Selenium ^c	mg/L	-	< 0.003	-	-
Silver ^c	mg/L	-	< 0.0005	-	-
Zinc ^c	mg/L	-	< 0.011	-	-
Ammonia nitrogen ^b	mg/L	1.0	0.4	0.5	0.8
Arsenic ^b	mg/L	< 0.0025	< 0.0025	< 0.0025	< 0.0025
Barium ^b	mg/L	0.0465	0.0390	0.0476	0.0496
Beryllium ^b	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Cadmium ^b	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium ^b	mg/L	< 0.044	< 0.044	< 0.044	< 0.044
Cobalt ^b	mg/L	< 0.026	< 0.026	< 0.026	< 0.026
Copper ^b	mg/L	< 0.017	< 0.017	< 0.017	< 0.017
Iron ^b	mg/L	0.8128	0.7509	0.6550	0.6624
Lead ^b	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Manganese ^b	mg/L	< 0.017	< 0.017	< 0.017	< 0.017
Mercury ^b	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel ^b	mg/L	< 0.04	< 0.04	< 0.04	< 0.04
Silver ^b	mg/L	< 0.0005	< 0.0005	< 0.0005	0.0007
Thallium ^b	mg/L	< 0.0015	< 0.0015	< 0.0015	< 0.0015
Vanadium ^b	mg/L	< 0.024	< 0.024	< 0.024	< 0.024
Zinc ^b	mg/L	< 0.011	< 0.011	< 0.011	< 0.011
Nitrate	mg/L	-	< 0.1	-	-
Phenols	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Hydrogen-3	pCi/L	< 100	< 100	< 100	< 100
Chloride	mg/L	-	116	-	-
Fluoride	mg/L	-	0.27	-	-
Sulfate	mg/L	-	211	-	-
TOCs	mg/L	2.5	1.8	2.3	2.2
TOCs	mg/L	2.4	1.8	2.3	2.4
TOCs	mg/L	2.3	1.9	2.3	2.3
TOCs	mg/L	2.3	1.9	2.4	2.2
TOXs	mg/L	0.015	< 0.010	0.023	0.028
TOXs	mg/L	0.017	0.012	0.023	0.029
Chloroform	µg/L	< 1	< 1	< 1	1

^a Well point elevation = 180.44 m (MSL); ground surface elevation = 230.37 m (MSL); casing material = stainless steel.

^b Filtered sample.

^c Unfiltered sample.

^d A hyphen indicates that no samples were collected.

6. GROUNDWATER PROTECTION

TABLE 6.30

Groundwater Monitoring Results, Sanitary Landfill Well 800191, 1999

Parameter	Unit	Date of Sampling			
		01/19/99	04/07/99	07/14/99	10/01/99
Water elevation ^a	m	225.73	225.69	225.19	224.97
Temperature	°C	9.6	10.5	12.1	12.7
pH	pH	6.98	6.75	7.03	6.81
Redox	mV	10	10	7	19
Conductivity	µmhos/cm	2,010	1,939	1,785	1,563
Chloride ^b	mg/L	172	125	87	101
Sulfate ^b	mg/L	202	199	208	181
TDS ^b	mg/L	1,481	1,491	1,364	1,022
Cyanide (total) ^c	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Arsenic ^c	mg/L	- ^d	0.0041	-	-
Barium ^c	mg/L	-	0.1615	-	-
Boron ^c	mg/L	-	0.1484	-	-
Cadmium ^c	mg/L	-	0.0002	-	-
Chromium ^c	mg/L	-	< 0.044	-	-
Cobalt ^c	mg/L	-	< 0.026	-	-
Copper ^c	mg/L	-	0.019	-	-
Iron ^c	mg/L	-	34.24	-	-
Lead ^c	mg/L	-	0.0088	-	-
Manganese ^c	mg/L	-	1.536	-	-
Mercury ^c	mg/L	-	< 0.0001	-	-
Nickel ^c	mg/L	-	< 0.04	-	-
Selenium ^c	mg/L	-	< 0.003	-	-
Silver ^c	mg/L	-	< 0.0005	-	-
Zinc ^c	mg/L	-	0.0887	-	-
Ammonia nitrogen ^b	mg/L	0.5	0.4	0.5	0.5
Arsenic ^b	mg/L	< 0.0025	< 0.0025	< 0.0025	< 0.0025
Barium ^b	mg/L	0.0822	0.0654	0.0713	0.0638
Beryllium ^b	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Cadmium ^b	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium ^b	mg/L	< 0.044	< 0.044	< 0.044	< 0.044
Cobalt ^b	mg/L	< 0.026	< 0.026	< 0.026	< 0.026
Copper ^b	mg/L	< 0.017	< 0.017	< 0.017	< 0.017
Iron ^b	mg/L	3.470	5.474	3.767	2.397
Lead ^b	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Manganese ^b	mg/L	1.635	1.364	1.426	1.467
Mercury ^b	mg/L	< 0.0001	0.0001	< 0.0001	< 0.0001
Nickel ^b	mg/L	< 0.04	< 0.04	< 0.04	< 0.04
Silver ^b	mg/L	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Thallium ^b	mg/L	< 0.0015	< 0.0015	< 0.0015	< 0.0015
Vanadium ^b	mg/L	< 0.024	< 0.024	< 0.024	< 0.024
Zinc ^b	mg/L	0.0192	0.0234	< 0.011	< 0.011
Nitrate	mg/L	-	< 0.1	-	-
Phenols	mg/L	< 0.005	< 0.005	< 0.005	0.039
Cesium-137	pCi/L	-	< 1.0	-	-
Hydrogen-3	pCi/L	110	< 100	< 100	< 100
Chloride	mg/L	-	122	-	-
Fluoride	mg/L	-	0.196	-	-
Sulfate	mg/L	-	203	-	-
TOCs	mg/L	6.3	7.1	6.5	6.7
TOCs	mg/L	6.0	7.2	6.7	7.3
TOCs	mg/L	6.1	7.0	6.6	7.6
TOCs	mg/L	6.1	7.0	6.5	7.6
TOXs	mg/L	0.040	0.041	0.021	0.028
TOXs	mg/L	0.023	0.048	0.026	0.027

^a Well point elevation = 222.77 m (MSL); ground surface elevation = 227.38 m (MSL); casing material = stainless steel.

^b Filtered sample.

^c Unfiltered sample.

^d A hyphen indicates that no samples were collected.

6. GROUNDWATER PROTECTION

TABLE 6.31

Groundwater Monitoring Results, Sanitary Landfill Well 800192, 1999

Parameter	Unit	Date of Sampling				
		01/19/99	04/07/99	07/14/99	10/01/99	10/01/99
Water elevation ^a	m	222.25	222.21	221.64	220.22	220.22
Temperature	°C	10.8	11.6	11.5	11.6	11.6
pH	pH	6.98	6.96	7.32	6.70	6.70
Redox	mV	13	1	-17	30	30
Conductivity	µmhos/cm	1,477	1,464	1,474	1,446	1,446
Chloride ^b	mg/L	75	74	69	71	67
Sulfate ^b	mg/L	111	129	140	130	132
TDS ^b	mg/L	1,098	1,014	1,150	1,008	1,028
Cyanide (total) ^c	mg/L	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Arsenic ^c	mg/L	- ^d	0.0134	-	-	-
Barium ^c	mg/L	-	0.6524	-	-	-
Boron ^c	mg/L	-	0.1033	-	-	-
Cadmium ^c	mg/L	-	< 0.0002	-	-	-
Chromium ^c	mg/L	-	< 0.044	-	-	-
Cobalt ^c	mg/L	-	< 0.026	-	-	-
Copper ^c	mg/L	-	< 0.017	-	-	-
Iron ^c	mg/L	-	21.02	-	-	-
Lead ^c	mg/L	-	0.005	-	-	-
Manganese ^c	mg/L	-	0.137	-	-	-
Mercury ^c	mg/L	-	< 0.0001	-	-	-
Nickel ^c	mg/L	-	< 0.04	-	-	-
Selenium ^c	mg/L	-	< 0.003	-	-	-
Silver ^c	mg/L	-	< 0.0005	-	-	-
Zinc ^c	mg/L	-	0.0196	-	-	-
Ammonia nitrogen ^b	mg/L	1.0	0.6	0.6	0.9	1.0
Arsenic ^b	mg/L	< 0.0025	< 0.0025	< 0.0025	< 0.0025	< 0.0025
Barium ^b	mg/L	0.3691	0.3427	0.4194	0.4092	0.0198
Beryllium ^b	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Cadmium ^b	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium ^b	mg/L	< 0.044	< 0.044	< 0.044	< 0.044	< 0.044
Cobalt ^b	mg/L	< 0.026	< 0.026	< 0.026	< 0.026	< 0.026
Copper ^b	mg/L	< 0.017	< 0.017	< 0.017	< 0.017	< 0.017
Iron ^b	mg/L	5.914	4.576	5.548	6.899	8.958
Lead ^b	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Manganese ^b	mg/L	0.2621	0.1237	0.1318	0.1720	0.1947
Mercury ^b	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel ^b	mg/L	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04
Silver ^b	mg/L	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Thallium ^b	mg/L	< 0.0015	< 0.0015	< 0.0015	< 0.0015	< 0.0015
Vanadium ^b	mg/L	< 0.024	< 0.024	< 0.024	< 0.024	< 0.024
Zinc ^b	mg/L	< 0.011	< 0.011	< 0.011	< 0.011	< 0.011
Nitrate	mg/L	-	0.14	-	-	-
Phenols	mg/L	< 0.005	< 0.005	< 0.005	0.005	0.010
Cesium-137	pCi/L	-	< 1.0	-	-	-
Hydrogen-3	pCi/L	384	358	333	400	454
Chloride	mg/L	-	75	-	-	-
Fluoride	mg/L	-	0.398	-	-	-
Sulfate	mg/L	-	129	-	-	-
TOCs	mg/L	14.5	9.1	9.1	11.9	11.6
TOCs	mg/L	14.3	9.2	9.0	11.1	12.0
TOCs	mg/L	14.4	9.1	9.1	12.7	12.3
TOCs	mg/L	14.3	9.0	9.2	11.1	11.9
TOXs	mg/L	0.033	< 0.010	0.024	0.033	0.025
TOXs	mg/L	0.034	< 0.010	0.026	0.026	0.031

^a Well point elevation = 208.71 m (MSL); ground surface elevation = 227.38 m (MSL); casing material = stainless steel.

^b Filtered sample.

^c Unfiltered sample.

^d A hyphen indicates that no samples were collected.

6. GROUNDWATER PROTECTION

TABLE 6.32

Groundwater Monitoring Results, Sanitary Landfill Well 800193D, 1999

Parameter	Unit	Date of Sampling			
		01/19/99	04/07/99	07/14/99	10/01/99
Water elevation ^a	m	192.57	192.60	192.52	192.18
Temperature	°C	10.6	12.3	11.8	11.3
pH	pH	7.22	7.03	7.38	6.88
Redox	mV	-3	-6	-20	11
Conductivity	µmhos/cm	1,325	1,321	1,310	1,296
Chloride ^b	mg/L	114	114	111	116
Sulfate ^b	mg/L	175	211	213	189
TDS ^b	mg/L	870	857	921	852
Cyanide (total) ^c	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Arsenic ^c	mg/L	- ^d	0.0031	-	-
Barium ^c	mg/L	-	0.0732	-	-
Boron ^c	mg/L	-	0.2163	-	-
Cadmium ^c	mg/L	-	< 0.0002	-	-
Chromium ^c	mg/L	-	< 0.044	-	-
Cobalt ^c	mg/L	-	< 0.026	-	-
Copper ^c	mg/L	-	< 0.017	-	-
Iron ^c	mg/L	-	2.384	-	-
Lead ^c	mg/L	-	< 0.002	-	-
Manganese ^c	mg/L	-	0.029	-	-
Mercury ^c	mg/L	-	< 0.0001	-	-
Nickel ^c	mg/L	-	< 0.04	-	-
Selenium ^c	mg/L	-	< 0.003	-	-
Silver ^c	mg/L	-	< 0.0005	-	-
Zinc ^c	mg/L	-	0.0274	-	-
Ammonia nitrogen ^b	mg/L	0.8	0.5	0.4	0.5
Arsenic ^b	mg/L	< 0.0025	< 0.0025	< 0.0025	< 0.0025
Barium ^b	mg/L	0.0562	0.0547	0.0615	0.0568
Beryllium ^b	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Cadmium ^b	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium ^b	mg/L	< 0.044	< 0.044	< 0.044	< 0.044
Cobalt ^b	mg/L	< 0.026	< 0.026	< 0.026	< 0.026
Copper ^b	mg/L	< 0.017	< 0.017	< 0.017	< 0.017
Iron ^b	mg/L	1.027	0.8139	0.6487	0.9495
Lead ^b	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Manganese ^b	mg/L	0.0453	0.0403	0.032	0.025
Mercury ^b	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel ^b	mg/L	< 0.04	< 0.04	< 0.04	< 0.04
Silver ^b	mg/L	< 0.0005	0.0005	< 0.0005	< 0.0005
Thallium ^b	mg/L	< 0.0015	< 0.0015	< 0.0015	< 0.0015
Vanadium ^b	mg/L	< 0.024	< 0.024	< 0.024	< 0.024
Zinc ^b	mg/L	< 0.011	< 0.011	< 0.011	< 0.011
Nitrate	mg/L	-	< 0.1	-	-
Phenols	mg/L	0.018	< 0.005	< 0.005	< 0.005
Hydrogen-3	pCi/L	< 100	< 100	< 100	< 100
Chloride	mg/L	-	110	-	-
Fluoride	mg/L	-	0.312	-	-
Sulfate	mg/L	-	218	-	-
TOCs	mg/L	2.9	3.5	3.6	2.9
TOCs	mg/L	2.9	3.4	3.4	3.1
TOCs	mg/L	3.0	3.4	3.0	3.0
TOCs	mg/L	3.0	3.4	3.2	3.0
TOXs	mg/L	0.024	0.032	0.016	< 0.010
TOXs	mg/L	0.014	0.045	0.011	0.027

^a Well point elevation = 181.91 m (MSL); ground surface elevation = 227.38 m (MSL); casing material = stainless steel.

^b Filtered sample.

^c Unfiltered sample.

^d A hyphen indicates that no samples were collected.

6. GROUNDWATER PROTECTION

TABLE 6.33

Groundwater Monitoring Results, Sanitary Landfill Well 800201, 1999

Parameter	Unit	Date of Sampling			
		01/21/99	04/06/99	07/14/99	10/01/99
Water elevation ^a	m	224.05	224.59	224.14	223.34
Temperature	°C	10.7	11.1	11.4	11.1
pH	pH	7.08	6.61	7.03	7.06
Redox	mV	4	10	-1	6
Conductivity	µmhos/cm	1,110	1,142	1,117	1,083
Chloride ^b	mg/L	8	8	11	9
Sulfate ^b	mg/L	64	66	80	74
TDS ^b	mg/L	722	731	749	747
Cyanide (total) ^c	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Arsenic ^c	mg/L	- ^d	0.0152	-	-
Barium ^c	mg/L	-	0.3431	-	-
Boron ^c	mg/L	-	0.106	-	-
Cadmium ^c	mg/L	-	< 0.0002	-	-
Chromium ^c	mg/L	-	< 0.044	-	-
Cobalt ^c	mg/L	-	< 0.026	-	-
Copper ^c	mg/L	-	0.0191	-	-
Iron ^c	mg/L	-	19.44	-	-
Lead ^c	mg/L	-	0.0079	-	-
Manganese ^c	mg/L	-	0.8301	-	-
Mercury ^c	mg/L	-	< 0.0001	-	-
Nickel ^c	mg/L	-	< 0.04	-	-
Selenium ^c	mg/L	-	< 0.003	-	-
Silver ^c	mg/L	-	< 0.0005	-	-
Zinc ^c	mg/L	-	0.0719	-	-
Ammonia nitrogen ^b	mg/L	3.5	2.5	3.5	2.5
Arsenic ^b	mg/L	0.0063	0.0058	0.0051	0.0050
Barium ^b	mg/L	0.2453	0.2552	0.2612	0.2409
Beryllium ^b	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Cadmium ^b	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium ^b	mg/L	< 0.044	< 0.044	< 0.044	< 0.044
Cobalt ^b	mg/L	< 0.026	< 0.026	< 0.026	< 0.026
Copper ^b	mg/L	< 0.017	< 0.017	< 0.017	< 0.017
Iron ^b	mg/L	2.385	2.814	2.220	1.419
Lead ^b	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Manganese ^b	mg/L	0.5609	0.4670	0.5571	0.5495
Mercury ^b	mg/L	< 0.0001	0.0001	< 0.0001	< 0.0001
Nickel ^b	mg/L	< 0.04	< 0.04	< 0.04	< 0.04
Silver ^b	mg/L	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Thallium ^b	mg/L	< 0.0015	< 0.0015	< 0.0015	< 0.0015
Vanadium ^b	mg/L	< 0.024	< 0.024	< 0.024	< 0.024
Zinc ^b	mg/L	0.0215	0.0250	< 0.0110	0.0137
Nitrate	mg/L	-	0.84	-	-
Phenols	mg/L	< 0.005	< 0.005	< 0.005	0.018
Hydrogen-3	pCi/L	< 100	< 100	< 100	< 100
Chloride	mg/L	-	10	-	-
Fluoride	mg/L	-	0.22	-	-
Sulfate	mg/L	-	70	-	-
TOCs	mg/L	3.7	29.7	28.7	32.1
TOCs	mg/L	3.8	30.4	28.8	34.6
TOCs	mg/L	3.7	29.3	28.6	32.6
TOCs	mg/L	3.7	29.1	28.6	32.5
TOXs	mg/L	0.014	0.010	< 0.010	0.014
TOXs	mg/L	0.020	< 0.010	0.012	0.010

^a Well point elevation = 217.20 m (MSL); ground surface elevation = 227.93 m (MSL); casing material = stainless steel.

^b Filtered sample.

^c Unfiltered sample.

^d A hyphen indicates that no samples were collected.

6. GROUNDWATER PROTECTION

TABLE 6.34

Groundwater Monitoring Results, Sanitary Landfill Well 800202, 1999

Parameter	Unit	Date of Sampling			
		01/21/99	04/06/99	07/14/99	10/01/99
Water elevation ^a	m	217.97	218.32	218.57	217.88
Temperature	°C	10.4	11.1	11.3	11.2
pH	pH	7.20	7.03	7.11	7.14
Redox	mV	-1	-4	-5	-
Conductivity	µmhos/cm	1,014	1,078	1,080	1,030
Chloride ^b	mg/L	16	16	15	19
Sulfate ^b	mg/L	74	83	79	73
TDS ^b	mg/L	668	669	687	662
Cyanide (total) ^c	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Arsenic ^c	mg/L	- ^d	0.0061	-	-
Barium ^c	mg/L	-	0.2101	-	-
Boron ^c	mg/L	-	0.1104	-	-
Cadmium ^c	mg/L	-	< 0.0002	-	-
Chromium ^c	mg/L	-	< 0.044	-	-
Cobalt ^c	mg/L	-	< 0.026	-	-
Copper ^c	mg/L	-	< 0.017	-	-
Iron ^c	mg/L	-	5.085	-	-
Lead ^c	mg/L	-	< 0.002	-	-
Manganese ^c	mg/L	-	0.1693	-	-
Mercury ^c	mg/L	-	< 0.0001	-	-
Nickel ^c	mg/L	-	< 0.04	-	-
Selenium ^c	mg/L	-	< 0.003	-	-
Silver ^c	mg/L	-	< 0.0005	-	-
Zinc ^c	mg/L	-	< 0.011	-	-
Ammonia nitrogen ^b	mg/L	2.0	1.5	2.0	1.5
Arsenic ^b	mg/L	0.0082	0.0088	0.0070	0.0051
Barium ^b	mg/L	0.1716	0.1833	0.1764	0.1871
Beryllium ^b	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Cadmium ^b	mg/L	0.0012	< 0.0002	< 0.0002	< 0.0002
Chromium ^b	mg/L	< 0.044	< 0.044	< 0.044	< 0.044
Cobalt ^b	mg/L	< 0.026	< 0.026	< 0.026	< 0.026
Copper ^b	mg/L	< 0.017	< 0.017	< 0.017	< 0.017
Iron ^b	mg/L	4.501	5.107	4.755	5.049
Lead ^b	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Manganese ^b	mg/L	0.1851	0.1901	0.1622	0.1477
Mercury ^b	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel ^b	mg/L	< 0.04	< 0.04	< 0.04	< 0.04
Silver ^b	mg/L	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Thallium ^b	mg/L	< 0.0015	< 0.0015	< 0.0015	< 0.0015
Vanadium ^b	mg/L	< 0.024	< 0.024	< 0.024	< 0.024
Zinc ^b	mg/L	< 0.011	< 0.011	< 0.011	< 0.011
Nitrate	mg/L	-	< 0.1	-	-
Phenols	mg/L	< 0.005	< 0.005	0.046	< 0.005
Hydrogen-3	pCi/L	< 100	< 100	< 100	< 100
Chloride	mg/L	-	17	-	-
Fluoride	mg/L	-	0.25	-	-
Sulfate	mg/L	-	86	-	-
TOCs	mg/L	30.1	12.7	12.5	15.1
TOCs	mg/L	29.7	12.7	12.4	15.4
TOCs	mg/L	29.8	12.6	12.5	15.3
TOCs	mg/L	29.9	30.4	12.6	15.9
TOXs	mg/L	0.013	< 0.01	< 0.01	< 0.01
TOXs	mg/L	< 0.01	0.01	< 0.01	< 0.01

^a Well point elevation = 217.20 m (MSL); ground surface elevation = 227.93 m (MSL); casing material = stainless steel.

^b Filtered sample.

^c Unfiltered sample.

^d A hyphen indicates that no samples were collected.

6. GROUNDWATER PROTECTION

TABLE 6.35

Groundwater Monitoring Results, Sanitary Landfill Well 800203D, 1999

Parameter	Unit	Date of Sampling				
		01/21/99	04/06/99	04/06/99	07/14/99	10/01/99
Water elevation ^a	m	192.66	192.71	192.71	192.59	192.24
Temperature	°C	10.8	11.0	11.0	11.5	11.6
pH	pH	7.42	7.14	7.14	7.20	7.25
Redox	mV	-5	-11	-11	-12	-5
Conductivity	µmhos/cm	1,108	1,066	1,066	1,119	1,017
Chloride ^b	mg/L	80	79	75	81	65
Sulfate ^b	mg/L	64	63	64	68	65
TDS ^b	mg/L	675	667	662	673	648
Cyanide (total) ^c	mg/L	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Arsenic ^c	mg/L	- ^d	0.0055	0.0053	-	-
Barium ^c	mg/L	-	0.1324	0.1260	-	-
Boron ^c	mg/L	-	0.1947	0.1932	-	-
Cadmium ^c	mg/L	-	< 0.0002	< 0.0002	-	-
Chromium ^c	mg/L	-	< 0.044	< 0.044	-	-
Cobalt ^c	mg/L	-	0.0355	< 0.0260	-	-
Copper ^c	mg/L	-	< 0.017	< 0.017	-	-
Iron ^c	mg/L	-	3.779	3.095	-	-
Lead ^c	mg/L	-	0.002	< 0.002	-	-
Manganese ^c	mg/L	-	0.0597	0.0408	-	-
Mercury ^c	mg/L	-	< 0.0001	< 0.0001	-	-
Nickel ^c	mg/L	-	< 0.04	< 0.04	-	-
Selenium ^c	mg/L	-	< 0.003	< 0.003	-	-
Silver ^c	mg/L	-	< 0.0005	< 0.0005	-	-
Zinc ^c	mg/L	-	0.1678	0.0120	-	-
Ammonia nitrogen ^b	mg/L	2.5	1.0	1.0	1.5	1.5
Arsenic ^b	mg/L	0.0054	0.0052	0.0054	0.0043	0.0035
Barium ^b	mg/L	0.1193	0.1211	0.1153	0.1116	0.1143
Beryllium ^b	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Cadmium ^b	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium ^b	mg/L	< 0.044	< 0.044	< 0.044	< 0.044	< 0.044
Cobalt ^b	mg/L	< 0.026	< 0.026	0.0267	< 0.026	< 0.026
Copper ^b	mg/L	< 0.017	< 0.017	< 0.017	< 0.017	< 0.017
Iron ^b	mg/L	1.933	2.200	2.160	1.201	1.032
Lead ^b	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Manganese ^b	mg/L	0.0405	0.0339	0.0333	0.0326	0.0312
Mercury ^b	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel ^b	mg/L	< 0.04	< 0.04	< 0.04	< 0.04	< 0.04
Silver ^b	mg/L	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Thallium ^b	mg/L	< 0.0015	< 0.0015	< 0.0015	< 0.0015	< 0.0015
Vanadium ^b	mg/L	< 0.024	< 0.024	< 0.024	< 0.024	< 0.024
Zinc ^b	mg/L	< 0.011	< 0.011	< 0.011	< 0.011	< 0.011
Nitrate	mg/L	-	< 0.1	< 0.1	-	-
Phenols	mg/L	0.008	< 0.005	< 0.005	< 0.005	0.020
Hydrogen-3	pCi/L	< 100	< 100	< 100	< 100	< 100
Chloride	mg/L	-	74	80	-	-
Fluoride	mg/L	-	0.416	0.376	-	-
Sulfate	mg/L	-	66	67	-	-
TOCs	mg/L	4.9	4.1	4.0	5.4	5.3
TOCs	mg/L	4.9	4.2	4.0	5.1	4.8
TOCs	mg/L	4.9	4.1	4.0	5.2	5.2
TOCs	mg/L	5.0	4.1	4.0	5.4	5.2
TOXs	mg/L	0.020	0.037	0.026	0.035	0.028
TOXs	mg/L	0.026	0.027	0.012	0.036	0.021
Chloroform	µg/L	< 1	< 1	< 1	< 1	2

^a Well point elevation = 189.47 m (MSL); ground surface elevation = 227.93 m (MSL); casing material = stainless steel.

^b Filtered sample.

^c Unfiltered sample.

^d A hyphen indicates that no samples were collected.

6. GROUNDWATER PROTECTION

TABLE 6.36

Groundwater Monitoring Results, Sanitary Landfill Well 800241, 1999

Parameter	Unit	Date of Sampling				
		01/21/99	04/12/99	07/15/99	10/04/99	10/04/99
Water elevation ^a	m	224.46	225.12	223.86	223.54	223.54
Temperature	°C	8.8	8.4	12.8	13.3	13.3
pH	pH	7.48	7.16	7.29	7.63	7.63
Redox	mV	-16	-10	-14	-14	-14
Conductivity	µmhos/cm	2,230	2,410	2,310	1,248	1,248
Chloride ^b	mg/L	481	512	531	175	181
Sulfate ^b	mg/L	151	148	161	159	157
TDS ^b	mg/L	1,401	1,347	1,499	826	847
Cyanide (total) ^c	mg/L	0.018	< 0.010	< 0.010	< 0.010	< 0.010
Arsenic ^c	mg/L	- ^d	0.0117	-	-	-
Barium ^c	mg/L	-	0.3412	-	-	-
Boron ^c	mg/L	-	0.4073	-	-	-
Cadmium ^c	mg/L	-	0.001	-	-	-
Chromium ^c	mg/L	-	0.7406	-	-	-
Cobalt ^c	mg/L	-	0.0542	-	-	-
Copper ^c	mg/L	-	0.1447	-	-	-
Iron ^c	mg/L	-	143.2	-	-	-
Lead ^c	mg/L	-	0.089	-	-	-
Manganese ^c	mg/L	-	2.349	-	-	-
Mercury ^c	mg/L	-	< 0.0001	-	-	-
Nickel ^c	mg/L	-	0.2723	-	-	-
Selenium ^c	mg/L	-	< 0.003	-	-	-
Silver ^c	mg/L	-	< 0.0005	-	-	-
Zinc ^c	mg/L	-	0.4735	-	-	-
Ammonia nitrogen ^b	mg/L	0.1	0.1	0.1	< 0.1	< 0.1
Arsenic ^b	mg/L	< 0.0025	< 0.0025	< 0.0025	< 0.0025	< 0.0025
Barium ^b	mg/L	0.0737	0.0576	0.0784	0.0559	0.0530
Beryllium ^b	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Cadmium ^b	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium ^b	mg/L	< 0.044	< 0.044	< 0.044	< 0.044	< 0.044
Cobalt ^b	mg/L	< 0.026	< 0.026	< 0.026	< 0.026	< 0.026
Copper ^b	mg/L	< 0.017	< 0.017	< 0.017	< 0.017	< 0.017
Iron ^b	mg/L	0.7457	1.1010	0.1662	1.3330	1.0090
Lead ^b	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Manganese ^b	mg/L	0.2653	0.3214	0.2618	0.2458	0.1934
Mercury ^b	mg/L	< 0.0001	0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel ^b	mg/L	0.2258	0.2197	< 0.0400	0.8620	0.6572
Silver ^b	mg/L	0.0005	0.0006	< 0.0005	< 0.0005	< 0.0005
Thallium ^b	mg/L	< 0.0015	< 0.0015	< 0.0015	< 0.0015	< 0.0015
Vanadium ^b	mg/L	< 0.024	< 0.024	< 0.024	< 0.024	< 0.024
Zinc ^b	mg/L	< 0.011	< 0.011	< 0.011	< 0.011	< 0.011
Nitrate	mg/L	-	< 0.1	-	-	-
Phenols	mg/L	0.013	< 0.005	< 0.005	< 0.005	0.005
Hydrogen-3	pCi/L	< 100	< 100	< 100	< 100	< 100
Chloride	mg/L	-	512	-	-	-
Fluoride	mg/L	-	0.188	-	-	-
Sulfate	mg/L	-	151	-	-	-
TOCs	mg/L	< 5.0	1.5	< 1.0	1.3	1.2
TOCs	mg/L	< 5.0	1.6	< 1.0	1.3	1.5
TOCs	mg/L	< 5.0	1.5	< 1.0	1.3	1.3
TOCs	mg/L	< 5.0	1.4	< 1.0	1.3	1.4
TOXs	mg/L	0.057	0.170	0.150	0.052	0.190
TOXs	mg/L	0.077	0.110	0.170	0.061	0.270

^a Well point elevation = 221.15 m (MSL); ground surface elevation = 226.10 m (MSL); casing material = stainless steel.

^b Filtered sample.

^c Unfiltered sample.

^d A hyphen indicates that no samples were collected.

6. GROUNDWATER PROTECTION

TABLE 6.37

Groundwater Monitoring Results, Sanitary Landfill Well 800243D, 1999

Parameter	Unit	Date of Sampling			
		01/21/99	04/12/99	07/15/99	10/06/99
Water elevation ^a	m	192.27	192.15	192.16	191.81
Temperature	°C	9.9	10.5	11.5	10.4
pH	pH	7.35	7.08	7.28	7.41
Redox	mV	-8	-5	-13	-13
Conductivity	µmhos/cm	874	831	873	739
Chloride ^b	mg/L	18	12	15	14
Sulfate ^b	mg/L	42	39	44	158
TDS ^b	mg/L	531	516	537	477
Cyanide (total) ^c	mg/L	0.019	< 0.010	< 0.010	< 0.010
Arsenic ^c	mg/L	- ^d	< 0.0025	-	-
Barium ^c	mg/L	-	0.1646	-	-
Boron ^c	mg/L	-	0.2429	-	-
Cadmium ^c	mg/L	-	< 0.0002	-	-
Chromium ^c	mg/L	-	< 0.044	-	-
Cobalt ^c	mg/L	-	< 0.026	-	-
Copper ^c	mg/L	-	< 0.017	-	-
Iron ^c	mg/L	-	2.868	-	-
Lead ^c	mg/L	-	< 0.002	-	-
Manganese ^c	mg/L	-	0.6396	-	-
Mercury ^c	mg/L	-	< 0.0001	-	-
Nickel ^c	mg/L	-	< 0.04	-	-
Selenium ^c	mg/L	-	< 0.003	-	-
Silver ^c	mg/L	-	< 0.0005	-	-
Zinc ^c	mg/L	-	0.0235	-	-
Ammonia nitrogen ^b	mg/L	0.3	0.2	0.2	0.3
Arsenic ^b	mg/L	< 0.0025	0.0026	< 0.0025	< 0.0025
Barium ^b	mg/L	0.1588	0.1439	0.1524	0.1398
Beryllium ^b	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Cadmium ^b	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium ^b	mg/L	< 0.044	< 0.044	< 0.044	< 0.044
Cobalt ^b	mg/L	< 0.026	< 0.026	< 0.026	< 0.026
Copper ^b	mg/L	< 0.017	< 0.017	< 0.017	< 0.017
Iron ^b	mg/L	1.129	1.226	0.1291	0.8222
Lead ^b	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Manganese ^b	mg/L	0.7145	0.5098	0.4663	0.5142
Mercury ^b	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel ^b	mg/L	< 0.04	< 0.04	< 0.04	< 0.04
Silver ^b	mg/L	< 0.0005	0.0005	< 0.0005	< 0.0005
Thallium ^b	mg/L	< 0.0015	< 0.0015	< 0.0015	< 0.0015
Vanadium ^b	mg/L	< 0.024	< 0.024	< 0.024	< 0.024
Zinc ^b	mg/L	0.0166	< 0.011	< 0.011	< 0.011
Nitrate	mg/L	-	< 0.1	-	-
Phenols	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Hydrogen-3	pCi/L	< 100	< 100	< 100	< 100
Chloride	mg/L	-	17	-	-
Fluoride	mg/L	-	0.326	-	-
Sulfate	mg/L	-	40	-	-
TOCs	mg/L	1.9	1.4	1.9	1.7
TOCs	mg/L	1.8	1.4	1.7	1.7
TOCs	mg/L	2.0	1.4	1.8	1.6
TOCs	mg/L	1.9	1.5	1.9	1.7
TOXs	mg/L	< 0.010	< 0.010	0.013	0.013
TOXs	mg/L	< 0.010	< 0.010	< 0.010	0.011

^a Well point elevation = 190.56 m (MSL); ground surface elevation = 226.10 m (MSL); casing material = stainless steel.

^b Filtered sample.

^c Unfiltered sample.

^d A hyphen indicates that no samples were collected.

6. GROUNDWATER PROTECTION

TABLE 6.38

Groundwater Monitoring Results, Sanitary Landfill
Well 800271, 1999

Parameter	Unit	Date of Sampling
		10/05/99
Water elevation ^a	m	223.05
Temperature	°C	14.2
pH	pH	7.41
Redox	mV	-17
Conductivity	µmhos/cm	676
Chloride ^b	mg/L	3
Sulfate ^b	mg/L	41
TDS ^b	mg/L	431
Cyanide (total)	mg/L	< 0.01
Ammonia nitrogen ^b	mg/L	< 0.1
Arsenic ^b	mg/L	< 0.0025
Barium ^b	mg/L	0.1004
Beryllium ^b	mg/L	< 0.0002
Cadmium ^b	mg/L	< 0.0002
Chromium ^b	mg/L	< 0.044
Cobalt ^b	mg/L	< 0.026
Copper ^b	mg/L	< 0.017
Iron ^b	mg/L	0.0985
Lead ^b	mg/L	< 0.002
Manganese ^b	mg/L	0.0969
Mercury ^b	mg/L	< 0.0001
Nickel ^b	mg/L	< 0.04
Silver ^b	mg/L	< 0.0005
Thallium ^b	mg/L	< 0.0015
Vanadium ^b	mg/L	< 0.024
Zinc ^b	mg/L	0.0617
Phenols	mg/L	0.009
Hydrogen-3	pCi/L	< 100
TOCs	mg/L	2.4
TOCs	mg/L	2.5
TOCs	mg/L	2.4
TOCs	mg/L	2.3
TOXs	mg/L	< 0.01
TOXs	mg/L	< 0.01

^a Well point elevation = 191.84 m (MSL); ground surface elevation = 226.48 m (MSL); casing material = stainless steel.

^b Filtered sample.

6. GROUNDWATER PROTECTION

TABLE 6.39

Groundwater Monitoring Results, Sanitary Landfill
Well 800273D, 1999

Parameter	Unit	Date of Sampling
		10/05/99
Water elevation ^a	m	192.29
Temperature	°C	11.1
pH	pH	7.8
Redox	mV	-38
Conductivity	µmhos/cm	1,042
Chloride ^b	mg/L	102
Sulfate ^b	mg/L	117
TDS ^b	mg/L	638
Cyanide (total)	mg/L	< 0.01
Ammonia nitrogen ^b	mg/L	0.7
Arsenic ^b	mg/L	< 0.0025
Barium ^b	mg/L	0.1134
Beryllium ^b	mg/L	< 0.0002
Cadmium ^b	mg/L	< 0.0002
Chromium ^b	mg/L	< 0.044
Cobalt ^b	mg/L	< 0.026
Copper ^b	mg/L	< 0.017
Iron ^b	mg/L	< 0.037
Lead ^b	mg/L	< 0.002
Manganese ^b	mg/L	0.0206
Mercury ^b	mg/L	< 0.0001
Nickel ^b	mg/L	< 0.04
Silver ^b	mg/L	< 0.0005
Thallium ^b	mg/L	< 0.0015
Vanadium ^b	mg/L	< 0.024
Zinc ^b	mg/L	0.0462
Phenols	mg/L	0.008
Hydrogen-3	pCi/L	< 100
TOCs	mg/L	6.6
TOCs	mg/L	4.8
TOCs	mg/L	5.4
TOCs	mg/L	4.4
TOXs	mg/L	0.019
TOXs	mg/L	0.036
Acetone	µg/L	10
Dibromomethane	µg/L	2

^a Well point elevation = 189.70 m (MSL); ground surface elevation = 226.48 m (MSL); casing material = stainless steel.

^b Filtered sample.

6. GROUNDWATER PROTECTION

TABLE 6.40

Groundwater Monitoring Results, Sanitary Landfill
Well 800281, 1999

Parameter	Unit	Date of Sampling
		10/05/99
Water elevation ^a	m	224.85
Temperature	°C	12.6
pH	pH	7.03
Redox	mV	7
Conductivity	µmhos/cm	1,612
Chloride ^b	mg/L	101
Sulfate ^b	mg/L	66
TDS ^b	mg/L	1,042
Cyanide (total)	mg/L	< 0.01
Ammonia nitrogen ^b	mg/L	< 0.1
Arsenic ^b	mg/L	< 0.0025
Barium ^b	mg/L	0.1357
Beryllium ^b	mg/L	< 0.0002
Cadmium ^b	mg/L	< 0.0002
Chromium ^b	mg/L	< 0.044
Cobalt ^b	mg/L	< 0.026
Copper ^b	mg/L	< 0.017
Iron ^b	mg/L	0.2542
Lead ^b	mg/L	< 0.002
Manganese ^b	mg/L	1.775
Mercury ^b	mg/L	< 0.0001
Nickel ^b	mg/L	< 0.04
Silver ^b	mg/L	< 0.0005
Thallium ^b	mg/L	< 0.0015
Vanadium ^b	mg/L	< 0.024
Zinc ^b	mg/L	0.0194
Phenols	mg/L	0.01
Hydrogen-3	pCi/L	588
TOCs	mg/L	4.2
TOCs	mg/L	4.2
TOCs	mg/L	4.2
TOCs	mg/L	4.3
TOXs	mg/L	0.082
TOXs	mg/L	0.066

^a Well point elevation = 224.60 m (MSL); ground surface elevation = 228.56 m (MSL); casing material = stainless steel.

^b Filtered sample.

6. GROUNDWATER PROTECTION

TABLE 6.41

Groundwater Monitoring Results, Sanitary Landfill
Well 800291, 1999

Parameter	Unit	Date of Sampling
		10/05/99
Water elevation ^a	m	226.59
Temperature	°C	10.7
pH	pH	7.31
Redox	mV	-9
Conductivity	µmhos/cm	1,132
Chloride ^b	mg/L	7
Sulfate ^b	mg/L	138
TDS ^b	mg/L	758
Cyanide (total)	mg/L	< 0.01
Ammonia nitrogen ^b	mg/L	< 0.1
Arsenic ^b	mg/L	< 0.0025
Barium ^b	mg/L	0.0733
Beryllium ^b	mg/L	< 0.0002
Cadmium ^b	mg/L	< 0.0002
Chromium ^b	mg/L	< 0.044
Cobalt ^b	mg/L	< 0.026
Copper ^b	mg/L	< 0.017
Iron ^b	mg/L	< 0.037
Lead ^b	mg/L	< 0.002
Manganese ^b	mg/L	0.1786
Mercury ^b	mg/L	< 0.0001
Nickel ^b	mg/L	< 0.04
Silver ^b	mg/L	< 0.0005
Thallium ^b	mg/L	< 0.0015
Vanadium ^b	mg/L	< 0.024
Zinc ^b	mg/L	0.0368
Phenols	mg/L	0.007
Hydrogen-3	pCi/L	< 100
TOCs	mg/L	2.8
TOCs	mg/L	2.8
TOCs	mg/L	2.6
TOCs	mg/L	2.7
TOXs	mg/L	< 0.01
TOXs	mg/L	0.01

^a Well point elevation = 223.97 m (MSL); ground surface elevation = 231.37 m (MSL); casing material = stainless steel.

^b Filtered sample.

6. GROUNDWATER PROTECTION

TABLE 6.42

Groundwater Monitoring Results, Sanitary Landfill
Well 800301, 1999

Parameter	Unit	Date of Sampling
		10/05/99
Water elevation ^a	m	227.58
Temperature	°C	10.6
pH	pH	7.35
Redox	mV	-9
Conductivity	µmhos/cm	1,060
Chloride ^b	mg/L	8
Sulfate ^b	mg/L	103
TDS ^b	mg/L	692
Cyanide (total)	mg/L	< 0.01
Ammonia nitrogen ^b	mg/L	0.1
Arsenic ^b	mg/L	0.0031
Barium ^b	mg/L	0.0697
Beryllium ^b	mg/L	< 0.0002
Cadmium ^b	mg/L	< 0.0002
Chromium ^b	mg/L	< 0.044
Cobalt ^b	mg/L	< 0.026
Copper ^b	mg/L	< 0.017
Iron ^b	mg/L	0.0966
Lead ^b	mg/L	< 0.002
Manganese ^b	mg/L	0.1653
Mercury ^b	mg/L	< 0.0001
Nickel ^b	mg/L	< 0.04
Silver ^b	mg/L	0.0012
Thallium ^b	mg/L	< 0.0015
Vanadium ^b	mg/L	< 0.024
Zinc ^b	mg/L	0.0455
Phenols	mg/L	0.007
Hydrogen-3	pCi/L	< 100
TOCs	mg/L	2.7
TOCs	mg/L	2.7
TOCs	mg/L	2.3
TOCs	mg/L	2.2
TOXs	mg/L	0.011
TOXs	mg/L	< 0.01

^a Well point elevation = 226.11 m (MSL); ground surface elevation = 233.42 m (MSL); casing material = stainless steel.

^b Filtered sample.

6. GROUNDWATER PROTECTION

TABLE 6.43

Groundwater Monitoring Results, Sanitary Landfill
Well 800331, 1999

Parameter	Unit	Date of Sampling
		10/05/99
Water elevation ^a	m	225.12
Temperature	°C	12.1
pH	pH	7.31
Redox	mV	-10
Conductivity	µmhos/cm	1,103
Chloride ^b	mg/L	8
Sulfate ^b	mg/L	138
TDS ^b	mg/L	755
Cyanide (total)	mg/L	< 0.01
Ammonia nitrogen ^b	mg/L	0.1
Arsenic ^b	mg/L	< 0.0025
Barium ^b	mg/L	0.0768
Beryllium ^b	mg/L	< 0.0002
Cadmium ^b	mg/L	< 0.0002
Chromium ^b	mg/L	< 0.044
Cobalt ^b	mg/L	< 0.026
Copper ^b	mg/L	< 0.017
Iron ^b	mg/L	< 0.037
Lead ^b	mg/L	< 0.002
Manganese ^b	mg/L	0.3053
Mercury ^b	mg/L	< 0.0001
Nickel ^b	mg/L	< 0.04
Silver ^b	mg/L	< 0.0005
Thallium ^b	mg/L	< 0.0015
Vanadium ^b	mg/L	< 0.024
Zinc ^b	mg/L	0.0118
Phenols	mg/L	0.008
Hydrogen-3	pCi/L	117
TOCs	mg/L	2.4
TOCs	mg/L	2.4
TOCs	mg/L	2.6
TOCs	mg/L	2.5
TOXs	mg/L	0.012
TOXs	mg/L	< 0.01

^a Well point elevation = 223.66 m (MSL); ground surface elevation = 228.80 m (MSL); casing material = stainless steel.

^b Filtered sample.

6. GROUNDWATER PROTECTION

TABLE 6.44

Groundwater Monitoring Results, Sanitary Landfill
Well 800341, 1999

Parameter	Unit	Date of Sampling
		10/05/99
Water elevation ^a	m	227.23
Temperature	°C	12.5
pH	pH	7.44
Redox	mV	-14
Conductivity	µmhos/cm	1,173
Chloride ^b	mg/L	11
Sulfate ^b	mg/L	163
TDS ^b	mg/L	800
Cyanide (total)	mg/L	< 0.01
Ammonia nitrogen ^b	mg/L	< 0.1
Arsenic ^b	mg/L	< 0.0025
Barium ^b	mg/L	0.0752
Beryllium ^b	mg/L	< 0.0002
Cadmium ^b	mg/L	< 0.0002
Chromium ^b	mg/L	< 0.044
Cobalt ^b	mg/L	< 0.026
Copper ^b	mg/L	< 0.017
Iron ^b	mg/L	0.0431
Lead ^b	mg/L	< 0.002
Manganese ^b	mg/L	0.3234
Mercury ^b	mg/L	< 0.0001
Nickel ^b	mg/L	< 0.04
Silver ^b	mg/L	< 0.0005
Thallium ^b	mg/L	< 0.0015
Vanadium ^b	mg/L	< 0.024
Zinc ^b	mg/L	< 0.011
Phenols	mg/L	0.005
Hydrogen-3	pCi/L	< 100
TOCs	mg/L	3.2
TOCs	mg/L	3.1
TOCs	mg/L	2.8
TOCs	mg/L	3.0
TOXs	mg/L	0.02
TOXs	mg/L	0.011

^a Well point elevation = 227.03 m (MSL); ground surface elevation = 230.85 m (MSL); casing material = stainless steel.

^b Filtered sample.

6. GROUNDWATER PROTECTION

TABLE 6.45

Groundwater Monitoring Results, Sanitary Landfill
Well 800351, 1999

Parameter	Unit	Date of Sampling
		10/05/99
Water elevation ^a	m	225.97
Temperature	°C	10.4
pH	pH	7.64
Redox	mV	-27
Conductivity	µmhos/cm	914
Chloride ^b	mg/L	8
Sulfate ^b	mg/L	27
TDS ^b	mg/L	567
Cyanide (total)	mg/L	0.34
Ammonia nitrogen ^b	mg/L	0.4
Arsenic ^b	mg/L	0.0036
Barium ^b	mg/L	0.133
Beryllium ^b	mg/L	< 0.0002
Cadmium ^b	mg/L	< 0.0002
Chromium ^b	mg/L	< 0.044
Cobalt ^b	mg/L	< 0.026
Copper ^b	mg/L	< 0.017
Iron ^b	mg/L	< 0.037
Lead ^b	mg/L	< 0.002
Manganese ^b	mg/L	0.0745
Mercury ^b	mg/L	< 0.0001
Nickel ^b	mg/L	< 0.04
Silver ^b	mg/L	< 0.0005
Thallium ^b	mg/L	< 0.0015
Vanadium ^b	mg/L	< 0.024
Zinc ^b	mg/L	0.052
Phenols	mg/L	0.006
Hydrogen-3	pCi/L	< 100
TOCs	mg/L	3.1
TOCs	mg/L	2.7
TOCs	mg/L	2.7
TOCs	mg/L	3.3
TOXs	mg/L	< 0.01
TOXs	mg/L	< 0.01

^a Well point elevation = 222.13 m (MSL); ground surface elevation = 233.64 m (MSL); casing material = stainless steel.

^b Filtered sample.

6. GROUNDWATER PROTECTION

TABLE 6.46

Groundwater Monitoring Results, Sanitary Landfill
Well 800361, 1999

Parameter	Unit	Date of Sampling
		10/05/99
Water elevation ^a	m	222.99
Temperature	°C	11.8
pH	pH	7.58
Redox	mV	-24
Conductivity	µmhos/cm	916
Chloride ^b	mg/L	12
Sulfate ^b	mg/L	111
TDS ^b	mg/L	606
Cyanide (total)	mg/L	< 0.01
Ammonia nitrogen ^b	mg/L	< 0.1
Arsenic ^b	mg/L	< 0.0025
Barium ^b	mg/L	0.0578
Beryllium ^b	mg/L	< 0.0002
Cadmium ^b	mg/L	< 0.0002
Chromium ^b	mg/L	< 0.044
Cobalt ^b	mg/L	< 0.026
Copper ^b	mg/L	0.023
Iron ^b	mg/L	< 0.037
Lead ^b	mg/L	< 0.002
Manganese ^b	mg/L	0.1311
Mercury ^b	mg/L	< 0.0001
Nickel ^b	mg/L	< 0.04
Silver ^b	mg/L	< 0.0005
Thallium ^b	mg/L	< 0.0015
Vanadium ^b	mg/L	< 0.024
Zinc ^b	mg/L	< 0.011
Phenols	mg/L	0.013
Hydrogen-3	pCi/L	262
TOCs	mg/L	2.1
TOCs	mg/L	2.2
TOCs	mg/L	2.2
TOCs	mg/L	2.1
TOXs	mg/L	0.015
TOXs	mg/L	< 0.01

^a Well point elevation = 221.21 m (MSL); ground surface elevation = 228.40 m (MSL); casing material = stainless steel.

^b Filtered sample.

6. GROUNDWATER PROTECTION

TABLE 6.47

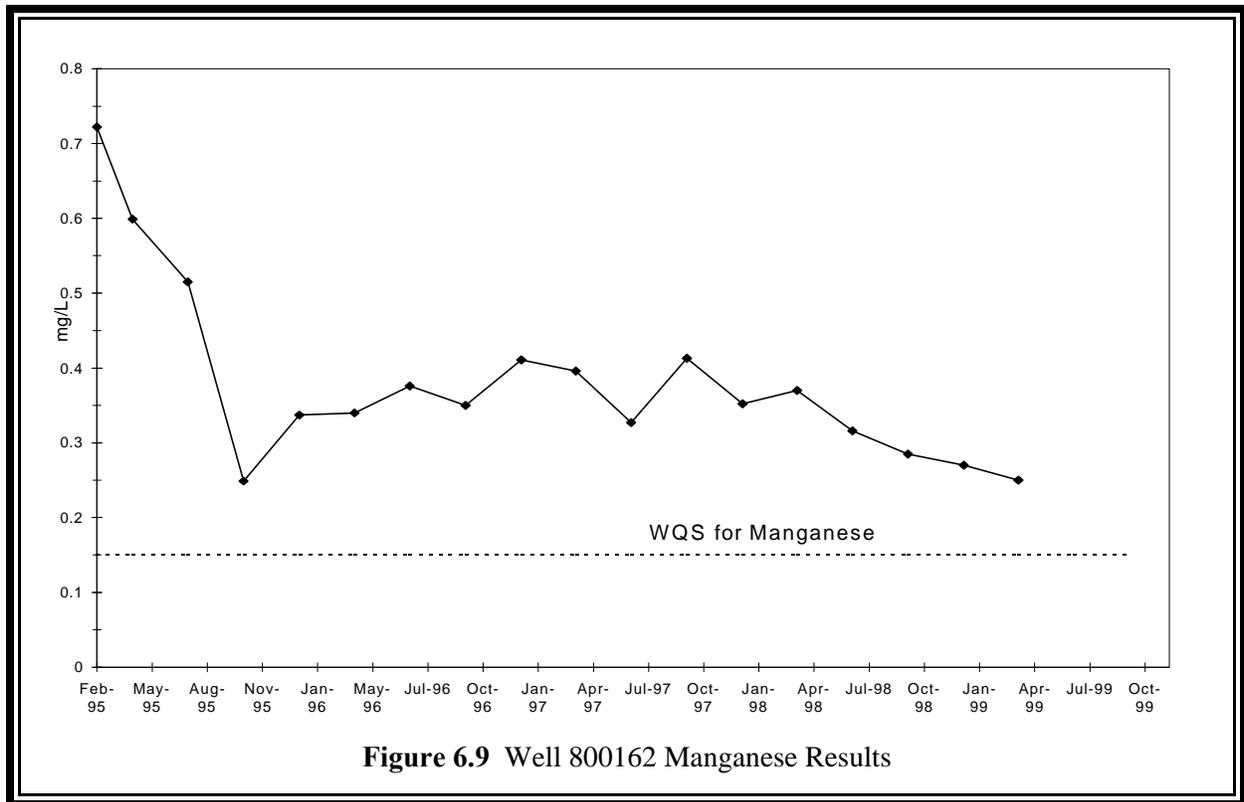
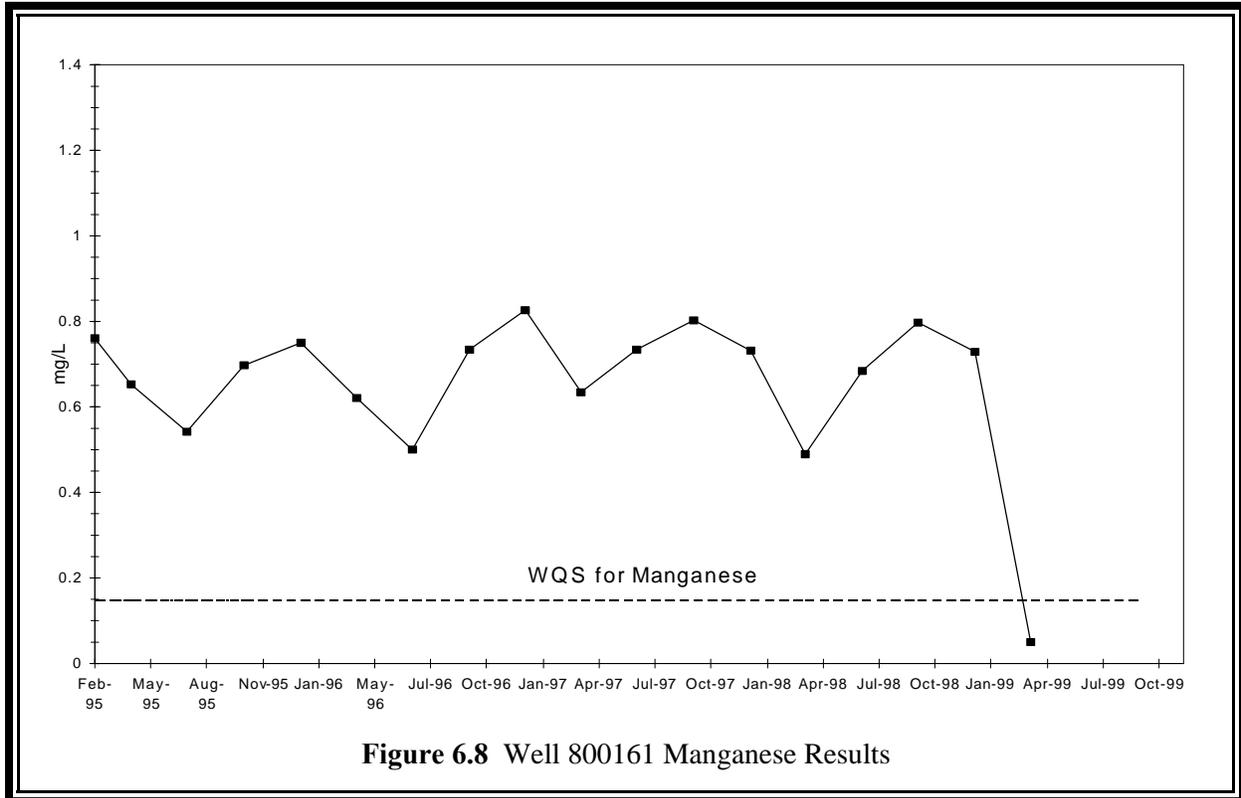
Groundwater Monitoring Results, Sanitary Landfill
Well 800371, 1999

Parameter	Unit	Date of Sampling
		10/05/99
Water elevation ^a	m	218.11
Temperature	°C	10.9
pH	pH	7.65
Redox	mV	-20
Conductivity	µmhos/cm	825
Chloride ^b	mg/L	16
Sulfate ^b	mg/L	20
TDS ^b	mg/L	508
Cyanide (total)	mg/L	< 0.01
Ammonia nitrogen ^b	mg/L	1.5
Arsenic ^b	mg/L	0.0044
Barium ^b	mg/L	0.2226
Beryllium ^b	mg/L	< 0.0002
Cadmium ^b	mg/L	< 0.0002
Chromium ^b	mg/L	< 0.044
Cobalt ^b	mg/L	< 0.026
Copper ^b	mg/L	< 0.017
Iron ^b	mg/L	< 0.037
Lead ^b	mg/L	< 0.002
Manganese ^b	mg/L	0.0728
Mercury ^b	mg/L	< 0.0001
Nickel ^b	mg/L	< 0.04
Silver ^b	mg/L	< 0.0005
Thallium ^b	mg/L	< 0.0015
Vanadium ^b	mg/L	< 0.024
Zinc ^b	mg/L	0.0488
Phenols	mg/L	< 0.005
Hydrogen-3	pCi/L	< 100
TOCs	mg/L	7.1
TOCs	mg/L	7.1
TOCs	mg/L	3.4
TOCs	mg/L	3.4
TOXs	mg/L	0.016
TOXs	mg/L	0.018
Acetone	µg/L	10

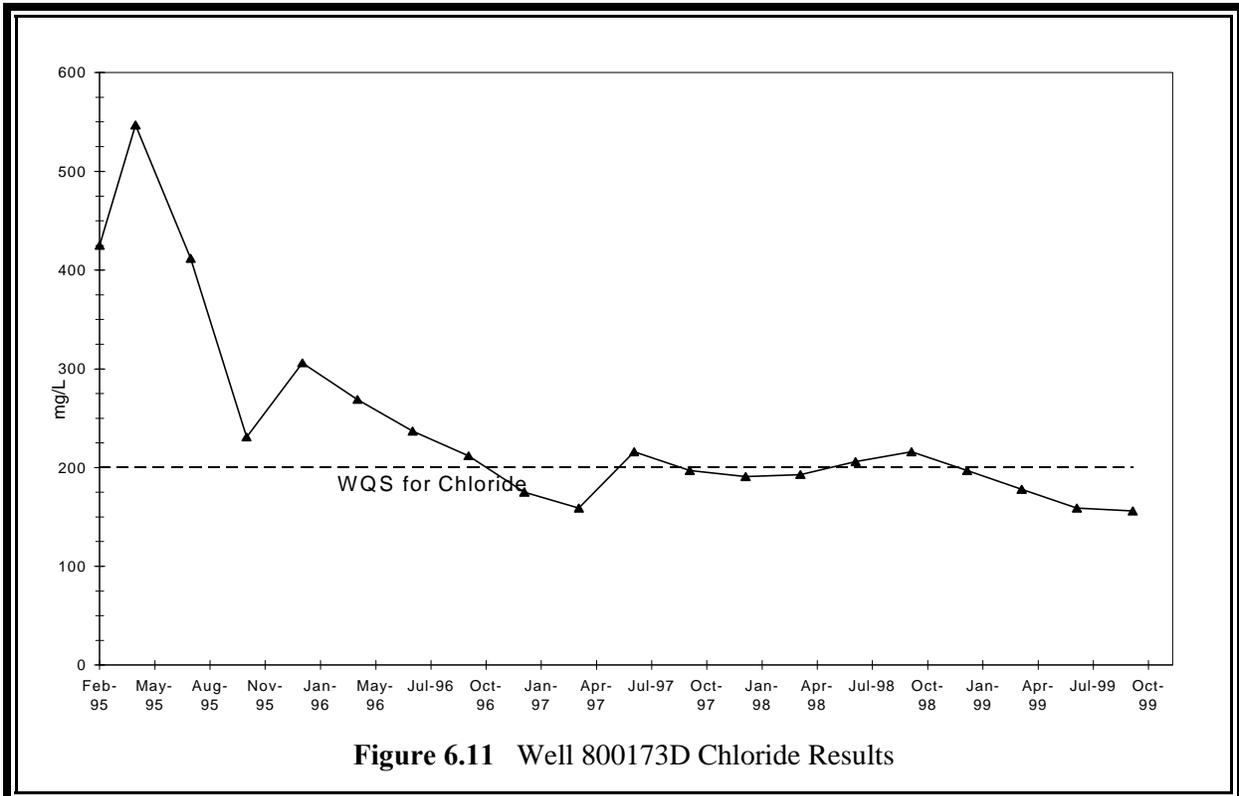
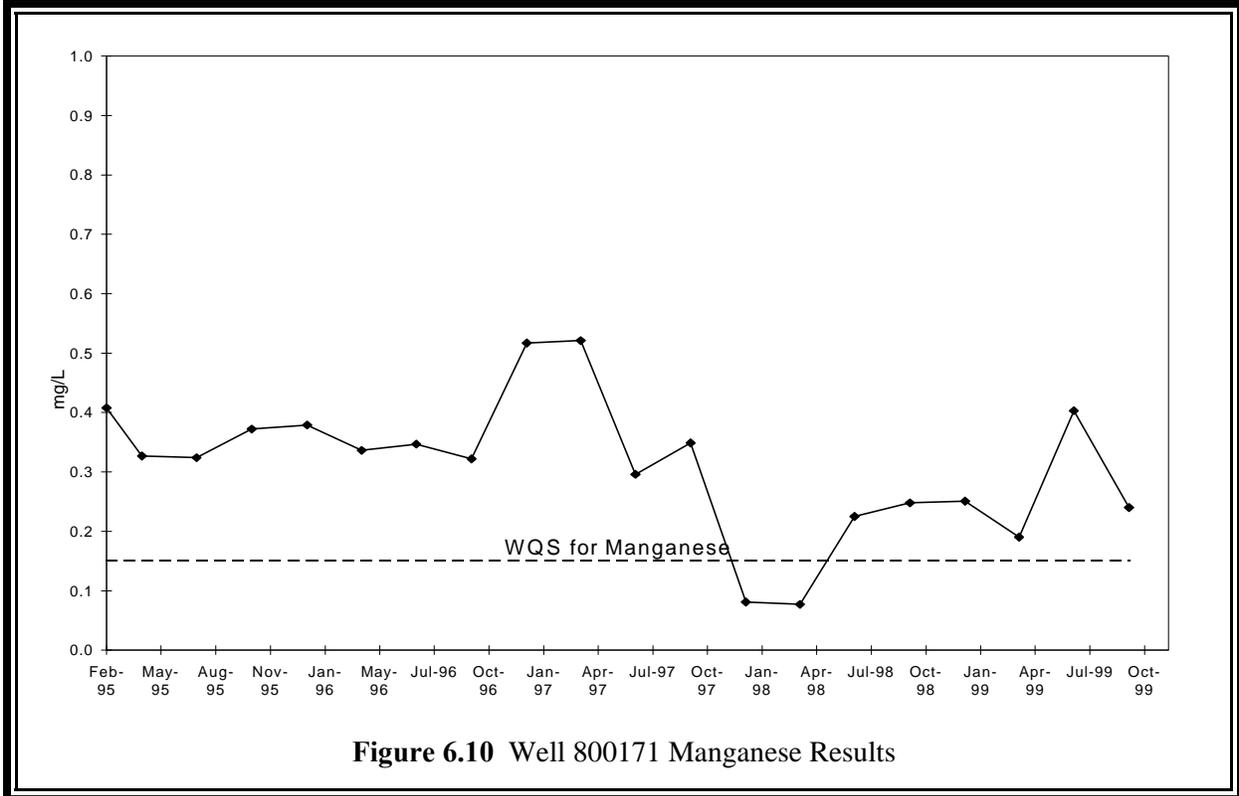
^a Well point elevation = 218.46 m (MSL); ground surface elevation = 228.37 m (MSL); casing material = stainless steel.

^b Filtered sample.

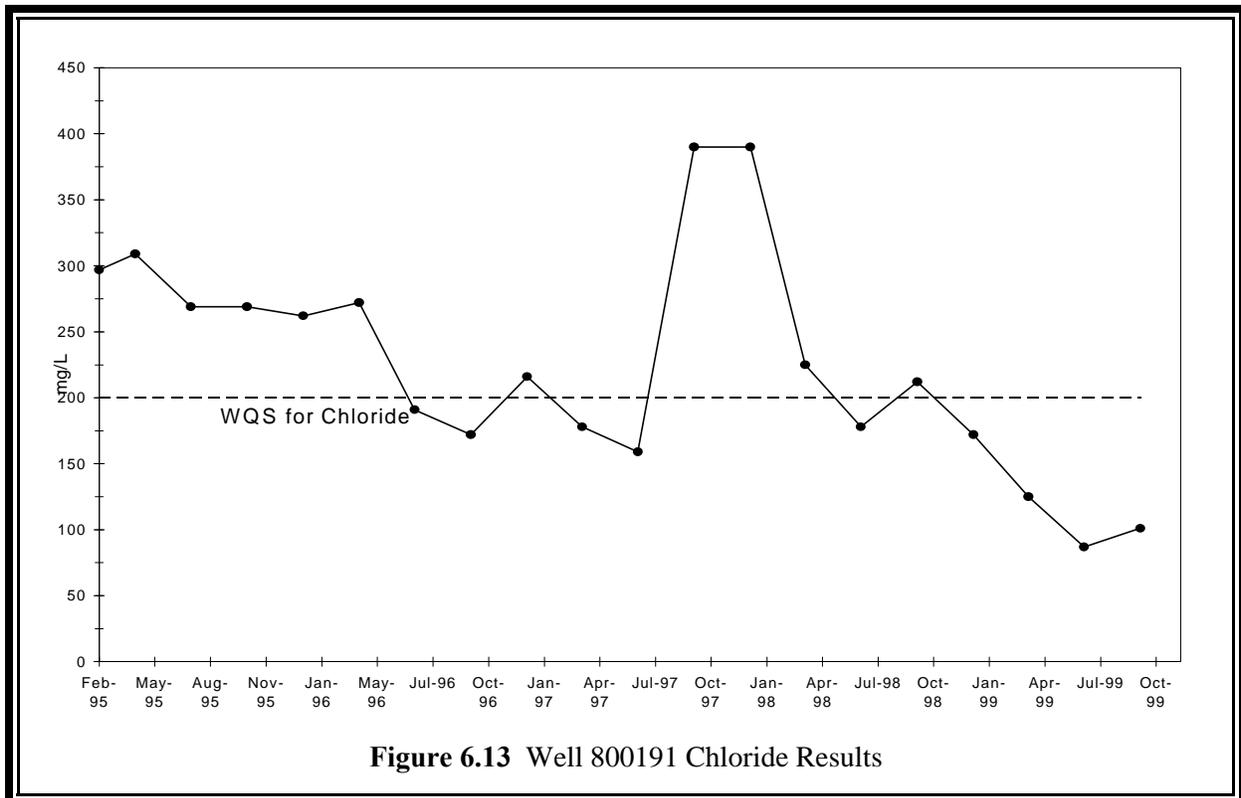
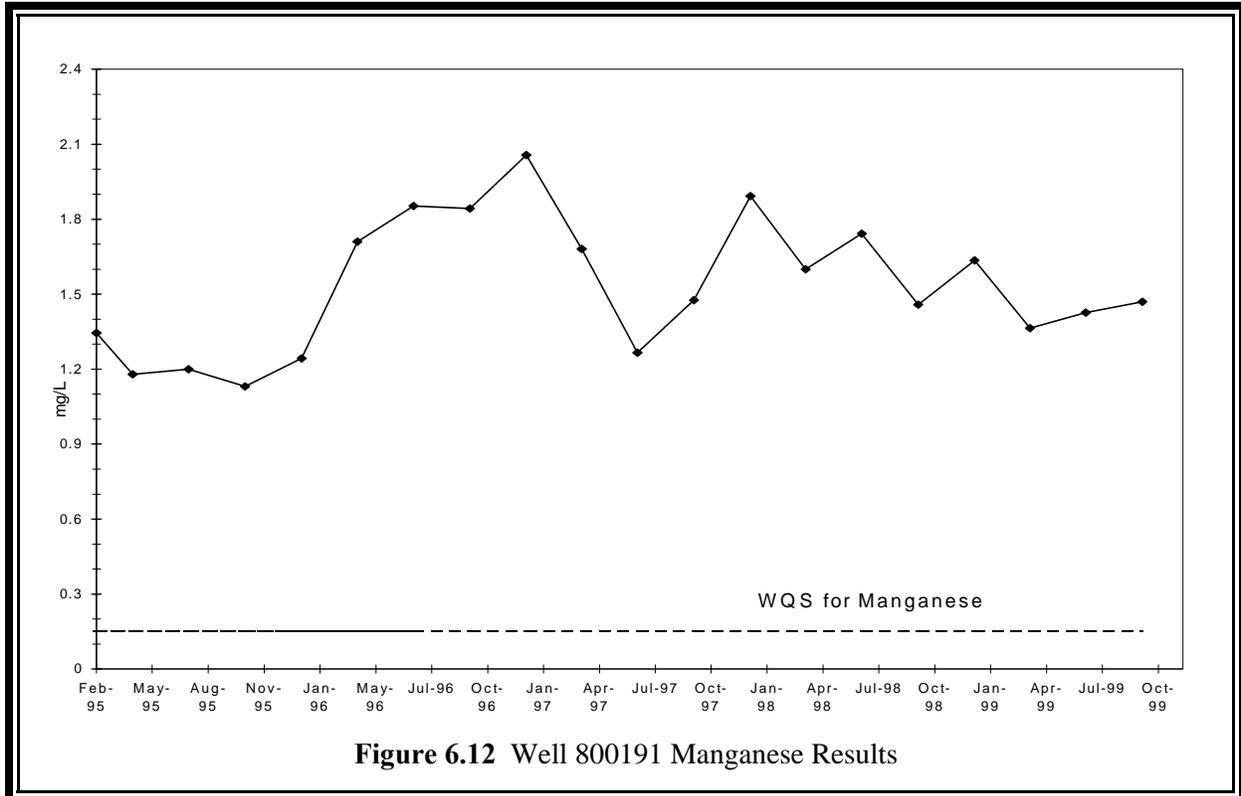
6. GROUNDWATER PROTECTION



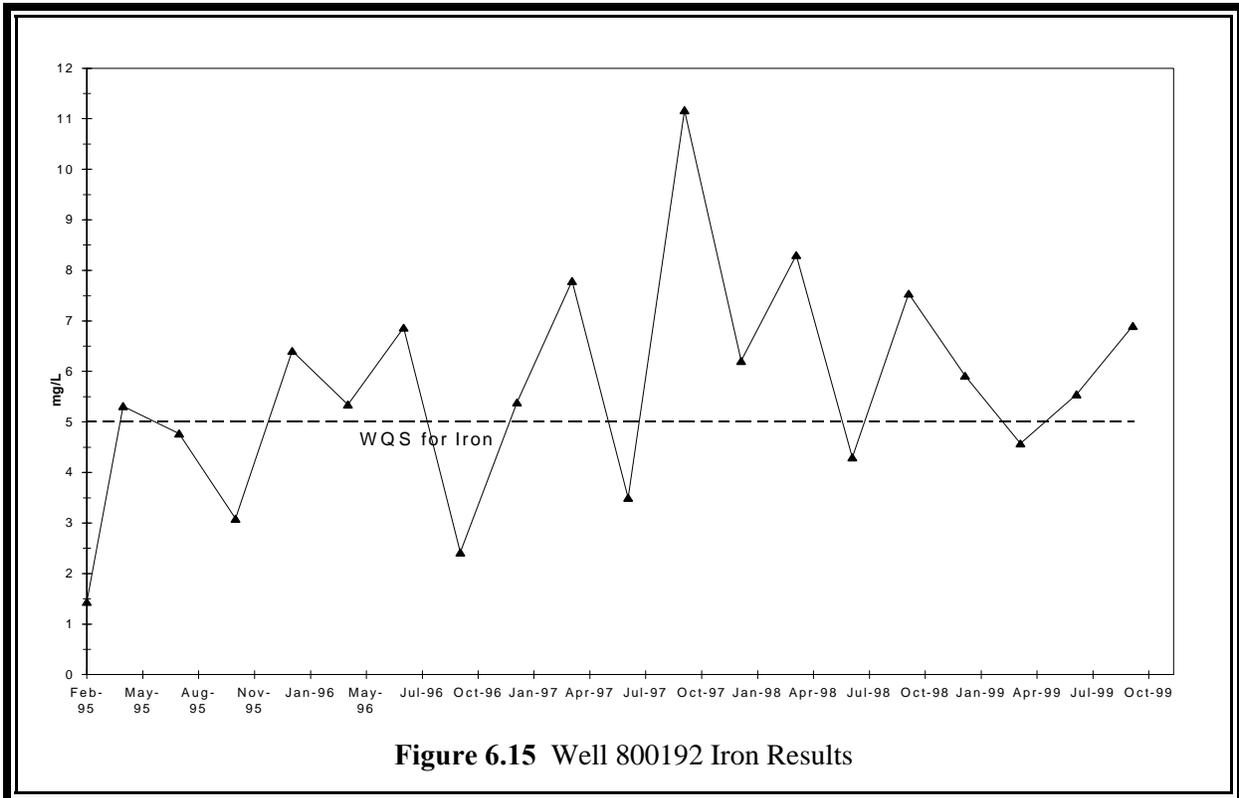
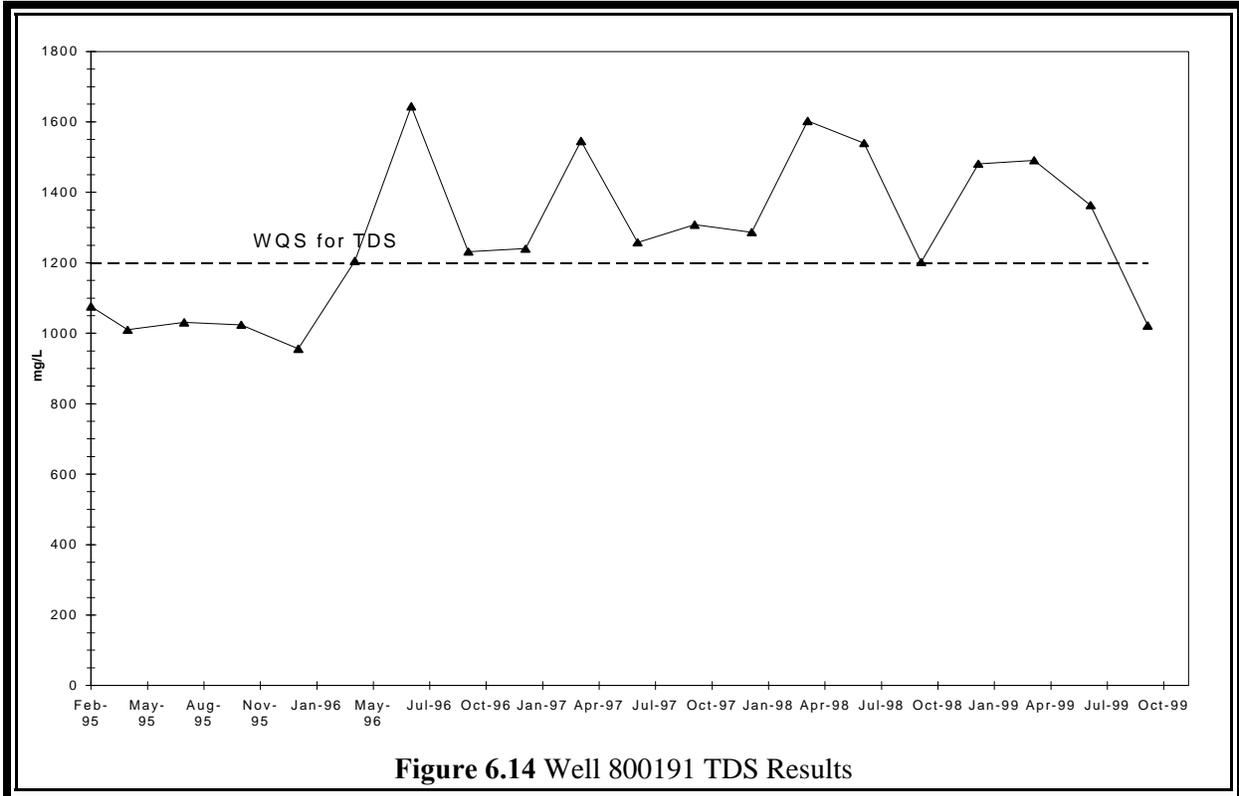
6. GROUNDWATER PROTECTION



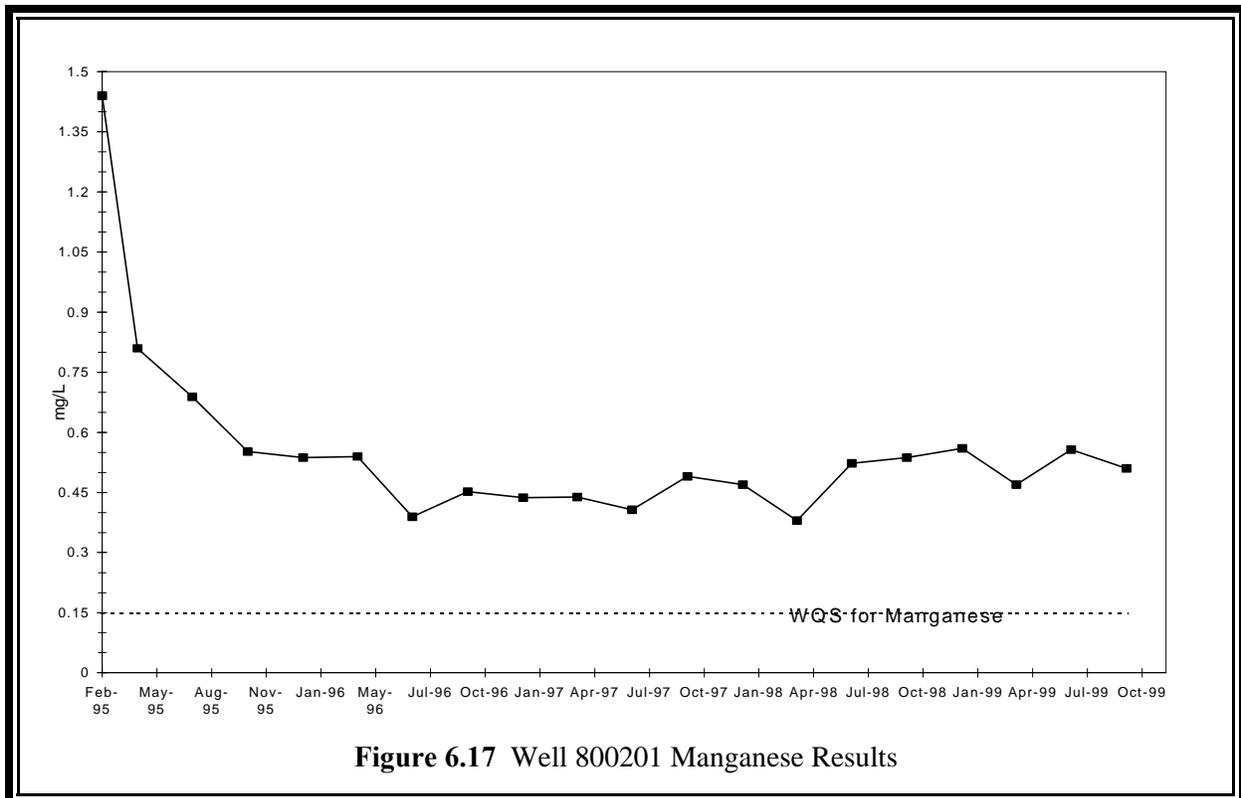
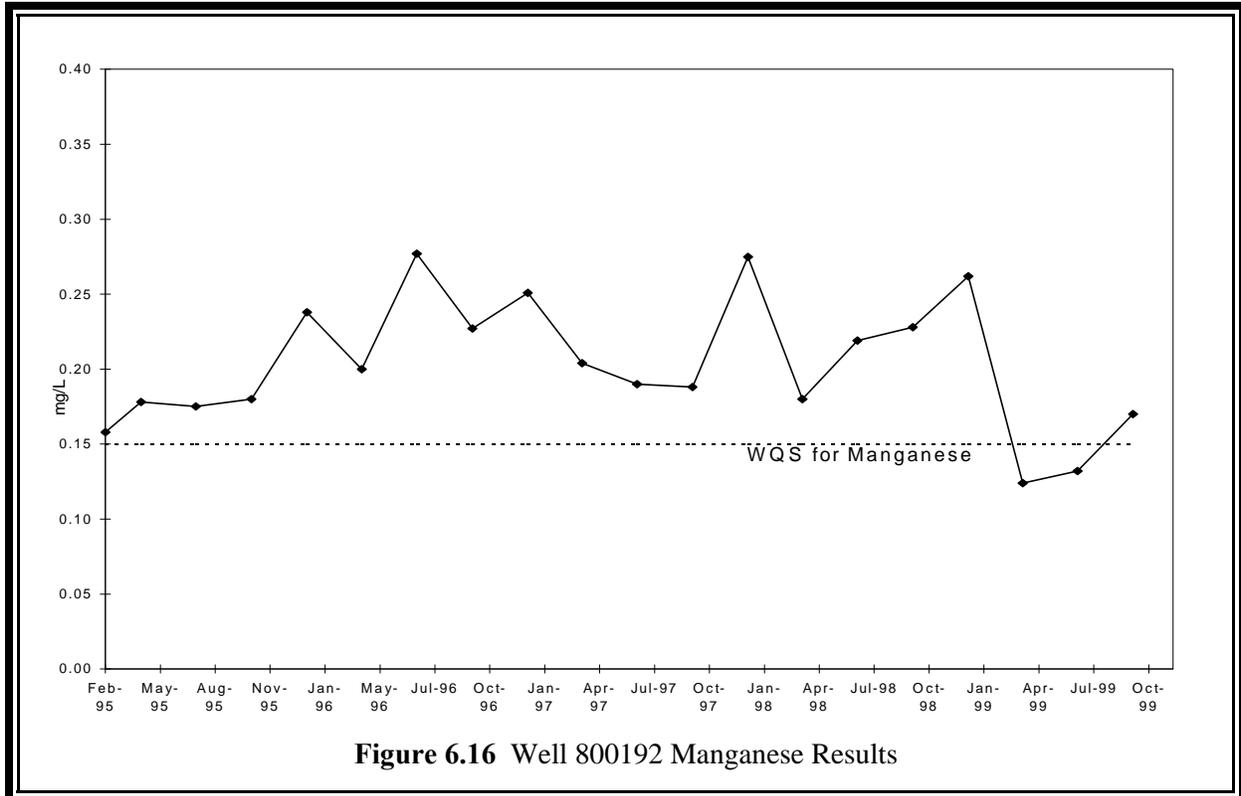
6. GROUNDWATER PROTECTION



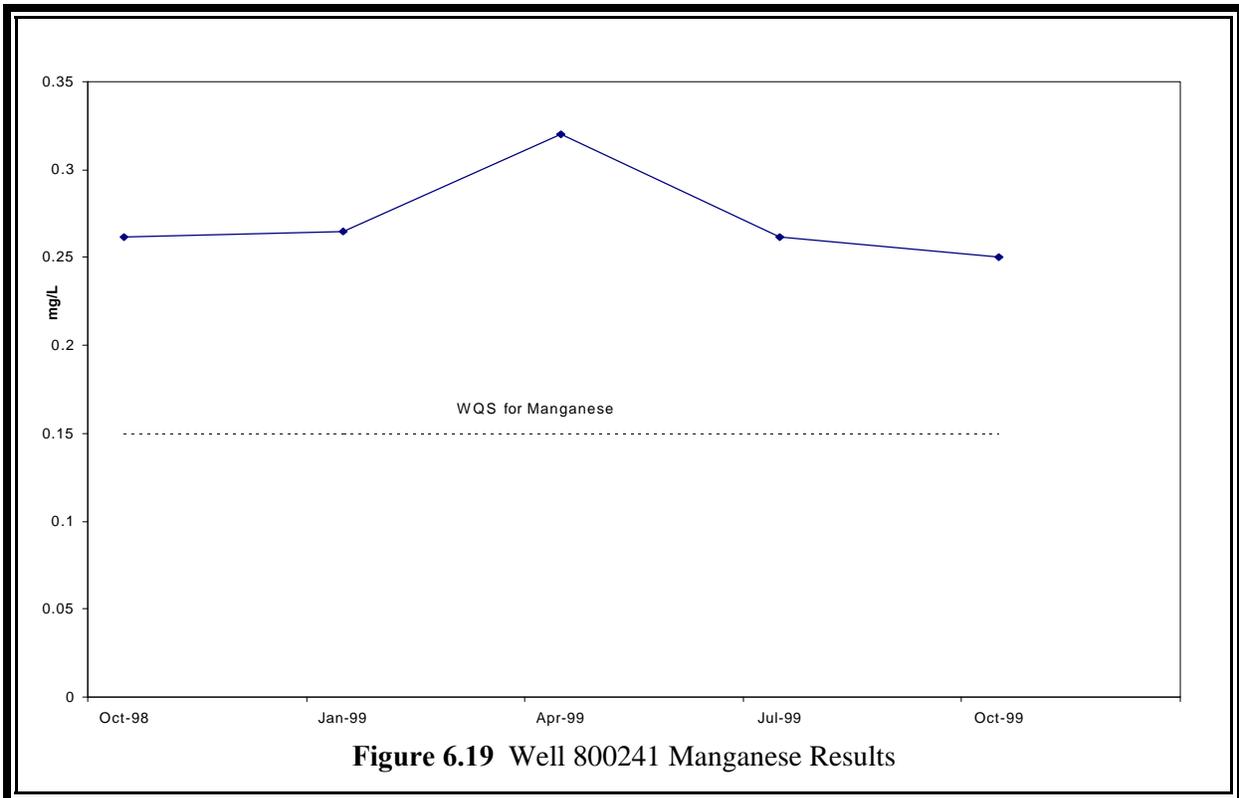
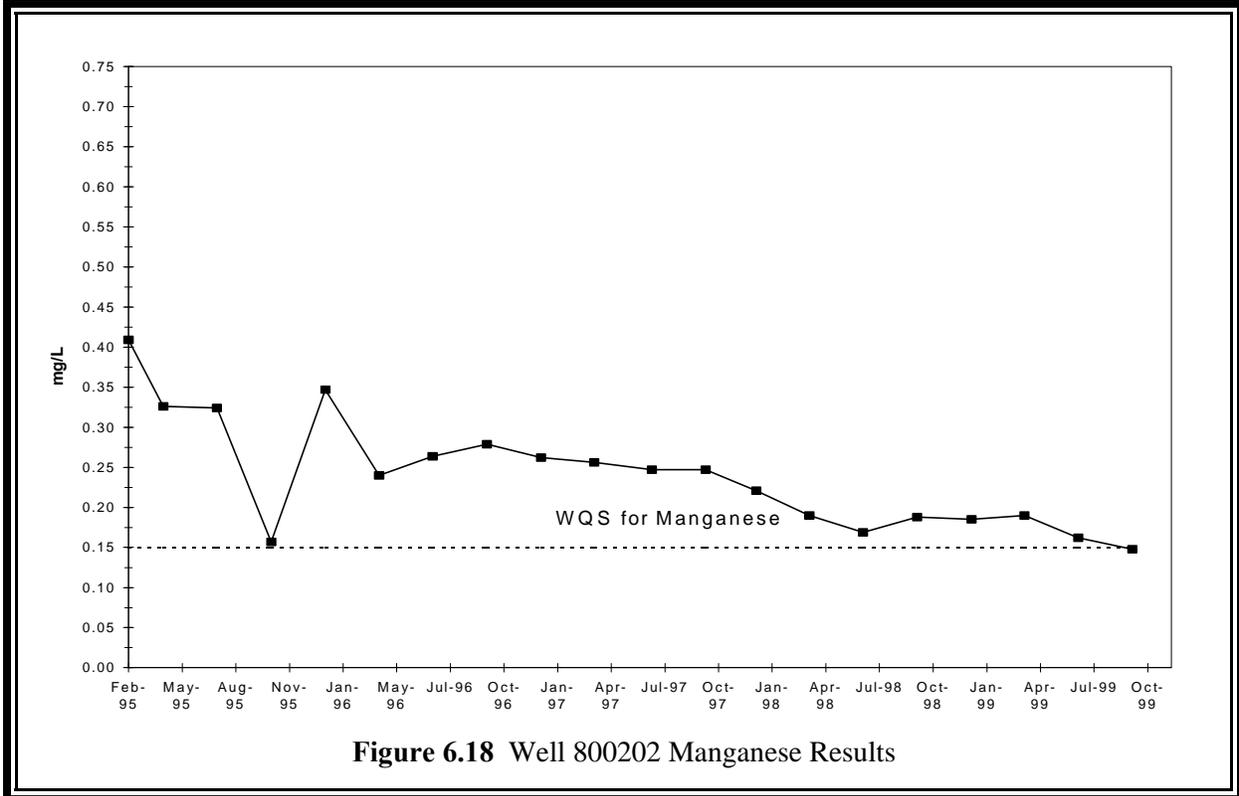
6. GROUNDWATER PROTECTION



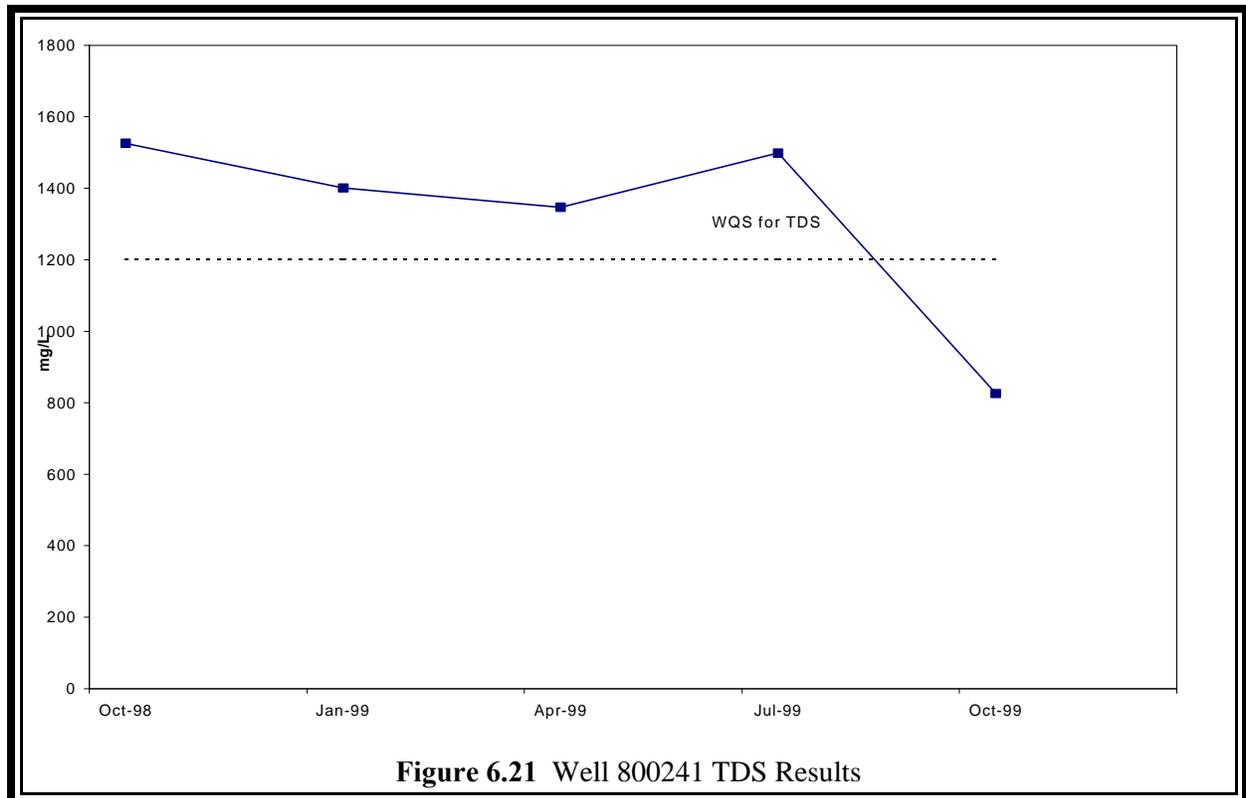
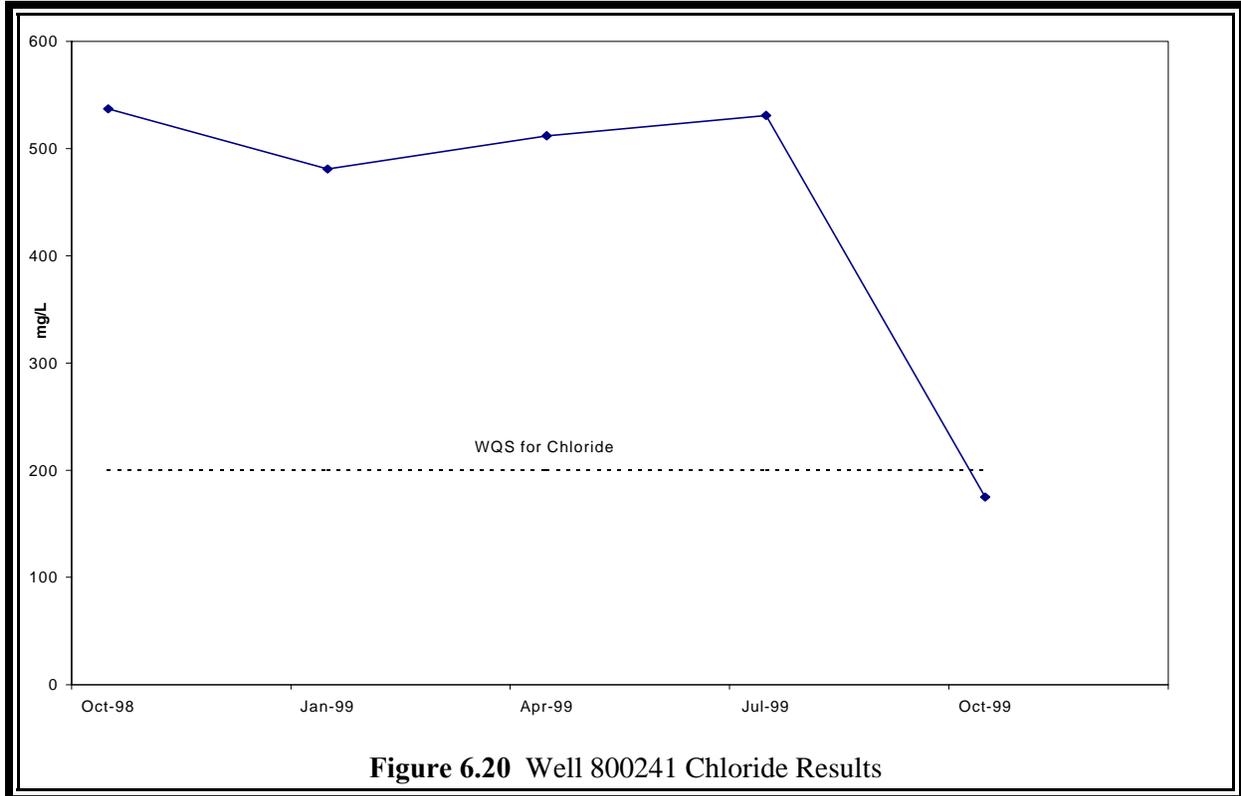
6. GROUNDWATER PROTECTION

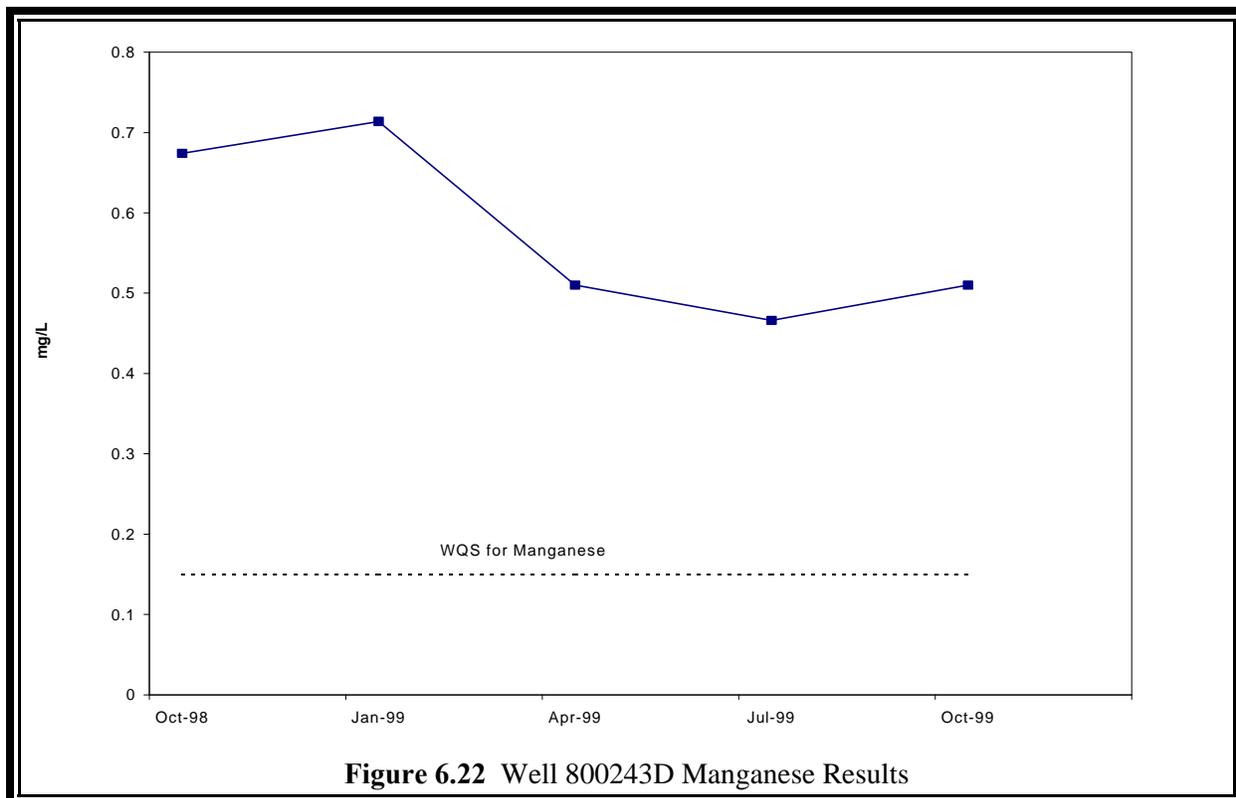


6. GROUNDWATER PROTECTION



6. GROUNDWATER PROTECTION





similar concentrations have been measured in monitoring wells several miles from the 800 Area Landfill.

In addition to Well 800241, Wells 800191 and 800381 contained concentrations of TDS above the WQS (1,200 mg/L) during one quarter. TDS levels in these wells ranged from 1,364 to 1,959 mg/L.

Unfiltered Routine Indicator Parameters. These specific parameters include cyanide, phenols (total recoverable), TOC, and TOX and are measured each quarter. All measured unfiltered routine indicator parameters were less than the appropriate WQS values, where applicable, except for cyanide in Well 800351.

Unfiltered Inorganic Parameters. These parameters are measured only during the second quarter and include arsenic, barium, boron, cadmium, chloride, chromium, cobalt, copper, cyanide, fluoride, iron, lead, manganese, mercury, nickel, nitrate as nitrogen, selenium, silver, sulfate, and zinc.

Chloride concentrations exceeded the WQS (200 mg/L) in Well 800241 only, possibly due to road salt intrusion.

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Iron concentrations exceeded the WQS (5 mg/L) in Wells 800161, 800163D, 800171, 800181, 800191, 800192, 800201, and 800202. Iron levels in these wells ranged from 5.1 to 38 mg/L. The iron exceedances are probably due to the requirement that these samples be unfiltered.

Lead concentrations exceeded the WQS (0.0075 mg/L) in Wells 800161, 800191, 800201, and 800241. Lead levels in these wells ranged from 0.0079 to 0.0890 mg/L.

Manganese concentrations exceeded the WQS (0.15 mg/L) in Wells 800161, 800162, 800171, 800181, 800191, 800201, 800202, 800241, and 800243D. Manganese levels in these wells ranged from 0.17 to 2.3 mg/L. Elevated manganese levels appear to be normal for this area.

Chromium and nickel concentrations exceeded the WQS (0.1 mg/L) only in 800241.

Organic Parameters. The unfiltered organic parameters were all below their respective detection limits except for trichloroethene in Well 800171 at 1.0 µg/L. The PQL is 5 µg/L. The PQL is the lowest concentration that can be reliably achieved within specific limits of precision and accuracy during routine operating conditions.

Radioactive Constituents. Samples collected from the 800 Area sanitary landfill monitoring wells were also analyzed for hydrogen-3. The results are shown in Tables 6.20 to 6.47. Although the disposal of radioactive materials was prohibited in the sanitary landfill, very low concentrations of hydrogen-3 were detected in Wells 800161, 800171, 800191, 800192, 800281, 800331, and 800361, probably because of inadvertent disposal of radioactivity in ANL-E trash. These results are consistent with 1997 and 1998 results. The presence of hydrogen-3 as tritiated water allows information to be obtained on the subsurface water flow pathway in the sanitary landfill area. The data indicate that the principal direction of subsurface water flow is to the south-southeast, with a small component to the northwest. This is consistent with the estimated subsurface water flow based on water level measurements and general flow patterns in the area. For those wells that had measurable levels of hydrogen-3, the samples were also analyzed for gamma-ray-emitting radionuclides. All concentrations were below their respective detection limits.

6.4. CP-5 Reactor Area

The CP-5 reactor is an inactive research reactor located in Building 330 (see Figure 1.1). The CP-5 5-MW research reactor was used from 1954 until operations ceased in 1979. In addition to the reactor vessel, the CP-5 complex contained several large cooling towers and an outdoor equipment yard for storing equipment and supplies. The reactor and associated yard area are in the process of being decommissioned. A single exploratory monitoring well was installed in 1989 in the yard immediately behind the reactor building, just outside the reactor fuel storage area of the complex. Two new wells were installed as part of a full characterization study of this site, which

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took place during 1993. The three wells have been sampled quarterly since 1995 and analyzed for radionuclides, metals, VOCs, SVOCs, pesticides, herbicides, and PCBs. A new deep well was installed during June 1997 to determine whether there had been any vertical migration of hydrogen-3 in the groundwater from the CP-5 reactor. The results are shown in Tables 6.48 to 6.51. Table 6.52 characterizes all wells in this area (see Figure 6.18 for locations).

Well 330011 is installed in a relatively porous, saturated region of soil and as a result, recharges quickly. Purging the well by removing several well volumes of water does not lower the water level appreciably. The water has a higher conductivity and temperature than similar wells at other locations. As in past years, the manganese WQS (0.15 mg/L) was exceeded three quarters, and levels ranged from 0.11 to 1.25 mg/L. Low levels of barium were noted each quarter; all levels were well below the WQS of 2 mg/L. As in past years, barium was detected each quarter in Well 330021; all levels were considerably below the appropriate WQS.

Manganese and nickel exceeded the WQS (0.15 and 0.10 mg/L, respectively) each quarter in Well 330031. Manganese levels ranged from 0.19 to 0.34 mg/L, and nickel levels ranged from 0.44 to 1.06 mg/L. The source of nickel is unknown. Similar manganese concentrations have been measured at distances from the CP-5 reactor (see Section 6.3.2.3). Chloride concentrations exceeded the WQS (200 mg/L) each quarter, and chloride levels ranged from 252 to 291 mg/L. Barium and iron were detected at levels well below the WQS each quarter, except for iron one quarter (5.4 mg/L) at the WQS (5 mg/L).

Barium, iron, and manganese were detected each quarter in Well 330012D; all levels were considerably below the appropriate WQS. Nickel was detected two quarters at levels well below the WQS (10 mg/L).

Each sample collected from Well 330011 in 1999 contained low concentrations of dichlorofluoromethane; concentrations ranged from 1 to 8 µg/L. These results are elevated compared with those noted in 1998. Well 330012D contained very low concentrations of dichlorofluoromethane each quarter; concentrations ranged from 1 to 9 µg/L. Low levels of trichlorofluoromethane were noted two quarters.

Radionuclide levels were greater than those noted in 1998 (see Figures 6.24 and 6.25). As in previous years, hydrogen-3 was detected in Wells 330011, 330021 (two quarters), and 330031. The levels of hydrogen-3 ranged from less than 100 to 1,281 pCi/L. Hydrogen-3 was also detected each quarter in samples from 330012D at levels of 186 to 2,651 pCi/L. The increase in the hydrogen-3 concentration during the last two quarters is being investigated. Strontium-90 was detected in Wells 330011 and 330012D, and the levels ranged from 0.45 to 1.46 pCi/L (Figure 6.25). Cesium-137 was detected occasionally, and the levels ranged from less than 1.0 to 1.75 pCi/L.

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TABLE 6.48

Groundwater Monitoring Results, 300 Area Well 330011, 1999

Parameter	Unit	Date of Sampling			
		03/19/99	06/11/99	09/03/99	11/16/99
Water elevation ^a	m	220.47	220.30	219.01	219.07
Temperature	°C	14.9	16.3	19.5	18.1
pH	pH	7.12	7.23	7.18	6.88
Redox	mV	-2	-12	6	15
Conductivity	µmhos/cm	944	874	1,122	1,458
Chloride ^b	mg/L	16	13	61	139
Arsenic ^b	mg/L	< 0.0025	< 0.0025	< 0.0025	< 0.0025
Barium ^b	mg/L	0.0445	0.0437	0.0870	0.0933
Beryllium ^b	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Cadmium ^b	mg/L	< 0.0002	< 0.0002	0.0002	< 0.0002
Chromium ^b	mg/L	< 0.044	< 0.044	< 0.044	< 0.044
Cobalt ^b	mg/L	< 0.026	< 0.026	< 0.026	< 0.026
Copper ^b	mg/L	< 0.017	< 0.017	< 0.017	< 0.017
Iron ^b	mg/L	< 0.037	< 0.037	< 0.037	< 0.037
Lead ^b	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Manganese ^b	mg/L	0.1835	0.1139	1.2500	0.6401
Mercury ^b	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel ^b	mg/L	< 0.04	< 0.04	< 0.04	< 0.04
Silver ^b	mg/L	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Thallium ^b	mg/L	< 0.0015	< 0.0015	< 0.0015	< 0.0015
Vanadium ^b	mg/L	< 0.024	< 0.024	< 0.024	< 0.024
Zinc ^b	mg/L	< 0.011	< 0.011	< 0.011	< 0.011
Cesium-137	pCi/L	< 1.0	< 1.0	< 1.0	< 1.0
Hydrogen-3	pCi/L	669	598	1,186	1,281
Strontium-90	pCi/L	0.45	0.45	0.70	0.90
Dichlorofluoromethane	µg/L	1	2	7	8

^a Well point elevation = 221.00 m (MSL); ground surface elevation = 227.10 m (MSL); casing material = steel.

^b Filtered sample.

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TABLE 6.49

Groundwater Monitoring Results, 300 Area Well 330021, 1999

Parameter	Unit	Date of Sampling			
		03/19/99	06/09/99	09/03/99	11/16/99
Water elevation ^a	m	227.02	226.10	224.94	224.27
Temperature	°C	8.2	10.8	14.1	12.5
pH	pH	7.46	7.24	7.52	7.30
Redox	mV	-18	-13	-16	-9
Conductivity	µmhos/cm	759	762	613	791
Chloride ^b	mg/L	5	6	5	7
Arsenic ^b	mg/L	< 0.0025	< 0.0025	< 0.0025	< 0.0025
Barium ^b	mg/L	0.0222	0.0241	0.0268	0.0326
Beryllium ^b	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Cadmium ^b	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium ^b	mg/L	< 0.044	< 0.044	< 0.044	< 0.044
Cobalt ^b	mg/L	< 0.026	< 0.026	< 0.026	< 0.026
Copper ^b	mg/L	< 0.017	< 0.017	< 0.017	< 0.017
Iron ^b	mg/L	< 0.037	< 0.037	< 0.037	< 0.037
Lead ^b	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Manganese ^b	mg/L	< 0.017	< 0.017	< 0.017	0.0618
Mercury ^b	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel ^b	mg/L	< 0.04	< 0.04	< 0.04	< 0.04
Silver ^b	mg/L	< 0.0005	< 0.0005	< 0.0005	0.0005
Thallium ^b	mg/L	< 0.0015	< 0.0015	< 0.0015	< 0.0015
Vanadium ^b	mg/L	< 0.024	< 0.024	< 0.024	< 0.024
Zinc ^b	mg/L	< 0.011	< 0.011	< 0.011	< 0.011
Cesium-137	pCi/L	1.5	< 1.0	1.8	< 1.0
Hydrogen-3	pCi/L	< 100	< 100	174	175
Strontium-90	pCi/L	< 0.25	< 0.25	< 0.25	< 0.25
Methylene chloride	µg/L	< 1	2	< 1	< 1

^a Well point elevation = 221.95 m (MSL); ground surface elevation = 227.75 m (MSL); casing material = stainless steel.

^b Filtered sample.

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TABLE 6.50

Groundwater Monitoring Results, 300 Area Well 330031, 1999

Parameter	Unit	Date of Sampling			
		03/19/99	06/09/99	09/03/99	11/16/99
Water elevation ^a	m	226.12	225.49	224.17	223.47
Temperature	°C	9.6	11.4	13.6	13.1
pH	pH	7.09	7.11	7.16	6.99
Redox	mV	-2	-7	8	7
Conductivity	µmhos/cm	1,903	1,807	1,431	1,757
Chloride ^b	mg/L	291	252	267	252
Arsenic ^b	mg/L	< 0.0025	< 0.0025	< 0.0025	< 0.0025
Barium ^b	mg/L	0.0461	0.0546	0.0539	0.0471
Beryllium ^b	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Cadmium ^b	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium ^b	mg/L	< 0.044	< 0.044	< 0.044	< 0.044
Cobalt ^b	mg/L	< 0.026	< 0.026	< 0.026	< 0.026
Copper ^b	mg/L	< 0.017	< 0.017	< 0.017	< 0.017
Iron ^b	mg/L	0.1619	5.411	2.375	1.512
Lead ^b	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Manganese ^b	mg/L	0.185	0.3363	0.3432	0.3257
Mercury ^b	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel ^b	mg/L	0.4446	1.063	0.603	0.7283
Silver ^b	mg/L	< 0.0005	< 0.0005	< 0.0005	0.0005
Thallium ^b	mg/L	< 0.0015	< 0.0015	< 0.0015	< 0.0015
Vanadium ^b	mg/L	< 0.024	< 0.024	< 0.024	< 0.024
Zinc ^b	mg/L	0.0115	0.0349	< 0.011	< 0.011
Cesium-137	pCi/L	< 1.0	< 1.0	< 1.0	< 1.0
Hydrogen-3	pCi/L	183	129	262	304
Strontium-90	pCi/L	< 0.25	< 0.25	< 0.25	< 0.25
Carbon disulfide	µg/L	< 1	< 1	< 1	1

^a Well point elevation = 221.95 m (MSL); ground surface elevation = 227.13 m (MSL); casing material = stainless steel.

^b Filtered sample.

6. GROUNDWATER PROTECTION

TABLE 6.51

Groundwater Monitoring Results, 300 Area Well 330012D, 1999

Parameter	Unit	Date of Sampling			
		03/19/99	06/11/99	09/03/99	11/16/99
Water elevation ^a	m	190.59	190.78	190.51	190.02
Temperature	°C	13.4	14.0	14.5	13.3
pH	pH	7.10	7.38	7.45	7.33
Redox	mV	-4	-26	-11	-11
Conductivity	µmhos/cm	1,164	1,123	1,098	1,262
Chloride ^b	mg/L	44	43	90	86
Arsenic ^b	mg/L	< 0.0025	< 0.0025	< 0.0025	< 0.0025
Barium ^b	mg/L	0.0595	0.0620	0.0727	0.0557
Beryllium ^b	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Cadmium ^b	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium ^b	mg/L	< 0.044	< 0.044	< 0.044	< 0.044
Cobalt ^b	mg/L	< 0.026	< 0.026	< 0.026	< 0.0260
Copper ^b	mg/L	< 0.017	< 0.017	< 0.017	< 0.017
Iron ^b	mg/L	0.1320	0.2746	0.1469	0.0745
Lead ^b	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Manganese ^b	mg/L	0.0711	0.0597	0.0680	0.0766
Mercury ^b	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel ^b	mg/L	0.0408	< 0.0400	< 0.0400	0.0495
Silver ^b	mg/L	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Thallium ^b	mg/L	< 0.0015	< 0.0015	< 0.0015	< 0.0015
Vanadium ^b	mg/L	< 0.024	< 0.024	< 0.024	< 0.024
Zinc ^b	mg/L	< 0.011	< 0.011	< 0.011	< 0.011
Cesium-137	pCi/L	< 1.0	< 1.0	< 1.0	1.1
Hydrogen-3	pCi/L	414	186	2,651	1,974
Strontium-90	pCi/L	0.59	0.47	1.03	1.46
Dichlorofluoromethane	µg/L	1	1	4	9
Trichlorofluoromethane	µg/L	< 1	< 1	3	8

^a Well point elevation = 185.65 m (MSL); ground surface elevation = 227.13 m (MSL); casing material = stainless steel.

^b Filtered sample.

6. GROUNDWATER PROTECTION

TABLE 6.52

Groundwater Monitoring Wells: 330 Area/CP-5 Reactor

ID Number	Well Depth (m bgs)	Ground Elevation (m AMSL)	Monitoring Zone (m AMSL)	Well Type ^a	Date Drilled
330011	6.1	227.10	224.2 – 221.1	0.05/PVC	8/89
330021	5.8	227.75	226.3 – 221.7	0.05/SS	9/93
330031	5.2	227.13	225.6 – 221.0	0.05/SS	9/93
330012D	41.5	227.13	191.7 – 185.6	0.05/SS	6/97

^a Inner diameter (m)/well material (PVC = polyvinyl chloride, SS = stainless steel).

The CP-5 was a heavy-water–moderated reactor. During its operational life, several incidents occurred that released small amounts of this heavy water containing high concentrations of hydrogen-3 to the environment. In addition, the normal operation released significant amounts of water vapor containing hydrogen-3 from the main ventilation system that may have condensed and fallen to the ground in the form of precipitation. These activities are believed to be responsible for the residual amounts of hydrogen-3 now found in the groundwater. All the hydrogen-3 monitoring results for the CP-5 wells are plotted in Figure 6.24. The source of the strontium-90 and cesium-137 is not known.

6.5. Monitoring of the Seeps South of the 300 Area

In spring 1996, during the RCRA Facility Investigation of the 317/319 Area, a series of groundwater seeps was discovered in a network of steeply eroded ravines in the Waterfall Glen Forest Preserve south and southeast of the 317 and 319 Areas. Three seeps (SP01, SP02, and SP04) are located about 200 m (600 ft) south of the 319 Area; two other seeps (SP03 and SP05) are located about 360 m (1,200 ft) south of the 317 Area. The locations are shown in Figure 6.26. The seeps are in ravines that are located in a pristine, heavily wooded section of the forest preserve; they carry storm water discharges from the 317 and 319 Areas. Water emanating from the seeps flows to the nearby ravine, where it forms a small rivulet in the bottom of the ravine. Approximately 30 m (100 ft) downstream of the seep area, the affected water from the seeps is no longer visible because it drains back into the soil in the bed of the ravine. During extended dry weather conditions, the flow disappears completely. The IEPA has designated this area as AOC-G — Off-Site Groundwater Seeps (South of the 317/319/ENE Area).

6. GROUNDWATER PROTECTION

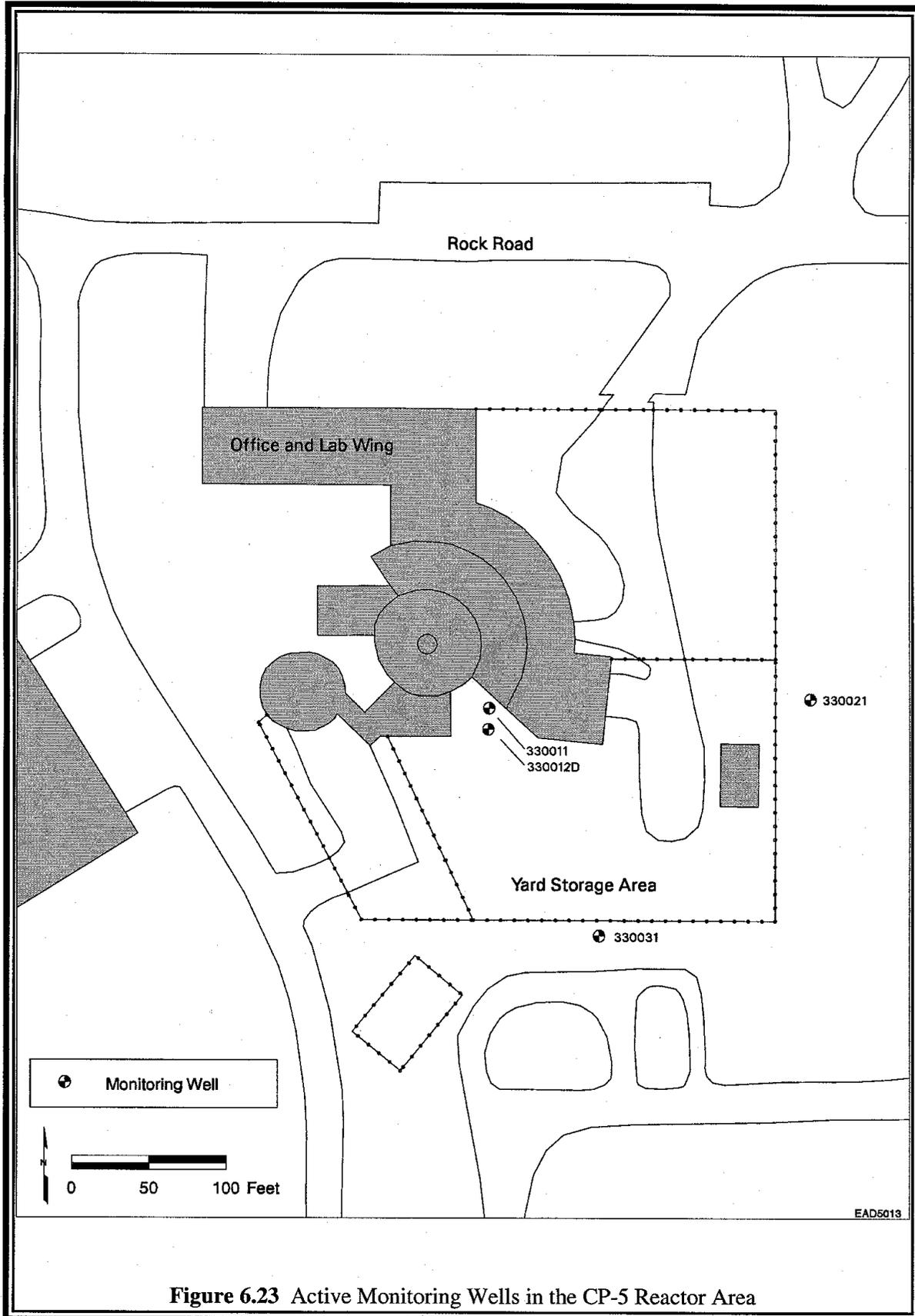
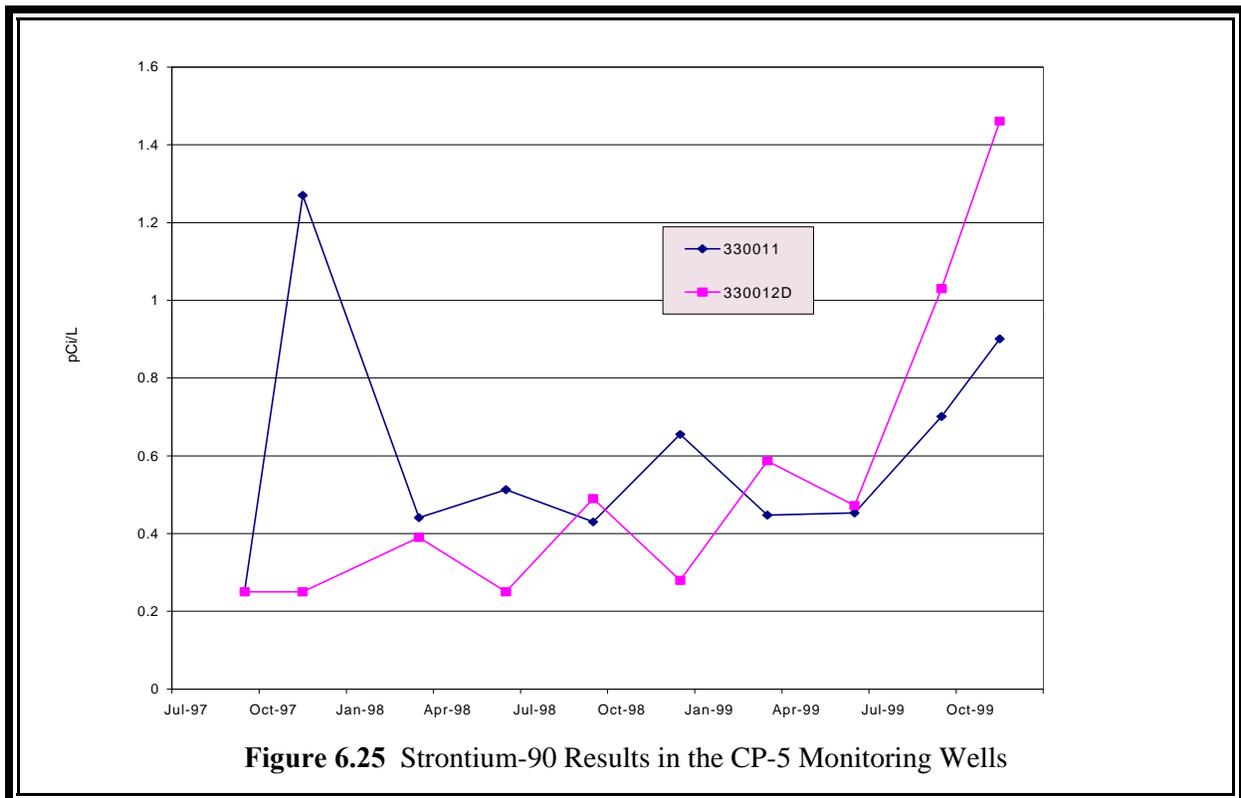
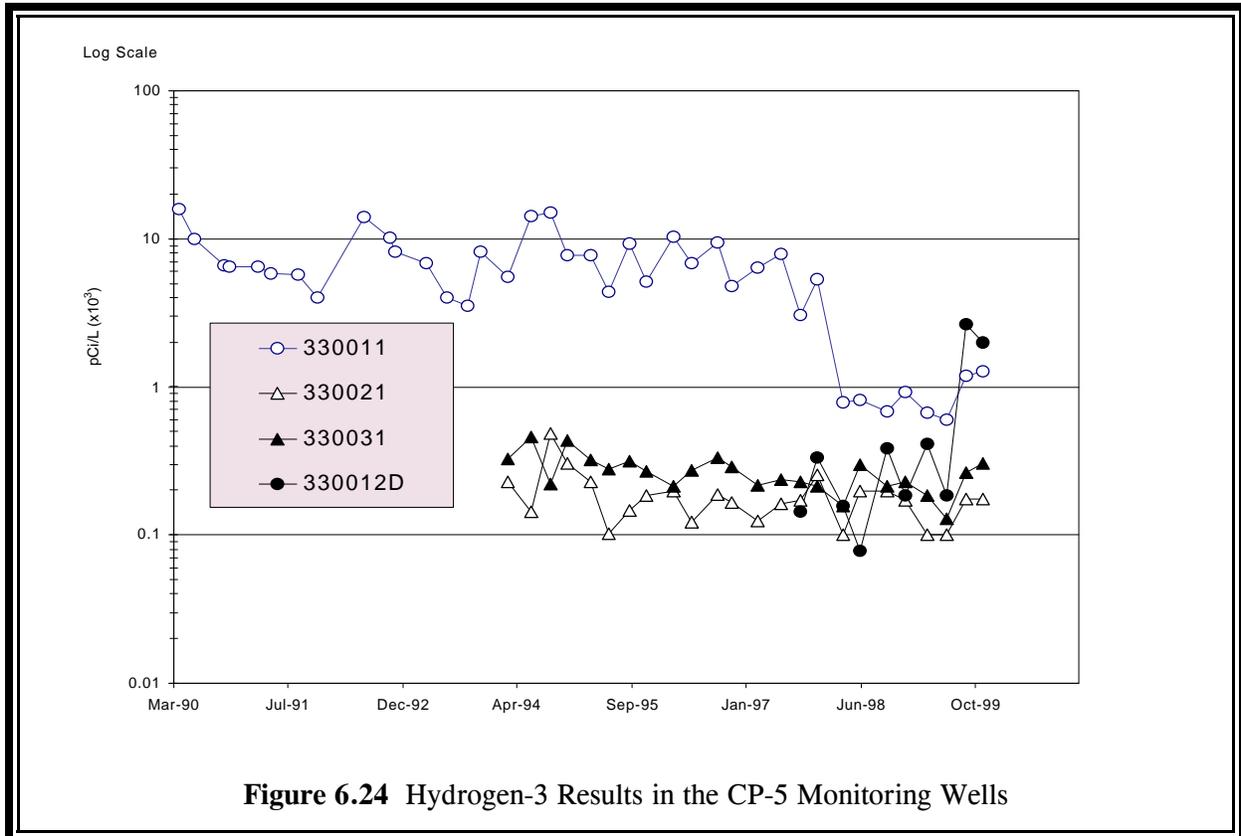


Figure 6.23 Active Monitoring Wells in the CP-5 Reactor Area

6. GROUNDWATER PROTECTION



6. GROUNDWATER PROTECTION

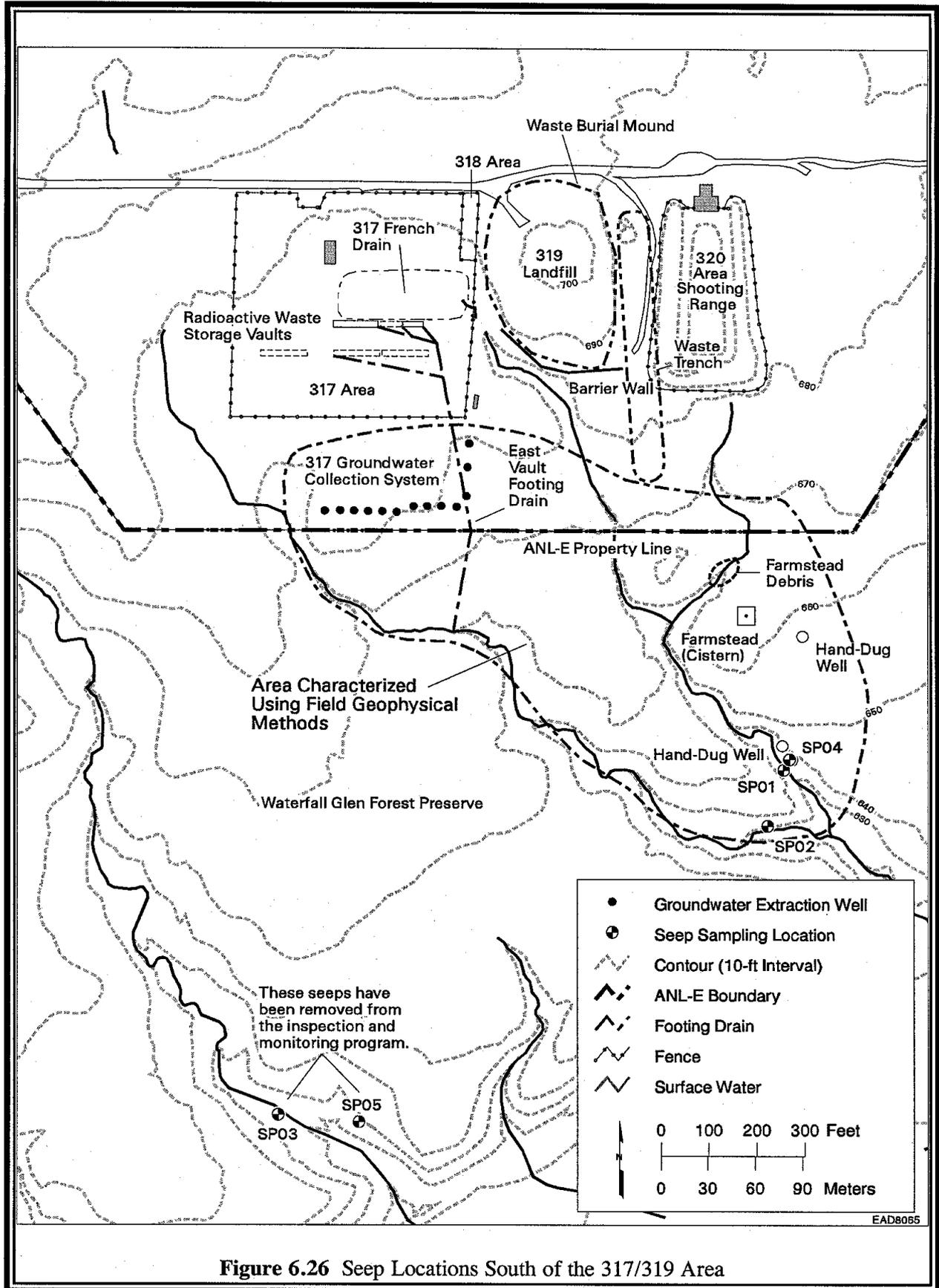


Figure 6.26 Seep Locations South of the 317/319 Area

6. GROUNDWATER PROTECTION

Samples were collected and analyzed for metals, VOCs, and selected radionuclides. Two groundwater seeps contained measurable levels of three VOCs — carbon tetrachloride, chloroform, and tetrachloroethene. Carbon tetrachloride and tetrachloroethene concentrations exceeded the Class I Groundwater Quality Standards. The other three seeps did not contain any quantifiable VOCs. Three of the five seeps, including the two containing the VOCs, were found to contain hydrogen-3 in measurable concentrations. Since the initial samples were collected, monthly samples were obtained through the end of 1997, and quarterly samples collected to the end of 1998. These results are summarized in the previous SER.¹⁶

During 1999, attempts were made to sample the three seeps quarterly. Unfortunately, all the seeps were dry during the middle quarters. The available data are given in Table 6.53. The hydrogen-3 and VOC results are consistent with past data, which indicates a gradual decline in concentrations since measurements began in 1996.

The presence of hydrogen-3 in the seep water supports the hypothesis that the 319 Area is the source of the contamination, because groundwater beneath the landfill contains hydrogen-3 at much higher concentrations. Hydrogen-3 was also detected in the 317 Area groundwater but at much lower concentrations. In addition, the mix of VOCs in groundwater under the 319 Landfill is different than the mix under the 317 Area but consistent with the mix found at the seeps. Geophysical characterization of the area indicates that there is a groundwater divide between the 317 and 319 Areas. The depth of contamination in the study areas is less well understood because the sampling techniques limited the sample collection depth to the upper regions of the glacial till. Because of the presence of the highly impermeable Lemont Drift underlying the more permeable Wadsworth till, the affected groundwater is almost certain to be limited to the upper permeable zones in the Wadsworth till. The seep monitoring and the area characterization study appear to have adequately described the source and pathway of the hydrogen-3 and VOC contaminants.

TABLE 6.53

Contaminant Concentrations in Seep Water, 1999

Site	Date Collected	Hydrogen-3 (pCi/L)	Carbon Tetrachloride (µg/L)	Chloroform (µg/L)	Tetrachloroethene (µg/L)
SP01	March 10	457 ± 49	9	2	< 1
	November 30	619 ± 56	10	3	< 1
SP02	March 10	541 ± 50	2	< 1	< 1
	November 30	1,559 ± 69	1	< 1	< 1
SP04	March 10	182 ± 44	201	24	5
	November 30	103 ± 46	311	32	8