Argonne National Laboratory-East

Site Environmental Report
for Calendar Year 2003

ANL-04/2

By N. W. Golchert and R. G. Kolzow

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ARGONNE NATIONAL LABORATORY-EAST SITE ENVIRONMENTAL REPORT FOR CALENDAR YEAR 2003

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N.W. Golchert and R.G. Kolzow
Safety, Environment, and Quality Assurance

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ARGONNE NATIONAL LABORATORY-EAST
9700 South Cass Avenue
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This Site Environmental Report (SER) was prepared by the Safety, Environment, and Quality Assurance (EQO) division at Argonne National Laboratory-East (ANL-E) for the U.S. Department of Energy (DOE). The results of the environmental monitoring program and an assessment of the impact of site operations on the environment and the public are presented in this publication. This SER and those for recent years are available on the Internet at http://www.anl.gov/ESH/anleser/.

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ACM	Asbestos-Containing Material
AEA	Atomic Energy Act of 1954
AEM-X	Argonne Equipment and Materials Exchange
AGHC	Alpha Gamma Hot Cell
ALARA	As-Low-As-Reasonably Achievable
ANL-E	Argonne National Laboratory-East
AOC	Area of Concern
APS	Advanced Photon Source
ATLAS	Argonne Tandem Linac Accelerating System
ATSR	Argonne Thermal Source Reactor
BAT	Best Available Technology
BCG	Biota Concentration Guide
BOD_5	Biochemical Oxygen Demand
CAA	Clean Air Act
CAAPP	Clean Air Act Permit Program
CAP-88	Clean Air Act Assessment Package-1988
CEDE	Committed Effective Dose Equivalent
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
CLP	Contract Laboratory Program
COD	Chemical Oxygen Demand
COE	U.S. Army Corps of Engineers
CP-5	Chicago Pile-Five
CRMP	Cultural Resources Management Plan
CWA	Clean Water Act
D&D	Decontamination and Decommissioning
DCA	1,1-Dichloroethane
DCG	Derived Concentration Guide
DMR	Discharge Monitoring Report
DOE	U.S. Department of Energy
DOE-ASO	DOE, Argonne Site Office
DOE-EML-QAP	DOE, Environmental Measurements Laboratory, Quality Assurance Program
E2	Energy Efficiency
EA	Environmental Assessment
EBWR	Experimental Boiling Water Reactor
EHS	Extremely Hazardous Substance
EIS	Environmental Impact Statement
EMS	Environmental Management System
ENE	East-Northeast
EO	Executive Order
EPA	U.S. Environmental Protection Agency

ACRONYMS

EPCRA	Emergency Planning and Community Right to Know Act
EPDMS	Environmental Protection Data Management System
EQO	Safety, Environment, and Quality Assurance
EQO-AS	EQO, Analytical Services
ERP	Environmental Remediation Program
ESA	Endangered Species Act
ESH	Environment, Safety and Health
FFCA	Federal Facility Compliance Act
FY	Fiscal Year
HAP	Hazardous Air Pollutant
HEPA	High-Efficiency Particulate Air
HSWA	Hazardous and Solid Waste Amendments
HVEM	High-Voltage Electron Microscopy
IAC	*Illinois Administrative Code*
ICRP	International Commission on Radiological Protection
IDNS	Illinois Department of Nuclear Safety
IEPA	Illinois Environmental Protection Agency
IHPA	Illinois Historic Preservation Agency
IPCB	Illinois Pollution Control Board
IPNS	Intense Pulsed Neutron Source
ISM	Integrated Safety Management
ISMS	Integrated Safety Management System
LC_{50}	Median Lethal Concentration
LEED	Leadership in Energy and Environmental Design
LEPC	Local Emergency Planning Committee
LLW	Low-Level Radioactive Waste
LTS	Long-Term Stewardship
LUCMOA	Land Use Control Memorandum of Agreement
LWTP	Laboratory Wastewater Treatment Plant
MACT	Maximum Achievable Control Technology
MSDS	Material Safety Data Sheet
MY	Model Year
NBL	New Brunswick Laboratory
NEPA	National Environmental Policy Act
NESHAPs	National Emission Standards for Hazardous Air Pollutants
NFA	No Further Action
NFR	No Further Remediation
NHPA	National Historic Preservation Act
NIST	National Institute of Standards and Technology
NPDES	National Pollutant Discharge Elimination System

NPL	National Priority List
NRHP	*National Register of Historic Places*
O&M	Operation and Maintenance
P2	Pollution Prevention
PA	Preliminary Assessment
PBT	Persistent, Bioaccumulative Toxic
PCB	Polychlorinated Biphenyl
PFS	Plant Facilities and Services
PPOA	Pollution Prevention Opportunity Assessment
PQL	Practical Quantification Limit
PSTP	Proposed Site Treatment Plan
PWA	Process Waste Assessment
QA	Quality Assurance
R&D	Research and Development
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
SER	Site Environmental Report
SERC	State Emergency Response Commission
SHPO	State Historic Preservation Office
SIP	Site Implementation Plan
SOP	Standard Operating Procedure
SPCC	Spill Prevention Control and Countermeasures
SSI	Site Screening Investigation
SVOC	Semivolatile Organic Compound
SWMU	Solid Waste Management Unit
SWPPC	Storm Water Pollution Prevention Committee
SWPPP	Storm Water Pollution Prevention Plan
SWTP	Sanitary Wastewater Treatment Plant
TCA	1,1,1-Trichloroethane
TCLP	Toxicity Characteristic Leaching Procedure
TDS	Total Dissolved Solids
TLD	Thermoluminescent Dosimeter
TOC	Total Organic Carbon
TOX	Total Organic Halogen
TRI	Toxic Release Inventory
TRU	Transuranic Waste
TSCA	Toxic Substances Control Act
TSS	Total Suspended Solids

ACRONYMS

USFWS	U.S. Fish and Wildlife Service
UST	Underground Storage Tank
VOC	Volatile Organic Compound
WIPP	Waste Isolation Pilot Plant
WMO	Waste Management Operations
WQS	Water Quality Standard
WTP	Wastewater Treatment Plant

This report discusses the accomplishments of the environmental protection program at Argonne National Laboratory-East (ANL-E) for calendar year 2003. The status of ANL-E environmental protection activities with respect to compliance with the various laws and regulations is discussed, along with the progress of environmental corrective actions and restoration projects. To evaluate the effects of ANL-E operations on the environment, samples of environmental media collected on the site, at the site boundary, and off the ANL-E site were analyzed and compared with applicable guidelines and standards. A variety of radionuclides were measured in air, surface water, on-site groundwater, and bottom sediment samples. In addition, chemical constituents in surface water, groundwater, and ANL-E effluent water were analyzed. External penetrating radiation doses were measured, and the potential for radiation exposure to off-site population groups was estimated. Results are interpreted in terms of the origin of the radioactive and chemical substances (i.e., natural, fallout, ANL-E, and other) and are compared with applicable environmental quality standards. A U.S. Department of Energy dose calculation methodology, based on International Commission on Radiological Protection recommendations and the U.S. Environmental Protection Agency's CAP-88 (Clean Air Act Assessment Package-1988) computer code, was used in preparing this report.

This report summarizes the ongoing environmental protection program activities conducted by Argonne National Laboratory-East (ANL-E) in calendar year 2003. It includes descriptions of the site, ANL-E missions and programs, the status of compliance with environmental regulations, environmental protection and restoration activities, and the environmental surveillance program. The surveillance program conducts regular monitoring for radiation, radioactive materials, and nonradiological constituents on the ANL-E site and in the surrounding region. These activities document compliance with appropriate standards and permit limits, identify trends, provide information to the public, and contribute to a better understanding of ANL-E's impact on the environment. The surveillance program supports the ANL-E policy of protecting the public, employees, and the environment from harm that may result from ANL-E activities, and of reducing environmental impacts to the greatest degree practicable.

In 2003, ANL-E completed all remedial actions at the site. The remediation plan is described in a document entitled *Environmental Restoration Program (EM-40) Baseline for Argonne National Laboratory-East*, which was prepared in early 1999.

Compliance Summary

Radionuclide emissions, the management of asbestos, and conventional air pollutants from ANL-E facilities are regulated under the Clean Air Act (CAA). A number of airborne radiological emission points at ANL-E are subject to National Emission Standards for Hazardous Air Pollutants (NESHAPs) regulations for radionuclide releases from U.S. Department of Energy (DOE) facilities (Title 40, Part 61, Subpart H, of the *Code of Federal Regulations* [40 CFR Part 61, Subpart H]). All such air emission sources were evaluated to ensure that these requirements are being addressed properly. The estimated hypothetical individual off-site radiation dose from ANL-E activities required to be reported by U.S. Environmental Protection Agency (EPA) regulations for 2003 was 0.057 mrem/yr. This is 0.6% of the 10 mrem/yr standard. This dose does not include contributions from radon-220 and radon-222 emissions, which are exempted in the regulations.

At ANL-E, asbestos-containing material (ACM) frequently is encountered during maintenance or renovation of existing facilities and equipment. Asbestos is removed and disposed of in strict accordance with NESHAPs and Occupational Safety and Health Administration worker protection standards. Approximately 162 m^3 (5,726 ft^3) of ACM was removed and disposed of at off-site landfills in Illinois during 2003.

The ANL-E site contains sources of conventional air pollutants. The steam plant and fuel-dispensing facilities operate continuously and are the only significant sources of continuous air pollutants. The emergency generators at the Advanced Photon Source (APS) and the engine test facility are also significant sources, when in operation. The Illinois Environmental Protection Agency (IEPA) issued the final ANL-E Clean Air Act Permit Program (CAAPP) Permit in April 2001. All previous air operating permits (with the exception of the open burning permits) were incorporated into this sitewide permit for all emission sources and activities. The ANL-E CAAPP Title V Permit requires continuous opacity and sulfur dioxide monitoring of the steam plant smoke stack from Boiler No. 5, the only boiler equipped to burn coal. Low-sulfur coal was burned in Boiler No. 5 for five months during 2003. During the period coal was burned, which occurred during colder weather to supplement the other gas-fired boilers, no exceedances were observed.

The goals of the Clean Water Act are achieved primarily through the National Pollutant Discharge Elimination System (NPDES) permit program. The federal government has delegated implementation of the NPDES program to the State of Illinois. An application to renew the existing permit was submitted to the IEPA during December 1998. The IEPA did not act to review the permit renewal application in 2003, and, therefore, as provided for in the IEPA regulations, ANL-E continues to operate under its 1994 permit, as modified, until a renewal permit is issued. During 2003, three exceedances of the NPDES permit limits were reported out of approximately 1,600 measurements.

ANL-E was granted interim status under the Resource Conservation and Recovery Act (RCRA) upon submitting a Part A Permit application in 1980. The IEPA issued a RCRA Part B Permit on September 30, 1997, which became effective on November 4, 1997. The permit addresses 25 hazardous waste treatment and storage facilities and establishes corrective action procedures and requirements for 49 Solid Waste Management Units (SWMUs) and 3 Areas of Concern (AOCs). Since the issuance of the permit, three additional AOCs have been added to the permit. By September 30, 2003, all planned remediation work was completed. However, ongoing activities are being conducted at 5 SWMUs and 2 AOCs. These seven units require continuing monitoring as part of the ANL-E long-term stewardship program.

ANL-E has prepared and implemented a sitewide underground storage tank (UST) compliance plan. The ANL-E site contains 17 USTs, which are in compliance with UST regulations.

The only Toxic Substances Control Act (TSCA)-regulated compounds in significant quantities at ANL-E are polychlorinated biphenyls (PCBs) contained in electrical capacitors, power supplies, and small transformers. The ANL-E PCB Item Inventory Program was initiated in 1995 to identify all suspect PCB-containing items. All pole-mounted transformers and circuit breakers containing PCBs have been replaced or retrofilled with non-PCB oil. All removal and disposal activities were conducted by licensed contractors specializing in such operations. During 2003, no radioactive PCB-contaminated articles, sludge, or debris were shipped off site for disposal, leaving 333 L (87 gal) in storage.

In 2003, most projects requiring National Environmental Policy Act (NEPA) review for assessment were determined to be categorical exclusions. One Environmental Assessment was completed in 2003 for the enhanced operations at the APS, including the conduct of Biosafety Level-3 research, construction and operation of the Center for Nanoscale Materials, and construction and operation of the Structural Genomics Facility.

The ANL-E Environment, Safety and Health and Infrastructure Management Plan identifies funding needs for on-site rehabilitation projects, environmental restoration projects, and waste management activities. The rehabilitation projects include identification of existing treatment facilities requiring upgrading or replacement. ANL-E environmental restoration activities consist of projects that assess and clean up inactive waste sites. These include two inactive landfills, three French drains (i.e., dry wells used to dispose of liquid chemicals), two inactive wastewater treatment facilities, and a number of areas that may have been contaminated with small amounts of hazardous chemicals. This work was funded by the DOE Office of Environmental Management, conducted at ANL-E by the Environmental Remediation Program, and was completed on September 30, 2003.

Ongoing compliance issues at ANL-E during 2003 were effluent concentrations of total dissolved solids (TDS) in excess of NPDES Permit effluent limits and elevated levels of some routine indicator parameters in the groundwater at the former sanitary landfill.

Environmental Surveillance Program

Airborne emissions of radioactive materials from ANL-E were monitored during 2003. The effective dose equivalents were estimated at the site perimeter and to a hypothetical maximally exposed member of the public, with the EPA's CAP-88 (CAA Assessment Package-1988) computer code. The estimated maximum perimeter dose from airborne releases was 0.55 mrem/yr in the east direction, while the estimated maximum dose to a member of the public was 0.057 mrem/yr. This latter value is 0.06% of the DOE radiation protection standard of 100 mrem/yr for all pathways. If the contribution of radon-220 is excluded from reporting, as required by 40 CFR Part 61, Subpart H, the estimated dose to a maximally exposed member of the public would remain 0.057 mrem/yr. The estimated population dose from releases to the approximately nine million people living within 80 km (50 mi) of the site was 3.70 person-rem.

Monitoring of particulates in ambient air was conducted for total alpha activity, total beta activity, strontium-90, isotopic thorium, isotopic uranium, and plutonium-239 at the ANL-E site perimeter and at off-site locations. No statistically significant difference was identified between samples collected at the ANL-E perimeter and samples collected off site. Monitoring was not conducted for hazardous chemical constituents in ambient air.

The only detectable radionuclides and chemical pollutants in surface water due to ANL-E releases were in Sawmill Creek, below the wastewater discharge point. At various times, measurable levels of hydrogen-3, strontium-90, plutonium-239, and americium-241 were detected. Of these radionuclides, the maximum annual release was 0.08 Ci of hydrogen-3. The other radionuclides were released at less than 0.001 Ci total. The hydrogen-3 was added to the wastewater as part of normal ANL-E operations. The dose to a hypothetical individual using water from Sawmill Creek as his or her sole source of drinking water would be 0.022 mrem/yr. However, no one uses this water for drinking, and dilution by the Des Plaines River reduces the concentrations of the measured radionuclides to levels below their respective detection limits downstream from ANL-E at Lemont. Sawmill Creek also is monitored for nonradiological constituents to demonstrate compliance with State of Illinois water quality standards. No parameters were detected above the limits established by the standards.

Sediment samples were collected from Sawmill Creek, above, at, and below the point of wastewater treatment plant effluent discharge. Elevated levels of plutonium-239 (up to

0.27 pCi/g) and americium-241 (up to 0.06 pCi/g) were detected in the sediment below the outfall and are attributed to past ANL-E releases.

Dose rates from penetrating radiation (gamma-rays) were measured at 17 perimeter and on-site locations and at 5 off-site locations in 2003 using thermoluminescent dosimeters. The off-site results averaged 87 ± 5 mrem/yr, which is consistent with the long-term average dose. Above-background doses occurred at one perimeter location and were due to ANL-E operations. At the south fence, radiation from a temporary storage facility for radioactive waste resulted in an average dose of 103 ± 23 mrem/yr for 2003, although no one occupies this area. The estimated dose from penetrating radiation to the nearest resident south of the site was less than 0.01 mrem/yr.

The potential radiation doses to members of the public from all sources and pathways due to ANL-E operations during 2003 were estimated by combining the exposure from inhalation, ingestion, and direct radiation pathways. The inhalation pathway would be primary. The highest estimated dose was approximately 0.080 mrem/yr to a hypothetical individual living east of the site, assuming he or she was outdoors at that location during the entire year and drinking Sawmill Creek water. Estimated doses from other pathways were not significant by comparison. The doses from ANL-E operations are well within all applicable standards and are insignificant when compared with doses received by the public from natural radiation (≈300 mrem/yr) or other sources, for example, medical x-rays and consumer products (≈60 mrem/yr).

Radiological and chemical constituents in the groundwater were monitored in several areas of the ANL-E site in 2003. The former ANL-E domestic water supply is monitored by collecting quarterly samples from the three inactive supply wells. All results from water supply wells were less than the limits established by the Safe Drinking Water Act.

Ten monitoring wells screened in the glacial drift and two in the dolomite were sampled quarterly at the 317 and 319 Areas and analyzed for radiological, volatile organic, semivolatile, PCB, and pesticide and herbicide constituents. The major organic contaminants detected were 1,4-dioxane, 1,1,1-trichloroethane, and 1,1-dichloroethane. Measurable levels of hydrogen-3 and strontium-90 were present in several of the wells. Remediation continued in this area using phytoremediation and groundwater extraction to remove volatile organic compounds (VOCs) and hydrogen-3 from groundwater.

Nine monitoring wells are screened in the glacial drift and one in the dolomite adjacent to the Chicago Pile-Five reactor. These wells were sampled quarterly, and samples were analyzed for selected radionuclides, metals, VOCs, semivolatile organic compounds (SVOCs), pesticides, herbicides, and PCBs. Measurable levels of hydrogen-3 and strontium-90 were detected regularly. Low levels of dichlorofluoromethane were detected, in addition to a few inorganic constituents. All concentrations were well below any applicable standard.

Twenty-six monitoring wells at the 800 Area Landfill were sampled on a quarterly basis and analyzed for metals, cyanide, phenols, total organic carbon, total organic halogens, VOCs, SVOCs, PCBs, pesticides, herbicides, and hydrogen-3. As in previous years, levels above Illinois Class I Groundwater Quality Standards for chloride, chromium, iron, lead, manganese, nickel, and TDS were found in some wells. Above-background levels of hydrogen-3 were detected in several of the wells, with concentrations up to 1,688 pCi/L. This is well below the standard of 20,000 pCi/L.

An extensive quality assurance program is maintained to cover all aspects of the environmental surveillance sampling and analysis programs. Approved documents are in place, along with supporting standard operating procedures. Newly collected data were compared with recent results and historical data to ensure that deviations from previous conditions were identified and evaluated promptly. Samples at all locations were collected using well-established and documented procedures to ensure consistency. Samples were analyzed by documented standard analytical procedures. Data quality was verified by a continuing program of analytical laboratory quality control, participation in interlaboratory cross-checks, and replicate sampling and analysis. Data were managed and tracked by a dedicated computerized data management system that assigns unique sample numbers, schedules collection and analysis, checks status, and prepares tables and information for the annual report.

ANL-E maintains a documented environmental management system that identifies responsibilities for environmental activities. ANL-E is committed to implementing that system as part of the overall Integrated Safety Management System.

1. INTRODUCTION

1.1. General

This annual report for calendar year 2003 of the Argonne National Laboratory-East (ANL-E) environmental protection program was prepared to inform the U.S. Department of Energy (DOE), environmental agencies, and the public about the levels of radioactive and chemical pollutants in the vicinity of ANL-E, and the amounts, if any, added to the environment by ANL-E operations. It also summarizes the compliance of ANL-E operations with applicable environmental laws and regulations and highlights significant accomplishments and issues related to environmental protection and environmental remediation. The report was prepared in accordance with the guidelines of DOE Orders 450.1[1] and 231.1A[2] and supplemental DOE guidance.

ANL-E conducts an environmental surveillance program on and near the site to determine the identity, magnitude, and origin of radioactive and chemical substances in the environment. The detection of any releases of such materials to the environment from ANL-E operations is of special interest, because one important function of this program is verification of the adequacy of the site's pollution control systems.

ANL-E is a DOE research and development (R&D) laboratory with several principal objectives. It conducts a broad program of research in the basic energy and related sciences (i.e., physical, chemical, material, computer, nuclear, biomedical, and environmental) and serves as an important engineering center for the study of nuclear and nonnuclear energy sources. Energy-related research projects conducted during 2003 included safety studies for light-water reactors; high-temperature superconductivity experiments; development of electrochemical energy sources, including fuel cells and batteries for vehicles and for energy storage; evaluation of heat exchangers for the recovery of waste heat from engines; and studies to promote clean, efficient transportation.

Other areas of research are basic biological research, heavy-ion research into the properties of super-heavy elements, the immobilization of radioactive waste products for safe disposal, fundamental studies of advanced computers, and the development of "chips" for the rapid assay of gene composition. Environmental research studies include the biological activity of energy-related mutagens and carcinogens, characterization and monitoring of energy-related pollutants, and new technologies for cleaning up environmental contaminants. A significant number of these laboratory studies require the controlled use of radioactive and chemically toxic substances.

The principal radiological facilities at ANL-E are the Advanced Photon Source (APS); a superconducting heavy-ion linear accelerator (Argonne Tandem Linac Accelerating System [ATLAS]); a 22-MeV pulsed electron linac; several other charged-particle accelerators (principally of the Van de Graaff and Dynamitron types); a large fast neutron source (Intense Pulsed Neutron Source [IPNS]) in which high-energy protons strike a uranium target to produce neutrons; chemical and metallurgical laboratories; and several hot cells and laboratories designed for work with multicurie quantities of the actinide elements and with irradiated reactor fuel materials. The DOE New Brunswick Laboratory (NBL), a plutonium and uranium measurements and analytical chemistry laboratory, is located on the ANL-E site.

The principal nonnuclear activities at ANL-E in 2003 that could have measurable impacts on the environment include the use of a coal-fired boiler (No. 5), discharge of wastewater from various sources, and the cleanup of inactive waste disposal areas.

1.2. Description of Site

ANL-E occupies the central 607 ha (1,500 acres) of a 1,514-ha (3,740-acre) tract in DuPage County. The site is 43 km (27 mi) southwest of downtown Chicago and 39 km (24 mi) west of Lake Michigan. It is north of the Des Plaines River Valley, south of Interstate Highway 55 (I-55), and west of Illinois Highway 83. Figures 1.1 and 1.2 are maps of the site, the surrounding area, and sampling locations of the monitoring program. Much of the 907-ha (2,240-acre) Waterfall Glen Forest Preserve surrounding the site was part of the ANL-E site before it was deeded to the DuPage County Forest Preserve District in 1973 for use as a public recreational area, nature preserve, and demonstration forest. In this report, facilities are identified by the alphanumeric designations in Figure 1.1 to facilitate their location.

The terrain of ANL-E is gently rolling, partially wooded, former prairie and farmland. The grounds contain a number of small ponds and streams. The principal stream is Sawmill Creek, which runs through the site in a southerly direction and enters the Des Plaines River about 2.1 km (1.3 mi) southeast of the center of the site. The land is drained primarily by Sawmill Creek, although the extreme southern portion drains directly into the Des Plaines River, which flows along the southern boundary of the forest preserve. This river flows southwest until it joins the Kankakee River about 48 km (30 mi) southwest of ANL-E to form the Illinois River.

The largest topographical feature of the area is the Des Plaines River valley, which is about 1.6 km (1 mi) wide. This valley contains the river, the Chicago Sanitary and Ship Canal, and the Illinois and Michigan Canal. The elevation of the channel surface of these waterways is 180 m (578 ft) above sea level. The bluffs that form the southern border of the site rise from the river channel at slope angles of 15 to 60° and reach an average elevation of 200 m (650 ft) above sea level at the top. The land then slopes gradually upward and reaches the average site elevation of 220 m (725 ft) above sea level at 915 m (3,000 ft) from the bluffs. Several large ravines oriented in a north-south direction are located in the southern portion of the site. The bluffs and ravines generally are forested with mature deciduous trees. The remaining portion of the site changes in elevation by no more than 7.6 m (25 ft) in a horizontal distance of 150 m (500 ft).

1.3. Population

The area around ANL-E has experienced a large population growth in the past 30 years. Large areas of farmland have been converted into housing. Table 1.1 gives the directional and

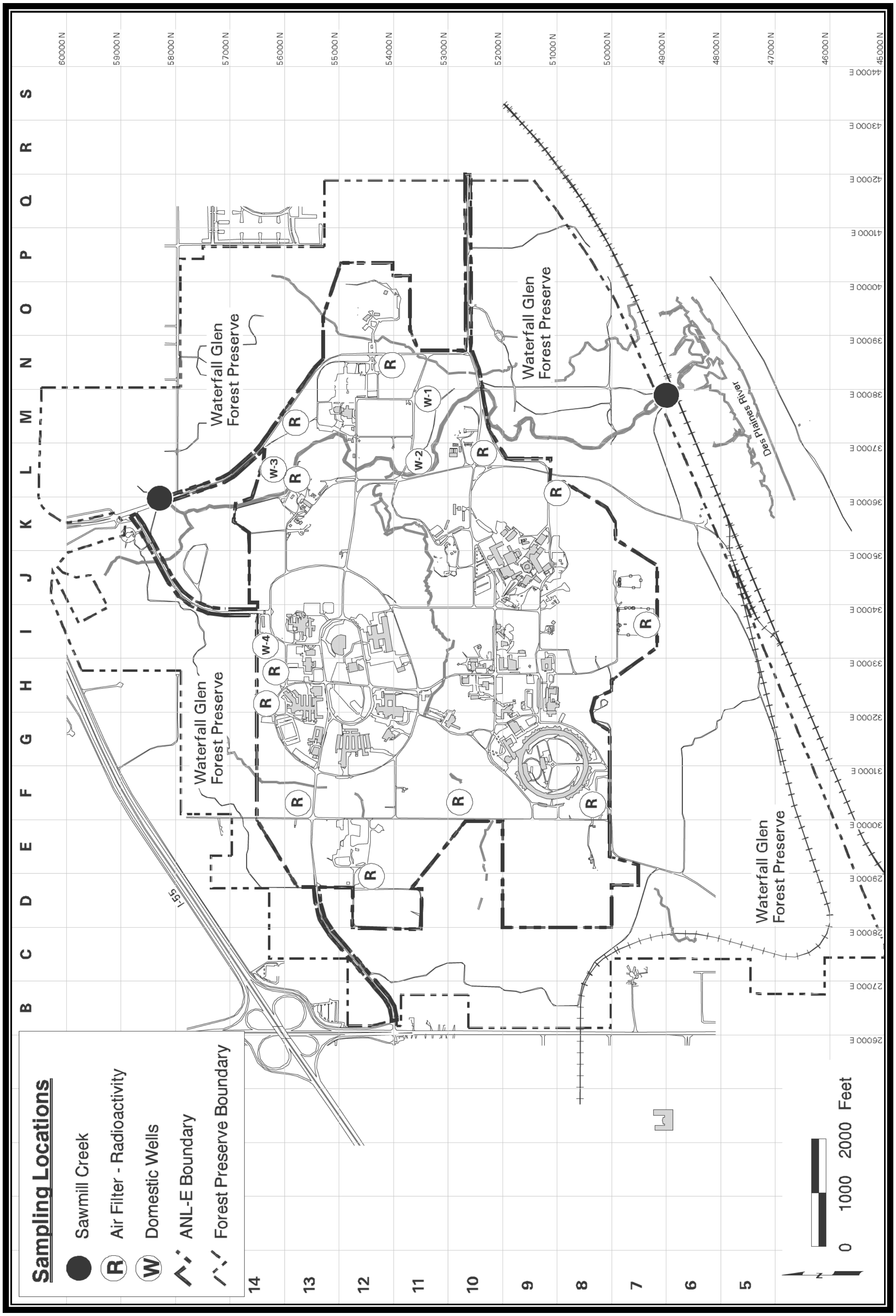


FIGURE 1.1 Sampling Locations at Argonne National Laboratory-East

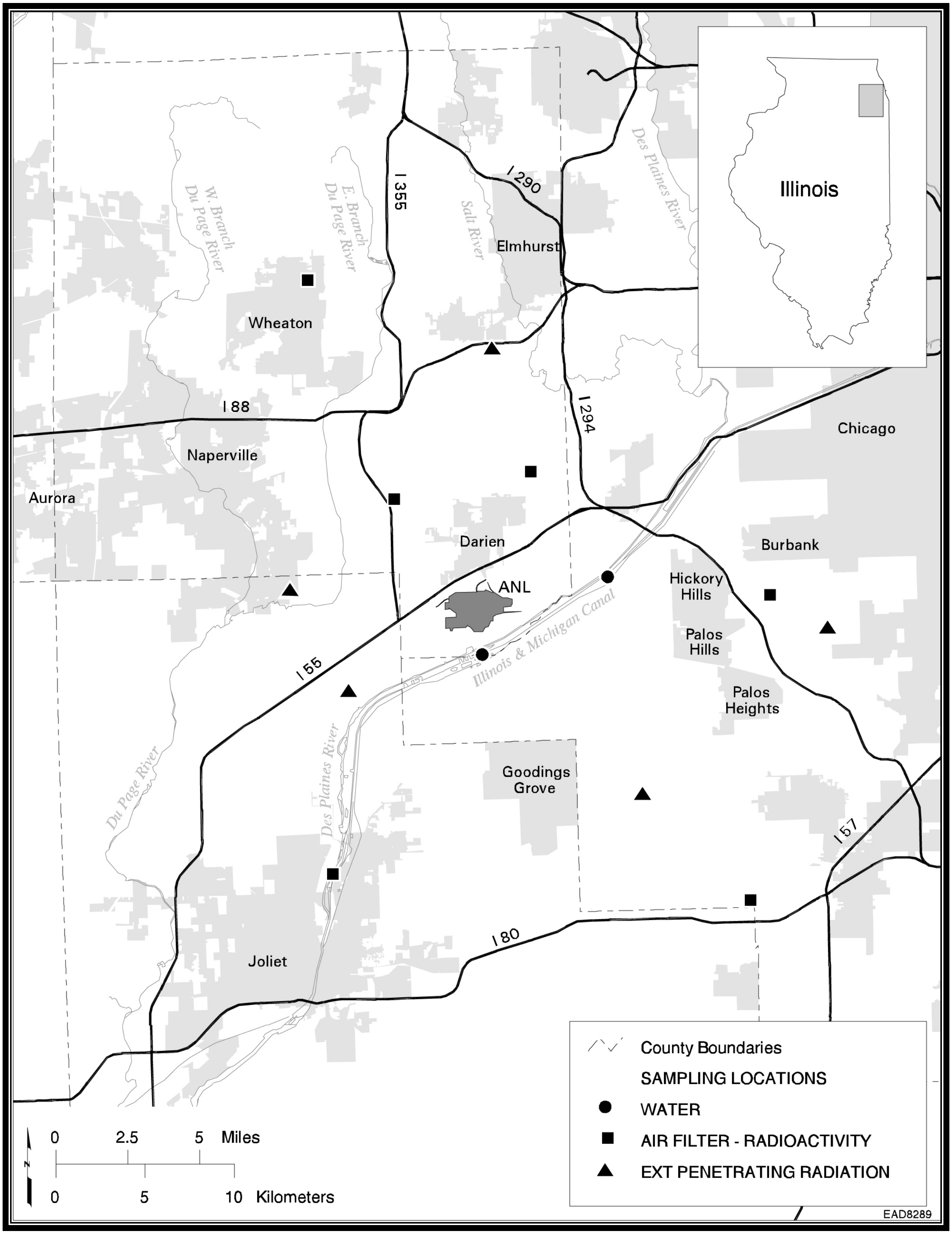


FIGURE 1.2 Sampling Locations near Argonne National Laboratory-East

TABLE 1.1

Population Distribution in the Vicinity of ANL-E, 2000

	Miles[a]									
Direction	0 – 1	1 – 2	2 – 3	3 – 4	4 – 5	5 – 10	10 – 20	20 – 30	30 – 40	40 – 50
N	0	1,269	3,646	6,190	9,651	46,597	183,061	353,821	222,737	309,159
NNE	0	611	4,112	5,971	6,169	40,711	302,525	492,536	102,273	1,094
NE	0	837	2,010	2,138	1,846	42,637	712,685	1,009,469	0	0
ENE	0	1,021	1,291	2,308	1,986	33,931	633,468	195,890	0	0
E	0	1,163	557	366	386	42,520	467,488	216,642	9,770	26,128
ESE	0	590	269	371	509	18,494	190,441	293,764	230,611	91,154
SE	0	309	271	459	947	25,059	131,937	120,187	34,557	17,023
SSE	0	451	400	1,014	1,327	18,433	42,321	9,904	14,172	15,963
S	0	628	2,302	2,148	1,221	8,181	31,084	4,436	36,505	36,639
SSW	0	529	2,329	2,645	1,001	18,156	89,111	12,221	20,350	7,739
SW	0	213	596	409	142	14,931	66,453	12,394	17,310	7,385
WSW	0	168	159	554	2,628	17,249	23,864	5,422	8,705	11,633
W	0	186	2,026	7,735	9,338	40,270	93,303	23,547	17,727	6,810
WNW	0	528	1,862	5,815	6,516	46,444	154,113	37,805	7,469	58,587
NW	0	711	2,317	7,057	7,769	45,993	83,324	123,290	23,881	19,530
NNW	0	1,088	2,628	5,961	9,457	34,008	217,040	263,590	172,437	122,112
Total	0	10,302	26,775	51,141	60,893	493,614	3,422,218	3,174,918	918,504	730,956
Cumulative total[b]	0	10,302	37,077	88,218	149,111	642,725	4,064,943	7,239,861	8,158,365	8,889,321

[a] To convert from miles to kilometers, multiply by 1.6.

[b] Cumulative total = the total of this sector plus the totals of all previous sectors.

annular 80-km (50-mi) population distribution for the area, which is used to derive the population dose calculations presented later in this report. The population distribution, centered on the Chicago Pile-Five (CP-5) reactor (Location 9G in Figure 1.1), was prepared by the Risk Assessment and Safety Evaluation Group of the Environmental Assessment Division at ANL-E and represents projections on the basis of 2000 census data.

1.4. Climatology

The climate of the area is representative of the upper Mississippi Valley, as moderated by Lake Michigan. The most important meteorological parameters for the purposes of this report are wind direction, wind speed, temperature, and precipitation. The wind data are used to select air sampling locations and distances from sources and to calculate radiation doses from air emissions. Temperature and precipitation data are useful in interpreting some of the monitoring results. The 2003 data were obtained from the on-site ANL-E meteorological station. The 2003 average monthly and annual wind rose at the 60-m (200-ft) level is shown in Figure 1.3. The wind rose is a polar coordinate plot in which the lengths of the radii represent the percentage frequency of wind speeds in classes of 2.01 to 6 m/s (4.5 to 13.4 mph), 6.01 to 10 m/s (13.4 to 22.4 mph), and greater than 10.01 m/s (22.4 mph). The number in the center of the wind rose represents the percentage of observations of wind speed less than 2 m/s (4.5 mph) in all directions. The direction of the radii from the center represents the direction from which the wind blows. Sixteen radii are shown on each plot at 22.5° intervals; each radius represents the average wind speed for the direction covering 11.25° on either side of the radius. The annual average wind rose for 2003 is consistent with the long-term average wind direction, which usually varies from the west to south, but with a significant northeast component.

Table 1.2 gives 2003 precipitation and temperature data. The monthly precipitation data for 2003 show a few differences from the ANL-E average. For example, May, July, and November were above the monthly average, while January, February, and June were below the average. The annual total was 2% below the annual average for the ANL-E data. The monthly temperatures were generally lower when compared with the long-term monthly average. The 2003 annual monthly average was 4% lower than the long-term annual average. The climatology information was provided by the Atmospheric Research Section of the Environmental Research Division.

1.5. Geology

The geology of the ANL-E area consists of about 30 m (100 ft) of glacial drift on top of nearly horizontal bedrock consisting of Niagaran and Alexandrian dolomite underlain by shale and older dolomites and sandstones of Ordovician and Cambrian age. The glacial drift sequence is composed of the Wadsworth and Lemont Formations. Both are dominated by fine-grained drift units but also contain sandy, gravelly, or silty interbeds. Niagaran and Alexandrian dolomite is approximately 60 m (200 ft) thick but has an irregular, eroded upper surface.

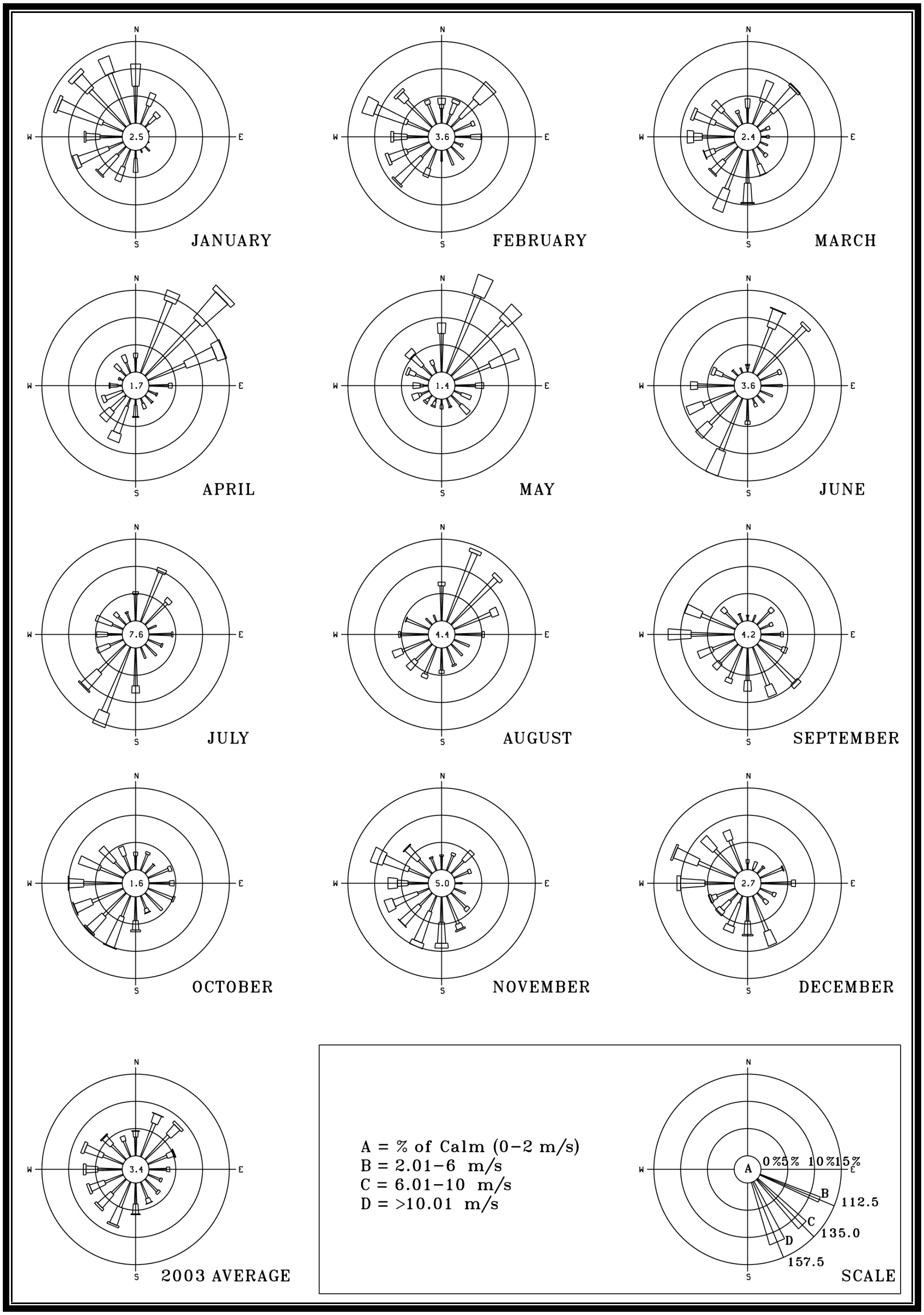


FIGURE 1.3 Monthly and Annual Wind Roses at Argonne National Laboratory-East, 2003

TABLE 1.2

ANL-E Weather Summary, 2003

	Precipitation (cm)			Temperature (°C)	
Month	ANL-E 2003	ANL-E Historical[a]		ANL-E 2003	ANL-E Historical[a]
January	1.27	4.15		−6.5	−4.5
February	0.66	4.42		−4.8	−1.9
March	4.21	5.98		3.4	3.0
April	8.33	8.64		9.2	9.2
May	14.91	9.73		13.7	15.2
June	2.29	8.99		19.7	20.6
July	17.95	10.43		23.2	23.1
August	9.40	10.34		23.3	22.1
September	7.24	8.76		17.4	17.9
October	5.05	8.70		11.8	11.3
November	15.14	8.61		5.5	7.2
December	4.72	4.65		−0.4	−2.8
Total	91.17	93.40	Monthly Average	9.6	10.0

[a] Averages were obtained from the ANL-E meteorological tower by using data from the last 20 years (1983–2002).

The southern boundary of ANL-E follows the bluff of a broad valley, which is now occupied by the Des Plaines River and the Chicago Sanitary and Ship Canal. This valley was carved by waters flowing out of the glacial Lake Michigan about 11,000 to 14,000 years ago. The soils on the site were derived from glacial drift over the past 12,000 years and are primarily of the Morley series, that is, moderately well-drained upland soils with a slope ranging from 2 to 20%. The surface layer is a dark grayish-brown silt loam, the subsoil is a brown silty clay, and the underlying material is a silty clay loam glacial drift. Morley soils have a relatively low organic content in the surface layer, moderately slow subsoil permeability, and a large water capacity. The remaining soils along creeks, intermittent streams, bottomlands, and a few small upland areas are of the Sawmill, Ashkum, Peotone, and Beecher series, which are generally poorly drained. They have a black to dark gray or brown silty clay loam surface layer, high organic matter content, and a large water capacity.

1.6. Seismicity

No tectonic features within 135 km (62 mi) of ANL-E are known to be seismically active. The longest inactive local feature is the Sandwich Fault. Smaller local features are the Des Plaines disturbance, a few faults in the Chicago area, and a fault of apparently Cambrian age.

Although a few minor earthquakes have occurred in northern Illinois, none have been positively associated with particular tectonic features. Most of the recent local seismic activity is believed to be caused by isostatic adjustments of the earth's crust in response to glacial loading and unloading, rather than by motion along crustal plate boundaries.

Several areas of considerable seismic activity are located at moderate distances (i.e., hundreds of kilometers) from ANL-E. These areas include the New Madrid Fault zone (southeast Missouri) in the St. Louis area, the Wabash Valley Fault zone along the southern Illinois-Indiana border, and the Anna region of western Ohio. Although high-intensity earthquakes have occurred along the New Madrid Fault zone, their relationship to plate motions remains speculative at this time.

According to estimates, ground motions induced by near and distant seismic sources in northern Illinois are expected to be minimal. However, peak accelerations in the ANL-E area may exceed 10% of gravity (the approximate threshold of major damage) once in approximately 600 years, with an error range of –250 to +450 years.

1.7. Groundwater Hydrology

Two principal aquifers are used as water supplies in the vicinity of ANL-E. The upper aquifer is the Niagaran and Alexandrian dolomite, which is approximately 60 m (200 ft) thick in the ANL-E area and has a piezometric surface between 15 and 30 m (50 and 100 ft) below the ground surface for much of the site. The lower aquifer is Galesville sandstone, which lies between 150 and 450 m (500 and 1,500 ft) below the surface. Maquoketa shale separates the upper dolomite aquifer from the underlying sandstone aquifer. This shale retards the hydraulic connection between the two aquifers.

Up until 1997, most groundwater supplies in the ANL-E area were derived from the Niagaran, and to some extent, the Alexandrian dolomite bedrock. Dolomite well yields are variable, but many approach 3,028 L/min (800 gal/min). In DuPage County, groundwater pumpage over the past 100 years has led to severe overdraft; in northeastern Illinois, the piezometric surface has been lowered in areas of heavy pumping. Delivery of Lake Michigan water to the major suburban areas is expected to relieve this problem. ANL-E now obtains all its domestic water from the City of Chicago water system.

1.8. Water and Land Use

Sawmill Creek flows through the eastern portion of the site. This stream originates north of the site, flows through the property in a southerly direction, and discharges into the Des Plaines River. Two small streams, one originating on site and the other just off site, which enter the site from the western boundary, combine to form Freund Brook, which discharges into Sawmill Creek. Along the southern margin of the property, the terrain slopes abruptly downward forming forested bluffs. These bluffs are dissected by ravines containing intermittent streams that discharge some site drainage into the Des Plaines River. In addition to the streams, various ponds and cattail marshes are present on the site. A network of ditches and culverts transports surface runoff toward the smaller streams.

The greater portion of the ANL-E site is drained by Freund Brook. Two intermittent branches of Freund Brook flow from west to east, drain the interior portion of the site, and ultimately discharge into Sawmill Creek. The larger, south branch originates in a marsh adjacent to the western boundary line of the site. It traverses wooded terrain for a distance of about 2 km (1.5 mi) before discharging into the Lower Freund Pond. The upper Freund Brook branch originates within the central part of the site and also discharges into the Lower Freund Pond.

Residential and commercial development in the area have resulted in the collection and channeling of runoff water into Sawmill Creek. Treated sanitary and laboratory wastewater from ANL-E are combined and discharged into Sawmill Creek at location 7M in Figure 1.1. In 2003, this effluent averaged 2.7 million L/day (0.72 million gal/day), which is similar to the averages for the last few years. The combined ANL-E effluent consisted of 65% laboratory wastewater and 35% sanitary wastewater. The water flow in Sawmill Creek upstream of the wastewater outfall averaged about 22 million L/day (6 million gal/day) during 2003.

Sawmill Creek and the Des Plaines River upstream of Joliet, about 21 km (13 mi) southwest of ANL-E, receive very little recreational or industrial use. A few people fish in these waters downstream of ANL-E, and some duck hunting takes place on the Des Plaines River. Water from the Chicago Sanitary and Ship Canal is used by ANL-E for cooling towers and by others for industrial purposes, such as hydroelectric generators and condensers. ANL-E usage is approximately 1.1 million L/day (0.3 million gal/day). The canal, which receives Chicago Metropolitan Sanitary District effluent water, is used for industrial transportation and some recreational boating. Near Joliet, the river and canal combine into one waterway, which continues until it joins the Kankakee River to form the Illinois River about 48 km (30 mi) southwest of ANL-E. The Dresden Nuclear Power Station complex is located at the confluence of the Kankakee, Des Plaines, and Illinois Rivers. This station uses water from the Kankakee River for cooling and discharges the water into the Illinois River. The first downstream location where water is used as a community water supply system is at Peoria, which is on the Illinois River about 240 km (150 mi) downstream of ANL-E. In the vicinity of ANL-E, only subsurface water (from both shallow and deep aquifers) and Lake Michigan water are used for drinking purposes.

The principal recreational area near ANL-E is the Waterfall Glen Forest Preserve, which surrounds the site (see Section 1.2 and Figure 1.1). The area is used for hiking, skiing, biking, and horseback riding. Sawmill Creek flows south through the eastern portion of the preserve on its way to the Des Plaines River. Several large forest preserves of the Forest Preserve District of Cook County are located east and southeast of ANL-E and the Des Plaines River. The preserves include the McGinnis and Saganashkee Sloughs (shown in Figure 1.2), as well as other smaller lakes. These areas are used for picnicking, boating, fishing, and hiking. A small park located in the eastern portion of the ANL-E site (Location 12-0 in Figure 1.1) is for the use of ANL-E and DOE employees. A local municipality has use of the park for athletic events. The park also contains a day-care center for children of ANL-E and DOE employees.

1.9. Vegetation

ANL-E lies within the Prairie Peninsula of the Oak-Hickory Forest Region. The Prairie Peninsula is a mosaic of oak forest, oak openings, and tall-grass prairie occurring in glaciated portions of Illinois, northwest Indiana, southern Wisconsin, and sections of other states. Much of the natural vegetation of this area has been modified by clearing and tillage. Forests in the ANL-E region, which are predominantly oak and hickory, are somewhat limited to slopes of shallow, ill-defined ravines or low morainal ridges. Gently rolling to flat intervening areas between ridges and ravines were predominantly occupied by prairie before their use for agriculture. The prevailing successional trend on these areas, in the absence of cultivation, is toward oak-hickory forest. Forest dominated by sugar maple, red oak, and basswood may occupy more pronounced slopes. Poorly drained areas, streamside communities, and floodplains may support forests dominated by silver maple, elm, and cottonwood. Figure 1.4 shows the vegetation communities.

Early photographs of the site indicate that most of the land that ANL-E now occupies was actively farmed. About 75% was plowed field and 25% was pasture, open oak woodlots, and oak forests. Starting in 1953 and continuing for three seasons, some of the formerly cultivated fields were planted with jack, white, and red pine trees. Other fields are dominated by bluegrass.

The deciduous forests on the remainder of the site are dominated by various species of oak, generally as large, old, widely spaced trees, which often do not form a complete canopy. Their large low branches indicate that they probably matured in the open, rather than in a dense forest. Other upland tree species include hickory, hawthorn, cherry, and ash.

DOE and ANL-E are members of the Chicago Wilderness Coalition, a partnership of more than 170 public and private organizations that have joined forces to protect, restore, and manage 81,000 ha (200,000 acres) of natural areas in the Chicago metropolitan region. Several activities are planned or are in progress to enhance oak woodland, savanna, wetland, and prairie habitats on the approximately 285 ha (700 acres) undeveloped at the ANL-E site.

1.10. Fauna

Terrestrial vertebrates that are commonly observed or likely to occur on the site include about 5 species of amphibians, 7 of reptiles, 40 of summer resident birds, and 25 of mammals. More than a hundred other bird species can be found in the area during migration or winter; however, they do not nest on the site or in the surrounding region. An unusual species on the ANL-E site is the fallow deer, a European species that was introduced to the area by a private landowner prior to government acquisition of the property in 1947. A population of native white-tailed deer also inhabits the ANL-E site. The white-tailed and fallow deer populations are each maintained at a target density of 15 deer/mi^2 under an ongoing deer management program.

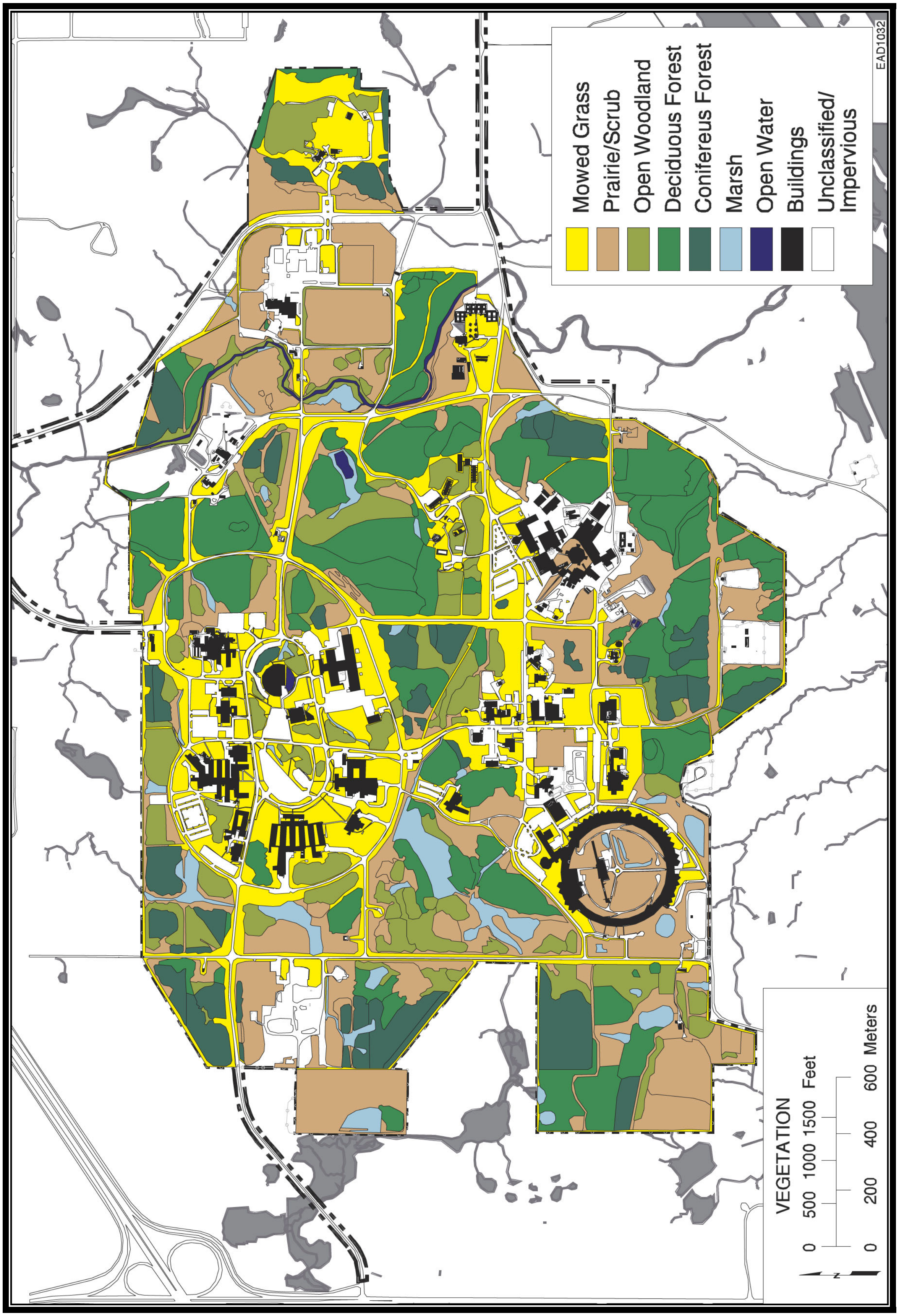


FIGURE 1.4 ANL-E Habitat

Freund Brook crosses the center of the site. The gradient of the stream is relatively steep, and riffle habitat predominates. The substrate is coarse rock and gravel on a firm mud base. Primary production in the stream is limited by shading, but diatoms and some filamentous algae are common. Aquatic macrophytes include common arrowhead, pondweed, duckweed, and bulrush. Invertebrate fauna consist primarily of dipteran larvae, crayfish, caddisfly larvae, and midge larvae. Few fish are present because of low summer flows and high temperatures. Other aquatic habitats on the ANL-E site include beaver ponds, artificial ponds, ditches, and Sawmill Creek.

The biotic community of Sawmill Creek is relatively impoverished, which reflects the creek's high silt load, steep gradient, and historic release of sewage effluent from the Marion Brook sewage treatment plant north of the site. The fauna consists primarily of blackflies, midges, isopods, flatworms, segmented worms, and creek chubs. A few species of minnows, sunfishes, and catfish are also present. Clean-water invertebrates, such as mayflies and stoneflies, are rare or absent. Fish species that have been recorded in ANL-E aquatic habitats include black bullhead, bluegill, creek chub, golden shiner, goldfish, green sunfish, largemouth bass, stoneroller, and orange-spotted sunfish.

The U.S. Fish and Wildlife Service (USFWS) has rated the Des Plaines River system, including ANL-E streams, as "poor" in terms of the fish species present because of domestic and industrial pollution and stream modification.

1.11. Cultural Resources

ANL-E, which is located in the Illinois and Michigan Canal National Heritage Corridor, is situated in an area known to have a long and complex cultural history. All periods listed in the cultural chronology of Illinois, with the exception of the earliest period (Paleo-Indian), have been documented in the ANL-E area either by professional cultural resource investigators or through interviews of local artifact collectors by ANL-E staff. A variety of site types, including mounds, quarries, lithic workshops, and habitation sites, have been reported by amateurs within a 25-km (16-mi) radius.

Forty-six archaeological sites have been recorded at ANL-E. These sites include prehistoric chert quarries, special purpose camps, base camps, and historical farmsteads. The range of human occupation spans several time periods (Early Archaic through Mississippian Prehistoric to Historical). Four sites have been determined to be eligible for the *National Register of Historic Places* (NRHP); 21 sites have been determined to be ineligible; and 21 sites have not been evaluated for eligibility.

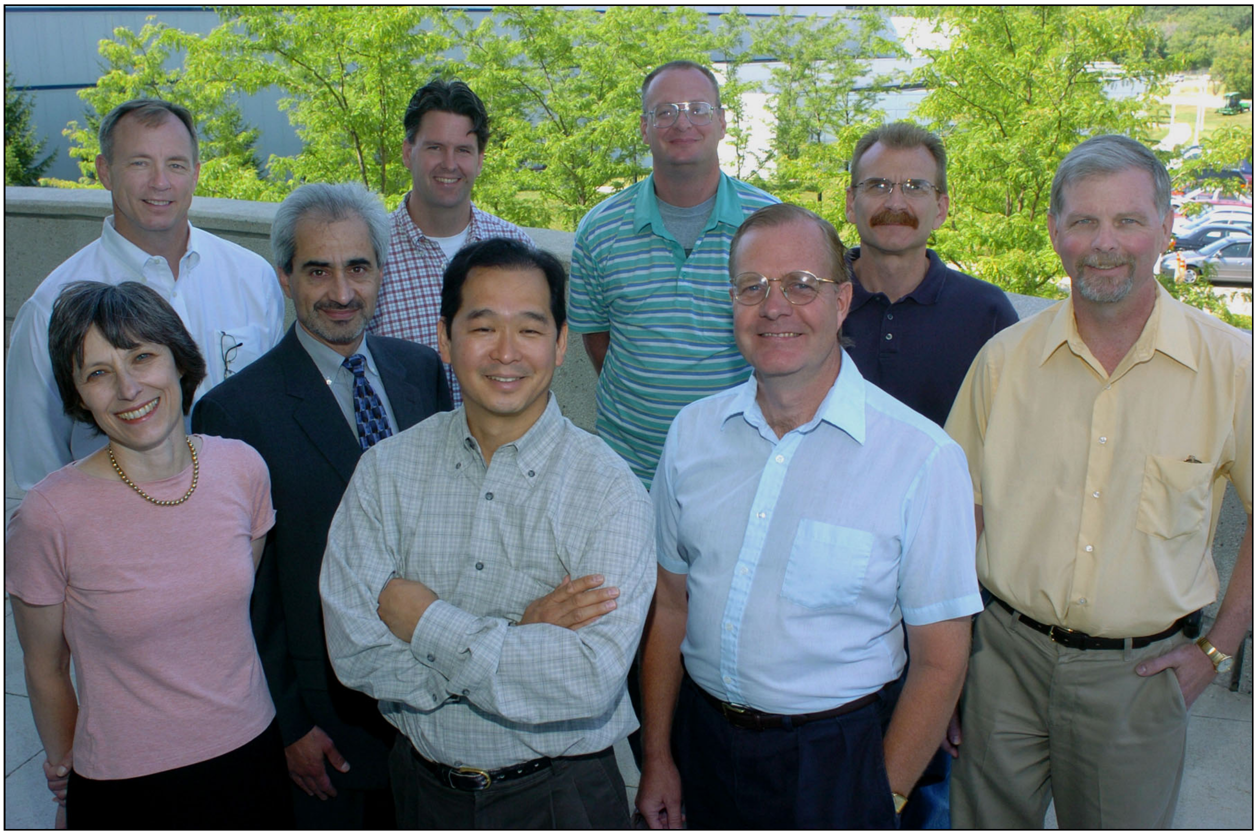
Cultural resources also include historic structures. Historic property surveys over the past several years identified two areas at ANL-E that are eligible for listing in the NRHP as historic districts, as well as several buildings that are individually eligible for listing in the NRHP.

1.12. Endangered Species

No federal-listed threatened or endangered species are known to occur on the ANL-E site, and no critical habitat of federally listed species exists on the site. Three federal-listed endangered species and one federal-listed threatened species are known to inhabit the Waterfall Glen Forest Preserve that surrounds the ANL-E property or are known to occur in the area.

The Hine's emerald dragonfly (*Somatochlora hineana*), federal and state listed as endangered, occurs in locations with calcareous seeps and wetlands along the Des Plaines River floodplain. Leafy prairie clover (*Dalea foliosa*), which is federal and state listed as endangered, is associated with dolomite prairie remnants of the Des Plaines River valley; two planted populations of this species occur in Waterfall Glen Forest Preserve. An unconfirmed capture of an Indiana bat (*Myotis sodalis*), which is federal and state listed as endangered, indicates that this species may occur in the area. The federal-listed threatened lakeside daisy (*Hymenoxys herbasea*) has a planted population in Waterfall Glen Forest Preserve. Additional state-listed species that occur in the area are identified in Section 2.10. Of these, Kirtland's snake, pied-billed grebe, black-crowned night heron, brown creeper, and red-shouldered hawk have been observed on ANL-E property.

2. COMPLIANCE SUMMARY



ANL-E is a government-owned, contractor-operated R&D facility that is subject to environmental statutes and regulations administered by the U.S. Environmental Protection Agency (EPA), the Illinois Environmental Protection Agency (IEPA), U.S. Army Corps of Engineers (COE), and the State Fire Marshal, as well as to numerous DOE Orders and Executive Orders. The status of ANL-E during 2003 with regard to these authorities is discussed in this chapter.

ANL-E has made a commitment to comply with all applicable environmental requirements, as described in the following policy statement:

> The policy of Argonne National Laboratory is that its activities are to be conducted in such a manner that worker and public health and safety and protection of the environment are given the highest priority. The Laboratory will comply with all applicable federal and state health, safety, and environmental laws, regulations, and orders, so as to protect the health and safety of workers and the public and to minimize accidental damage to property.

2.1. Clean Air Act

The Clean Air Act (CAA) is a federal statute that sets emission limits for air pollutants and determines emission limits and operating criteria for certain hazardous air pollutants (HAPs). The program for compliance with the requirements is implemented by individual states through a State Implementation Plan (SIP) that describes how that state will ensure compliance with the air quality standards for stationary sources.

Under Title V of the Clean Air Act Amendments of 1990, ANL-E submitted a Clean Air Act Permit Program (CAAPP) application to the IEPA for a sitewide, federally enforceable operating permit to cover emissions of all regulated air pollutants at the facility. The finalized CAAPP Title V Permit was issued on April 3, 2001. This permit supersedes the prior individual state air pollution control permits, with two exceptions for prior open burning permits. The open burning permits are renewed each year. ANL-E meets the definition of a major source because of potential emissions of oxides of nitrogen in excess of 22.68 t/yr (25 tons/yr) and sulfur dioxide in excess of 90.72 t/yr (100 tons/yr) at the Building 108 Central Heating Plant (see Table 2.4).

Facilities subject to Title V must characterize emissions of all regulated air pollutants, not only those that qualify them as major sources. In addition to oxides of nitrogen and sulfur dioxide, ANL-E also must evaluate emissions of carbon monoxide, particulates, volatile organic compounds (VOCs), HAPs (a list of 188 chemicals, including radionuclides), and ozone-depleting substances. The air pollution control permit program requires that facilities pay annual fees on the basis of the total amount of regulated air pollutants (except carbon monoxide) they are allowed to emit.

The ANL-E site contains a large number of air emission point sources. The vast majority are laboratory ventilation systems that are exempt from state permitting requirements, except for those systems emitting radionuclides. In 2003, two construction permits were issued: one for the construction of a pilot-scale surface prep facility in Building 208 and radionuclide hoods and gloveboxes in Building 203; the second for radioactive hoods and gloveboxes in the H-Wing of Building 212. The permitted air emission sources are listed in Table 2.15.

2.1.1. National Emission Standards for Hazardous Air Pollutants

The National Emission Standards for Hazardous Air Pollutants (NESHAPs) constitute a body of federal regulations that set forth emissions limits and other requirements, such as monitoring, record keeping, and operational and reporting requirements, for activities generating emissions of certain HAPs. The only standards affecting ANL-E operations are those for asbestos and radionuclides. By the time of the issuance of the sitewide ANL-E Title V Permit, the IEPA had issued a total of 23 air pollution control permits to ANL-E for NESHAPs sources. All ANL-E operating NESHAPs Permits were incorporated into the sitewide ANL-E Title V Permit.

In 2002, the EPA proposed a number of additional NESHAPs that could have potential impacts on ANL-E operations. Specifically, NESHAPs (also known as Maximum Achievable Control Technology or MACT standards) were proposed to regulate HAP emissions from institutional boilers, reciprocal internal combustion engines, and engine testing facilities.

These MACT standards would be applicable to major HAP sources (facilities with emissions or potential emissions of 9 t/yr [10 tons/yr] of any HAP, or 23 t/r [25 tons/yr] of all combined HAPs). While ANL-E had not been categorized as a major HAP source in the original CAAPP application, HAP emissions from combustion sources had not been included, because at the time, the IEPA indicated that reliable emission factors were not available. In 2002, the IEPA stated that HAP emissions from combustion sources needed to be included to determine applicability of the upcoming MACT standards.

On the basis of potential to emit, it was determined that by considering combustion sources, ANL-E would now be categorized as a major HAP source and therefore would be subject to the MACT standards when they became final in 2003. As a consequence, following coordination with the IEPA, an application for a minor permit modification was prepared and submitted to the IEPA on November 18, 2002, requesting that an enforceable limit of 11,000 t/yr (12,000 tons/yr) of coal for Boiler No. 5 be included in the CAAPP Permit. This limit would reduce ANL-E’s potential HAP emissions to levels below the major source threshold. The IEPA later determined that this change constituted a significant modification to the CAAPP Permit. The revised CAAPP Permit was issued on March 27, 2003.

2.1.1.1. Asbestos Emissions

Many buildings on the ANL-E site contain large amounts of asbestos-containing material (ACM), such as thermal system insulation around pipes and tanks, spray-applied surfacing material for fireproofing, floor tile, and asbestos-cement (Transite) panels. This material is removed as necessary during renovations or maintenance of equipment and facilities. The removal and disposal of this material are governed by the asbestos NESHAPs.

ANL-E maintains an asbestos abatement program designed to ensure compliance with these and other regulatory requirements. In general, ACM is removed from buildings either by specially trained ANL-E crews (for small-scale, short-duration projects) or by outside contractors (for large-scale insulation removal projects). All removal work is performed in accordance with both NESHAPs and Occupational Safety and Health Administration requirements governing worker safety at ACM removal sites.

Approximately 162 m^3 (5,726 ft^3) of ACM was generated from ANL-E asbestos removal projects during 2003. The 57 small removal projects that were completed generated 123 m^3 (4,358 ft^3) of ACM waste. Approximately 103 m^3 (3,360 ft^3) of this ACM waste was generated from many separate small removal operations during the Fire Safety Improvements Project in Buildings 223 and 362. Most of the waste material generated was polyethylene sheeting used to construct barriers and decontamination chambers in each work area. Seven large removal projects generated the remaining 39 m^3 (1,368 ft^3) of ACM waste. Table 2.1 provides asbestos abatement information for the large removal projects. The IEPA was notified during December 2003 that no more than 71 m^3 (2,500 ft^3) of ACM waste is expected to be generated from small-scale projects during 2004.

A separate portion of the asbestos removal standards contains requirements for disposing of ACM. Off-site shipments are to be accompanied by completed shipping manifests. Asbestos disposal information is provided in Table 2.2. Until closure of the ANL-E landfill in September 1992, asbestos from small-scale projects was disposed of on site in a designated location within the 800 Area Landfill.

2.1.1.2. Radionuclide Emissions

The NESHAPs standard for radionuclide emissions from DOE facilities (Title 40, Part 61, Subpart H of the *Code of Federal Regulations* [40 CFR Part 61, Subpart H]) establishes the emission limits for the release of radionuclides other than radon to the air and the corresponding requirements for monitoring, reporting, and record keeping. A number of emissions points at ANL-E are subject to these requirements and are operated in compliance with them. These points include ventilation systems for hot cell facilities for storage and handling of radioactive materials (Buildings 205 and 212), ventilation systems for particle accelerators (Building 375, IPNS facility, and the Building 411 APS linac), and several ventilation systems associated with the Building 350 NBL. In addition, many ventilation systems and fume hoods are used occasionally for processing small quantities of radioactive materials.

TABLE 2.1

Large-Scale Asbestos Abatement Projects DOE/IEPA Notification, 2003

Completion Date	Asbestos Abatement Contractor	Notification Quantity		Material	Building	Disposal Quantity (ft^3)	Landfill
		ft	ft^2				
2/4/2003	ANL-E PFS[a] Waste Management Operations	0	315	Floor tile and Mastic®[b]	205	16	Environtech[c]
2/7/2003	Environmental Cleansing Corporation	820	580	Tank and pipe insulation	212	810	Environtech
2/14/2003	ANL-E PFS Waste Management Operations	0	760	Floor tile[b]	202	48	Environtech
2/15/2003	ANL-E PFS Waste Management Operations	0	5,800	Floor tile	350	286	Environtech
8/20/2003	Universal Asbestos Removal	0	1,425	Floor tile and Mastic®[b]	203	144	Environtech
9/30/2003	ANL-E PFS Waste Management Operations	55	0	Pipe insulation	202	48	Hanford[d]
12/5/2003	ANL-E PFS Waste Management Operations	0	210	Floor tile[b]	205	16	Environtech

[a] PFS = Plant Facilities and Services.

[b] Courtesy notification, nonfriable material removed intact.

[c] Environtech Landfill, Morris, IL.

[d] DOE Hanford Facility, Richland, WA.

The amount of radioactive material released to the atmosphere from ANL-E emissions sources is extremely small, thereby contributing little to the off-site dose. The maximum off-site dose to a member of the general public for 2003 was 0.057 mrem, which is less than 0.6% of the 10 mrem/yr EPA standard. Section 4.6.1 contains a more detailed discussion of these emissions points and compliance with the standard.

2.1.2. Conventional Air Pollutants

The ANL-E site contains a number of sources of conventional air pollutants, including a steam plant; gasoline and ethanol/gasoline blend fuel-dispensing facilities; two alkali metal reaction booths; two dust collection systems, the engine test facility; a number of diesel generators; and fire training activities. These facilities are operated in compliance with applicable regulations and permit conditions.

TABLE 2.2

Disposal of Asbestos-Containing Materials, 2003

Project Size	Landfill	Quantity (ft^3)	Total Quantity (ft^3)
Small-scale	Environtech[a]	4,358	4,358
Large-scale (IEPA Notification)	Environtech Hanford[b]	1,320 48[c]	1,368
		Total	5,726

[a] Environtech Landfill, Morris, IL.

[b] DOE Hanford Facility, Richland, WA.

[c] Pending shipment to Hanford.

The Title V Permit requires continuous opacity and sulfur dioxide monitoring of the smoke stack from Boiler No. 5, the only one of the five boilers at the steam plant equipped to burn coal. The permit requires submission of a quarterly report listing any exceedances beyond emissions limits for this boiler (30% opacity averaged over 6 minutes and 0.82 kg [1.8 lb] of sulfur dioxide per million Btu averaged over a 1-hour period). Table 2.3 gives the hours that Boiler No. 5 operated on low-sulfur coal during 2003, as well as the amount of low-sulfur coal burned. There were no exceedances at Boiler No. 5 in 2003.

An annual compliance certification must be submitted to the IEPA and the EPA each May 1 for the previous calendar year, detailing any deviations from the Title V Permit and subsequent corrective actions. Two deviations were reported for 2003.

The first deviation involved noncompliance with the cold-cleaning rule, which began when the Title V Permit commenced in April 2001. This noncompliance continued into 2003. To address this situation, in the spring of 2003, ANL-E submitted a petition for an adjusted standard to the Illinois Pollution Control Board (IPCB). The adjusted standard request to exempt R&D applications from the cold-cleaning requirements was sought only for those situations when no acceptable solvent alternatives are available. Both the EPA and IEPA reviewed and supported the petition.

A hearing was held on September 16, 2003 where testimony was presented to IPCB representatives. Following the public comment period, the IPCB issued an adjusted standard on December 18, 2003, allowing solvent usage in R&D applications as requested by ANL-E.

The second deviation involved the omission of some of the monthly record keeping at the Transportation Research Facility. Following an investigation, corrective action was implemented to prevent recurrence.

Landfill gas monitoring is conducted quarterly at the 800 Area Landfill via three gas wells placed into the waste area and 10 gas wells at the perimeter of the landfill; Figure 2.1 shows their locations. In addition to the wells, ambient air is sampled in two nearby buildings and at three open-air locations to assess the presence of methane. The gas monitoring near the landfill determines whether or not methane is migrating from the landfill. Results indicate that methane is being generated. No migration of this compound has been noted, with the exception of a low level of methane (1.3%) detected only during the fourth quarter at perimeter well G8.

TABLE 2.3

Boiler No. 5 Operation, 2003

Month	Operated (hours)	Low-Sulfur Coal Burned (tons)
January[a]	677.5	2,260.4
February	672.0	2,371.8
March	744.0	2,423.9
April	282.5	775.1
May	0	0
June	0	0
July	0	0
August	0	0
September	0	0
October	0	0
November	0	0
December	494.0	1,485.7
Total	2,870.0	9,316.9

[a] Boiler No. 5 operated 16 hours on natural gas.

Fuel-dispensing facilities include a commercial service station and the Building 46 Grounds and Transportation facility. Except for ethanol vapors from alternate fuel usage, these facilities have VOC emissions typical of any commercial gasoline service station.

Pursuant to *Illinois Administrative Code*, Title 35, Part 254 (35 IAC Part 254), ANL-E submits an emissions summary to the IEPA each May 1 for the previous year. The summary for 2003 is presented in Table 2.4.

2.1.3. Clean Fuel Fleet Program

As mandated under the CAA and 35 IAC Part 241, the fifth annual Clean Fuel Fleet Program report was submitted to the IEPA on October 16, 2003, for vehicle acquisitions in Model Year (MY) 2003 (September 1, 2002–August 31, 2003). One light-duty vehicle and three heavy-duty vehicles were reported. Total vehicle acquisitions were in compliance with the percentages required by the Clean Fuel Fleet Program.

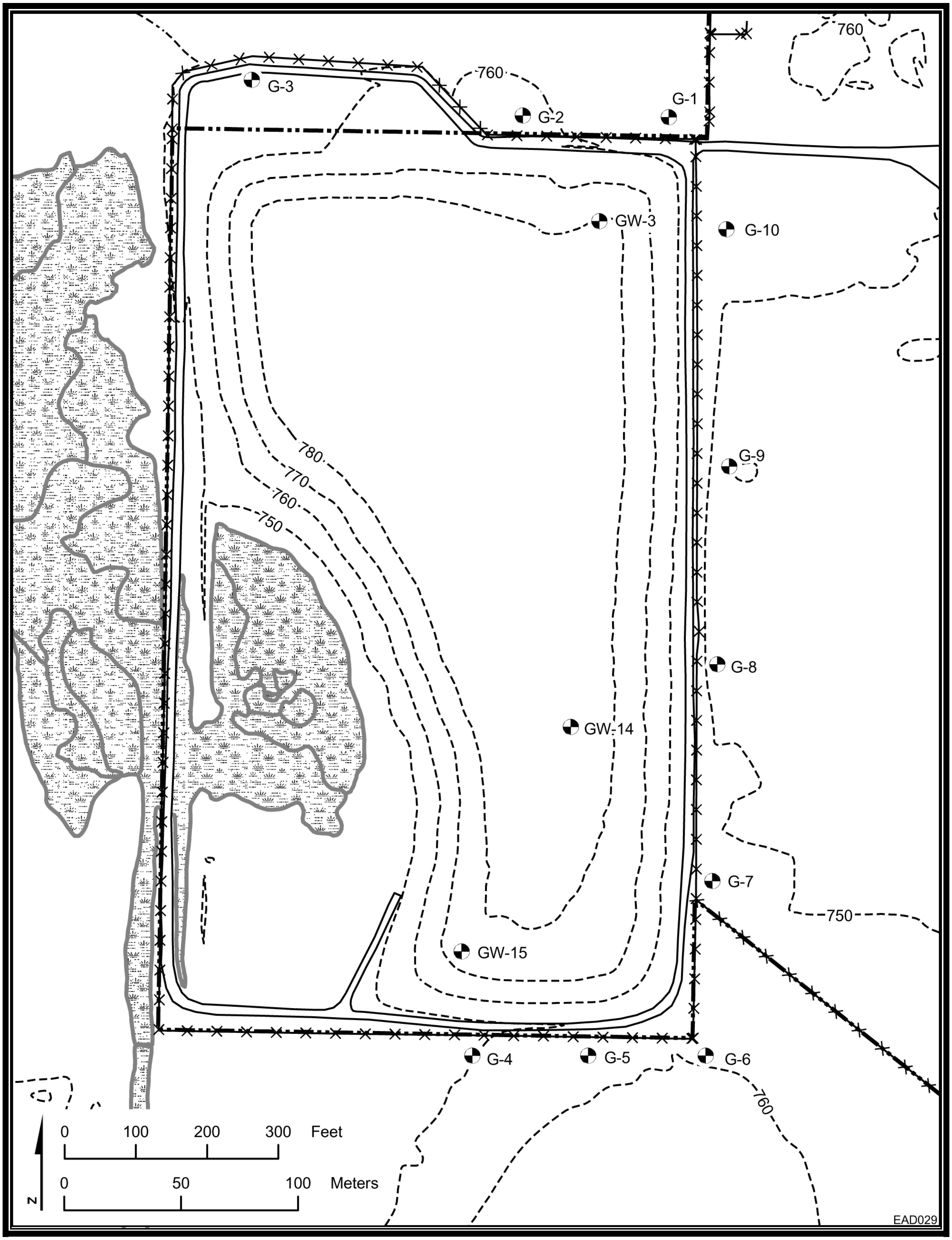


FIGURE 2.1 800 Area Landfill Gas Monitoring Wells

TABLE 2.4

2003 Annual Emissions Report: Emissions Summary

Building No. and Source	CO[a]	NO_x	PM/PM_{10}	$PM_{2.5}$[b]	SO_2	VOM	HAP[c]	NH_3[b]
46: Ethanol/Gasoline	–[d]	–	–	–	–	0.7	–	–
46: 10,000 Gal Gasoline	–	–	–	–	–	14.3	–	–
108: Boiler 1	19,550	65,165	711	422	142	332	–	114
108: Boiler 2	677	2,258	25	15	5	11	–	4
108: Boiler 3	19,140	63,799	696	433	139	325	–	112
108: Boiler 4	5,406	18,020	197	122	39	91	–	32
108: Boiler 5 (coal-fired)	48,448	102,467	727	298	197,173	339	12,581	5.3
108: Boiler 5 (gas-fired)	27	39	1	1	0.2	0.5	–	0.2
108: Sulfuric Acid Tank[e]	–	–	–	–	–	–	–	–
200: Peak Shaving Generator	0	0	0	0	0	0	–	0
200: M-Wing Hot Cells (R)[f]	–	–	–	–	–	–	–	–
202: Peak Shaving Generator	0	0	0	0	0	0	–	0
206: Alkali Reaction Booth (R)[f]	–	–	<1	–	–	–	–	
208: Surface Preparation Facility	–	0	0	–	–	–	0	–
212: Alpha Gamma Hot Cell (R)[f]	–	–	–	–	–	–	–	–
212: Building Exhausts[e]	–	–	–	–	–	–	–	–
300: 8,000 Gal Gasoline	–	–	–	–	–	33.7	–	–
300: 10,000 Gal Gasoline	–	–	–	–	–	7.6	–	–
300: 6,000 Gal Gasoline	–	–	–	–	–	12.0	–	–
301: Hot Cell D&D Project (R)[f]	–	–	–	–	–	–	–	–
303: Mixed Waste Storage (R)[f]	–	–	–	–	–	–	–	–
306: Building Vents (R)[f]	–	–	<1	–	–	–	–	–
306: Bulking Sheds	–	–	1	–	–	143	4.9	–
306: Vial Crusher/Chemical Photooxidation Unit (R)[f]	–	–	–	–	–	11.9	–	–
308: Alkali Reaction Booth[e]	–	–	–	–	–	–	–	–
315: MACE Project (R)[f]	180	–	–	–	–	–	–	–
317: Lead Brick Cleaning (R)[f]	–	–	–	–	–	–	–	–
330: CP-5 D&D Project (R)[f]	–	–	–	–	–	–	–	–
331: Rad Waste Storage (R)[f]	–	–	–	–	–	–	–	–
350: NBL Pu/U Hoods (R)[f]	–	–	–	–	–	–	–	–
363: Central Shop Dust Collector[e]	–	–	–	–	–	–	–	–
368: Woodshop Dust Collector[e]	–	–	–	–	–	–	–	–
370: Alkali Reaction Booth[e]	–	–	–	–	–	–	–	–
375: Intense Pulsed Neutron Source (R)[f]	–	–	–	–	–	–	–	–
400: APS Facility (R)[f]	–	61	–	–	–	–	–	–
400: APS Generator Caterpillar (1 unit)	376	1,959	70	69	162	53	–	1.3
400: APS Generator Kohler (2 units)	2,069	2,792	109	77	573	99	–	1.5
595: Lab Wastewater Plant (R)[f]	–	–	–	–	–	286	0.2	–
Lab Rad Hoods (R)[f]	–	–	–	–	–	–	–	–
PCB Tank Cleanout	–	–	–	–	–	0	–	–
Torch Cut Lead-Based Paint[e]	–	–	–	–	–	–	–	–
Transportation Research Facility	6,105	12,021	855	535	776	1,138	–	10
WMO Portable HEPA - (6) (R)[f]	–	–	<1	–	–	–	–	–
Total (lb/yr)	101,978	268,581	3,392	1,993	199,009	2,897	12,586	279
Total (tons/yr)	50.99	134.29	1.70	0.9963	99.50	1.45	6.29	0.1397
CAAPP Permit Limit (tons/yr)	(237.60)[g]	639.10	66.02	–	332.20	18.65	10.00	–

Footnotes on next page.

TABLE 2.4 (Cont.)

[a] Abbreviations: APS = Advanced Photon Source; CAAPP = Clean Air Act Permit Program; CP-5 = Chicago Pile-Five reactor; CO = carbon monoxide; D&D = decontamination and decommissioning; HAP = hazardous air pollutant; HEPA = high-efficiency particulate air; MACE = melt attack and coolability experiment; NBL = New Brunswick Laboratory; NH_3 = ammonia; NO_x = oxides of nitrogen; PCB = polychlorinated biphenyl; PM_{10} = particulate matter less than 10 microns; $PM_{2.5}$ = particulate matter less than 2.5 microns; Pu = plutonium; SO_2 = sulfur dioxide; U = uranium; VOM = volatile organic material; and WMO = Waste Management Operations.

[b] As of 2003, emissions of $PM_{2.5}$ and a precursor, ammonia (NH_3), must be included.

[c] These compounds are HAPs, but are not classified as VOMs or particulates.

[d] A dash indicates that the pollutant is not permitted from that particular unit (or it is classified as an insignificant activity); a zero means that the source is permitted for emissions of that pollutant but that there were no emissions for the year.

[e] These sources have been designated as insignificant in the CAAPP.

[f] (R) = radionuclide source regulated by NESHAPs (40 CFR Part 61, Subpart H).

[g] Not a permit limit, but the maximum potential emission level for CO.

2.2. Clean Water Act

The Clean Water Act (CWA) was established in 1977 as a major amendment to the Federal Water Pollution Control Act of 1972 and was modified substantially by the Water Quality Act of 1987. Section 101 of the CWA provides for the restoration and maintenance of water quality in all waters throughout the country, with the ultimate goal of "fishable and swimmable" water quality. The act established the National Pollutant Discharge Elimination System (NPDES) permitting system, which is the regulatory mechanism designed to achieve this goal. The authority to implement the NPDES program has been delegated to those states, including Illinois, that have developed a program substantially the same and at least as stringent as the federal NPDES program.

The 1987 amendments to the CWA significantly changed the thrust of regulatory activities. Greater emphasis is placed on monitoring and control of toxic constituents in wastewater, the permitting of outfalls composed entirely of storm water, and the imposition of regulations governing sewage sludge disposal. These changes in the NPDES program resulted in much stricter discharge limits in the 1990s and greatly expanded the number of chemical constituents monitored in the effluent.

2.2.1. Wastewater Discharge Permitting

The NPDES permitting process administered by the IEPA is the primary tool for enforcing the requirements of the NPDES program. Before wastewater can be discharged to any receiving stream, each wastewater discharge point (outfall) must be characterized and described in a permit application. The IEPA then issues a permit that, for each outfall, contains numeric limits and monitoring frequencies on certain pollutants likely to be present and sets forth a number of additional specific and general requirements, including sampling and analysis schedules and reporting and record-keeping requirements. NPDES permits are effective for 5 years and must be renewed by the submission of a permit application at least 180 days prior to the expiration of the existing permit.

Wastewater discharge at ANL-E is permitted by NPDES Permit No. IL 0034592. This permit was renewed during 1994 (effective October 30, 1994), modified in 1995 (effective August 24, 1995), and was to expire on July 1, 1999. An application to renew the existing permit was submitted timely to the IEPA on December 28, 1998. In 2001, a previously unknown storm water discharge point was discovered and characterized. On February 12, 2002, ANL-E submitted a supplementary permit application covering this outfall and an oil water separator for Building 376, along with comments regarding the preliminary draft NPDES Permit. Just prior to the end of 2002, the IEPA issued the "Final Draft Permit" for public comment. ANL-E sent comments to the IEPA in January 2003 covering the "Final Draft Permit" and several provisions ANL-E had requested previously. At the end of the year, the IEPA had not acted on these or any other comments, and ANL-E continues to operate, as provided for in the IEPA regulations, under the existing permit issued in 1994 until the IEPA issues a renewal permit.

Wastewater at ANL-E is generated by a number of activities and consists of sanitary wastewater (from restrooms, cafeteria sinks and sinks in certain buildings and laboratories, and steam boiler blowdown), laboratory wastewater (from laboratory sinks and floor drains in most buildings), and storm water. Water softener regenerant from boiler house activities is discharged into the DuPage County sewer system. Cooling water and cooling tower blowdown are discharged into storm water ditches that are monitored as part of the NPDES Permit. The current permit authorizes the release of wastewater from 40 separate outfalls, most of which discharge directly or indirectly into Sawmill Creek. Two of the outfalls are internal sampling points that combine to form the main wastewater outfall, Outfall 001. Table 2.5 lists these outfalls; Figure 2.2 shows their locations.

2.2.1.1. NPDES Permit Activities

Total dissolved solids (TDS) analyses results historically have demonstrated an annual cycle, culminating in periodic discharge limit violations occurring in the winter at Outfall 001. Investigations into the causes of the heightened TDS concentration during winter have focused on three sources of increased TDS contribution during the winter months: (1) increased boiler activity with its associated increase in high TDS wastewater (i.e., boiler blowdown), (2) salt usage in the boiler house area that drains to the boiler house pond, and (3) road salt used for sitewide snowmelt. To deal effectively with the boiler house area problems, the boiler house equalization pond was routed to DuPage County for periodic discharge of up to 227,125 L/day (60,000 gal/day).

To accomplish this, in 2000, ANL-E completed an application to DuPage County to allow the discharge of this wastewater under the existing permit with the county. An application was also sent to the IEPA. Historically, all wastewater in the equalization pond was directed to the Sanitary Wastewater Treatment Plant (SWTP). This permit application was acted upon by the

TABLE 2.5

Characterization of NPDES Outfalls at ANL-E, 2003

Outfall	Description	Average Flow[a]
001A	Sanitary Treatment Plant	0.247
001B	Laboratory Treatment Plant	0.467
001	Combined Outfall	0.714
003A	Swimming Pool	0.0
003B	300 Area (Condensate)	0.014
003C	Building 205 Footing Tile Drainage	0.024
003D&E	Steam Trench Drainage (Condensate)	0.004/<0.001
003F	Building 201 Fire Pond Overflow Storm Water	0.092
003G	North Building 201 Storm Sewer (Condensate)	0.019
003H	Building 212 Cooling Tower Blowdown	<0.001
003I	Buildings 200 and 211 Cooling Tower Blowdown	0.015
003J	Building 213 and Building 213 Parking Lot Storm Water	0.005
004	Building 203 Cooling Tower and Building 221 Footing Drainage and Storm Water	0.017
005A	Westgate Road Storm Water	Storm water only
005B	800 Area East Storm Water	Storm water only
005C	Building 200 West	0.021
005D	Storm Water	Storm water only
005E	Building 203 West Footing Drainage and Condensate	0.015
006	Cooling Tower Blowdown and Storm Water	0.033
007	Domestic Cooling Water for Compressor and Storm Water	0.018
008	Transportation and Grounds Storm Water	0.019
010	Coal Pile Runoff Emergency Overflow	Storm water only
101	North Fence Line Marsh Storm Discharge	Storm water only
102	100 Area Storm Water Discharge	Storm water only
103	Southeast 100 Area Storm Water	Storm water only
104	Northern East Area Storm Water Discharge	Storm water only
105A&B	Building 40 Storm Water Discharge	Storm water only
106A&B	Southern East Area Storm Water Discharge	Storm water only
108	Eastern 300 Area Storm Water and Cooling Water	0.022
110	Shooting Range Storm Water Discharge	Storm water only
111	319 Landfill and Northeast 317 Area	Storm water only
112A&B	Southern and Western 317 Area	Storm water only
113	Southern and Eastern 800 Area Landfill Storm Water Runoff	<0.001
114	Northern and Western 800 Area Landfill Storm Water Runoff	<0.001
115	314, 315, and 316 Cooling Water, Eastern and Southern APS Area	0.004
116	Water Treatment Plant and Storm Water	0.005

[a] Flow is measured in million gallons per day, except for outfalls with storm water only.

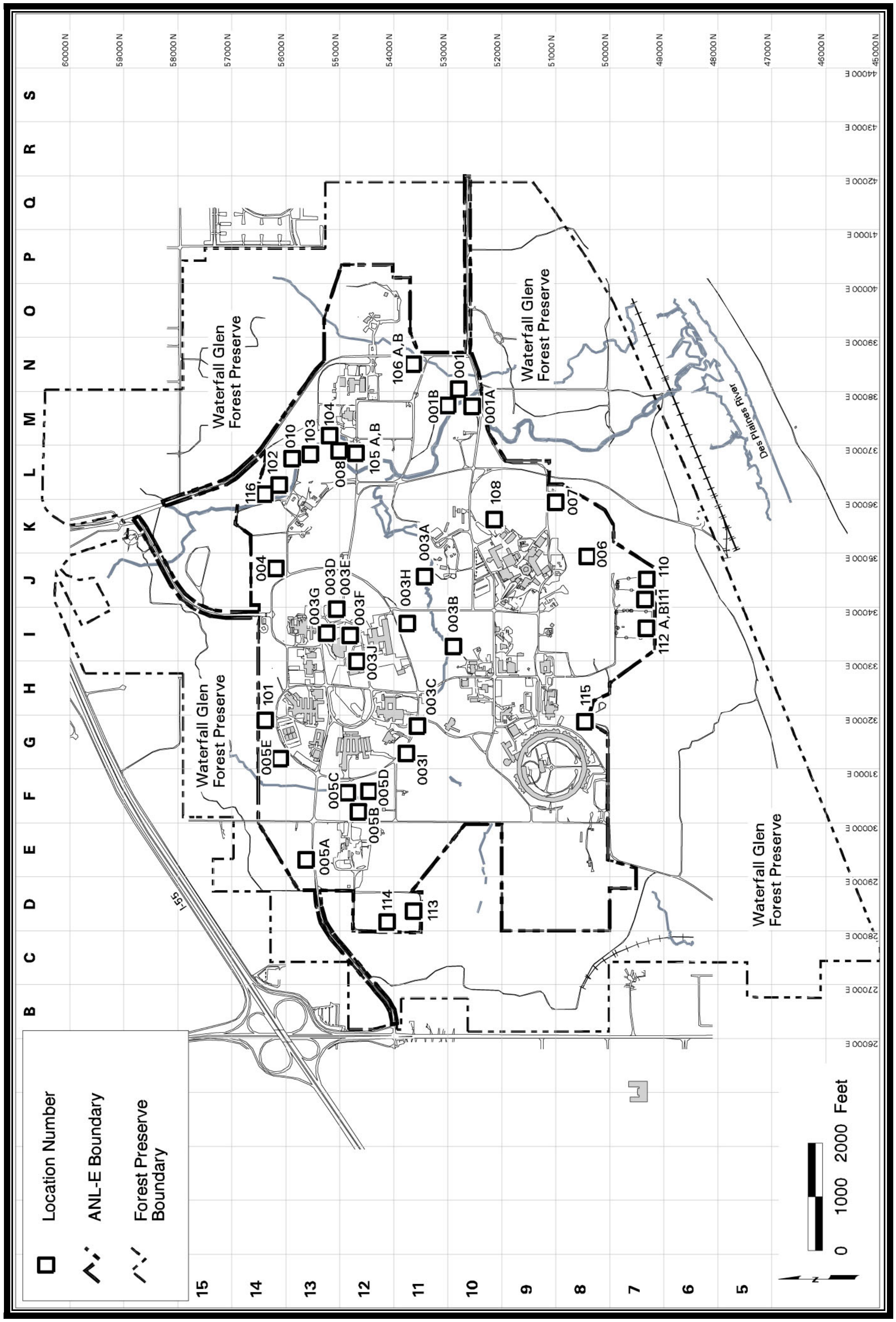


FIGURE 2.2 NPDES Permit Locations

IEPA, and a new permit was issued in 2001 covering this discharge (see Table 2.15). Redirection of the equalization pond wastewater to DuPage County is intended to be accomplished only during the heating season in late fall and winter. This was begun in a testing mode late in 2001, and then put into service in the spring of 2002. Experience to date seems to indicate that this action has reduced TDS concentrations at the wastewater treatment plant (WTP) during the heating season.

2.2.1.2. Compliance with NPDES Permit

Wastewater is treated at ANL-E in two independent treatment systems, the sanitary system and the laboratory system. The sanitary wastewater collection and treatment system collects wastewater from sanitation facilities, the cafeteria, office buildings, and other portions of the site that do not contain radioactive or hazardous materials. This wastewater is treated in a biological wastewater treatment system consisting of primary clarifiers, trickling filters, final clarifiers, and slow sand filters. Wastewater generated during research-related activities, including those that utilize radioactive materials, generally flows to a series of retention tanks located in each building that are pumped to the laboratory wastewater sewer after radiological analysis and release certification. Treatment in the Laboratory Wastewater Treatment Plant (LWTP) consists primarily of aeration, solids-contactor clarification, and pH adjustment. Additional steps can be added, including powder-activated carbon addition for organic removal, alum addition, and polymer addition or adjustment, if analysis demonstrates that any of these are required.

Figure 2.3 shows the two wastewater treatment systems that are located adjacent to each other. The volume of wastewater discharged from these facilities in 2003 averaged 0.96 million L/day (0.25 million gal/day) for the sanitary wastewater and 1.80 million L/day (0.47 million gal/day) for the laboratory process wastewater.

Results of the routine monitoring required by the NPDES Permit are submitted monthly to the IEPA in a Discharge Monitoring Report (DMR). As required by the permit, any exceedance of permit limits or conditions is reported by telephone to the IEPA within 24 hours, and a written explanation of the exceedance is submitted with each DMR. During 2003, there were three exceedances of NPDES Permit limits out of approximately 1,600 measurements. One was an exceedance of the TDS limit at Outfall 001 attributed to road salt associated with snowmelt. The second was that the concentration limit for biochemical oxygen demand (BOD_5) (20 mg/L daily maximum) was exceeded at Outfall 001A in February. The cause of the exceedance was not identified. The third exceedance occurred when the mass loading limit of total suspended solids (TSS) (136 lb/day daily maximum) at Outfall 001B was exceeded on July 15, 2003. This exceedance was attributed to an excessive precipitation event on that day that resulted in a reduced clarifier retention time. Figure 2.4 presents the data for the total number of exceedances each year over the past 14 years.

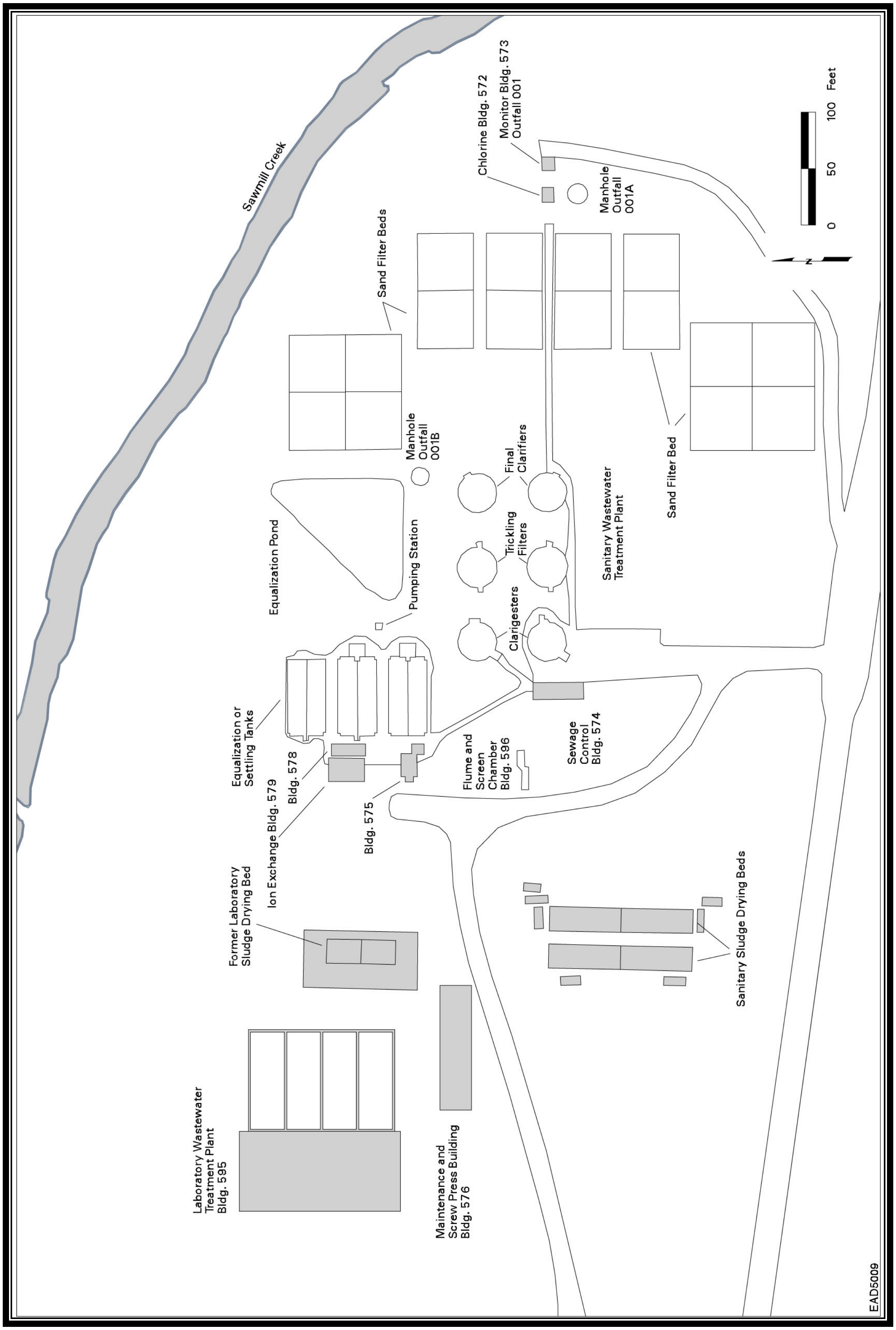


FIGURE 2.3 ANL-E Wastewater Treatment Plant

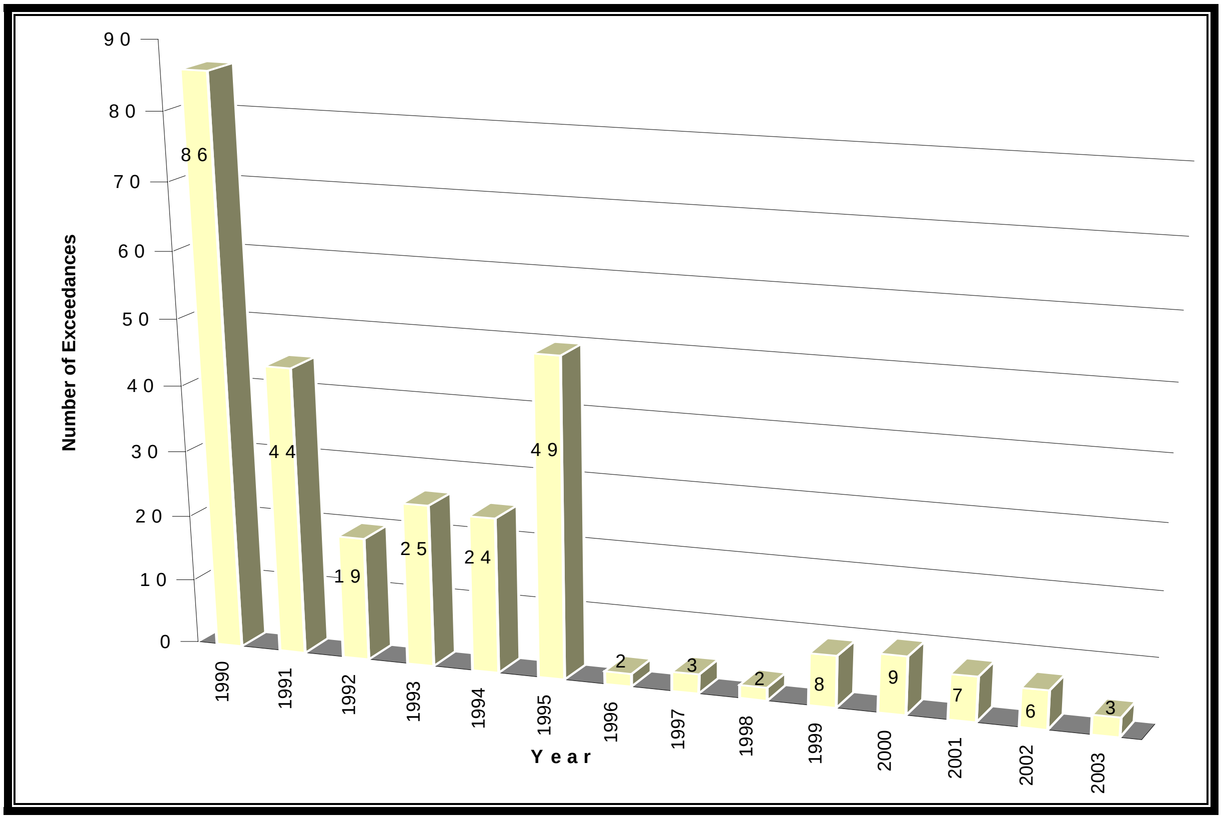


FIGURE 2.4 Total Number of NPDES Exceedances, 1990 to 2003

2.2.1.3. Priority Pollutant Analysis and Biological Toxicity Testing

The NPDES Permit requires semiannual testing of Outfall 001B, the LWTP outfall, for all the priority pollutants — 124 metals and organic compounds identified by the IEPA as being of particular concern. During 2003, this sampling was conducted in June and December. Results were similar to 2002. Organic compound concentrations were very low. Chloroform (3 μg/L and 6 μg/L) was detected in both the June and December samples, as was bromodichloromethane (2 μg/L) and dibromochloromethane (1 μg/L). Bromoform (1 μg/L) was detected in the June sample. It is suspected that the chloroform, dibromochloromethane, bromodichloromethane, and bromoform result from the contact of chlorinated water with organic chemicals and residues from cooling tower biocide treatment chemicals. All semivolatile concentrations were below the detection limits. Low concentrations of copper (0.017 mg/L), phenols (0.02 mg/L), and zinc (0.070 mg/L) were detected at levels well below the corresponding effluent limits (see Table 5.8). These findings are discussed further in Chapter 5.

In addition to the priority pollutant analysis, the permit requires annual biological toxicity testing of the combined effluent stream, Outfall 001. This testing was conducted June 23 through June 27, 2003. The data indicate that the effluent was not acutely toxic to either the fathead minnow or the water flea. Data from the past 10 years suggest that cessation of chlorination of ANL-E effluent can be correlated with a beneficial effect on aquatic life in the receiving streams.

Special Condition No. 9 of the NPDES Permit requires annual aquatic toxicity testing of Outfalls 003H, 003I, 003J, 004, 006, and 115 during the months of July and August. The samples were collected July 21 through July 25, 2003, and August 25 through August 29, 2003. A review of the July data indicates that Outfalls 003H, 003I, 003J, 004, and 006 exhibited no toxicity for either the water flea or the fathead minnow. Outfall 115 was acutely toxic to the water flea but not to the fathead minnow. The toxicant was unidentified, but may have been chlorinated drinking water. The August data indicate that Outfalls 003H, 003J, 004, 006, and 115 were not actually toxic for either the water flea or the fathead minnow. Similar to toxicity observed in August 2002, Outfall 003I was acutely toxic to the water flea. The toxicant was unidentified.

The acute toxicity observed at these outfalls is believed to be related primarily to residual chlorine levels in the domestic water, some of which is discharged to the outfalls. Chlorine levels that are necessary to protect the water distribution system are high enough to cause measurable acute toxic effects in these tests. Another source of halogen compounds identified earlier is discharged cooling water containing water treatment chemicals used in various cooling towers throughout the site. Steps are being taken to redirect these nonstorm wastewater discharges into ANL-E's sewer systems to reduce the toxicity problems at these outfalls.

2.2.1.4. Storm Water Regulations

In November 1990, the EPA promulgated regulations governing the permitting and discharge of storm water from industrial sites. The ANL-E site contains a large number of small-scale operations that are considered industrial activities under these regulations and, thus, are subject to these requirements. An extensive storm water characterization and permitting program was initiated in 1991 and continues as required in present and pending NPDES Permits; ANL-E's NPDES Permit includes both industrial and stormwater discharges to surface water.

The NPDES Permit contains two special conditions requiring Storm Water Pollution Prevention Plans (SWPPPs): (1) a stand-alone plan for the APS construction site (Special Condition No. 12), which was accomplished years ago and no longer is required since the completion of APS construction, and (2) a sitewide plan for the remainder of the ANL-E site (Special Condition No. 11). Special Condition No. 11 additionally requires ANL-E to inspect and report annually on the effectiveness of the sitewide SWPPP. In 2003, the annual inspection was completed and a report was submitted to the IEPA in December. The Storm Water Pollution Prevention Committee (SWPPC), the ANL-E organization that performs the annual inspection, concluded that the SWPPP should undergo a complete joint review with the DOE-Argonne Site Office (ASO), and then be rewritten and reissued. This will be accomplished in spring 2004.

2.2.2. NPDES Inspections and Audits

The IEPA conducted a compliance inspection on April 18 and 19, 2003. No issues were identified.

2.2.3. General Effluent and Stream Quality Standards

In addition to specific NPDES Permit conditions, ANL-E discharges are required to comply with general effluent limits contained in 35 IAC Part 304. Also, wastewater discharges must be of sufficient quality to ensure that Sawmill Creek complies with IEPA General Use Water Quality Standards (WQSs) found in 35 IAC Part 302, Subpart B. Chapter 5 of this report, which presents the results of the routine environmental monitoring program, also describes the general effluent limits and WQSs applicable to the outfalls and discusses compliance with these standards.

2.2.4. Spill Prevention Control and Countermeasures Plan

ANL-E maintains a Spill Prevention Control and Countermeasures (SPCC) Plan as required by the CWA and EPA regulations at 40 CFR Part 112. This plan describes the planning, design features, and response measures that are in place to prevent oil or oil products from being released to navigable waters of the United States. Persons with specific duties and responsibilities in such situations are identified, as are reporting and record-keeping requirements mandated by the regulations. Regular training is conducted on implementation of this plan. No reportable spills occurred in 2003 that required activation of the SPCC Plan.

DOE-ASO participated in a joint appraisal of the SPCC Plan in December 2002. The SPCC assessment report is pending. One deficiency and three opportunities for improvement were noted. The deficiency covered needed improvements in inspection record keeping. The opportunities for improvement included a rewrite of the SPCC Plan to conform to new regulations; the revised plan is due for completion by the end of 2004.

2.2.5. Clean Water Action Plan

The Clean Water Action Plan Program, instituted in 1998, constitutes a voluntary commitment by federal agencies to work cooperatively to improve water quality in the United States. The approach is for federal agencies to form partnerships to identify watersheds with the most critical water quality problems. The goals of the plan are to establish initiatives to reduce public health threats, improve stewardship of natural resources, strengthen control of polluted runoff, and make water quality information more accessible to the public.

Although no formal plans related to this initiative have been established at ANL-E, several activities have been undertaken to support this initiative. ANL-E has worked with the IEPA to reduce or eliminate surface water discharges of regulated pollutants. Special focus has been on exceedances of NPDES Permit parameter limits. Past upgrades to the ANL-E physical plant included acquisition of Lake Michigan water to replace dolomite well water as the source of domestic water. Lake Michigan water has a much lower TDS content than dolomite water, and the use of Lake Michigan water has reduced the amounts of TDS and copper that are discharged (water with lower TDS levels is less aggressive at dissolving copper from piping). The rehabilitation of the SWTP resulted in compliance with the ammonia-nitrogen limit. The upgrade of the LWTP also was completed, which gives ANL-E a number of options for treating various waste streams more effectively.

During 2003, the re-routing of chlorinated sources was curtailed due to lack of funding. Further funding for this improvement program is anticipated in 2004.

The Clean Water Action Plan includes a strategy to achieve a net national increase of 100,000 wetland acres per year by 2005. ANL-E is contributing to this effort by increasing the size of an existing wetland by up to 3 ha (6 acres). This wetland restoration effort is discussed further in Section 2.13.

2.3. Resource Conservation and Recovery Act

The Resource Conservation and Recovery Act (RCRA) and its implementing regulations are intended to ensure that facilities that treat, store, or dispose of hazardous waste do so in a way that protects human health and the environment. The Hazardous and Solid Waste Amendments of 1984 (HSWA) created a set of restrictions on land disposal of hazardous waste. In addition, the HSWA also require that releases of hazardous waste or hazardous constituents from any Solid Waste Management Unit (SWMU) at a RCRA-permitted facility be remediated, regardless of when the waste was placed in the unit or whether the unit originally was intended as a waste disposal unit. The RCRA program includes regulations governing management of underground storage tanks (USTs) containing hazardous materials or petroleum products. The IEPA has been authorized to administer most aspects of the RCRA program in Illinois. The IEPA issued a RCRA Part B Permit to ANL-E and DOE on September 30, 1997. The permit became effective on November 4, 1997.

The ANL-E Environmental Remediation Program (ERP) was responsible for achieving compliance with all applicable environmental requirements related to assessing and cleaning up releases of hazardous materials from inactive waste sites. The corrective action portion of the RCRA Part B Permit provides the primary regulatory vehicle. This program is described in greater detail in Chapter 3.

The permit has been modified nine times. Table 2.6 presents a summary of the RCRA Part B Permit modifications.

2.3.1. Hazardous Waste Generation, Storage, Treatment, and Disposal

The nature of the research activities conducted at ANL-E results in the generation of small quantities of a large number of waste chemicals. Many of these materials are classified as hazardous waste under RCRA. ANL-E has 25 Hazardous Waste Management Units; 17 container storage units and 1 tank storage unit, and 4 miscellaneous treatment units and 3 tank chemical treatment units. Table 2.7 provides descriptions of all of the units. Closure of the concrete storage

TABLE 2.6

Summary of Modifications to the RCRA Part B Permit

Modification Application Number	Purpose	IEPA Approval Date
1	Update the application and request a number of Class 1 modifications.	Pending
2	Allows ANL-E to accept the ash from the incineration of ANL-E generated mixed waste at the DOE-owned Waste Experimental Reduction Facility in Idaho, in the event that it cannot be disposed of otherwise.	February 1999
3	(1) Allows use of Building 303 to store surplus chemicals; (2) updates the operating procedures for the Building 308 Alkali Metal Passivation Booth, and (3) updates the RCRA Contingency Plan.	August 2000
4	One Class 1 Modification and one Class 2 Modification allow ANL-E to (1) change the name of the DOE signatory authorized to sign documents related to the ANL-E RCRA Part B Permit, and (2) use a concrete pad at Building 331 for the storage of solid radioactive and mixed waste.	January 2001
5	Class 1 Modification allows ANL-E to update the RCRA Contingency Plan.	February 2002
6	Class 1 Modification allows ANL-E to change the name of the ANL-E signatory authorized to sign documents related to the ANL-E RCRA Part B Permit.	March 2002
7	(1) Update the RCRA Contingency Plan, and (2) allow ANL-E to receive seven drums of defense contact-handled mixed transuranic waste from the Missouri University Research Reactor facility in Columbia, Missouri. At ANL-E, the drums will be characterized and certified for disposal and shipped to the Waste Isolation Pilot Plant located in Carlsbad, New Mexico.	November 2002
8	Approve design and equipment changes to the permitted Building 306 Metal Precipitation/Filtration Treatment Unit.	November 2002
9	(1) Remove references to the Facility 317 Concrete Storage Pad, and (2) remove condition regarding the management of seven 55-gallon drums of contact-handled transuranic mixed waste from the Missouri University Research Reactor facility.	August 2003

TABLE 2.7

Permitted Hazardous Waste Treatment and Storage Facilities, 2003

Description	Location	Purpose
Storage		
Concrete Storage Pad	Building 331	Storage of solid radioactive waste and solid mixed waste (MW) in the form of steel-encased lead shielding containers and containerized solid MW.
Container Storage Area	Building 325C, East	Storage of liquid and solid bulk or lab-packed flammable and reactive hazardous waste and solid and liquid bulk polychlorinated biphenyls (PCBs) and miscellaneous PCB units.
	Building 325C, West	Storage of bulk and lab-packed liquid flammable hazardous waste.
	Building 303 Mixed Waste Storage Facility	Storage of containers of ignitable, corrosive, oxidizing, reactive, solid hazardous, radiological, or MW.
	Building 331 Radioactive Waste Storage Facility	Storage of containers of flammable, toxic, corrosive, oxidizing hazardous, radiological, or MW.
Dry Mixed Waste Storage Area	Building 374A	Storage of solid MW and radioactively contaminated lead bricks.
Mixed Waste Container Storage	Building 329	Storage of containers of bulk and lab-packed ignitable MW or compatible waste.
Portable Storage Units (4)	Building 306	Storage of hazardous, radiological, or MW (3 of 4 units).
		Bulking operations to consolidate and reduce the volume of lab-packed waste in containers (1 of 4 units).
Hazardous Waste Storage Facility[a]	Building 307	Proposed permitted storage facility for hazardous waste.

TABLE 2.7 (Cont.)

Description	Location	Purpose
Tank Storage	Building 306	Storage of corrosive and toxic mixed waste and radiological liquid wastes (4,000 gal; currently not used).
Mixed Waste Storage	Building 306 - Storage Room A-142	Storage of ignitable MW.
	Building 306 - Storage Room A-150	Storage of solid and liquid MW.
	Building 306 - Storage Room C-131	Storage of ignitable, corrosive, and reactive hazardous waste.
	Building 306 - Storage Room C-157	Storage of corrosive and oxidizer MW.
	Building 306 - Storage Room D-001	Storage of solid MW containing toxic metal constituents.
Treatment		
Alkali Metal Passivation Booth	Building 206	Destruction of water reactive alkali metals possibly contaminated with radionuclides.
Alkali Metal Passivation Booth	Building 308	Destruction of water reactive alkali metals.
Chemical/Photooxidation Unit	Building 306	Treatment of ignitable liquid MW containing organic contaminants.
Dry Ice Pellet Decontamination Unit	317 Area	Treatment of solid MW having radionuclide and/or RCRA metal surface contamination.
Low-Level Radioactive Waste (LLW) Neutralization/ Precipitation System	Building 306	Treatment of aqueous, corrosive LLW, some of which is contaminated with heavy metals.
Mixed Waste Immobilization/ Macroencapsulation Unit	Building 306	Treatment of solid, semisolid, and organic liquid MW containing RCRA metals.
Transuranic (TRU) Neutralization/Precipitation Treatment Unit	Building 306	Treatment of corrosive, aqueous MW containing transuranic radionuclides and RCRA metals.

[a] This facility is permitted. However, it has not yet been built.

pad in the 317 Area was completed and approved by the IEPA in 2003. Figure 2.5 shows the locations of the major active hazardous waste treatment, storage, and disposal areas at ANL-E.

ANL-E prepares an annual Hazardous Waste Report. The report is submitted to the IEPA by March 1 of each year and describes the activity of the previous year. It is a summation of all RCRA waste activities, including generation, storage, and treatment. The report describing such activities during 2003 was submitted to the IEPA on March 1, 2004. The RCRA-permitted storage facilities, designed and operated in compliance with RCRA requirements, allow for accumulation and storage of waste pending off-site disposal. ANL-E's on-site permitted treatment facilities address a small number of hazardous wastes generated by ANL-E operations. Off-site treatment and disposal take place at approved hazardous waste treatment and disposal facilities. Hazardous wastes that were generated, disposed of, or recycled during 2003 are described in Table 2.8.

2.3.2. Hazardous Waste Treatability Studies

The IEPA requires ANL-E to submit a report by March 15 of each year that estimates the number of hazardous waste treatability studies and the amount of waste expected to be used in the studies during the current year.

One treatability study, Amalgamation of Radioactive Elemental Mercury Waste Stream, was conducted in March 2003. The treatment process consisted of combining mercury with various powdered metals to determine the most suitable amalgamation method for the mercury waste stream. A total of 4 kg (9 lb) of ANL-E's mercury waste stream was treated. Treatment residues, analyzed for the presence of mercury by using the toxicity characteristic leaching procedure (TCLP), were shipped to Envirocare, Inc. in Clive, Utah for disposal. The treatability study will be continued in 2004. Approximately 4 to 6 kg (9 to 13 lb) are expected to be treated.

Two additional treatability studies have been proposed at ANL-E for 2004. The first study, Passivation of Lithium Metal Waste Contaminated with Transuranic Radionuclides, will be initiated during July 2004, with completion scheduled for September 2004. The waste is currently stored in a RCRA-permitted storage unit. The process involves the reaction of lithium metal waste with an aqueous solution until the reactive characteristic is removed. The resulting aqueous solution will be solidified and managed as nonhazardous radioactive waste, which will be packaged for disposal at an off-site DOE facility. A total of 50 to 60 kg (110 to 132 lb) will be treated during 2004. The second study, Neutralization of Transuranic Corrosive Waste with Heavy Metals, was originally begun in 1998. The treatment process uses caustic neutralization of transuranic corrosive waste that also contains concentrations of metals in excess of the maximum toxicity characteristic concentrations. Once neutralized, the waste is solidified with sorbents approved by the DOE Waste Isolation Pilot Plant (WIPP). Treatment residues are stored in RCRA-permitted on-site units until shipment to WIPP, which is planned for June 2004. Heavy metals present are solidified with the solid matrix. Approximately 150 to 175 kg (331 to 386 lb) are expected to be treated during 2004.

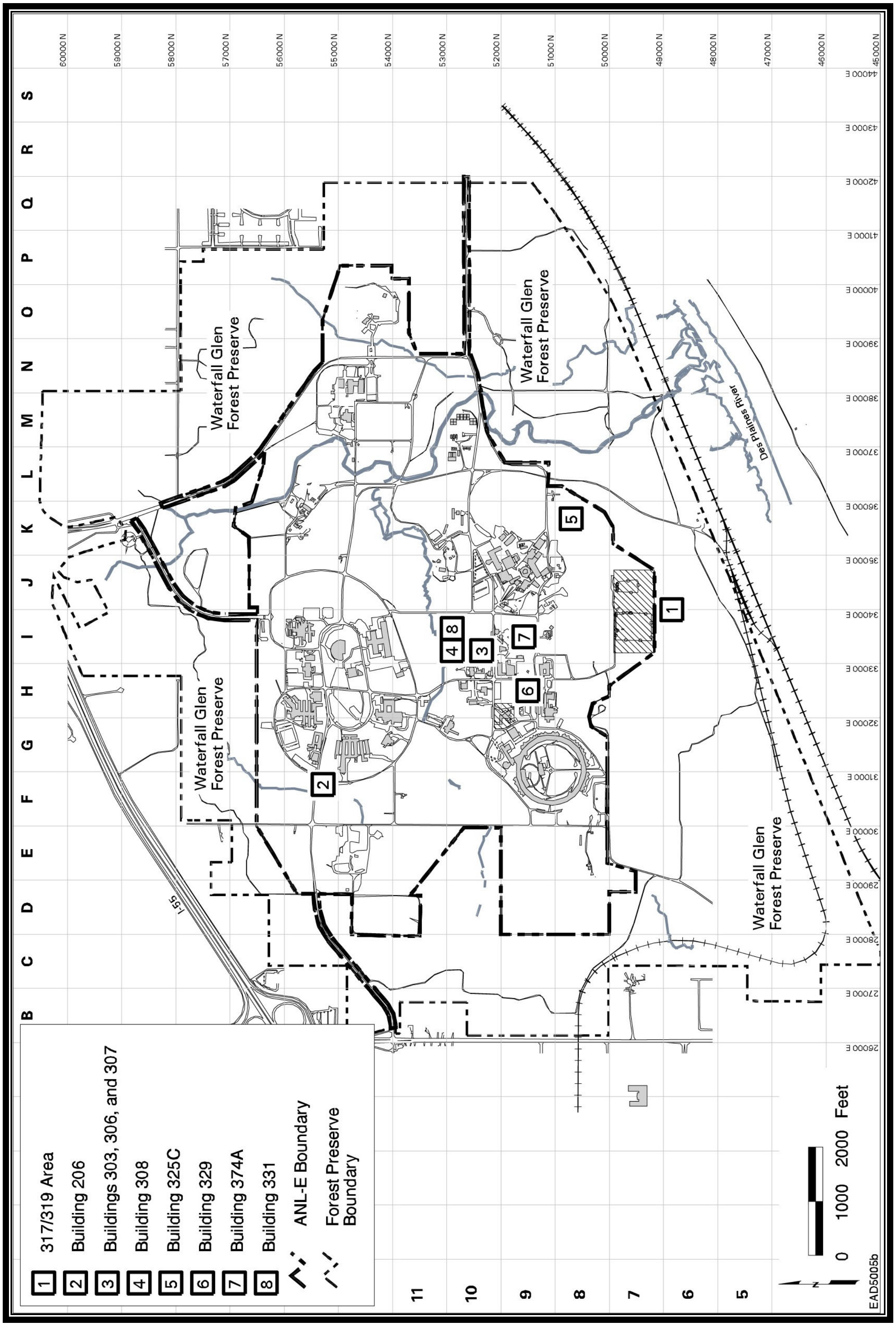


FIGURE 2.5 Major Treatment, Storage, and/or Disposal Areas at ANL-E

TABLE 2.8

Hazardous Waste Generation, Treatment, Disposal, or Recycle, 2003

Waste	Volume (gal)[a]	Weight (lb)
Generated and Disposed of or Recycled		
Acidic cleaning solutions	30	270
Acidic plating waste	220	2,002
Aerosol cans	86	205
Aqueous solutions with lead	220	1,848
Brake cleaner fluid[b]	14	117
Bulked laboratory solvents	800	5,600
Caustic cleaning solutions	115	966
Compressed gases	4	16
Diesel fuel waste[b]	170	1,122
Diesel fuel contaminated debris	220	880
Electropolishing solutions	340	5,148
Heavy metal-contaminated debris	55	220
Immersion cleaner fluid[b]	19	154
Labpacks of liquid chemicals	1,185	9,476
Labpacks of solid chemicals	328	1,310
Lead-contaminated debris	3,045	12,180
Mercury contaminated debris	140	560
Plating wastes containing lead	195	1,638
Solvent-containing debris	85	340
Used oil[b]	1,570	3,600
Zinc bromide solution	2,195	18,502
Generated and Treated		
Alkali metals	59	472
Universal Hazardous Waste		
Mercury-containing lamps[b]	9,734	9,734
Lead acid batteries[b]	425	6,000

[a] In accordance with RCRA regulations, waste amounts are reported in units of gallons, regardless of the physical form of the waste.

[b] Recycled waste.

2.3.3. Mixed Waste Generation, Storage, Treatment, and Disposal

A small number of hazardous wastes that ANL-E generates also exhibit radioactivity, thereby making them “mixed waste.” The hazardous component of mixed waste is subject to RCRA regulations, while the radioactive component is subject to regulation under the Atomic Energy Act of 1954 (AEA) as implemented by DOE Orders. Accordingly, facilities storing or disposing of mixed waste must comply with both DOE requirements and RCRA permitting and facility standards. ANL-E generates several types of mixed waste, including acids, solvents, and sludges and debris contaminated with radionuclides. The RCRA Part B Permit provides for on-site treatment in five mixed waste treatment systems. These systems include neutralization of low-level radioactive waste (LLW) and transuranic (TRU) corrosive aqueous waste and the stabilization of sludge and soil. In addition, during 2003, some of the mixed waste was sent off site to Envirocare of Utah, Inc., Salt Lake City, Utah, or Perma-Fix Environmental Services, Inc., Kingston, Tennessee, commercial treatment and disposal facilities. Table 2.9 lists the mixed waste generated, stored, treated on site, or shipped off site for disposal in 2003.

2.3.4. Federal Facility Compliance Act Activities

The Federal Facility Compliance Act of 1992 (FFCA) amended RCRA to clarify the application of its requirements and sanctions to federal facilities. The FFCA also requires that DOE prepare mixed waste treatment plans for DOE facilities that store or generate mixed waste. The Proposed Site Treatment Plan (PSTP) for mixed waste generated at ANL-E was submitted to the IEPA and the Illinois Department of Nuclear Safety (IDNS) in March 1995. Mixed waste at ANL-E has been managed in accordance with the PSTP since October 1995. ANL-E’s RCRA Part B Permit provides for on-site treatment of certain mixed waste as required by the PSTP.

During 2003, ANL-E completed the treatment milestones for waste streams that included evaporator/concentrator bottoms, combustible solids with organics, reactive compounds, TRU elemental lead, and TRU metal debris with cadmium.

In 2004, ANL-E will be working on completing treatment of lower-volume waste streams. Complete treatment of all stored mixed waste is expected by September 2006. Six mixed waste streams will be treated under the PSTP; five will be treated by September 2004, and the remaining one will be treated by September 2006.

2.3.5. RCRA Inspections: Hazardous Waste

A RCRA Compliance Inspection was conducted by EPA Region V on August 11 and 12, 2003. EPA Region V reviewed pertinent documentation, such as inspection records; the contingency, waste analysis, and closure plans; and annual reports. All permitted storage and treatment units were inspected. The EPA determined that ANL-E provided an exemplary waste management program and is in compliance with RCRA regulations.

2.3.6. Underground Storage Tanks

The ANL-E site currently contains 17 USTs. Seven of the existing tanks are being used to store fuel oil for emergency generators. The on-site vehicle fueling and maintenance facilities

TABLE 2.9

Mixed Waste Generation, Treatment, Storage, and Disposal, 2003

Waste	Volume (gal)	Weight (lb)
Generated		
MW acidic solutions	77	770
MW acidic solutions with heavy metals	237	2,133
MW alkali metals	68	544
MW aqueous solutions with heavy metals	47	423
MW elemental mercury	31	279
MW flammable liquids	113	1,130
MW inorganic nitrates	19	380
MW debris with heavy metals	7,619	30,476
MW debris with organics	43	172
MW lead articles	185	16,650
MW sludge with heavy metals	280	2,800
MW soil with heavy metals	145	1,305
TRU acidic solutions	240	2,160
TRU debris with heavy metals	55	220
Shipped for Treatment/Disposal		
MW debris with volatile organics	299	1,196
MW debris with heavy metals	6,475	25,900
MW lead articles	1,920	172,800
MW flammable liquids	81	810
MW sludges with heavy metals	1,355	13,550
TRU debris with heavy metals	17,138	68,552
Treated		
MW acidic solutions with heavy metals	232	2,088
MW acidic solutions	60	600
MW aqueous solutions with heavy metals	196	1,764
MW soil with heavy metals	272	2,448
In Storage		
MW acidic solutions	77	770
MW acidic solutions with heavy metals	237	2,133
MW alkali metals	253	2,024
MW aqueous solutions with heavy metals	47	423
MW elemental mercury	85	765
MW flammable liquids	113	1,130
MW inorganic nitrates	309	6,180
MW debris with heavy metals	1,891	7,564
MW debris with volatile organics	43	172
MW lead articles	1,375	123,750
MW sludges with heavy metals	280	2,800

TABLE 2.9 (Cont.)

Waste	Volume (gal)	Weight (lb)
MW soil with heavy metals	145	1,305
TRU acids	240	2,160
TRU debris with heavy metals	55	220
TRU sludge	4,631	41,679

(Building 46 and the on-site service station) use underground tanks to store diesel, gasoline, used oil, antifreeze, and ethanol/gasoline blend. On June 13, 2003, the Illinois State Fire Marshal certified that the USTs at ANL-E are in compliance with the regulations.

2.4. Solid Waste Disposal

In September 1992, ANL-E ceased operation of its 800 Area Landfill, which had begun operating in 1966. The IEPA issued the original operating permit in 1981 in accordance with 35 IAC Part 807 and several subsequent supplemental permits. On March 25, 2003, the IEPA determined that the postclosure care of the 800 Area Landfill would be carried out under the corrective action provisions (Section V) of ANL-E's RCRA Part B Permit.

Groundwater Quality Standards of some routine indicator parameters have been consistently exceeded. Exceedances occur primarily in shallow, perched pockets of groundwater in the glacial drift that is not in direct communication with the deeper dolomite bedrock aquifer. To aid in the determination of the nature and extent of these exceedances, in 1999, additional groundwater monitoring wells were installed around the landfill. Hydrogen-3 has been noted in several wells at the 800 Area Landfill. The 800 Area Landfill groundwater monitoring program is discussed in detail in Section 6.3.

ANL-E generates a large volume and variety of nonhazardous special wastes. Some otherwise special waste, such as sanitary sewage sludge, is certified to the IEPA as "nonspecial waste" pursuant to IEPA regulations. Table 2.10 gives the nonhazardous special and nonspecial wastes generated, stored, disposed of, or recycled during 2003. All nonhazardous special and nonspecial wastes generated at ANL-E in 2003 were disposed of at permitted off-site special waste landfills. The IEPA began requiring annual nonhazardous special waste reporting in 1991. The report is required to be submitted by February 1 of each year to describe the activity of the previous year. It is a summation of all manifested nonhazardous and polychlorinated biphenyl (PCB) wastes shipped out of state.

TABLE 2.10

Generation, Storage, Disposal, or Recycling of Special and Nonspecial Waste, 2003

Waste	Volume	Weight (lb)
Nonhazardous Special Waste Disposal		
Contaminated soil (remediation waste)	11,820 yd^3	23,640,000
Lime sludge	13,000 yd^3	26,000,000
Medical waste	168 ft^3	737
Nonhazardous liquid chemicals	2,460 gal	14,738
Nonhazardous solid chemicals	5,385 gal	19,376
Petroleum naptha[a] (parts washers)	839 gal	5,631
Used oil[a]	3,175 gal	22,880
Certified Nonspecial Waste Disposal		
Nonspecial fly ash	989 yd^3	835,705
Nonspecial laboratory sewage sludge	150 yd^3	300,000
Toxic Substances Control Act (TSCA) Special Waste Disposal		
Asbestos	310 yd^3	310,000
PCBs	400 gal	4,380
Materials Recycled		
Compressed gases[a]	20 gal	200
Fly ash[a]	2,415 gal	2,040,675
Sanitary sewage sludge[a]	72,000 gal	604,800
TSCA Mixed Waste Generated		
Radioactive PCB articles	5 gal	45
TSCA Mixed Waste in Storage		
Radioactive PCB sludge and debris	57 gal	505
Radioactive PCB articles	30 gal	270

[a] Recycled waste.

ANL-E also periodically generates radioactive waste containing other regulated materials. Table 2.10 lists the quantities of such waste stored on site or disposed of off site.

2.5. National Environmental Policy Act

The National Environmental Policy Act of 1969 (NEPA) established a national environmental policy that promotes consideration of environmental factors in federal or federally sponsored projects. NEPA requires that the environmental impacts of proposed actions with potentially significant effects be considered in an Environmental Assessment (EA) or Environmental Impact Statement (EIS). DOE has promulgated regulations in Title 10, Part 1021 of the *Code of Federal Regulations* (10 CFR Part 1021) that list classes of actions that ordinarily require those levels of documentation or that are categorically excluded from further NEPA review. No EISs were prepared during 2003. One EA was completed in 2003 for the enhanced operations at the APS, which includes the conduct of Biosafety Level-3 research, and construction and operation of the Center for Nanoscale Materials.

2.6. Safe Drinking Water Act

The Safe Drinking Water Act of 1974 (SDWA) established a program to ensure that public drinking water supplies are free of potentially harmful materials. This mandate is carried out through the institution of national drinking water quality standards, such as Maximum Contaminant Levels and Maximum Contaminant Level Goals, as well as through the imposition of wellhead protection requirements, monitoring requirements, treatment standards, and regulation of underground injection activities. The regulations implementing the SDWA in 40 CFR Parts 141–143 establish Primary and Secondary National Drinking Water Regulations that set forth requirements to protect human health (primary standards) and provide aesthetically acceptable water (secondary standards).

2.6.1. Applicability to ANL-E

In January 1997, ANL-E incorporated Lake Michigan water as its domestic source water, thereby replacing the dolomite groundwater that formerly constituted its source of drinking water. The Lake Michigan water is purchased from the DuPage County Water Commission. As such, ANL-E is now a customer rather than a supplier of water. Consequently, on January 23, 1997, the DuPage County Health Department (DPCHD) notified DOE that the federal and state monitoring requirements applicable to a “non-transient, non-community” public water supply were no longer applicable. Nevertheless, ANL-E voluntarily provides to on-site personnel the Consumer Confidence Report on drinking water quality that ANL-E receives as a customer of the DuPage County Water Commission. The report indicates that all measured contaminants meet the drinking water standards.

2.6.2. Water Supply Monitoring

During 2003, ANL-E continued an informational monitoring program at the previously used dolomite domestic wells; quarterly samples were analyzed for radionuclides and VOCs. No radionuclides or VOCs were detected.

2.7. Federal Insecticide, Fungicide, and Rodenticide Act

During 2003, all exterior pesticides and herbicides at ANL-E were applied by a licensed contractor who provides the chemicals used and removes any unused portions. ANL-E coordinates the contractor's activities and ensures that the chemicals are EPA-approved, that they are used properly, and that any unused residue is removed from the site by the contractor.

In addition, routine applications of pesticides are performed within buildings, as needed. Indoor pesticide applications are provided by Illinois Department of Public Health (IDPH)-licensed contractors under the direction of Plant Facilities and Services (PFS)-Custodial Services or on-site contractors, depending on the building involved. The indoor applications involve EPA "Restricted Use" products.

In 2003, approximately 12,160 L (3,200 gal) of commercial-grade herbicide was applied throughout the ANL-E site. Fertilizer with weed control is included in the quantity of herbicide. Also in 2003, ANL-E requested and received a Federal Insecticide, Fungicide, and Rodenticide Act establishment number for the Energy Systems Division. Work by this division in creating a product requires the establishment number as well as annual reporting up to completion of the work.

2.8. Comprehensive Environmental Response, Compensation, and Liability Act

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) addresses the cleanup of hazardous waste disposal sites and the response to hazardous substance spills. Under CERCLA, the EPA collects site data regarding sites subject to CERCLA action through generation of a Preliminary Assessment (PA) report, followed up by a Site Screening Investigation (SSI). Sites then are ranked, on the basis of the data collected, according to their potential for affecting human health or causing environmental damage. The sites with the highest rankings are placed on the National Priority List (NPL) and are subject to mandatory cleanup actions. No ANL-E sites are included in the NPL.

On December 21, 1999, the EPA published interim guidance redefining "Federally permitted releases" under CERCLA. This action may have a significant impact on ANL-E with respect to what types of air emissions will need to be reported under Section 101(10)(H) of CERCLA. The guidance provides an extremely narrow definition of how CERCLA substances released to the air would be exempted from reporting as a federally permitted release. To date, the EPA has announced it would hold implementation of the guidance in abeyance until the guidance is revised.

2.8.1. CERCLA Program at ANL-E

In early 1990, the EPA requested that DOE submit SSI reports for 6 of 13 ANL-E sites for which PA reports previously had been submitted. Upon further discussions between the EPA and DOE, one of the six sites was eliminated from consideration, and three adjacent units (317/319/East-Northeast [ENE]) were treated as a single site. As a result, three SSI reports were submitted to the EPA in January 1991. Table 2.11 lists the sites for which a PA report was submitted. As indicated in the table, these sites have either been cleaned up or have been closed.

2.8.2. CERCLA Remedial Actions

The sites described in the SSI reports (see Table 2.11) are included as SWMUs in the RCRA Part B Permit. The RCRA Part B Permit, effective November 4, 1997, contains procedures and requirements that govern the corrective action of these sites. Therefore, the remediation of the listed units that are also SWMUs either has been addressed or has occurred under the RCRA Program, not CERCLA. As of the end of 2003, corrective actions had been completed on all of the on-site units described in the CERCLA document, through the corrective action program, voluntary cleanup, or the RCRA closure process for permitted units. Section 3.1.1 of this report contains a discussion of the RCRA corrective actions program. The cleanup of the CP-5 reactor was completed as part of the ANL-E decontamination and decommissioning (D&D) program under the oversight of DOE.

2.8.3. Emergency Planning and Community Right to Know Act (Superfund Amendments and Reauthorization Act, Title III)

Title III of the 1986 Superfund Amendments and Reauthorization Act (SARA) amendments to CERCLA is the Emergency Planning and Community Right to Know Act (EPCRA), a free-standing provision. EPCRA requires providing federal, state, and local emergency planning authorities information regarding the presence and storage of hazardous substances and their planned and unplanned environmental releases, including providing response to emergency situations involving hazardous materials. Under EPCRA, ANL-E has been required to submit reports pursuant to Sections 302, 304, 311, 312, and 313, which are discussed below. Table 2.12 gives ANL-E’s status in regard to EPCRA.

Section 302 of SARA Title III, Planning Notification, addresses notifying and updating the Local Emergency Planning Committee (LEPC) and the State Emergency Response Commission (SERC) as to the presence of extremely hazardous substances (EHSs) at ANL-E, including laboratory usage, that exceed any EHS threshold planning quantity. The Section 302 information for 2003 was transmitted to the LEPC and SERC during June and December of 2003.

TABLE 2.11

List of Inactive Waste Disposal Sites at ANL-E
Described in Various CERCLA Reports

Site Name
On Current ANL-E Property
319 Area Landfill and French Drain[a,b,c]
800 Area Landfill and French Drain[a,b]
810 Area Paint Shop[d]
Compressed Gas Cylinder Disposal Area, 318 Area[a,b,c]
Decommissioned Reactor CP-5, Building 330[a,d]
French Drain, 317 Area[a,b,c]
Gasoline Spill, Gasoline Station[d]
Landfill East-Northeast of the 319 Area[a,b,c]
Liquid Waste Treatment Facility, Building 34[a,b]
Mixed Waste Storage, 317 Area[e]
Shock Treatment Facility, 317 Area[b]
Wastewater Holding Basin, Sewage Treatment Plant[a,b]

[a] RCRA SWMU; No Further Action (NFA) issued by the IEPA

[b] RCRA corrective action completed.

[c] Currently under long-term stewardship.

[d] Remediation completed.

[e] RCRA closure completed 2003.

TABLE 2.12

Status of EPCRA Reporting, 2003

EPCRA Section	Description of Reporting	Status
Section 302	Planning notification	Required
Section 304	EHS release notification	Not required in 2003
Section 311–312	Material Safety Data Sheet (MSDS) chemical inventory	Required
Section 313	Toxic Release Inventory (TRI) reporting	Required

Section 304 of SARA Title III, Extremely Hazardous Substances Release Notification, requires that the LEPC and state emergency management agencies be notified of accidental or unplanned releases of Section 302 hazardous substances to the environment. Also, the National Response Center is notified if a release exceeds the CERCLA Reportable Quantity for that particular hazardous substance. The procedures for notification are described in the ANL-E Comprehensive Emergency Management Plan. There were no incidents requiring notification during 2003.

Under SARA Title III, Section 311, Material Data Safety Sheet (MSDS)/Chemical Inventory, ANL-E is required to provide applicable emergency response agencies with MSDSs, or a list of MSDSs, for each hazardous chemical stored on site. The 2003 information was transmitted to the LEPC and the Illinois Emergency Management Agency during June and December of 2003.

Pursuant to EPCRA Section 312, ANL-E is required to report certain information regarding inventories and the locations of hazardous chemicals to state and local emergency authorities upon request. Petroleum products need to be reported. However, chemicals used in research laboratories under the direct supervision of a technically qualified individual are exempt from reporting. The report on Section 312 (Tier 2) information for 2003 was provided to DOE on February 24, 2004. Table 2.13 lists the hazardous chemicals reported.

Section 313 of SARA Title III, Toxic Release Inventory (TRI) Reporting, requires facilities to prepare an annual report entitled "Toxic Chemical Release Inventory, Form R" if annual usage of listed toxic chemicals exceed certain thresholds. ANL-E is not within the range of Standard Industrial Codes specified in the statute. ANL-E reports this information, however, because DOE, which is subject to Executive Order (EO) 13148, "Greening the Government

TABLE 2.13

ANL-E, SARA, Title III, Section 312, Chemical List, 2003

	Physical Hazard			Health Hazard	
Compound	Fire	Pressure	Reactivity	Acute	Chronic
Ethanol/gasoline	X	–[a]	–	X	–
Aluminum sulfate	–	–	–	X	–
Diesel fuel/heating oil	X	–	–	–	–
Gasoline	X	–	–	X	–
Mepiquat chloride	–	–	–	X	–
Mepiquat pentaborate	–	–	–	X	–
Optibor® boric acids	–	–	–	X	–
Sulfuric acid	–	–	–	X	–

[a] A dash indicates that the compound does not fall within the particular hazard class.

through Leadership in Environmental Management” (April 21, 2000), directs ANL-E to do so. No reports were filed from 1997 to 2000, because no listed chemicals usage exceeded reporting thresholds. However, new requirements regarding a class of TRI compounds called persistent, bioaccumulative toxics (PBTs) came into effect in 2000. As a result, ANL-E filed one report under Section 313 in 2003 for activities in 2002 for lead. Use of lead included machining of various types of lead articles in excess of the 45-kg (100-lb) reporting threshold.

2.9. Toxic Substances Control Act

The Toxic Substances Control Act (TSCA) was enacted to require chemical manufacturers and processors to develop adequate data on the health and environmental effects of their chemical substances. The EPA has promulgated regulations to implement the provisions of TSCA. These regulations are found in CFR Title 40, “Protection of the Environment, Chapter I: Environmental Protection Agency, Subchapter R - Toxic Substances Control Act.” These regulations provide specific authorizations and prohibitions on the manufacturing, processing, and distribution in commerce of designated chemicals. The principal impact of these regulations at the ANL-E site concerns the handling of asbestos and PCBs. Suspect PCB-containing items that are subject to this act are identified through the ANL-E PCB Item Inventory Program.

2.9.1. PCBs in Use at ANL-E

PCB items in use or in storage for reuse are tracked by the ANL-E PCB Item Inventory Program. All PCB items identified by the PCB Item Inventory Program have been labeled appropriately with a unique number for inventory and tracking purposes. These items are included in the ANL-E Annual PCB Report, which describes the location, quantity, manufacturer, and unique identification number for all PCBs on site. This report is not submitted to regulatory agencies but is kept on file at ANL-E. The Annual PCB Report for 2003 is to be completed by June 30, 2004. The PCBs in use at ANL-E are contained in capacitors and power supplies. Waste Management Operations (WMO) processes PCB-contaminated equipment and oil for disposal. The regulations governing the use and disposal of PCBs can be found in 40 CFR Part 761.

2.9.2. Disposal of PCBs

Disposal of PCBs from ANL-E operations includes materials lab-packed and bulked and aggregated solids shipped off site through WMO. This includes PCB-containing materials that also contain radioactive substances known as TSCA mixed waste. Table 2.10 contains the amount of PCBs and PCB-contaminated materials and TSCA mixed waste in storage and shipped by ANL-E during 2003.

Several years ago, contamination from historical PCB spills resulted in the generation of sludge contaminated by both PCBs and low-level radioactivity from the building retention tanks and holding tanks at the laboratory WTP. During 2003, no radioactive PCB-contaminated sludge and debris were shipped off site for disposal. Radioactive PCB-contaminated sludge, debris, or articles in storage totaled 333 L (87 gal).

2.10. Endangered Species Act

The Endangered Species Act of 1973 (ESA) is federal legislation designed to protect plant and animal resources from the adverse effects of development. To comply with the ESA, federal agencies are required to assess the area of a proposed project to determine whether it contains any threatened or endangered species, or critical habitat of such species.

At ANL-E, the applicable requirements of the ESA are identified and satisfied through the NEPA project review process. All proposed projects must provide a statement describing the potential impact to threatened or endangered species and critical habitat. This statement is included in the general Environmental Review Form. If the potential exists for an adverse impact, this impact will be assessed further and will be evaluated through consultation with the USFWS, and, if necessary, the preparation of a more detailed NEPA document, such as an EA or EIS. Where appropriate, this information is shared with affected state and federal stakeholders, so that potential adverse impacts are assessed fully and any steps to minimize these impacts can be identified.

No federal-listed threatened or endangered species are known to occur on the ANL-E site, and no critical habitat of federal-listed species exists on the site. Three federal-listed endangered species and one federal-listed threatened species are known to inhabit the Waterfall Glen Forest Preserve that surrounds the ANL-E property, or to occur elsewhere in the area.

The Hine's emerald dragonfly (*Somatochlora hineana*), federal and state listed as endangered, occurs in locations with calcareous seeps and wetlands along the Des Plaines River floodplain. Leafy prairie clover (*Dalea foliosa*), which is federally and state listed as endangered, is associated with dolomite prairie remnants of the Des Plaines River valley; two planted populations of this species occur in Waterfall Glen Forest Preserve. An unconfirmed capture of an Indiana bat (*Myotis sodalis*), which is federal and state listed as endangered, indicates that this species may occur in the area. The federal-listed threatened and state-listed endangered lakeside daisy (*Hymenoxys herbacea*) has a planted population in Waterfall Glen Forest Preserve.

Other federal-listed species could occur in the ANL-E area as extremely rare nonbreeders during migration or in winter. These include the bald eagle (*Haliaeetus leucocephalus*), federal and state-listed as threatened; piping plover (*Charadrius melodus*), federal and state-listed as endangered; and least tern (*Sterna antillarum*), federal and state-listed as endangered.

Although state-listed species that occur in the area are not covered by the ESA, the following state-listed species are evaluated in the NEPA process:

- Endangered
  - Black-crowned night heron (*Nycticorax nycticorax*)
  - Glade quillwort (*Isoetes butleri*)
  - Osprey (*Pandion haliaetus*)
  - Shadbush (*Amelanchier interior*)
  - Tuckerman's sedge (*Carex tuckermanii*)

- Threatened
  - Blanding's turtle (*Emydoidea blandingii*)
  - Brown creeper (*Certhia americana*)
  - Hill's thistle (*Cirsium hillii*)
  - Kirtland's snake (*Clonophis kirtlandii*)
  - Marsh speedwell (*Veronica scutellata*)
  - Pied-billed grebe (*Podilymbus podiceps*)
  - Red-shouldered hawk (*Buteo lineatus*)
  - River otter (*Lutra canadensis*)
  - Slender sandwort (*Arenaria patula*)
  - White lady's slipper (*Cypripedium candidum*)

Of these, Kirtland's snake, pied-billed grebe, black-crowned night heron, red-shouldered hawk, and brown creeper have been observed on ANL-E property. Impacts to these species also would be assessed during the NEPA process.

2.11. National Historic Preservation Act

The National Historic Preservation Act (NHPA) of 1966, as amended, requires federal agencies to assess the impact of proposed projects on historic or culturally important sites, structures, or objects within the sites of proposed projects. It further requires federal agencies to assess all archaeological sites, historic buildings, and objects on such sites to determine whether any qualify for inclusion in the NRHP. The act also requires federal agencies to consult with the State Historic Preservation Office (SHPO) and the Advisory Council on Historic Preservation, as appropriate, when determining if proposed actions would adversely affect properties that are eligible for listing on the NRHP.

The NHPA is implemented at ANL-E through the NEPA review process, as well as through the ANL-E digging permit process. All proposed actions must consider the potential impact to historic or culturally important properties or artifacts and document this consideration on the Environmental Review Form. Prior to disturbing the soil, an ANL-E digging permit must be obtained from the PFS Division. This permit must be signed by the designated permit reviewer after verifying the location of nearby archaeological sites and documenting the fact that no significant cultural resources would be affected. If the proposed site has not been surveyed for the presence of historic properties, a cultural resources survey is conducted by qualified personnel, and any artifacts found are documented and carefully removed. At ANL-E, DOE consults with the Illinois SHPO through the Illinois Historic Preservation Agency (IHPA) and the Advisory Council on Historic Preservation, as appropriate, if proposed actions would adversely affect properties eligible for listing on the NRHP.

In fall 2001, DOE entered into a programmatic agreement with the IHPA and the Advisory Council on Historic Preservation for management of cultural resources at ANL-E. This agreement streamlines compliance with the NHPA by allowing standard mitigation measures and by excluding from Section 106 review certain categories of activities that are unlikely to adversely affect historic structures.

Work on a Cultural Resources Management Plan (CRMP) that will replace the programmatic agreement is continuing. A draft for public review is expected in 2004.

Cultural resources include both historic structures and archaeological sites. Phase I archaeological surveys have been completed for the entire ANL-E facility, and 46 archaeological sites have been recorded. Four of the sites are eligible for the NRHP. Twenty-one sites have been determined to be ineligible, and 21 recorded sites have not yet been formally evaluated for eligibility. An excavation was conducted in August 2003 north of the APS ring to reevaluate the eligibility of a farmstead site.

In fall 2001, ANL-E completed a two-phased Sitewide Historic Property Inventory. The historic context portions of this inventory add significantly to the nuclear energy and nuclear science portions of the DOE Cold War story. On the basis of inventory reports, DOE determined that two areas — the Main Campus District and the Freund Estate District — are eligible for listing on the NRHP as historic districts and that seven buildings are individually eligible for listing on the NRHP. In addition to the special facilities that were identifed as part of the D&D program, including the reactors CP-5, Argonne Thermal Source Reactor (ATSR) (removed), Experimental Boiling Water Reactor (EBWR) (removed), and Zero Power Reactors (ZPRs) VI and IX, the survey also identified the Alpha-Gamma Hot Cell (AGHC) and High-Voltage Electron Microscopy (HVEM) microscope.

The Main Campus District includes six scientific buildings: Buildings 200, 202, 203, 205, 206, and 211. These buildings were identified on the basis of their contribution in association with advancements in nuclear research and the development of nuclear power reactors (Criterion A), and for their engineering and design value as a unique specialized and cohesive scientific facility (Criterion C). The Freund Estate district includes five facilities: the former Freund Lodge (Building 600), the pool (603), bathhouse (604), pavilion (606), and tennis courts (616). All are eligible for listing under Criterion B, on the basis of their association with an important local personality, Erwin O. Freund.

Buildings 200 (M-Wing), 203, 205, 212, 350, and Buildings 315/316 of the 314/315/316 complex are the seven buildings that are eligible for individual listing. In addition to these seven active ANL-E facilities, three other buildings — Buildings 301, 330, and 331 — were found to be eligible, but subsequently have been mitigated by recordation for disposal.

Building 203 is significant because of its association with a Nobel Prize winner, Maria Goeppert-Mayer. In January 2002, the IHPA concurred with the results of the sitewide survey regarding the eligible districts and facilities. ANL-E is developing management plans to augment the procedural mechanisms identified in the programmatic agreement and CRMP.

In fiscal year (FY) 2003, an archaeological survey was conducted on a 10.7-ha (26.4-acre) parcel on the northwest corner of Eastwood Extension Drive and Outer Circle Drive as part of the environmental review for a new facility. No archaeological remains were identified during the survey. Also in FY 2003, Phase II excavations were conducted at Site 11-Du-201, the remains of a mid-nineteenth century farmstead that was determined eligible for the NRHP. The purpose of the excavations was to identify the nature and age of the archaeological deposits at site 11-Du-201, which will aid in managing the site, given that it is adjacent to a wetland mitigation project. The results of the excavations will be presented in a report to be completed in 2004.

In December 2003, a Phase I survey was conducted on a 7-ha (18-acre) parcel located east of the North Gate entrance to ANL-E and north of 94th Street. This survey was conducted as part of the NEPA review for a planned computer facility. The survey identified historic remains that date to the early twentieth century. No evidence of prehistoric use of this area was encountered.

2.12. Floodplain Management

Federal policy on managing floodplains is contained in EO 11988, “Floodplain Management” (May 24, 1977). In addition, 10 CFR Part 1022 describes DOE’s implementation of this Executive Order. The Executive Order requires federal facilities to avoid, to the extent possible, adverse impacts associated with the occupancy and modifications of floodplains. To construct a project in a floodplain, DOE must demonstrate that there is no reasonable alternative to the floodplain location.

The ANL-E site is located approximately 46 m (150 ft) above the nearest large body of water (Des Plaines River); thus, it is not subject to major flooding. The 100- and 500-year floodplains are limited to low-lying areas near Sawmill Creek, Freund Brook, Wards Creek, and other small streams and associated wetlands and low-lying areas. No significant structures are located in the areas. To ensure that these areas are not adversely affected, new facility construction is not permitted within these areas, unless there is no practical alternative. Any impacts to floodplains would be fully assessed in a floodplain assessment, and, as appropriate, documented in the NEPA documents prepared for a proposed project.

2.13. Protection of Wetlands

Federal policy on wetland protection is contained in EO 11990, “Protection of Wetlands” (May 24, 1977). In addition, 10 CFR Part 1022 describes DOE’s implementation of this EO. The EO requires federal agencies to identify potential impacts to wetlands resulting from proposed activities and to minimize these impacts. Where impacts cannot be avoided, mitigating action must be taken by repairing the damage or replacing the wetlands with an equal or greater amount of a man-made wetland as much like the original wetland as possible.

Section 404 of the CWA establishes a program to regulate the discharge of dredged and fill material into waters of the United States, including wetlands. The COE administers this program. Activities regulated under this program include disturbance of wetlands for development projects, infrastructure improvements, and conversion of wetlands to uplands for farming and forestry. The COE uses a permit system to identify and enforce wetland mitigation efforts.

ANL-E completed a sitewide wetland delineation in 1993. All wetlands present on site were identified and mapped following the 1987 U.S. Army *Corps of Engineers Wetlands Delineation Manual*.[3] The delineation map shows the areal extent of all wetlands present at ANL-E down to 500 m^2 (1/8th acre). Thirty-five individual wetland areas were identified; their total area is approximately 20 ha (50 acres).

In February 1989, the COE issued a permit to DOE under Section 404 of the CWA, addressing the construction of the APS facility at ANL-E. The permit was required because construction of the APS involved the filling of three small wetland areas, known as Wetlands A, B, and E, which totaled 0.7 ha (1.8 acres) in size. Issuance of the permit was contingent upon approval of a mitigation plan submitted to the COE by DOE. The plan outlined procedures for the construction of a new wetland area, Wetland R, and also identified actions to be taken to avoid impacts to a fourth wetland, Wetland C, just under 0.4 ha (1 acre), during APS construction activities.

During October 1996, the COE inspected Wetlands C and R and determined that they were no longer being managed in accordance with the original APS construction permit. The deficiencies noted were excessively dry soil conditions in Wetland C, caused by altered hydrology, and a poor quality biological community in Wetland R. In response to this finding, ANL-E prepared a management plan for Wetland R in January 1997 and began investigating the cause of the problems with Wetland C. The COE verbally agreed with these response actions. Implementation of the plan began in 1997.

Mitigative actions for Wetland R, as described in the 1997 management plan, involved improving the mix of vegetation through controlled burns, herbicide application, and planting of desirable plants. Controlled burns were completed in 1997, March 2000, March 2001, and April 2002. In 2003, herbicide activities continued to control invasive species at Wetland R.

In 1998, the restoration of Wetland C, just under 0.4 ha (1 acre), was begun. In April 2000, the existing wetland was assessed to determine the current status and to identify alternate means of mitigating any damage incurred. This assessment determined that this area no longer meets the criteria for a wetland by virtue of the lack of appropriate hydrological conditions. The conditions no longer existed to maintain enough water in the soil to support a wetland ecology. In response to this finding, a mitigation plan for Wetland C was prepared and submitted to the COE. This plan recommended mitigating the loss of Wetland C by developing an equivalent area of wetland in a location more conducive to the proper conditions required to sustain a wetland ecology. The proposed location is several hundred feet north of the APS facility, adjacent to a large natural wetland area. The wetland restoration could result in up to an additional 2 ha (6 acres) of wetland. The COE approved this mitigation plan on November 21, 2001. Planting of native species and herbicide application began in 2000, and controlled burns were completed in 2001. An EA was completed in September 2001 for wetland management activities. This EA encompasses the Wetland C restoration and management activities. In 2002, the drain tiles were removed from the mitigation wetland to restore groundwater. The area was extensively treated with herbicide. In 2003, the mitigation wetland was again treated with herbicide.

2.14. Wildlife Management and Related Monitoring

DOE manages the numbers of white-tailed and fallow deer at the site through an interagency agreement with the U.S. Department of Agriculture. DOE began the deer management program in 1995 to alleviate traffic safety hazards and ecological damage caused by extremely high deer densities. More than 600 deer were removed in the winter of 1995 to 1996, and more than 80 deer were removed the following winter to achieve target densities of 20 deer/mi^2 for each species. Smaller numbers of deer have been removed each year since 1997.

DOE lowered its target density for white-tailed deer to 15 deer/mi^2 in 2001 to better achieve its objectives of reducing deer and vehicle collisions, allowing oak trees to regenerate, and allowing deer-sensitive herbaceous species to recover.

DOE and the Forest Preserve District of DuPage County coordinate deer management efforts in order to preserve and enhance biodiversity at ANL-E and the surrounding Waterfall Glen Forest Preserve.

2.14.1. Deer Population Monitoring

The deer population is monitored frequently by spotlight survey to meet the requirements of Deer Population Control Permits and to aid in making deer management decisions. Twenty-four white-tailed deer were removed in the fall of 2003 to maintain the target density of 15 deer/mi^2. No fallow deer were removed in 2003.

2.14.2. Deer Health Monitoring

The health of the white-tailed deer herd is evaluated by assessing the deer that are removed each year for mean live and dressed weights and the amounts of fat stored in various organs. The health of the white-tailed deer herd has been improving since the deer management program began in 1995.

2.14.3. Deer Tissue Monitoring

Samples taken from the muscles of deer are analyzed periodically for radionuclides to verify that deer meat donated to charity does not pose a radiological health hazard. Samples sent to the IDNS radiochemistry laboratory in November 2000 were analyzed for gamma-ray-emitting radionuclides and hydrogen-3. Naturally occurring potassium-40 (at background levels) was the only gamma-ray-emitting radionuclide identified. Hydrogen-3 was not detected in any sample. No samples were collected in 2001, 2002, or 2003.

2.14.4. Vegetation Damage

Woodland vegetation is monitored periodically to determine the effects of browsing by deer on woody vegetation and to assess forest health. This monitoring is conducted to meet conditions of Deer Population Control Permits and to help make deer and habitat management decisions. DOE changed its vegetation monitoring protocol in the fall of 2000 to better gauge overall forest health. The new protocol is an adapted form of the Illinois Forest Watch Monitoring Manual issued by the Illinois Department of Natural Resources. It calls for fall surveys of woody vegetation and spring surveys of herbaceous vegetation and tree seedlings. Data collected in two sampling plots in 2000, 2001, 2002, and 2003 indicate that oak trees do not appear to be regenerating at ANL-E.

2.15. Current Issues and Actions

The purpose of this section is to summarize the most important issues related to environmental protection encountered during 2003. Table 2.14 lists all water effluent exceedances reported during 2003. Exceedances of the NPDES wastewater discharge limits and Ground Water Quality Standards at the 800 Area Landfill Area are discussed in Chapters 5 and 6, respectively.

TABLE 2.14

Summary of 2003 Water Effluent Exceedances

Date	Outfall	Parameter	Assessment
02/11/03	001A	BOD_5	Cause undetermined
03/18/03	001	TDS	Salt usage associated with snowmelt
07/15/03	001B	TSS	Reduced clarifier retention time due to excessive precipitation

2.15.1. Clean Water Act — NPDES

As in previous years, ANL-E occasionally exceeded NPDES permit limits in 2003. In past years, the TDS concentration was the most persistent exceedance of the NPDES permit limits. The limit for TDS was exceeded only one time at Outfall 001 (the WTP discharge point). Boiler house blowdown and road salt runoff contribute to high TDS concentrations at Outfall 001 in the winter. The boiler house equalization pond collects runoff from salted roads in the boiler house area. To reduce winter concentrations of TDS, in 2002, ANL-E connected the boiler house equalization pond to the DuPage County sewer so that up to 227,125 L/d (60,000 gal/d) of equalization pond water can be diverted from the WTP to the county sewer during the heating season. The continued reduction in TDS exceedances at Outfall 001 appears to indicate that the redirection of the equalization pond wastewater is working to reduce TDS concentrations.

Multiple exceedances of total residual chlorine (TRC) at Outfall 007 in November and December of 2002 were considered to constitute a significant violation under the applicable regulations. ANL-E identified and eliminated the source of the chlorine following the exceedances, and in early 2003, submitted to the IEPA both the required verbal reports and a final written report.

ANL-E has had occasional positive toxicity test results at several outfalls. These appear to be due to residual chlorine from discharge of chlorinated drinking water into these outfalls and from cooling tower blowdown that may contain antifouling agents. Many of these discharges have been redirected into the sewer system to be processed at the WTP.

2.15.2. Solid Waste Disposal

The IEPA-approved 800 Area Landfill groundwater monitoring program continues to indicate that the Ground Water Quality Standards of some inorganic parameters consistently are being exceeded in several wells. The 1999 expansion of the groundwater monitoring well network is providing additional information about the nature of these exceedances. Additional information about the source and extent of these exceedances is needed before a plan of action to resolve the issue can be formulated. Hydrogen-3 concentrations in the 800 Area Landfill wells for the past five years were evaluated. Most concentrations were below the hydrogen-3 detection limit; a few wells, however, contained hydrogen-3 levels just above the detection limits, primarily in the south and southeast direction from the landfill. Hydrogen-3 concentrations in wells on the west and north side of the landfill were below the detection limit on all of the samples reviewed. On the basis of historical analytical data from the perimeter monitoring wells, it appears that any potential for hydrogen-3 to migrate to the northwest and west and impact the water supplies of residents in those directions is extremely low. The groundwater monitoring program is discussed in detail in Section 6.3.

2.15.3. Remedial Actions

Remediation of waste management units was completed in 2003. During 2003, ANL-E initiated the process for transition from active remediation to long-term operation, maintenance, and monitoring of these sites. These activities are described in detail in Section 3.1.1.

2.16. Environmental Permits

Table 2.15 lists all the environmental permits in effect at the end of 2003. Other portions of this chapter discuss special requirements of these permits and compliance with those requirements.

TABLE 2.15

ANL-E Environmental Permits in Effect December 31, 2003

Type	Subject of Permit	Site Location	Issued	Expiration Date
Air	Title V-ANL-E	Sitewide	04/03/01	04/03/06
Air	Open-Burning Permit - Fire Dept.[a]	333	04/18/03	04/18/04
Air	Open Burning - Vegetation	Sitewide	01/29/03	01/29/04
Hazardous Waste	RCRA Part B	Sitewide	09/30/97	11/04/07
Miscellaneous	Deer Population Control Permit	Sitewide	11/17/03	02/14/04
Miscellaneous	Nuisance Wildlife Control	Sitewide	01/31/03	01/31/04
Solid Waste	Landfill	800 Area	03/31/82	–[b]
Solid Waste	Landfill	800 Area	03/30/89	–
Solid Waste	Landfill	800 Area	04/12/89	–
Solid Waste	Landfill Groundwater Assessment	800 Area	09/30/91	–
Solid Waste	Landfill Leachate Characterization	800 Area	09/30/91	–
Solid Waste	Landfill Leachate Test Wells	800 Area	08/31/90	–
Solid Waste	Landfill Revised Closure Plan[c]	800 Area	04/24/92	–
Solid Waste	Landfill Supplemental Closure Plan	800 Area	09/15/92	–
Solid Waste	Landfill Supplemental Permit Groundwater	800 Area	04/19/94	–
Solid Waste	Landfill Supplemental Permit Groundwater	800 Area	01/11/95	–
Solid Waste	Landfill Supplemental Permit Groundwater	800 Area	11/20/97	–
Solid Waste	Landfill Supplemental Permit Groundwater	800 Area	08/25/98	–
Solid Waste	Landfill Supplemental Permit Groundwater	800 Area	06/16/99	–
Solid Waste	Landfill Supplemental Permit Groundwater	800 Area	04/25/00	–
Solid Waste	Landfill Supplemental Permit Landfill Gas	800 Area	10/01/02	–
Water	Discharge to DuPage County Public Works	100 Area	08/10/01	–
Water	Lime Sludge Application - Land Application	Sitewide	10/01/02	09/30/07
Water	NPDES Permitted Outfalls	Sitewide	10/31/94	–[d]

[a] This unit has been designated as an insignificant source in the ANL-E Title V Permit.

[b] A dash indicates that these permits have been superseded by the RCRA Part B Permit.

[c] Includes gas monitoring program.

[d] The existing permit continues to be in effect while the revised permit application is undergoing IEPA review.

3. ENVIRONMENTAL PROGRAM INFORMATION

3.1 Major Environmental Programs

DOE and ANL-E policies require that all operations be conducted in compliance with applicable environmental statutes, regulations, and standards, and that environmental obligations be carried out consistently across all operations and organizations. Protection of the environment and human health and safety are given high priority. A number of programs and organizations exist at ANL-E to ensure compliance with these authorities and to monitor and minimize the impact of ANL-E operations on the environment.

The ERP was designed to achieve compliance with all applicable environmental requirements related to assessing and cleaning up releases of hazardous materials from inactive waste sites. The corrective action portion of the RCRA Part B Permit provides the primary regulatory vehicle, although several voluntary cleanup projects are included in the program. This program was completed on September 30, 2003. However, seven SWMUs could not be remediated to free release status (No Further Action [NFA]) and were transitioned to the ANL-E Long-Term Stewardship (LTS) program.

3.1.1. Remedial Actions Progress in 2003

In 2003, ANL-E completed all the remaining planned remedial actions at the site. The plan is described in a document entitled *Environmental Restoration Program (EM-40) Baseline for Argonne National Laboratory-East*[4] that was completed in early 1999.

As of the end of FY 2003, the remediation work on all units listed in the RCRA Part B Permit — 49 SWMUs and 6 Areas of Concern (AOCs) — was completed, as well as three voluntary cleanup projects. ANL-E has received final acknowledgment from the IEPA of either an NFA or No Further Remediation (NFR) (for long-term operation and maintenance [O&M] sites) on 50 sites.

On August 22, 2003, the DOE entered into a Land Use Control Memorandum of Agreement (LUCMOA) with the IEPA. The agreement applies to SWMUs and AOCs where land use controls are necessary to ensure the protection of human health and the environment. There are 5 SWMUs and 2 AOCs covered under the LUCMOA. In December, the DOE conducted an inspection of the seven units and determined that the ANL-E monitoring controls were operating as required by the RCRA Part B Permit.

In FY 2003, the ERP took action on 11 sites. Assessment or design work was completed for 3, final cleanup field work was completed for 3, and continuing remediation activities were conducted for 1 (the lime sludge project). Reports were submitted to the IEPA requesting NFA for six of these sites.

Table 3.1 lists each of the release sites worked on during the fiscal year, the scope of the work, whether or not the work resulted in a request to the IEPA for NFA, and whether the SWMU/AOC is covered under the LUCMOA.

TABLE 3.1

Status of Release Sites, 2003

Site Name	Site Number	FY 2003 Work Scope	NFA Requested in FY 2003	Included in LUCMOA
Newly Identified Suspected Solid Waste Landfill	SWMU No. 744	ANL-E conducted Tier 2 evaluation of the groundwater data and prepared a Land Use Control document.	Yes	Yes
317 Area French Drain	SWMU No. 11	Prepared a Work Plan for extending the phytoremediation system. The enhancements were completed and a report submitted to the IEPA.	No	Yes
Freund Ponds	SWMU No. 7	Prepared Land Use Control document.	No	Yes
Lime Sludge Pond	Former SWMU No. 8	Removed an additional 19,114 m^3 (25,000 yd^3) of lime sludge from the lagoon.	No	No
570 Area - Unlined Holding Basin	SWMU No. 133	Implemented Construction Work Plan. Completed remediation field work and submitted a construction report requesting NFA.	No	No
ENE Landfill	SWMU No. 19	Prepared Land Use Control document.	Yes	Yes
Contaminated Soil near Former Building 24	AOC-F	Prepared Land Use Control document.	Yes	Yes
Sediment near ENE Landfill	AOC-I	Conducted sediment characterization and submitted report to the IEPA. Prepared Land Use Control document.	Yes	Yes
Bldg. 330 Yard with Mixed Materials for Decommissioning	SWMU No. 151	Prepared supplemental groundwater investigation report and submitted it to the IEPA with request for NFA.	Yes	No
320 Area Shooting Range	SWMU No. 498	Prepared Construction Report and submitted it to the IEPA with a request for NFA.	Yes	No

As part of an ongoing effort to improve the efficacy of the long-term remedial actions within the 300 Area, specifically the 317 and 319 Areas of the site, the ERP staff conducted enhancements in the 317/319 Area. The phytoremediation system was expanded by planting 144 new trees. The 317 Area French Drain was regraded and covered with an impermeable fabric to promote the drainage of precipitation away from the French Drain area. This will also serve to encourage the roots of the trees to grow downward to the contaminated soil.

Routine operations and monitoring of the two groundwater extraction systems south of the 317 and 319 Areas were carried out. Monitoring of these systems shows that they are operating as intended by preventing contaminated groundwater from leaving the site.

3.1.2. Environmental Monitoring Program Description

As required by DOE Orders 450.1[1], 231.1A,[2] and permit requirements, ANL-E conducts a routine environmental monitoring program. This program is designed to determine the effect of ANL-E operations on the environment surrounding the site. This section describes this monitoring program. In 2003, a total of 2,227 samples were collected and 28,800 analyses were performed. A general description of the rationale for sampling for each media is presented. Greater detail is provided in the ANL-E Environmental Monitoring Plan.

3.1.2.1. Air Sampling

ANL-E conducts an air monitoring program for conventional and radioactive pollutants to assess the impact of ANL-E operations on the environment and the public health. Air monitoring is necessary since the NESHAPs radiological inventory indicates that sufficient material is used in laboratory hood applications that a potential exists for releases. Monitoring also is conducted to estimate radiological releases that could occur if the high-efficiency particulate air (HEPA) filters failed. In addition, several major facilities have radiological airborne emissions because of the nature of the operation. Examples of these emissions are air activation products from the APS and IPNS and hydrogen-3 from the Alpha Gamma Hot Cell Facility. The air monitoring program consists of effluent monitoring and environmental surveillance of airborne contaminants. Effluent monitoring primarily includes continuous monitoring of airborne effluents (radionuclides and conventional pollutants) from stacks. Environmental surveillance includes continuous direct collection of airborne pollutants on filters at selected stations located around the perimeter of ANL-E, and off-site analysis of the collected particulate matter for radionuclides.

3.1.2.2. Water Sampling

Water samples are collected to determine what, if any, radionuclides or selected hazardous chemicals used or generated at ANL-E enter the environment by the water pathway. Surface water samples are collected from 28 NPDES outfalls and from Sawmill Creek below the point at which ANL-E discharges its treated wastewater. The results of radiological analysis of water samples at these locations are compared with upstream and off-site results to determine the ANL-E contribution. The results of the chemical analyses are compared with the applicable IEPA stream quality standards to determine whether the site is degrading the quality of the creek. These results are discussed in detail in Chapters 4 and 5.

Surface water samples are collected from Sawmill Creek and combined into a single weekly composite sample. A continuous sampling device has been installed at this location to improve sample collection representativeness. To provide control samples, Sawmill Creek is sampled upstream of ANL-E once a month. The Des Plaines River is sampled twice a month below, and monthly above, the mouth of Sawmill Creek to determine whether radionuclides in the creek are detectable in the river.

In addition to surface water, subsurface water samples also are collected at 53 locations. These samples are collected quarterly from monitoring wells located near areas that have the potential for adversely impacting groundwater. These areas are the 800 Area Landfill, the 317/319 waste management area, the ENE Landfill, the 570 Area, and the site of the inactive CP-5 reactor. The monitoring wells are purged, and samples are collected from the recharged well water. These samples are analyzed for both chemical and radiological constituents, as discussed in Chapter 6. Samples from the three on-site wells that formerly provided domestic water also are collected and analyzed for hazardous and radioactive constituents. Samples are collected quarterly from the wellheads of the three ANL-E wells that formerly provided the domestic water supply. The water is pumped to the surface and collected in appropriate containers, depending on the required analysis. The ANL-E groundwater monitoring program is summarized in Table 3.2.

At the time of sample collection for radiological analysis, the sampling location, time, date, and collector identification number are recorded on a label attached to the sample container. Upon return to the laboratory, the information is transferred to the Environmental Protection Data Management System (EPDMS). Each sample is assigned a unique number that

TABLE 3.2

Summary of Groundwater Monitoring Program by Area, 2003[a]

	ANL-E Site	East Area	317/319 Area	800 Area
Number of wells	87	38	179	73
Wells monitored	4	13	56	28
Sampling events	16	52	224	112
Analyses	122	66	674	1,344
Results	1,040	263	4,533	8,540
% Nondetects	97	90	91	82

[a] Because of program integration, the wells monitored, sampling events, analyses, results, and nondetectable results overlap among monitoring purposes.

accompanies it through all analyses. After the sample has been logged in, an aliquot is removed for hydrogen-3 analysis. Appropriate aliquots are then taken, depending on the analysis.

For nonradiological analysis, samples are collected and preserved using EPA-prescribed procedures. Specific collection procedures are used for other components, as well as EPA methods. All samples are analyzed within the required holding period, or noncompliance is documented. The quality control requirements of either SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods*,[5] or the Contract Laboratory Program (CLP) must be met, or deviations must be documented. Each sample is assigned a unique number that serves as a reference source. When duplicate samples are obtained, unique numbers are assigned, and an indication that duplicates exist is entered in the data management system.

3.1.2.3. Bottom Sediment

Bottom sediment accumulates small amounts of radionuclides that may be present from time to time in a stream and, as a result, acts as an accumulator of the radionuclides that are present in the water. The sediment provides evidence of radionuclides in the surface water system. These samples are not routinely analyzed for chemical constituents. Bottom sediment samples are collected annually from Sawmill Creek above, at, and from several locations below the point at which ANL-E discharges its treated wastewater. Sediment is collected from each location with a stainless-steel scoop and is transferred to a glass bottle.

At the time of sample collection, the date, time, and sample collector identification are recorded on sample labels affixed to the sample container. Upon return to the laboratory, the information is transferred to the EPDMS. Each sample is assigned a unique number that accompanies it through the process.

3.1.2.4. External Penetrating Radiation

Measurements of direct penetrating gamma radiation emanating from several sources within ANL-E are taken by using aluminum oxide thermoluminescent dosimeters (TLDs) provided by a commercial vendor. Each measurement is the average of two chips exposed in the same packet. Dosimeters are exposed at 17 locations at the site perimeter and on site, and at 5 off-site locations. All dosimeters are changed quarterly. At the time of dosimeter collection, the date, time, and collector identification number are recorded on a preprinted label affixed to the container. Each sample is assigned a unique number that accompanies it through the process. After completion of the exposure period, the TLDs are mailed to the vendor for reading. When the dose information is provided by the vendor, it is entered into the EPDMS.

A fast neutron monitoring program was established in 2002 to determine if any neutron dose was measurable in the vicinity of facilities that had the potential to produce fast neutrons. Four environmental neutron dosimeters were placed at locations around the IPNS facility that were most likely to result in neutron dose; a second set of four dosimeters was placed around the ATLAS facility. A dosimeter was placed off site to monitor background neutron doses in an area unaffected by ANL-E operations. The neutron dosimeters are changed quarterly and mailed to the vendor for reading. The results are entered into the EPDMS upon receipt.

3.1.2.5. Data Management

ANL-E manages the large amount of data assembled in the environmental monitoring program in a structured manner that allows a number of reports to be generated. Basic data management, including sample record keeping, is implemented with the EPDMS computerized record-keeping system. All sample and analytical data are maintained in the EPDMS for eventual output in formats required for either regulatory compliance reports or for annual reports. In addition, reports are provided for trend analysis, statistical analysis, and tracking.

The ANL-E–developed EPDMS is the basic data management tool; it generates sampling schedules, all other tracking and calculation routines, and the final analytical result tabulations. The EPDMS supports the radiological and nonradiological sample scheduling and data collection portions of the monitoring program.

The starting point for effluent monitoring and environmental surveillance is establishing a set of sampling locations and a sample schedule. On the basis of regulatory parameters, pathway analysis, or professional judgment, sample locations for the various media are identified and entered into the EPDMS. For each sample location, nine categories of data are entered into the EPDMS: geographic code, location description, sampling frequency, sample type, exact sampling position, last date sampled, sampling priority (same location with multiple samples), size of sample to collect, and analytes.

Once the data are entered, the EPDMS is used to generate a sampling schedule. Every week a schedule for the next week is printed out, along with uniquely numbered preprinted labels for the sample containers. These items are provided to the staff who conduct the sampling in the field. Field data are entered into the EPDMS. At the time the samples are submitted to the analytical laboratory, chain of custody documents are generated. The EPDMS distributes sample data electronically (via diskette) to the EQO-AS data management system and accepts back the analytical data (via diskette or e-mail).

As the laboratory results are compiled, the data are entered into the EPDMS. This permits up-to-date tracking of all samples currently in process. When the analysis for each sample is completed and the results electronically entered into the EPDMS, the completed final results sample card is retained in a file as an additional quality assurance (QA) measure.

Complete data sets for all samples are maintained by the EPDMS. When all results have been completed and entered into the EPDMS, a final result card is generated that lists all data related to each sample. The electronic files are backed up by the computer network server. The printed final result card is filed after review, then ultimately placed in DOE’s archives in Chicago. Final results are thus available both on line via the network and in hard copy.

3.1.3. Waste Minimization and Pollution Prevention

During 2003, ANL-E continued to enhance its pollution prevention and waste minimization efforts. ANL-E continues to develop and implement a comprehensive sitewide Pollution Prevention (P2) Program in accordance with local, state, federal, DOE, and site-specific P2 regulations and requirements. The P2 Program performs tracking and trending of waste and pollution at ANL-E, and monitors the progress with regard to DOE P2/Energy Efficiency (E2) Goals and Performance Measures. ANL-E continues to maintain waste generation rates below the levels established by the DOE P2 and E2 Leadership Goals.

ANL-E management continues to foster a work environment that promotes the development and implementation of P2 activities. ANL-E management has instituted a P2 Policy Statement and a requirement that all new project reviews include the use of a P2 Review Checklist. In addition, ANL-E has used the Integrated Safety Management (ISM) System to promote and institutionalize P2 strategies across the ANL-E site.

ANL-E won a 2003 DOE Pollution Prevention Award in the category of Model Facility Demonstration/Complex-Wide Achievement. This award recognizes the efforts and accomplishments of the overall ANL-E P2 Program and activities. ANL-E also won the 2003 Illinois Governor’s Award for Continuous Improvement for Pollution Prevention.

3.1.3.1. P2 Assessments and Reviews

Historically, the ANL-E P2 Program has identified, developed, and performed Pollution Prevention Opportunity Assessments (PPOAs) and Process Waste Assessments (PWAs). During FY 2003, the following PWAs were performed:

- Electronic Equipment Recycling Pilot Program,
- Aqueous Parts Washing in Vehicle Maintenance,
- Battery Recycling Program,
- Desktop Printer Cartridge Recycling, and
- Native Plants for Landscaping.

The Electronic Equipment Recycling Pilot Program between ANL-E and Fermi National Accelerator Laboratory was initiated in September 2003. During the three months of this pilot program, ANL-E shipped more than 11,611 kg (25,600 lb) of excess electronic material to Fermilab. Transferring this material generated a cost savings for ANL-E of approximately $5,000 during the 90-day pilot period. On the basis of this initial success, the program has been continued on a permanent basis.

During 2003, the Battery Recycling Program was expanded into the majority of buildings at ANL-E. This program continues to divert routinely used batteries, approximately 363 kg (800 lb) per year, from the waste stream.

The P2 Program continued to monitor the courtyards that were landscaped with native plants. The information will be utilized by the Land Management and Habitat Restoration Committee to determine whether it is cost-efficient to use native plants in additional landscaping activities throughout the ANL-E site.

3.1.3.2. Waste Reduction and Recycling

ANL-E's comprehensive solid waste recycling program effectively recycles/reduces the following waste/materials: surplus laboratory chemicals, mixed office paper, cardboard, aluminum, glass, plastics, metals, toner cartridges, construction and demolition debris, fly ash, coal fines, sanitary waste sludge, lead, lead acid batteries, transparencies, fluorescent lightbulbs, computers, and electronic equipment. ANL-E annually maintains sanitary waste levels below the 2005 DOE P2 target goals and recycles materials at levels beyond the established goal of 45%. During FY 2003, ANL-E recycled 80% of sanitary waste from all operations. Since 1996, ANL-E has recycled approximately 87,000 t (95,000 tons) of materials, generating cost savings estimated at about $4.0 million.

ANL-E has consistently generated routine LLW, mixed waste, and hazardous waste at levels below the 2005 DOE P2 target goal. ANL-E aggressively tracks, reviews, and assesses (by using PPOA and PWA) the hazardous and radioactive waste streams in an effort to identify alternatives to disposal (e.g., segregation, treatment, reuse, recycling, etc.) for these materials/wastes.

ANL-E continues to utilize programs, such as the Argonne Chemical Exchange System and the Surplus Office Supply Exchange, that allow employees and contractors to minimize waste and reuse available materials. ANL-E expanded this reuse opportunity with the development of the Argonne Equipment and Materials Exchange (AEM-X). The AEM-X program was developed to assist ANL-E employees to recycle and reuse surplus equipment, supplies, and materials by promoting the availability or need of items via the ANL-E e-mail system.

During 2003, a qualified vendor was secured to recycle/reuse coal combustion fly ash from the boiler house. More than 500 t (551 tons) of fly ash was recycled.

3.1.3.3. Affirmative Procurement Program

ANL-E's commitment to environmental quality, as demonstrated by the purchasing of environmentally preferable products, has resulted in an award-winning Affirmative Procurement Program. These efforts have made it easier for employees to purchase recycled-content products, made it less difficult to track purchases, and heightened the overall awareness level for buying recycled items. In 2003, the Affirmative Procurement purchases rose to 70% of purchases that contained recycled products.

3.1.3.4. Sustainable Design

During 2003, the ANL-E's Central Supply Facility was officially awarded the "Silver" rating by the U.S. Green Buildings Council for Leadership in Energy and Environmental Design (LEED). This building is the first federally owned building to achieve the "Silver" LEED rating within any federal agency. In addition, the P2 Program continues to promote sustainable design and environmentally preferable building material and construction methods by including a Sustainable Design Web page on the ANL-E P2 Web site.

3.2. Environmental Support Programs

3.2.1. Self-Assessment

In line with the principles of integrated safety management, line management is responsible for internal self-assessment. This process focuses on the activities of an individual organization and is intended to stimulate continuous improvement. The results are reported to those who have the authority and responsibility for the organization's performance. At the beginning of the calendar year, each organization develops an agenda of activities to be reviewed. A schedule is prepared, and assignments are made to manage the organization's self-assessment program. The ANL-E-wide results and conclusions of the assessment program are summarized by line management and submitted to the Director of Safety, Environment, and Quality Assurance (EQO). The actual performance during the year is monitored by the line organization as well as by the oversight organization assisting senior management in fulfilling its oversight responsibilities.

3.2.2. Environmental Training Programs

ANL-E has a comprehensive training program that includes mechanisms to identify, track, and document training requirements for every employee. Environmental protection training for ANL-E personnel is provided primarily by the EQO Training Section, although some training may be delivered by subject-matter experts from other organizations. Personnel training addresses various requirements, such as those contained in DOE Orders, or EPA or U.S. Department of Transportation regulations. Required training is identified by a Job Hazards Checklist form that is completed by every employee and is reviewed by each employee's supervisor.

Designation of training and records of training are managed through the Training Management System, an on-line computer-based system that tracks the training status of each employee. Environmental protection training courses and course descriptions are listed in the Training Course Catalog available from divisional training management system representatives, the EQO Training Section, or Human Resources.

3.2.3. Site Environmental Performance Measures Program

Effective FY 1995, the Prime Contract between DOE and The University of Chicago to operate ANL-E made provisions for a fee based on the performance of various research and operations activities, including ESH and Projects and Infrastructure Management performance. Performance objectives and supporting metrics have been developed as a part of the contract and for determination of the performance fee. At the end of the performance period, a rating (outstanding, excellent, good, or marginal) is assigned to each set of activities subject to the evaluation process. These ratings are part of the basis for the performance fee.

For the period of the performance-based contract October 2002 to September 2003, the environmental measurements were included in two categories. One category was identified as the ESH category and the other as Projects and Infrastructure Management. The ratings of the measurements in these categories directly affected the performance-based fee. The environmental measurements and their corresponding ratings include the following:

- Compliance with environmental permit conditions (outstanding);
- Habitat restoration plan and goals development (outstanding);
- Compliance with air effluent limits (outstanding);
- Compliance with water effluent limits (marginal);
- Compliance with environmental project schedule (outstanding);
- Compliance with environmental project cost (outstanding);
- Waste minimization/pollution prevention (outstanding); and
- Completion of Environmental Management System (EMS) Description (outstanding).

The overall rating of the Projects and Infrastructure Management categories, based on a roll-up of the individual performance ratings during the contract period, was outstanding.

3.2.4. Environmental Management Systems/EO 13148

DOE issued DOE Order 450.1,[1] "Environmental Protection Program," on January 15, 2003, to implement the requirements in EO 13148. The objective of DOE Order 450.1 is to implement sound stewardship practices that are protective of the air, water, land, and other natural and cultural resources potentially impacted by DOE operations and by which DOE cost-effectively meets or exceeds compliance with applicable environmental, public health, resource protection laws, regulations, and DOE requirements. This objective must be accomplished by implementing EMSs at DOE sites. These EMSs must be part of Integrated Safety Management Systems (ISMSs). The requirements of EO 13148 and DOE Order 450.1 are imposed on the contractors by the Contractor Requirements Document of DOE Order 450.1.

A draft ANL-E Environmental Management System Description Document was completed and submitted to DOE-ASO on January 23, 2003. A joint DOE/ANL-E work group was established to review the draft document. The document was restructured so as to mirror the organizational structure of the existing ANL-E ISMS document and cover the elements identified in DOE Order 450.1. The final ANL-E EMS was submitted to DOE-ASO on June 27, 2003. DOE-ASO approved the ANL-E document on July 14, 2003. DOE issued a draft implementation guide for DOE Order 450.1 on October 24, 2003 (final on February 18, 2004), and the ANL-E EMS is consistent with the guide.

In late 2003, an ANL-E training course was drafted (issued January 24, 2004) that provides information on DOE Order 450.1, EO 13148, and the ANL-E EMS. This course is part of the implementation process for the ANL-E EMS and is intended for upper management and environmental professionals.

3.2.5. Ecological Restoration Program

DOE and ANL-E recognize the importance of enhancing and preserving biodiversity and have committed to supporting the Biodiversity Recovery Plan prepared by Chicago Wilderness partnership organizations. Ongoing ecological restoration activities include enhancing oak woodland, savanna, wetland, and prairie habitats in the undeveloped areas on the ANL-E site. Six acres (2.4 ha) of vacant land that formerly was occupied by Quonset huts has been converted to prairie. Controlled burns and hand clearing of invasive shrubs are restoring sunlight to oak woodlands so that native flowers and grasses can grow. The upland area around a site wetland has been planted with prairie species to cleanse water feeding the wetland. The area surrounding a man-made pond outside the main administration building is being used to demonstrate the use of native plants for landscaping after invasive weedy plants were removed and replaced by native species.

3.3. Compliance with DOE Order 435.1

DOE Order 435.1 “Radioactive Waste Management,”[6] requires that an environmental monitoring and surveillance program be conducted to determine any releases or migration from LLW treatment, storage, or disposal sites. Compliance with these requirements is an integral part of the ANL-E sitewide monitoring and surveillance program. Waste management operations in general are covered by the perimeter air monitoring network and monitoring of the liquid effluent streams and Sawmill Creek. The analytical results are presented in Chapter 4 of this report.

Of particular interest is monitoring of the waste management activities formally conducted in the 317 Area. These include air particulate monitoring for total alpha, total beta, and gamma-ray emitters, and radiochemical determinations of plutonium, uranium, thorium, and strontium-90; direct radiation measurements with TLDs; surface water discharges for hydrogen-3 and gamma-ray emitters; and subsurface water samples at all the monitoring wells with analyses for hydrogen-3, strontium-90, and gamma-ray emitters, plus selected monitoring for VOCs. Direct radiation measurements are also conducted at other waste management areas: Building 306, Building 331, and the 398A Area. The results are presented in Chapters 4 and 6 of this report.

4. ENVIRONMENTAL RADIOLOGICAL PROGRAM INFORMATION

4.1. Description of Monitoring Program

The radioactivity of the environment around ANL-E in 2003 was determined by measuring radionuclide concentrations in air, surface water, subsurface water, and sediment, and by measuring the external photon penetrating radiation and potential neutron exposure. Sample collections and measurements were made at the site perimeter and off site for comparative purposes. Some on-site results are also reported when they are useful in interpreting perimeter and off-site results.

Because radioactivity is primarily transported by air and water, the sample collection program concentrates on these media. In addition, samples of materials from the streambeds also are analyzed. The program follows the guidance provided in the DOE Environmental Regulatory Guide.[7] The results of radioactivity measurements are expressed in terms of pCi/L for water; fCi/m^3 and aCi/m^3 for air; and pCi/g and fCi/g for bottom sediment. Penetrating radiation measurements are reported in units of mrem/yr, and population dose is reported in units of person-rems.

DOE has provided guidance[8] for effective dose equivalent calculations for members of the public based on International Commission on Radiological Protection (ICRP) Publications 26 and 30.[9,10] Those procedures have been used in preparing this report. The methodology requires that three components be calculated: (1) the committed effective dose equivalent (CEDE) from all sources of ingestion, (2) the CEDE from inhalation, and (3) the direct effective dose equivalent from external radiation. These three components were summed for comparison with the DOE effective dose equivalent limits for environmental exposure. The guidance requires that sufficient data on exposure to radionuclide sources be available to ensure that at least 90% of the total CEDE is accounted for. The primary radiation dose limit for members of the public is 100 mrem/yr. The effective dose equivalents for members of the public from all routine DOE operations (natural background and medical exposures excluded) shall not exceed 100 mrem/yr and must adhere to the as-low-as-reasonably-achievable (ALARA) process or be as far below the limits as is practical, taking into account social, economic, technical, practical, and public policy considerations. Routine DOE operations are normally planned operations and exclude actual or potential accidental or unplanned releases.

The measured or calculated environmental radionuclide concentrations were converted to a 50-year CEDE with the use of the CEDE conversion factors[11] and were compared with the annual dose limits for uncontrolled areas. The CEDEs were calculated from the DOE Derived Concentration Guides (DCGs)[8] for members of the public on the basis of a radiation dose of 100 mrem/yr. The numerical values of the CEDE conversion factors used in this report are provided later in this chapter (Table 4.27). Occasionally, other standards are used, and their sources are identified in the text.

4.2. Air

The radioactive content of particles in the air was determined by collecting and analyzing air filter samples. The sampling locations are shown in Figures 1.1 and 1.2. ANL-E uses continuously operating air samplers to collect samples for the measurement of concentrations of airborne particles contaminated by radionuclides. Currently, nonradiological air contaminants in ambient air are not monitored. Particle samplers are placed at 13 locations around the ANL-E perimeter and at 6 off-site locations, approximately 8 km (5 mi) from ANL-E, to determine the ambient or background concentrations.

Airborne particle samples for measurement of total alpha, total beta, and gamma-ray emitters are collected continuously at 12 perimeter locations and at 5 off-site locations on glass fiber filter media. Average flow rates on the air samplers are about 70 m^3/h (2,472 ft^3/h). Filters are changed weekly. ANL-E staff change the filters on perimeter samplers, and the filters on off-site samplers are changed and mailed to ANL-E by cooperating local agencies. Additional samples of particles in air, used for radiochemical analysis of plutonium and other radionuclides, are collected at one perimeter location and at one off-site location. These samples are collected on special filter media that are changed by ANL-E staff every 10 days. The sampling units are serviced every six months, and the flow meters are recalibrated annually.

At the time of sample collection, the date and time when sampling was begun and the date and time when sample collection was completed are recorded on a label attached to the sample container. The samples are then transported to ANL-E, where this information is then transferred to the EPDMS.

Each air filter sample collected for alpha, beta, and gamma-ray analyses is cut in half. Half of each sample for any calendar week is combined with all the other perimeter samples from that week and packaged for gamma-ray spectrometry. A similar package is prepared for the off-site filters for each week. A 5-cm (2-in.) circle is cut from the other half of the filter, mounted in a 5-cm (2-in.) low-lip stainless-steel planchet, and counted to determine alpha and beta activity. The remainder of the filter is saved.

The air filter samples collected for radiochemical analysis are composited by location for each month. After the addition of appropriate tracers, the samples are ashed, then sequentially analyzed for plutonium, thorium, uranium, and strontium, because these radionuclides are those most likely to be in the air due to ANL-E operations.

Stack monitoring is conducted continuously at five locations (see Section 4.7.1), that is, those emission points that have a probability of releasing measurable concentrations of radionuclides. The results of these measurements are used to estimate the annual off-site dose using the required EPA CAP-88 (Clean Air Act Assessment Package-1988)[12] atmospheric dispersion computer code and dose conversion method.

Samples were collected at the site perimeter to determine whether a statistically significant difference exists between perimeter measurements and measurements taken from samples collected at various off-site locations. The off-site samples establish the local background concentrations of naturally occurring or ubiquitous man-made radionuclides, such as from nuclear weapons testing fallout. Higher levels of radioactivity in the air measured at the site perimeter may indicate radioactivity releases from ANL-E, provided that the perimeter sample results are greater than the background sample results by an amount greater than the relative error of the measurement. The relative error is a result of natural variation in background concentrations as well as sampling and measurement error. This relative error is typically 5 to 20% of the measurement value for most of the analyses, but approaches 100% at values near the detection limit of the instrument.

Table 4.1 summarizes the monthly total alpha and beta activities for the individual weekly sample analyses. These measurements were made in low-background gas-flow proportional counters, and the counting efficiencies used to convert counting rates to disintegration rates were those measured for a 0.30-MeV beta and a 5.5-MeV alpha on filter paper. The results were obtained by measuring the samples at least four days after they were collected to avoid counting the natural activity due to short-lived radon and thoron decay products. This activity is normally present in air and disappears within four days by radioactive decay. The average concentrations of gamma-ray emitters, as determined by gamma-ray spectrometry performed on composite weekly samples, are given in Table 4.2. The gamma-ray detector is a shielded germanium diode calibrated for each gamma-ray–emitting nuclide measured.

Comparison of perimeter to off-site alpha and beta concentrations over the past several years shows that the perimeter results are consistently lower. This was most pronounced this year, particularly during the summer months. An investigation of this difference showed that there was significantly less particulate material collected on the perimeter air filters. In addition, the off-site samples would occasionally not be changed on the weekly schedule and run for two weeks. These samples would have a significant amount of particulate material on the filter. The differences in concentration appear to be a function of the mass of material on the filter, which is probably related to the location of the air sampler. The perimeter samplers are sited in grassy, open areas, away from buildings, roads, and other sources of airborne particulate material. The off-site samplers are located within municipal complexes, within secured locations, and are typically exposed to higher levels of airborne particulate material, especially resuspended soil, which contains naturally occurring radionuclides.

The perimeter beta activity averaged 14 fCi/m^3, which is similar to the average value for the past five years. The gamma-ray emitters listed in Table 4.2 are those that have been present in the air for past years and are of natural origin. The beryllium-7 concentration increases in the spring, which indicates its stratospheric origin. The concentration of lead-210 in the air is due to the radioactive decay of gaseous radon-222 and is similar to the concentration last year. The annual average radiation measurements for the on-site samples were less than the off-site samples as discussed above.

The annual average alpha and beta activities since 1985 are displayed in Figure 4.1. The elevated beta activity in 1986 was due to fallout from the Chernobyl incident. If the radionuclides attributed to the Chernobyl incident are subtracted from the annual beta average of 40 fCi/m^3, the

TABLE 4.1

Total Alpha and Beta Activities in Air Filter Samples, 2003
(concentrations in fCi/m^3)

Month	Location	No. of Samples	Alpha Activity Avg.	Alpha Activity Min.	Alpha Activity Max.	Beta Activity Avg.	Beta Activity Min.	Beta Activity Max.
January	Perimeter	48	1.84	0.73	3.80	18.82	7.18	33.92
	Off-Site	12	2.42	1.67	3.83	26.20	15.44	40.89
February	Perimeter	48	1.43	0.51	3.01	15.91	6.64	28.03
	Off-Site	13	2.33	0.51	3.69	22.83	7.90	38.20
March	Perimeter	48	1.61	0.62	3.40	17.02	6.14	32.83
	Off-Site	13	2.81	1.53	4.13	23.44	7.29	41.20
April	Perimeter	58	1.30	0.47	2.94	11.52	4.95	16.96
	Off-Site	22	2.28	0.87	3.92	16.13	5.60	29.40
May	Perimeter	48	1.02	0.03	2.43	8.82	2.69	14.00
	Off-Site	17	1.60	0.32	2.77	10.75	1.62	17.36
June	Perimeter	48	1.04	0.37	2.21	10.28	4.46	17.05
	Off-Site	14	1.53	0.03	3.49	11.90	0.46	18.91
July	Perimeter	58	0.98	0.19	2.45	12.49	4.95	20.33
	Off-Site	16	1.48	0.47	3.29	13.96	4.98	23.66
August	Perimeter	45	1.33	0.48	2.95	14.52	4.40	29.83
	Off-Site	14	2.19	0.89	3.90	21.20	10.35	36.55
September	Perimeter	48	1.31	0.37	3.78	16.87	4.79	39.11
	Off-Site	16	2.55	1.17	4.77	22.79	8.08	41.96
October	Perimeter	60	1.23	0.39	2.61	15.84	5.36	33.83
	Off-Site	23	1.90	0.08	3.94	20.12	5.34	38.38
November	Perimeter	48	2.27	0.39	9.50	14.88	5.77	33.18
	Off-Site	12	2.26	1.28	4.17	23.72	8.10	34.67
December	Perimeter	47	1.23	0.52	2.47	15.93	5.33	29.54
	Off-Site	19	2.64	0.64	7.33	27.58	6.42	40.28
Annual Summary	Perimeter	604	1.37 ± 0.40	0.03	9.50	14.35 ± 3.8	2.69	39.11
	Off-Site	191	2.15 ± 0.40	0.03	7.33	19.70 ± 6.1	0.46	41.96

TABLE 4.2

Gamma-Ray Activity in Air Filter Samples, 2003
(concentrations in fCi/m^3)

Month	Location	Beryllium-7	Lead-210
January	Perimeter	64	19
	Off-Site	71	23
February	Perimeter	60	16
	Off-Site	73	18
March	Perimeter	77	16
	Off-Site	85	18
April	Perimeter	67	10
	Off-Site	80	10
May	Perimeter	60	7
	Off-Site	66	8
June	Perimeter	34	9
	Off-Site	34	8
July	Perimeter	32	10
	Off-Site	31	11
August	Perimeter	74	12
	Off-Site	69	15
September	Perimeter	64	16
	Off-Site	66	16
October	Perimeter	43	13
	Off-Site	43	13
November	Perimeter	35	12
	Off-Site	47	19
December	Perimeter	37	8
	Off-Site	40	13
Annual	Perimeter	55 ± 9	13
Summary	Off-Site	60 ± 10	14
Dose(mrem)	Perimeter	(0.00013)	(1.48)
	Off-Site	(0.00015)	(1.64)

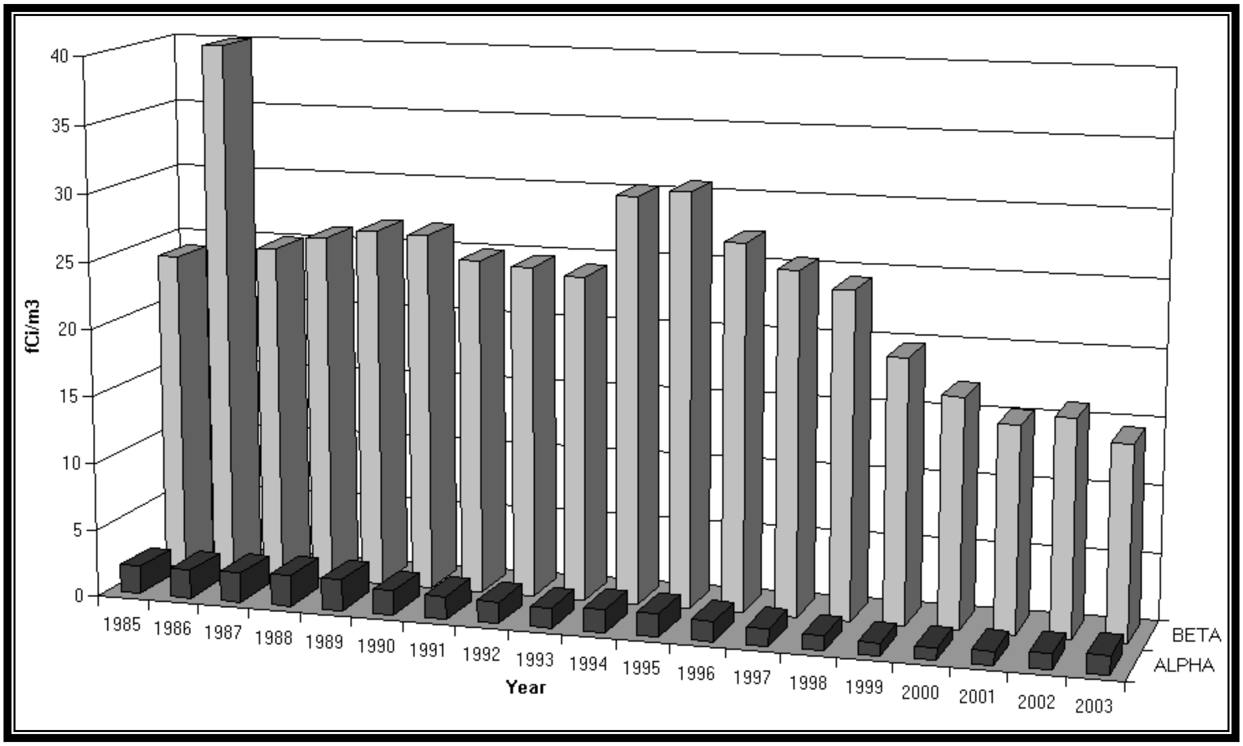


FIGURE 4.1 Comparison of Total Alpha and Beta Activities in Air Filter Samples

net would be 27 fCi/m^3, very similar to the averages of the other years. Figure 4.2 presents the annual average concentrations of the two major gamma-ray–emitting radionuclides in air. The annual average beryllium-7 concentrations have decreased regularly since 1987, reached a minimum in 1991, increased until 1996, and have now decreased. The changes in the beryllium-7 air concentrations have been observed worldwide by the DOE Environmental Measurements Laboratory's Surface Air Sampling Program and are attributed to changes in solar activity.[13]

Samples for radiochemical analyses were collected at perimeter location 7I (Figure 1.1) and off the site in Downers Grove (Figure 1.2). Collections were made on polystyrene filters. The total air volume filtered for the monthly samples was approximately 20,000 m^3 (700,000 ft^3). Samples were ignited at 500°C (950°F) to remove organic matter and were prepared for analysis by vigorous treatment with hot hydrochloric, hydrofluoric, and nitric acids.

Plutonium and thorium were separated on an ion-exchange column, and the uranium was extracted from the column effluent. Following the extraction, the aqueous phase was analyzed for radiostrontium by a standard radiochemical procedure. The separated plutonium, thorium, and uranium fractions were electrodeposited and measured by alpha spectrometry. The chemical recoveries were monitored by adding known amounts of plutonium-242, thorium-229, and uranium-236 tracers prior to ignition. Because spectrometry cannot distinguish between plutonium-239 and plutonium-240, when plutonium-239 is mentioned in this report, the alpha activity due to the plutonium-240 isotope is also included. The results are given in Table 4.3.

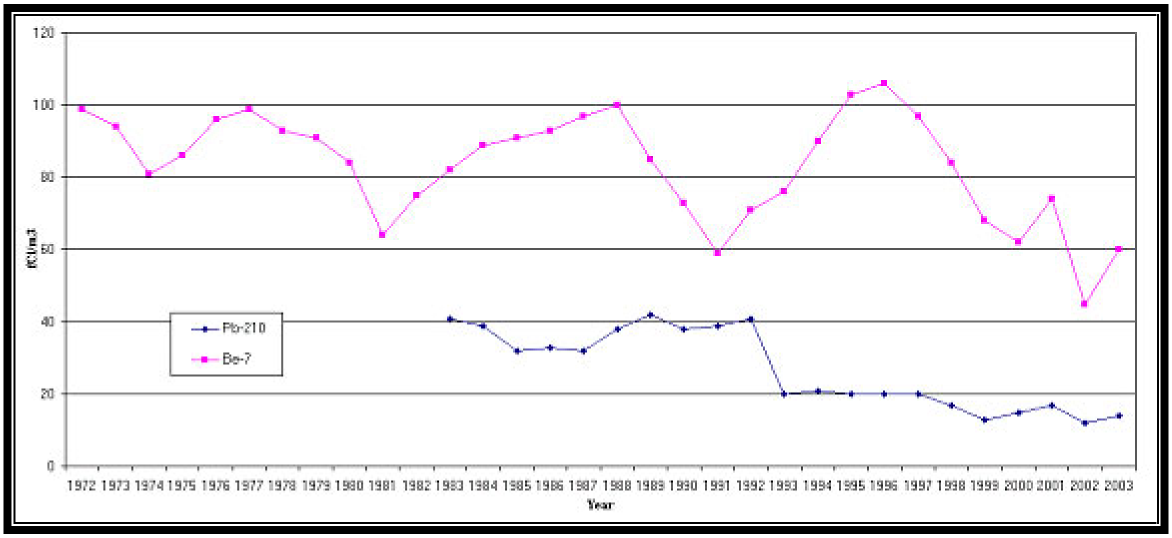


FIGURE 4.2 Comparison of Gamma-Ray Activity in Air Filter Samples

The strontium-90 concentrations have decreased over the past several years; consequently, during 2003, all of the results were less than the detection limit of 10 aCi/m^3. Strontium-89 was not observed above the detection limit of 100 aCi/m^3. The plutonium-239 concentrations at all locations were similar to those of the last few years. The thorium and uranium concentrations were in the same range as in the past and are considered to be of natural origin. The amounts of thorium and uranium in a sample were proportional to the mass of inorganic material collected on the filter paper. The presence of most of these airborne elements can be attributed to the resuspension of soil.

The major airborne effluents released at ANL-E during 2003 are listed by location in Table 4.4; Figure 4.3 shows the annual releases of the major sources since 1985. The radon-220 releases from Building 200, due to radioactive contamination from the "proof-of-breeding" program conducted in the mid 1980s, have been greatly reduced. The hydrogen-3 emitted from Building 212 is from hydrogen-3 recovery studies, while short-lived neutron activation products are emitted from the IPNS and APS. In addition to the radionuclides listed in Table 4.4, several other fission products also were released in millicurie or smaller amounts. The quantities listed in Table 4.4 were measured by on-line stack monitors in the exhaust systems of the buildings, except those for Building 350.

Phytoremediation is being applied to the 317/319 Area to complete the cleanup of the groundwater in the area, which was contaminated in the past by the disposal of liquid wastes to the soil in French drains. Phytoremediation is a natural process by which woody and herbaceous plants extract pore water and entrained chemical substances from subsurface soil, degrade volatile organic constituents, and transpire water vapor to the atmosphere. The system consists of planting shallow-rooted willow and special deep-rooted poplar trees. A mixture of grasses and

TABLE 4.3

Strontium, Thorium, Uranium, and Plutonium Concentrations
in Air Filter Samples, 2003
(concentrations in aCi/m^3)

Month	Location[a]	Strontium-90	Thorium-228	Thorium-230	Thorium-232	Uranium-234	Uranium-238	Plutonium-239
January	7I	<10	7 ± 3	7 ± 2	4 ± 2	6 ± 2	7 ± 2	0.5 ± 0.3
	Off-Site	< 10	1 ± 2	1 ± 1	1 ± 1	1 ± 2	2 ± 1	0.2 ± 0.2
February	7I	< 10	8 ± 3	9 ± 3	5 ± 2	10 ± 4	9 ± 3	0.3 ± 0.2
	Off-Site	< 10	1 ± 2	2 ± 1	1 ± 1	2 ± 2	2 ± 1	0.3 ± 0.2
March	7I	< 10	5 ± 3	8 ± 3	4 ± 2	12 ± 3	10 ± 2	0.8 ± 0.4
	Off-Site	< 10	1 ± 2	2 ± 1	< 1	2 ± 2	3 ± 2	0.1 ± 0.1
April	7I	< 10	13 ± 4	14 ± 3	8 ± 3	15 ± 3	13 ± 2	0.8 ± 0.4
	Off-Site	< 10	2 ± 2	2 ± 1	1 ± 1	2 ± 2	2 ± 1	0.4 ± 0.2
May	7I	< 10	8 ± 3	8 ± 2	5 ± 2	9 ± 3	9 ± 2	1.2 ± 0.6
	Off-Site	< 10	1 ± 2	2 ± 1	1 ± 1	2 ± 2	2 ± 1	0.2 ± 0.2
June	7I	< 10	12 ± 4	14 ± 3	11 ± 3	16 ± 3	14 ± 2	1.5 ± 0.6
	Off-Site	< 10	2 ± 2	2 ± 1	1 ± 1	3 ± 1	1 ± 1	0.5 ± 0.3
July	7I	< 10	< 1	1 ± 1	1 ± 1	1 ± 1	1 ± 1	< 0.1
	Off-Site	< 10	< 1	1 ± 1	< 1	< 1	< 1	0.1 ± 0.1
August	7I	< 10	< 1	1 ± 1	1 ± 1	1 ± 1	1 ± 1	0.1 ± 0.1
	Off-Site	< 10	< 1	< 1	< 1	< 1	< 1	0.1 ± 0.1
September	7I	< 10	1 ± 1	2 ± 1	1 ± 1	1 ± 1	1 ± 1	0.1 ± 0.1
	Off-Site	< 10	< 1	< 1	< 1	< 1	< 1	< 0.1
October	7I	< 10	1 ± 1	2 ± 1	1 ± 1	7 ± 1	2 ± 1	0.1 ± 0.1
	Off-Site	< 10	< 1	< 1	< 1	< 1	< 1	0.1 ± 0.1
November	7I	–[b]	2 ± 1	1 ± 1	1 ± 1	1 ± 1	1 ± 1	< 0.1
	Off-Site	–	< 1	< 1	< 1	< 1	< 1	< 0.1
December	7I	–	4 ± 5	4 ± 2	1 ± 2	8 ± 2	7 ± 2	0.2 ± 0.3
	Off-Site	–	6 ± 3	4 ± 2	2 ± 1	2 ± 2	1 ± 1	0.2 ± 0.2
Annual	7I	< 10	5 ± 2	6 ± 2	3 ± 2	7 ± 2	6 ± 2	0.5 ± 1.0
	Off-Site	< 10	1 ± 1	1 ± 1	1 ± 1	1 ± 2	1 ± 1	0.2 ± 1.0
Dose	7I	<(0.00011)	(0.0128)	(0.0111)	(0.0355)	(0.00039)	(0.00029)	(0.0011)
(mrem)	Off-Site	<(0.00011)	(0.0027)	(0.0025)	(0.0063)	(0.00008)	(0.00005)	(0.0004)

[a] Perimeter locations are given in terms of the grid coordinates in Figure 1.1.

[b] A dash indicates that the results were lost.

TABLE 4.4

Summary of Airborne Radioactive Emissions from ANL-E Facilities, 2003

Building	Nuclide	Half-Life	Amount Released (Ci)	Amount Released (Bq)
200	Radon-220	56 s	25.4	9.4×10^{11}
205	Hydrogen-3 (tritiated water [HTO])	12.3 yr	1.2	4.4×10^{10}
212 (Alpha Gamma Hot Cell Facility)	Hydrogen-3 (HTO)	12.3 yr	8.38	3.1×10^{11}
	Hydrogen-3 (tritiated hydrogen gas [HT])	12.3 yr	78.8	2.9×10^{12}
	Krypton-85	10.7 yr	13.6	5.0×10^{11}
	Radon-220	56 s	1.88	7.0×10^{10}
350 (NBL)	Uranium-234	2.4×10^{5} yr	1.2×10^{-5}	4.4×10^{5}
	Uranium-238	4.5×10^{9} yr	1.2×10^{-5}	4.4×10^{5}
	Neptunium-237	2.1×10^{6} yr	9.4×10^{-10}	3.4×10^{1}
	Plutonium-238	87.7 yr	4.8×10^{-8}	1.8×10^{3}
	Plutonium-239	2.4×10^{4} yr	2.5×10^{-6}	9.2×10^{4}
	Plutonium-240	6.6×10^{4} yr	3.2×10^{-7}	1.2×10^{4}
	Plutonium-241	14.4 yr	4.1×10^{-6}	1.5×10^{5}
	Plutonium-242	3.8×10^{5} yr	4.9×10^{-10}	1.4×10^{1}
375 (IPNS)	Carbon-11	20 m	2205.4	8.2×10^{13}
	Argon-41	1.8 h	88.0	3.3×10^{11}
411/415 (APS)	Carbon-11	20 m	0.15	5.5×10^{9}
	Nitrogen-13	10 m	10.71	4.0×10^{11}
	Oxygen-15	122 s	1.16	4.4×10^{10}

legumes are also planted around the trees to address shallow soil contamination and to prevent soil erosion. Approximately 800 trees were planted in the fall of 1999.

One of the major groundwater contaminants in the 317/319 Area is hydrogen-3, as tritiated water. The phytoremediation process will translocate the hydrogen-3 from the groundwater to the air as water vapor. Since the hydrogen-3 is released over an area of approximately 2 ha (5.5 acres), traditional point source monitoring for airborne hydrogen-3 water vapor is of little value to determine the quantity of hydrogen-3 released to the air. The annual inventory of hydrogen-3 released to the air can be estimated from the hydrogen-3 content of the groundwater and the extraction rate at which various aged trees remove groundwater. On the basis of the age and type of tree, estimates are available on the average consumption rate of groundwater per tree per month of the growing season. For this estimate, it is assumed that all of the groundwater that is extracted is transpired.

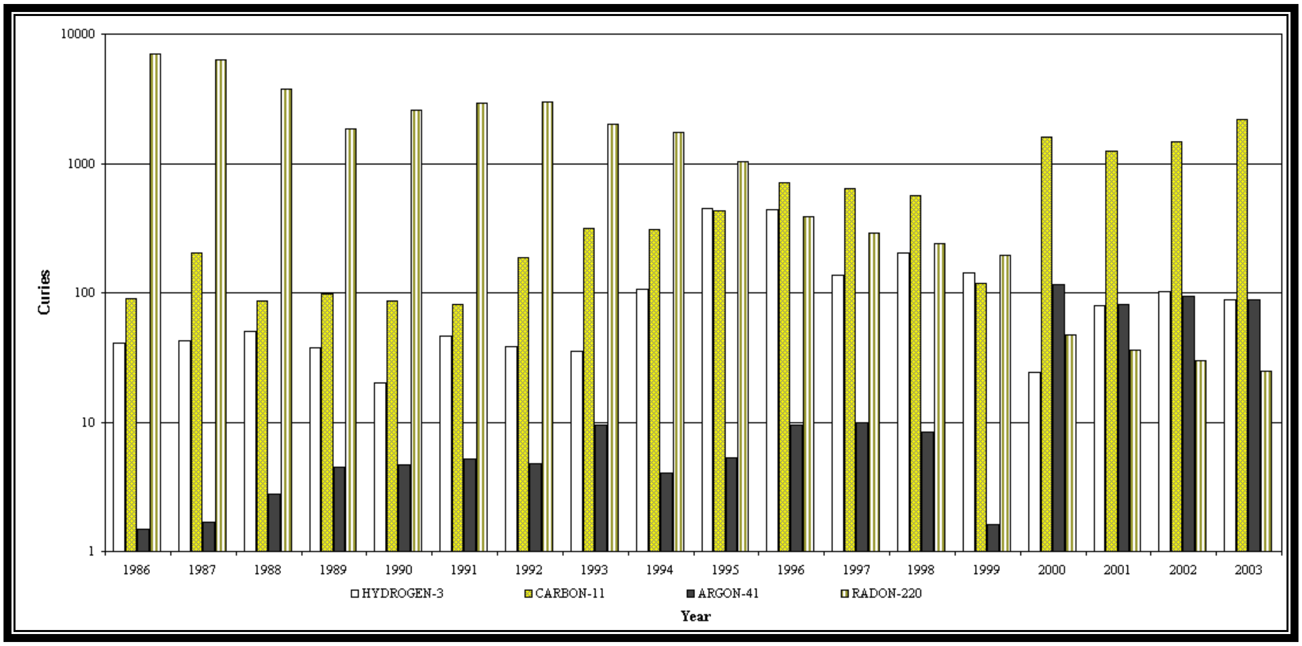


FIGURE 4.3 Selected Airborne Radionuclide Emissions

Quarterly monitoring is conducted at the 18 wells that are within the phytoremediation plantation. The average hydrogen-3 concentration for 2003 for all the wells was 661 pCi/L. The annual amount of hydrogen-3 released is then the product of the annual volume of water released for all 800 trees multiplied by the hydrogen-3 concentration in the groundwater. For 2003, the total hydrogen-3 released was 0.01 Ci. Applying the CAP-88 code,[12] an estimate of the annual dose to the maximally exposed individual was 0.0000002 mrem. This estimated dose is extremely small compared with the 10-mrem annual dose limit of NESHAPs.

4.3. Surface Water

All water samples collected in the monitoring program were acidified to 0.1N with nitric acid and filtered immediately after collection. Total nonvolatile alpha and beta activities were determined by counting the residue remaining after evaporation of the water and then applying weight-dependent counting efficiency corrections determined for plutonium-239 (for alpha activity) and thallium-204 (for beta activity) to obtain disintegration rates. Hydrogen-3 was measured from a separate aliquot; this activity does not appear in the results for total nonvolatile beta activity. Analyses for the radionuclides were performed by specific radiochemical separations followed by appropriate counting. One-liter aliquots were used for all analyses except for hydrogen-3 and the transuranium nuclides. Hydrogen-3 analyses were performed by liquid scintillation counting of 9 mL (0.03 oz) of a distilled sample in a nonhazardous cocktail. Analyses for transuranium nuclides were performed on 10-L (3-gal) samples with chemical separation methods followed by alpha spectrometry. Plutonium-236 was used to determine the yields of plutonium and neptunium, which were separated from the sample together. A group separation of a fraction containing the transplutonium elements was monitored for recovery with an americium-243 tracer. Isotopic uranium concentrations were determined by alpha spectrometry by using uranium-236 as an isotopic tracer.

Liquid wastewater from buildings or facilities that use or process radioactive materials is collected in retention tanks. When a tank is full, it is sampled and analyzed for alpha and beta radioactivity. If the radioactivity exceeds the release limits, the tank is processed by evaporation and the residue is disposed of as solid LLW. If the radioactivity is below the release limits, the wastewater is conveyed to the laboratory WTP in dedicated pipes to waste storage tanks. At the influent to the WTP, all effluent wastewater is screened for gamma-ray radioactivity. The release limits are based on the DCGs for plutonium-239 (0.03 pCi/mL) for alpha activity, and for strontium-90 (1.0 pCi/mL) for beta activity. These radionuclides were selected because of their potential for release and their conservative allowable limits in the environment. The effluent monitoring program documents that no liquid releases above the DCGs have occurred and reinforces demonstration of compliance with the use of best available technology (BAT) as required by DOE Order 5400.5.[8]

Another component of the radiological effluent monitoring program, which was instituted in 1999, is the radiological analysis of the main water treatment plant discharge (Outfall 001). Metals have been analyzed at this location for a number of years (see Table 5.8). The same radiological constituents that are determined in Sawmill Creek are also analyzed at this location. Samples are collected daily, and equal portions are combined for each week and analyzed to obtain an average weekly concentration. Table 4.5 gives the results for 2003. The results show that the radionuclides hydrogen-3 and possibly strontium-90 detected in the effluent water can be attributed to ANL-E operations. However, analysis of the ANL-E domestic water, which is obtained for Lake Michigan, indicates strontium-90 at about 0.4 pCi/L. This was confirmed by the direct analysis of Lake Michigan water. The concentrations are very low and a small fraction of the DOE limits; these findings reinforce ANL-E compliance with DOE Order 5400.5 for use of BAT for releases of liquid effluents. To estimate the total annual quantity of each radionuclide released to the environment, the product of the annual average concentration and the annual volume of water discharged (9.79×10^8 L) is computed. These results are given in Table 4.6.

ANL-E wastewater is discharged into Sawmill Creek (Location 7M in Figure 1.1). The creek runs through the ANL-E grounds, drains surface water from much of the site, and flows into the Des Plaines River about 500 m (1,600 ft) downstream from the ANL-E wastewater outfall. Sawmill Creek was sampled upstream from the ANL-E site and downstream from the wastewater discharge point to determine whether radioactivity was added to the stream by ANL-E wastewater or surface drainage. The sampling locations are shown in Figure 1.1. Daily samples were collected below the wastewater outfall. Equal portions of the daily samples collected each week were combined and analyzed to obtain an average weekly concentration. Samples were collected upstream of the site once a month and were analyzed for the same radionuclides measured in the below-outfall samples.

Table 4.7 gives the annual summaries of the results obtained for Sawmill Creek. Comparison of the results and 95% confidence levels of the averages for the two sampling locations shows that the following radionuclides found in the creek water can be attributed to

TABLE 4.5

Radionuclides in Effluents from the ANL-E Wastewater Treatment Plant, 2003

Activity	No. of Samples	Concentration (pCi/L) Avg.	Concentration (pCi/L) Min.	Concentration (pCi/L) Max.	Dose (mrem) Avg.	Dose (mrem) Min.	Dose (mrem) Max.
Alpha	52	0.7 ± 1.9	<0.1	3.9	–[a]	–	–
Beta	52	11 ± 3	5	15	–	–	–
Hydrogen-3	52	< 100	<100	312	< 0.0046	< 0.0046	0.0143
Strontium-90	52	0.48 ± 0.12	0.29	0.85	0.046	0.028	0.082
Cesium-137	52	< 2.0	< 2.0	< 2.0	< 0.07	< 0.07	< 0.07
Uranium-234	52	0.22 ± 0.17	0.04	0.49	0.042	0.011	0.078
Uranium-238	52	0.19 ± 0.14	0.04	0.42	0.032	0.007	0.071
Neptunium-237	52	< 0.0010	< 0.0010	0.0014	< 0.0028	< 0.0028	< 0.0028
Plutonium-238	52	< 0.0010	< 0.0010	0.0079	< 0.0028	< 0.0028	0.0221
Plutonium-239	52	< 0.0010	< 0.0010	0.0026	< 0.0031	< 0.0031	0.0081
Americium-241	52	< 0.0010	< 0.0010	0.0017	< 0.0033	< 0.0033	0.0057
Curium-242 and/or Californium-252	52	< 0.0010	< 0.0010	< 0.0010	< 0.0007	< 0.0007	< 0.0007
Curium-244 and/or Californium-249	52	< 0.0010	< 0.0010	< 0.0010	< 0.0034	< 0.0034	< 0.0034

[a] A dash indicates no CEDEs for alpha and beta.

ANL-E operations: hydrogen-3, strontium-90, neptunium-237, plutonium-238, plutonium-239, americium-241, and curium-244 and/or californium-249. The concentrations of all these nuclides are low and at a small fraction of DOE concentration limits. In Sawmill Creek, below the ANL-E outfall, the annual average concentrations of most measured radionuclides were similar to recent annual averages. All the annual averages were well below the applicable DOE standards.

On the basis of the results of the Storm Water Characterization Study (see Section 2.2.2), two perimeter surface water locations were identified that contained measurable levels of radionuclides. They were south of the 319 Area, Location 7J, and south of the 800 Area Landfill, Location 11D (see Figure 1.1). Samples were scheduled to be collected quarterly and analyzed for hydrogen-3, strontium-90, and gamma-ray emitters. The results are presented in Table 4.8.

The source of the radionuclides at Location 7J appears to be leachate from the 319 Area Landfill. A subsurface barrier wall and leachate collection system were constructed south of the 319 Landfill in November 1995 and became operational in 1996. Since the construction and operation of the leachate collection system, radionuclide concentrations in surface water at Location 7J have decreased substantially. The hydrogen-3 at Location 11D is probably also from the leachate; the decrease in the concentration from earlier years is due to the completion of the clay cap on the 800 Area Landfill in the fall of 1993.

TABLE 4.6

Total Radioactivity Released, 2003

Radionuclide	WTP Outfall (Ci)
Hydrogen-3	0.08
Strontium-90	0.0005
Plutonium-239	<0.0001
Americium-241	<0.0001
Total	0.08

One of the ANL-E waste management locations is within the 398A fenced area (Location 8J in Figure 1.1). Surface water drainage from this area is collected in a small pond at the south (downgradient) end of the 398A area. To evaluate whether any radionuclides are being transported by storm water flow through the 398A area, quarterly sampling is conducted from the 398A pond and analyzed for hydrogen-3 and gamma-ray–emitting radionuclides. All hydrogen-3 results were below the detection limit of 100 pCi/L, and gamma-ray spectrometric analysis did not detect any radionuclides associated with ANL-E activities above the detection limit of 2 pCi/L.

Because Sawmill Creek empties into the Des Plaines River, data on the radioactivity in this river is important in assessing the contribution of ANL-E wastewater to environmental radioactivity. The Des Plaines River was sampled twice a month below and once a month above the mouth of Sawmill Creek to determine whether the radioactivity in the creek had any effect on the radioactivity in the river. Table 4.9 gives the annual summaries of the results obtained for these two locations. The average nonvolatile alpha, beta, and uranium concentrations in the river were very similar to past averages and remained in the normal range. Results were similar above and below the creek for all radionuclides, because the activity in Sawmill Creek was reduced by dilution to the point that it was not detectable in the Des Plaines River.

4.4. Bottom Sediment

The radioactive content of bottom sediment was measured in Sawmill Creek. A grab sample technique was used to obtain bottom sediments. After drying, grinding, and mixing, portions of each of the bottom sediment samples were analyzed by the same methods described in Section 4.2 for air filter residues. The plutonium and americium were separated from the same 10-g (0.35-oz) aliquot of sediment. Results are given in terms of the oven-dried (110°C [230°F]) weight.

A set of sediment samples was collected on October 30, 2003, from the Sawmill Creek bed, above, at the outfall, and at several locations below the point at which ANL-E discharges its

TABLE 4.7

Radionuclides in Sawmill Creek Water, 2003

Activity	Location[a]	No. of Samples	Concentration (pCi/L) Avg.	Min.	Max.	Dose (mrem) Avg.	Min.	Max.
Alpha	16K	12	1.2 ± 3.4	0.1	3.2	–[b]	–	–
(Nonvolatile)	7M	52	1.0 ± 1.8	0.1	3.8	–	–	–
Beta	16K	12	9 ± 18	3	25	–	–	–
(Nonvolatile)	7M	52	10 ± 6	5	18	–	–	–
Hydrogen-3	16K	12	< 100	< 100	132	< 0.0046	< 0.0046	0.0061
	7M	52	< 100	< 100	396	< 0.0046	< 0.0046	0.0182
Strontium-90	16K	12	< 0.25	< 0.25	0.35	< 0.024	< 0.024	0.033
	7M	51	0.41 ± 0.29	< 0.25	0.93	0.040	< 0.024	0.088
Cesium-137	16K	12	< 2.0	< 2.0	< 2.0	< 0.07	< 0.07	< 0.07
	7M	52	< 2.0	< 2.0	< 2.0	< 0.07	< 0.07	< 0.07
Uranium-234	16K	12	0.74 ± 0.28	0.17	1.53	0.140	0.033	0.291
	7M	52	0.34 ± 0.31	0.01	0.90	0.065	0.002	0.171
Uranium-238	16K	12	0.64 ± 0.32	0.13	1.23	0.109	0.023	0.208
	7M	52	0.29 ± 0.29	0.02	0.75	0.050	0.004	0.127
Neptunium-237	16K	12	< 0.0010	< 0.0010	< 0.0010	< 0.0028	< 0.0028	< 0.0028
	7M	52	< 0.0010	< 0.0010	0.0014	< 0.0028	< 0.0028	0.0039
Plutonium-238	16K	12	< 0.0010	< 0.0010	0.0012	< 0.0028	< 0.0028	0.0033
	7M	52	< 0.0010	< 0.0010	0.0013	< 0.0028	< 0.0028	0.0036
Plutonium-239	16K	12	< 0.0010	< 0.0010	< 0.0010	< 0.0031	< 0.0031	< 0.0031
	7M	52	< 0.0010	< 0.0010	0.0094	< 0.0031	< 0.0031	0.0291
Americium-241	16K	12	< 0.0010	< 0.0010	0.0038	< 0.0033	< 0.0033	0.0125
	7M	50	< 0.0010	< 0.0010	0.0018	< 0.0033	< 0.0033	0.0059
Curium-242 and/or	16K	12	< 0.0010	< 0.0010	< 0.0010	< 0.0007	< 0.0007	< 0.0007
Californium-252	7M	50	< 0.0010	< 0.0010	0.0014	< 0.0007	< 0.0007	0.0010
Curium-244 and/or	16K	12	< 0.0010	< 0.0010	< 0.0010	< 0.0034	< 0.0034	< 0.0034
Californium-249	7M	50	< 0.0010	< 0.0010	0.0015	< 0.0034	< 0.0034	0.0051

[a] Location 16K is upstream from the ANL-E site, and location 7M is downstream from the ANL-E wastewater outfall.

[b] A dash indicates no CEDEs for alpha and beta.

TABLE 4.8

Radionuclides in Storm Water Outfalls, 2003
(concentrations in pCi/L)

Date Collected	Location 7J Hydrogen-3	Location 7J Strontium-90	Location 7J Cesium-137	Location 11D Hydrogen-3
03/13/03	<100	0.51	<2	Dry
May 2003	Dry	Dry	Dry	Dry
07/07/03	<100	0.74	<2	Dry
10/14/03	<100	0.60	<2	Dry

treated wastewater (Location 7M in Figure 1.1). The results, as listed in Table 4.10, show that the concentrations in the samples collected above the outfall at Location 7M are similar to those of the off-site samples collected in past years.[14] The plutonium, americium, and cesium-137 concentrations are elevated below the outfall, which indicates that their origin is in ANL-E wastewater. Plutonium results varied widely among locations and were strongly dependent on the retentiveness of the bottom material. The changes in concentrations of these nuclides with time and location indicate that the sediment material in this area has a dynamic nature.

4.5. External Penetrating Gamma Radiation

Levels of external penetrating gamma radiation at and in the vicinity of the ANL-E site were measured with aluminum oxide TLD chips provided and read by a commercial vendor. Each measurement reported represents the average of two chips exposed in the same packet. Dosimeters were exposed at 17 locations at the site boundary and on the site. Readings were also taken at five off-site locations (Figure 1.2) for comparative purposes. Three locations were added to the network in 1999 to monitor radioactive waste management activities. They are east of Building 306 (Location 9/10 I), south of Building 331 (Location 9 H/I), and next to the 398A radioactive waste storage area (Location 9J).

The results are summarized in Tables 4.11 and 4.12, and the site boundary and on-site readings are shown in Figure 4.4. Measurements were taken during the four successive exposure periods shown in the tables, and the results were calculated in terms of annual dose for ease in comparing measurements made for different elapsed times. The uncertainty of the averages given in the tables is the 95% confidence limit calculated from the standard deviation of the average.

The off-site results averaged 87 ± 5 mrem/yr and were slightly lower than last year's off-site average of 93 ± 4 mrem/yr.[15] To compare boundary results for individual sampling periods, the standard deviation of the 20 individual off-site results is useful. This value is 9 mrem/yr; thus, individual results in the range of 87 ± 18 mrem/yr may be considered to be the average natural background with a 95% probability.

TABLE 4.9

Radionuclides in Des Plaines River Water, 2003

			Concentration (pCi/L)			Dose (mrem)		
Activity	Location[a]	No. of Samples	Avg.	Min.	Max.	Avg.	Min.	Max.
Alpha	A	12	1.0 ± 0.5	0.1	2.1	–[b]	–	–
(Nonvolatile)	B	24	1.3 ± 0.5	0.3	4.9	–	–	–
Beta	A	12	12 ± 4	6	19	–	–	–
(Nonvolatile)	B	24	13 ± 4	5	22	–	–	–
Hydrogen-3	A	12	< 100	< 100	104	< 0.0046	< 0.0046	0.0048
	B	24	< 100	< 100	171	< 0.0046	< 0.0046	0.0079
Strontium-90	A	12	< 0.25	< 0.25	0.32	< 0.024	< 0.024	0.031
	B	24	< 0.25	< 0.25	0.30	< 0.024	< 0.024	0.028
Uranium-234	A	12	0.46 ± 0.06	0.18	1.11	0.089	0.035	0.211
	B	24	0.40 ± 0.05	0.11	1.05	0.078	0.022	0.200
Uranium-238	A	11	0.40 ± 0.06	0.14	1.08	0.069	0.024	0.181
	B	23	0.34 ± 0.04	0.07	0.88	0.057	0.013	0.148
Neptunium-237	A	12	< 0.0010	< 0.0010	< 0.0010	< 0.0028	< 0.0028	< 0.0028
	B	12	< 0.0010	< 0.0010	< 0.0010	< 0.0028	< 0.0028	< 0.0028
Plutonium-238	A	12	< 0.0010	< 0.0010	0.0018	< 0.0028	< 0.0028	0.0050
	B	12	< 0.0010	< 0.0010	0.0013	< 0.0028	< 0.0028	0.0036
Plutonium-239	A	12	< 0.0010	< 0.0010	0.0013	< 0.0031	< 0.0031	0.0040
	B	12	< 0.0010	< 0.0010	0.0023	< 0.0031	< 0.0031	0.0071
Americium-241	A	12	< 0.0010	< 0.0010	0.0058	< 0.0033	< 0.0033	0.0191
	B	12	< 0.0010	< 0.0010	< 0.0010	< 0.0033	< 0.0033	< 0.0033
Curium-242 and/or	A	12	< 0.0010	< 0.0010	< 0.0010	< 0.0007	< 0.0007	< 0.0007
Californium-252	B	12	< 0.0010	< 0.0010	< 0.0010	< 0.0007	< 0.0007	< 0.0007
Curium-244 and/or	A	12	< 0.0010	< 0.0010	< 0.0010	< 0.0034	< 0.0034	< 0.0034
Californium-249	B	12	< 0.0010	< 0.0010	< 0.0010	< 0.0034	< 0.0034	< 0.0034

[a] Location A, near Willow Springs, is upstream; location B, near Lemont, is downstream from the mouth of Sawmill Creek. See Figure 1.2.

[b] A dash indicates no CEDEs for alpha and beta.

The site boundary at Location 7I had dose rates consistently above the average background. This was the result of radiation from ANL-E's 317 Area in the northern half of grid 7I. In the past, waste was packaged and temporarily stored in this area before removal for permanent disposal off site. In 2003, the dose at this perimeter fence location was 103 ± 23 mrem/yr. Approximately 300 m (960 ft) south of the fence in grid 6I, the measured dose dropped to 97 ± 11 mrem/yr, which is within the normal background range.

In the past, an elevated on-site dose had been measured at Location 9H, next to the CP-5 reactor, where irradiated hardware from the reactor was stored. During the past few years, considerable cleanup of the CP-5 reactor yard has occurred as part of the CP-5 reactor D&D project. The dose at Location 9H decreased from about 1,200 mrem/yr in 1989 to 93 mrem/yr in 2003.

TABLE 4.10

Radionuclides in Bottom Sediment, 2003

Location	Concentration (pCi/g)					Concentration (fCi/g)		
	Potassium-40	Cesium-137	Radium-226	Thorium-228	Thorium-232	Plutonium-238	Plutonium-239	Americium-241
Sawmill Creek 25 m above outfall	14.7 ± 0.59	0.02 ± 0.01	0.78 ± 0.05	0.51 ± 0.03	3.18 ± 0.12	< 0.1	1.63 ± 0.69	0.96 ± 0.56
Sawmill Creek at outfall	15.5 ± 0.61	0.46 ± 0.03	1.63 ± 0.06	0.56 ± 0.03	0.59 ± 0.07	21.8 ± 2.54	269 ± 17.2	63.3 ± 5.27
Sawmill Creek 50 m below outfall	7.84 ± 0.44	0.05 ± 0.01	0.55 ± 0.04	0.59 ± 0.03	2.44 ± 0.10	0.26 ± 0.30	6.20 ± 1.27	2.33 ± 0.82
Sawmill Creek 100 m below outfall	14.3 ± 0.58	0.08 ± 0.01	0.70 ± 0.05	0.46 ± 0.02	3.09 ± 0.12	0.18 ± 0.02	7.73 ± 1.46	2.83 ± 0.83
Sawmill Creek at Des Plaines River	11.8 ± 0.53	< 0.01	0.60 ± 0.04	0.44 ± 0.03	0.42 ± 0.06	5.99 ± 1.38	11.1 ± 1.93	0.38 ± 0.34

TABLE 4.11

Environmental Penetrating Gamma Radiation at Off-Site Locations, 2003
(dose rate in mrem/yr)

	Period of Measurement				
	Jan. 2–April 1	April 1–July 1	July 1–Oct. 2	Oct. 2–Jan. 5	Average
Lemont	78	80	95	101	88 ± 14
Clarendon Hills	86	79	84	106	89 ± 5
Orland Park	73	55	91	125	86 ± 37
Woodridge	82	88	94	101	91 ± 11
Willow Springs	75	78	89	94	83 ± 12
Average	79 ± 4	76 ± 11	91 ± 4	105 ± 15	87 ± 5

Three new locations were added to monitor radioactive waste facilities and areas. Significant movement of radioactive waste took place, principally waste from the D&D of the CP-5 reactor and the relocation of radioactive waste from the 317 Area to the 398A Area. Some waste is repacked in Building 306 (Location 9/10 I). The dose from these operations was above normal background levels. The elevated dose levels in the 398A Area (Location 9J) are from waste relocated from the 317 Area, historic waste, and D&D waste temporarily stored pending shipment. The Building 331 yard (Location 9 H/I) is being used as a staging area to load trucks for shipment off site. A number of radioactive waste shipments were made during 2003, as reflected by the elevated dose rates. The 398A Area was also used as a staging area to load trucks for shipment off site. Depending on the number of shipments, the dose rates will vary from quarter to quarter.

4.6. Neutron Monitoring

An environmental fast neutron monitoring program was first established in 2002 at IPNS. Although ANL-E does not have any operating nuclear reactors, several facilities produce fast neutrons and have the potential to release these to the environment. To estimate the dose to the environment during normal operation of these facilities, one of the facilities, the IPNS, was selected for monitoring.

The IPNS produces up to several hundred MeV neutrons for experimental work. Pulses of high-energy protons from an accelerator system are directed by magnets contained in a heavily shielded beamline enclosure into the target area. The target consists of depleted uranium discs contained within stainless-steel housing. The target is cooled by water. The neutron-generating facilities and target support systems are encased within a biological shield that provides structural support and shielding of steel and concrete. Air emissions from this facility are discussed in Section 4.7.1.

TABLE 4.12

Environmental Penetrating Gamma Radiation at ANL-E, 2003
(dose rate in mrem/yr)

	Period of Measurement				
	Jan. 2–April 1	April 1–July 1	July 1–Oct. 2	Oct. 2–Jan. 5	Average
14G – Boundary	96	98	98	112	101 ± 11
14I – Boundary	80	79	86	98	86 ± 12
14L – Boundary	82	78	95	106	90 ± 15
6I - 200 m N of Quarry Road	96	86	98	108	97 ± 11
7I - Center, Waste Storage Area Facility 317	178	110	72	104	116 ± 56
7I - Boundary	89	99	99	126	103 ± 23
8H - Boundary	84	79	92	116	93 ± 21
8H - 65 m S of Building 316	87	93	95	105	95 ± 10
8H - 200 m NW of Waste Storage Area (Heliport)	88	84	91	105	92 ± 12
8H - Boundary, Center, St. Patrick Cemetery	89	89	101	110	98 ± 13
9H - 50 m SE of CP-5	82	89	90	112	93 ± 19
9 H/I - 50 m E of Building 331	1,087	1,374	1,179	473	1,028 ± 499
9/10 I - E of D306	134	–[b]	546	692	457 ± 409
9/10 I - 65 m NE of Building 350, 230 m NE of Building 316	79	81	97	100	89 ± 14
9/10 EF – Boundary	90	93	93	118	99 ± 18
9J - 50 m W of 398A Area	455	460	600	546	515 ± 88
10/11 K – Lodging Facilities	81	80	81	–	81 ± 1

[a] See Figure 1.1.

[b] A dash indicates that the sample was lost.

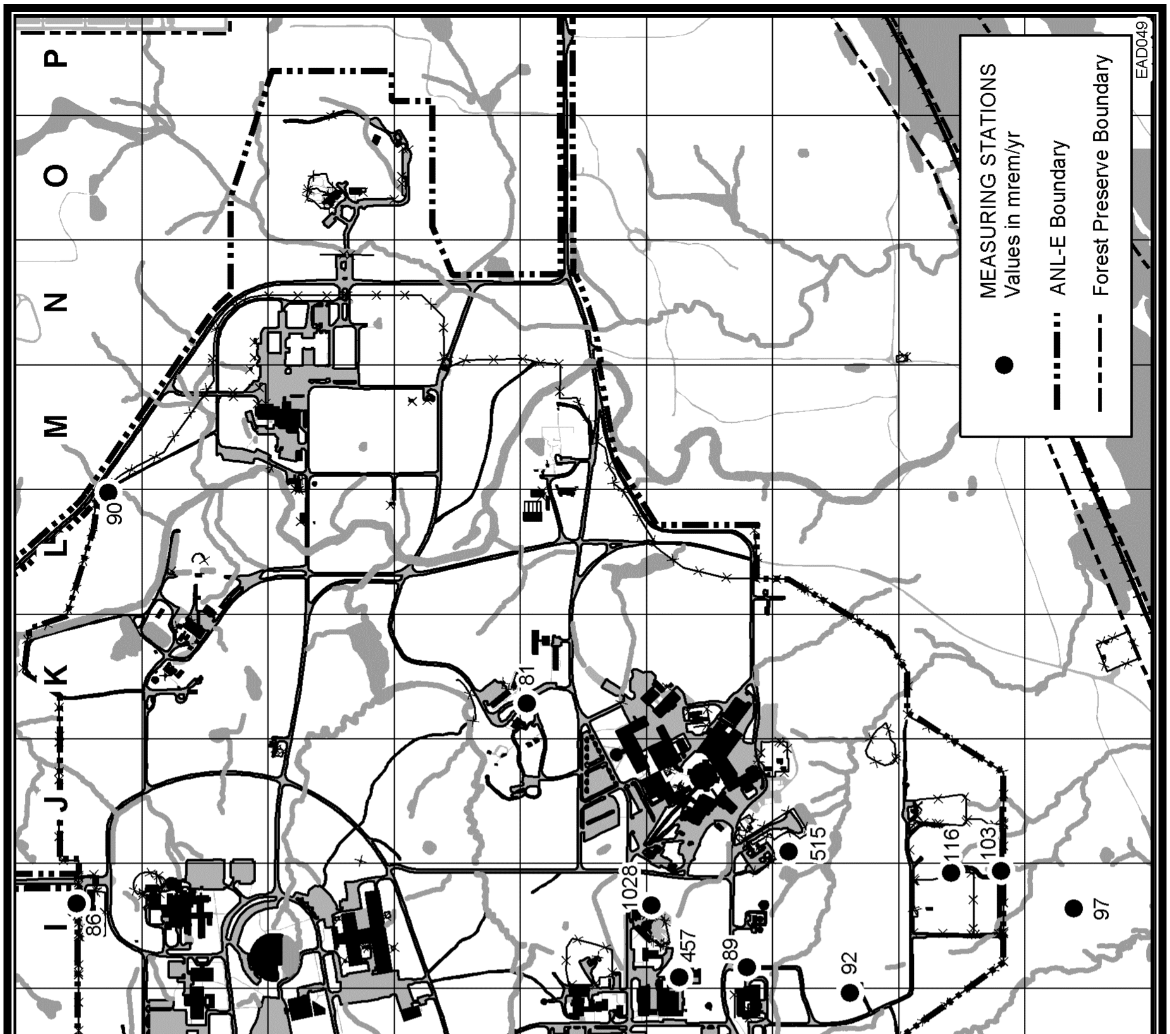


FIGURE 4.4 Penetrating Radiation Measurements at the ANL-E Site, 2003

Beginning in January 2002, four environmental neutron monitors were obtained from a commercial vendor and placed at locations that were most likely to result in neutron dose. A fifth dosimeter was placed at an off-site location to monitor background neutron dose in areas uneffected by ANL-E operations. The neutron dosimeters were changed quarterly. The results are given in Table 4.13 and shown in Figure 4.5.

The results are expressed in units of dose (mrem) for the time the dosimeter was in the field. Therefore, the annual dose is the sum of the individual measurements. Because IPNS does not operate continuously, there may be time periods of up to a month when the system is not generating neutrons. The monitored locations are outside but near to the facility. Although these areas are not continuously occupied, measurements in 2003 indicated the potential for neutron dose. Any nearby workers would receive a significantly lower dose, and the dose to the fence line is estimated to be less than 0.01 mrem.

Beginning in January 2003, a set of four fast neutron dosimeters was placed around the ATLAS facility (location 13H in Figure 1.1). ATLAS is the world's first superconducting accelerator for projectiles heavier than electrons. It has the capability of producing heavy-ion beams from hydrogen to uranium, to energies as high as 17 MeV per nucleon. Because of the many and varied types of experiments that are conducted at ATLAS, the potential exists for the production of fast neutrons.

TABLE 4.13

Fast Neutron Dose at ANL-E, 2003
(dose in mrem)

	Period of Measurement				
On-Site Location	Jan 2–Apr 1	Apr 1–July 1	July 1–Oct 2	Oct 2–Jan 5	Total
60 m NE of Building 375	160	90	60	110	420
30 m NW of Building 375	20	70	30	80	200
45 m SW of Building 375	20	50	20	70	160
60 m S of Building 375	< 1	30	20	30	80
50 m ENE of ATLAS	< 1	< 1	< 1	< 1	< 1
60 m NNE of ATLAS	< 1	< 1	< 1	< 1	< 1
80 m NW of ATLAS	< 1	< 1	< 1	< 1	< 1
120 m WNW of ATLAS	< 1	< 1	< 1	< 1	< 1
Off-Site Location					
Woodridge	< 1	< 1	< 1	< 1	< 1

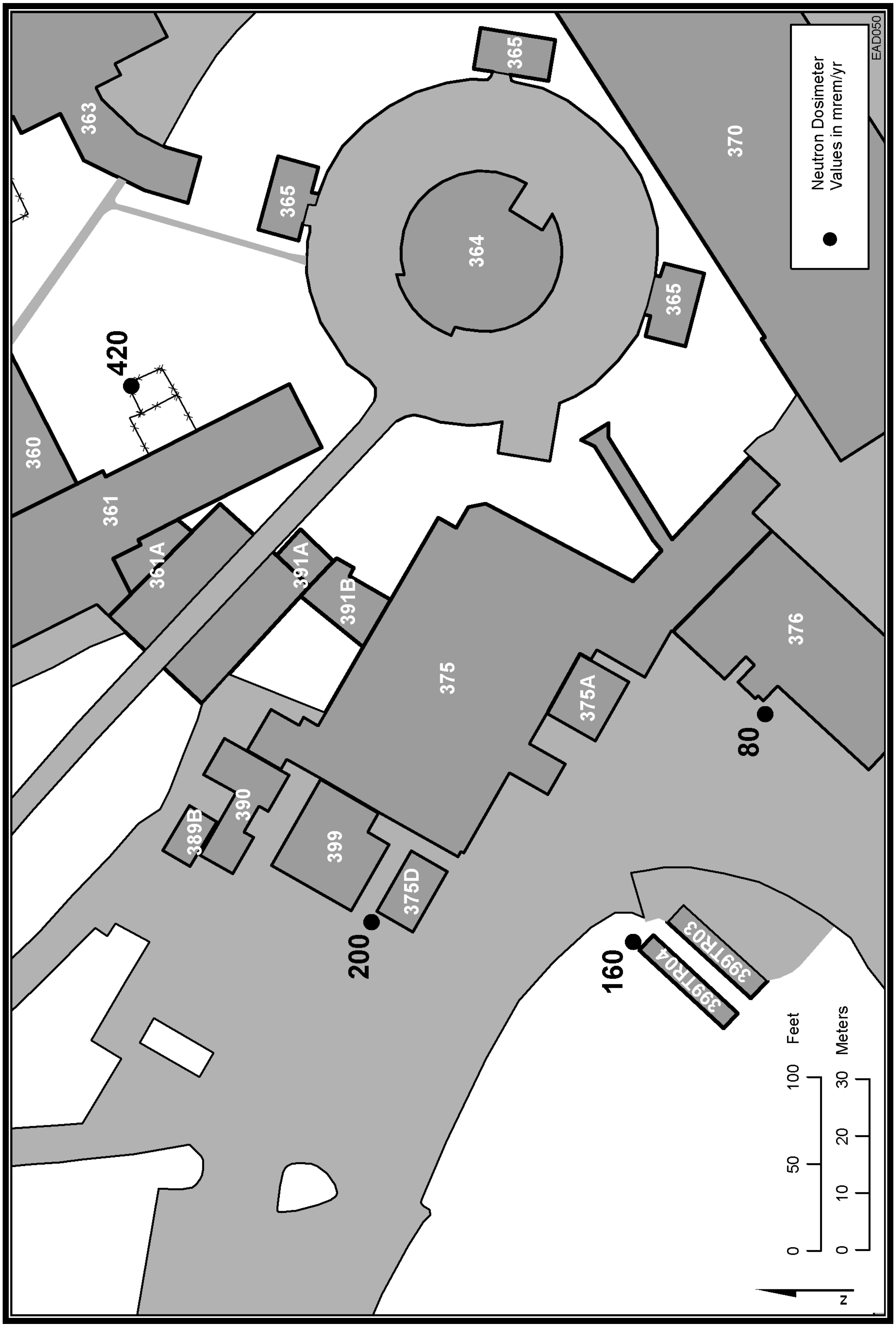


FIGURE 4.5 Neutron Dose Measurements, 2003

The four neutron dosimeters were placed at various distances east, north, and west of the ATLAS facility. The dosimeters were changed on the same schedule as the IPNS dosimeters. The results are shown in Table 4.13. No fast neutron dose was measurable at any of the ATLAS dosimeter locations. This program will be continued in 2004.

4.7. Estimates of Potential Radiation Doses

The radiation doses at the site boundary and off the site that could have been received by the public from radioactive materials and radiation leaving the site were calculated. Calculations were performed for three exposure pathways — airborne, water, and direct radiation from external sources.

4.7.1. Airborne Pathway

DOE facilities with airborne releases of radioactive materials are subject to 40 CFR Part 61, Subpart H,[16] which requires the use of the EPA's CAP-88 code[12] to calculate the dose for radionuclides released to the air and to demonstrate compliance with the regulation. The dose limit applicable for 2003 for the air pathway is a 10-mrem/yr effective dose equivalent. The CAP-88 computer code uses a modified Gaussian plume equation to estimate both horizontal and vertical dispersion of radionuclides released to the air from stacks or area sources. For 2003, doses were calculated for hydrogen-3, carbon-11, nitrogen-13, oxygen-15, argon-41, krypton-85, radon-220 plus daughters, and a number of actinide radionuclides. The annual releases are those listed in Table 4.4; separate calculations were performed for each of the six release points. The wind speed and direction data shown in Figure 1.3 were used for these calculations. In the past, the wind stability classes had been determined by the temperature differences between the 10-m (33-ft) and 60-m (197-ft) levels. To improve the determination of stability levels, the categories were obtained from daytime measurements of solar radiation and nighttime measurements of the standard deviation of the horizontal wind speed. Doses were calculated for an area extending out to 80 km (50 mi) from ANL-E. The population distribution of the 16 compass segments and 10 distance increments given in Table 1.1 was used. The dose rate was calculated at the midpoint of each interval and integrated over the entire area to give the annual population cumulative dose.

Distances from the specific facilities that exhaust radiological airborne emissions (see Table 4.4) to the fence line (perimeter) and nearest resident were determined in the 16 compass segments. Calculations also were performed to evaluate the major airborne pathways — ingestion, inhalation, and immersion — both at the point of maximum perimeter exposure and to the maximally exposed resident. The perimeter and resident doses and the maximum doses are listed, respectively, for releases from Buildings 200 (Tables 4.14 and 4.15), Building 205 (Tables 4.16 and 4.17), Building 212 (Tables 4.18 and 4.19), Building 350 (Tables 4.20 and 4.21), Building 375 (Tables 4.22 and 4.23), and Building 411 (Tables 4.24 and 4.25). The doses given in these tables are the committed whole body effective dose equivalents.

TABLE 4.14

Radiological Airborne Releases from Building 200, 2003

Direction	Distance to Perimeter (m)	Dose[a] (mrem/yr)	Distance to Nearest Resident (m)	Dose[a] (mrem/yr)
N	500	5.1×10^{-3}	1,000	1.4×10^{-3}
NNE	600	4.6×10^{-3}	1,100	1.4×10^{-3}
NE	750	3.1×10^{-3}	2,600	3.0×10^{-4}
ENE	1,700	6.4×10^{-4}	3,100	2.3×10^{-4}
E	2,400	3.0×10^{-4}	3,500	1.6×10^{-4}
ESE	2,200	2.9×10^{-4}	3,600	1.3×10^{-4}
SE	2,100	2.4×10^{-4}	4,000	8.2×10^{-5}
SSE	2,000	3.9×10^{-4}	4,000	1.2×10^{-4}
S	1,500	4.4×10^{-4}	4,000	9.0×10^{-5}
SSW	1,000	1.5×10^{-3}	2,500	3.0×10^{-4}
SW	800	2.5×10^{-3}	2,200	5.5×10^{-4}
WSW	1,100	6.4×10^{-4}	1,500	3.7×10^{-4}
W	750	1.7×10^{-3}	1,500	5.0×10^{-4}
WNW	800	9.2×10^{-4}	1,300	4.0×10^{-4}
NW	600	1.7×10^{-3}	1,100	5.8×10^{-4}
NNW	600	2.5×10^{-3}	800	1.5×10^{-3}

[a] Source term: radon-220 = 25.4 Ci (plus daughters).

A significant D&D program was completed in 1995 for the M-Wing hot cells in Building 200, which constituted the source of the radon-220 emissions. Cleanup of the major source of the radon-220, cell M-1, resulted in a decrease of radon-220 emissions from 3,000 Ci in 1992 to 193 Ci in 1999. The radon-220 emissions were reduced further in 1999, to the present 25.4 Ci, because of the termination of the nuclear medical program that separates radium-224 from the thorium-228 parent and continued D&D of other cells. Also, the hydrogen-3 recovery program in Building 205 was terminated, and final cleanup of the area was completed in July 2003. The 2003 hydrogen-3 releases were primarily from the cleanup activities.

The doses from each of the CAP-88 dose assessments were combined on the basis of the assumption that the CP-5 reactor is the central emission point for the site. The 16 compass directions from CP-5 were established for each perimeter and actual resident location. The six individual building assessments were then overlayed on the CP-5 grid, and the estimated dose was summed according to which values fell within the CP-5 segments. This approach provides an estimated dose to an actual individual and is not just the sum of the maximum doses from the individual building runs.

TABLE 4.15

Maximum Perimeter and Individual Doses
from Building 200 Air Emissions, 2003
(dose in mrem/yr)

Pathway	Perimeter (500 m N)	Individual (800 m NNW)
Ingestion	7.0×10^{-15}	2.5×10^{-15}
Inhalation	5.1×10^{-3}	1.5×10^{-3}
Air immersion	3.5×10^{-5}	9.4×10^{-6}
Ground surface	2.4×10^{-6}	8.5×10^{-7}
Total	5.1×10^{-3}	1.5×10^{-3}
Radionuclide		
Thallium-208	3.1×10^{-5}	8.0×10^{-6}
Bismuth-212	5.8×10^{-4}	2.0×10^{-4}
Lead-212	2.9×10^{-3}	1.0×10^{-3}
Radon-220	1.6×10^{-3}	2.4×10^{-4}
Total	5.1×10^{-3}	1.5×10^{-3}

The highest perimeter dose was in the east direction, with a maximum value of 0.55 mrem/yr (Location 9L in Figure 1.1). Essentially all of this dose can be attributed to air immersion of carbon-11 from the IPNS facility. The maximum perimeter dose is slightly higher than last year and is due to carbon-11 emissions from the IPNS. The programmatic need for continued operation of the facility will result in continued releases of carbon-11.

The full-time resident who would receive the largest annual dose (0.057 mrem/yr), if he or she were outdoors during the entire year, is located approximately 2.5 km (1.6 mi) ENE of the IPNS facility. The major contributor to the whole body dose is the air immersion dose from carbon-11 (0.053 mrem/yr). Releases of radon-220 plus daughters contribute less than 1% of the resident dose. If radon-220 plus daughters were excluded from the calculation, the NESHAPs reportable dose to the maximally exposed individual would be 0.057 mrem/yr.

The individual doses to the maximally exposed member of the public and the maximum fence line dose are shown in Figure 4.6. The decreases in individual and population doses from 1988 to 1999 are due in part to the decrease of radon-220 emissions as a result of the cleanup of the Building 200 M-Wing hot cells. The increase from 1999 to 2003 is principally due to increased emissions from the IPNS as a result of increased operating time.

TABLE 4.16

Radiological Airborne Releases from Building 205, 2003

Direction	Distance to Perimeter (m)	Dose[a] (mrem/yr)	Distance to Nearest Resident (m)	Dose[a] (mrem/yr)
N	850	4.5×10^{-5}	1,300	2.2×10^{-5}
NNE	1,000	4.2×10^{-5}	2,100	1.2×10^{-5}
NE	1,200	3.1×10^{-5}	2,700	8.0×10^{-6}
ENE	2,400	9.5×10^{-6}	3,000	7.1×10^{-6}
E	2,200	9.4×10^{-6}	2,400	4.9×10^{-6}
ESE	2,000	1.8×10^{-5}	3,500	3.8×10^{-6}
SE	1,800	1.6×10^{-5}	3,900	2.7×10^{-6}
SSE	1,500	3.4×10^{-5}	4,000	3.6×10^{-6}
S	1,300	6.8×10^{-5}	3,900	2.8×10^{-6}
SSW	1,100	1.7×10^{-5}	2,400	9.4×10^{-6}
SW	900	6.8×10^{-5}	2,100	2.5×10^{-5}
WSW	1,100	1.7×10^{-5}	1,800	7.4×10^{-6}
W	1,300	1.5×10^{-5}	1,800	1.1×10^{-5}
WNW	1,100	1.5×10^{-5}	1,700	7.6×10^{-6}
NW	1,100	1.6×10^{-5}	1,500	9.9×10^{-6}
NNW	900	3.0×10^{-5}	1,500	1.3×10^{-5}

[a] Source term: hydrogen-3 = 1.2 Ci.

The population data in Table 1.1 were used to calculate the cumulative population dose from airborne radioactive effluents from ANL-E operations. The results are given in Table 4.26, along with the natural external radiation dose. The natural radiation dose listed is the product of the 80-km (50-mi) population and the natural radiation dose of 300 mrem/yr.[17] It is assumed that this dose is representative of the entire area within an 80-km (50-mi) radius. The population dose resulting from ANL-E operations since 1987 is shown in Figure 4.7.

The potential radiation exposures by the inhalation pathways also were calculated by the methodology specified in DOE Order 5400.5.[8] The total quantity for each radionuclide inhaled, in microcuries (µCi), is calculated by multiplying the annual average air concentrations by the general public breathing rate of 8,400 m^3/yr.[18] This annual intake is then multiplied by the CEDE conversion factor for the appropriate lung retention class.[8] The CEDE conversion factors are in units of rem/µCi, and this calculation gives the 50-year CEDE. Table 4.27 lists the applicable CEDE factors.

The calculated doses in Tables 4.1 and 4.2 were derived by using this procedure. Because they are all essentially at perimeter locations, these doses represent the fence-line values for those

TABLE 4.17

Maximum Perimeter and Individual Doses from
Building 205 Air Emissions, 2003
(dose in mrem/yr)

Pathway	Perimeter (900 m SW)	Individual (2,100 m SW)
Ingestion	1.6×10^{-5}	6.0×10^{-6}
Inhalation	5.2×10^{-5}	1.9×10^{-5}
Air immersion	–[a]	–
Ground surface	–	–
Total	6.8×10^{-5}	2.5×10^{-5}
Radionuclide		
Hydrogen-3	6.8×10^{-5}	2.5×10^{-5}

[a] A dash indicates no exposure by this pathway.

radionuclides measured. These doses are the same as the off-site measurements and represent the ambient dose for the area from these nuclides. No doses were calculated for the total alpha and total beta measurements because the guidance does not provide CEDE conversion factors for such measurements.

An evaluation was conducted of potential sensitive receptors of ANL-E airborne releases, including children at the Argonne Child Development Center (Location 120 in Figure 1.1). The airborne dose from ANL-E is estimated to be about 0.10 mrem/yr at this location. This assumes full-time, outdoor exposure. Assuming that the children are present about 8 hours per day, 5 days per week, the actual dose is closer to 0.03 mrem/yr. Additional potential sensitive receptors are located at the Darien school on 91st Street, west of Route 83. The estimated full-time, outdoor dose at this location is about 0.01 mrem/yr. Again, assuming that the children are only present at this location 6 hours per day, 5 days per week, and for 35 weeks a year, the actual dose is closer to 0.001 mrem/yr.

4.7.2. Water Pathway

Following the methodology outlined in DOE Order 5400.5,[8] the annual intake of radionuclides (in µCi) ingested with water is obtained by multiplying the concentration of radionuclides in microcuries per milliliter (µCi/mL) by the average annual water consumption of a member of the general public (7.3×10^5 mL). This annual intake is then multiplied by the

TABLE 4.18

Radiological Airborne Releases from Building 212, 2003

Direction	Distance to Perimeter (m)	Dose[a] (mrem/yr)	Distance to Nearest Resident (m)	Dose[a] (mrem/yr)
N	800	3.2×10^{-3}	2,000	7.4×10^{-4}
NNE	1,000	2.8×10^{-3}	2,500	6.4×10^{-4}
NE	1,300	1.9×10^{-3}	2,000	9.4×10^{-4}
ENE	1,500	1.5×10^{-3}	2,500	6.7×10^{-4}
E	1,600	1.1×10^{-3}	2,800	4.7×10^{-4}
ESE	1,200	1.5×10^{-3}	2,500	4.6×10^{-4}
SE	1,400	9.5×10^{-4}	3,500	2.2×10^{-4}
SSE	1,400	1.4×10^{-3}	4,500	2.1×10^{-4}
S	1,500	8.3×10^{-4}	5,000	1.4×10^{-4}
SSW	1,600	1.2×10^{-3}	5,000	2.1×10^{-4}
SW	1,400	1.7×10^{-3}	2,400	9.1×10^{-4}
WSW	1,300	8.7×10^{-4}	2,300	3.5×10^{-4}
W	1,700	7.8×10^{-4}	2,200	5.2×10^{-4}
WNW	1,500	5.9×10^{-4}	2,000	3.8×10^{-4}
NW	1,300	8.0×10^{-4}	2,000	4.1×10^{-4}
NNW	1,000	1.6×10^{-3}	2,000	5.5×10^{-4}

Source terms:	hydrogen-3 (HT)	=	78.8 Ci
	hydrogen-3 (HTO)	=	8.38 Ci
	krypton-85	=	13.6 Ci
	antimony-125	=	1.3×10^{-6} Ci
	iodine-125	=	2.2×10^{-6} Ci
	iodine-129	=	5.8×10^{-6} Ci
	cesium-134	=	1.2×10^{-8} Ci
	cesium-137	=	7.4×10^{-8} Ci
	europium-154	=	4.5×10^{-9} Ci
	europium-155	=	1.1×10^{-9} Ci
	radon-220	=	1.88 Ci
	plutonium-238	=	4.0×10^{-9} Ci
	plutonium-239	=	4.3×10^{-10} Ci
	americium-241	=	1.1×10^{-9} Ci
	americium-243	=	8.1×10^{-11} Ci
	curium-244	=	1.1×10^{-8} Ci.

TABLE 4.19

Maximum Perimeter and Individual Doses
from Building 212 Air Emissions, 2003
(dose in mrem/yr)

Pathway	Perimeter (800 m N)	Individual (2,000 m NE)
Ingestion	7.5×10^{-4}	2.2×10^{-4}
Inhalation	2.4×10^{-3}	7.1×10^{-4}
Air immersion	4.1×10^{-6}	1.2×10^{-6}
Ground surface	7.6×10^{-6}	2.0×10^{-6}
Total	3.2×10^{-3}	9.4×10^{-4}
Radionuclide		
Hydrogen-3	3.2×10^{-3}	9.3×10^{-4}
Krypton-85	6.1×10^{-6}	1.8×10^{-6}
Antimony-125	2.1×10^{-7}	7.1×10^{-8}
Iodine-125	1.6×10^{-7}	4.3×10^{-8}
Iodine-129	1.4×10^{-5}	3.7×10^{-6}
Cesium-134	5.9×10^{-9}	2.0×10^{-9}
Cesium-137	1.3×10^{-9}	4.1×10^{-10}
Europium-154	5.6×10^{-9}	1.9×10^{-9}
Europium-155	5.6×10^{-11}	1.9×10^{-11}
Radon-220	2.6×10^{-5}	9.0×10^{-7}
Plutonium-238	2.8×10^{-7}	8.2×10^{-8}
Plutonium-239	3.2×10^{-8}	9.4×10^{-9}
Americium-241	1.3×10^{-7}	3.8×10^{-8}
Americium-243	9.6×10^{-9}	2.8×10^{-9}
Curium-244	6.9×10^{-7}	2.0×10^{-7}
Total	3.9×10^{-3}	9.4×10^{-4}

CEDE conversion factor for ingestion (Table 4.27) to obtain the dose received in that year. This procedure was carried out for all radionuclides, and the individual results were summed to obtain the total ingestion dose.

The only significant location where radionuclides attributable to ANL-E operations could be found in off-site water was Sawmill Creek below the wastewater outfall (see Table 4.7). Although this water is not used for drinking purposes, the 50-year effective dose equivalent was calculated for a hypothetical individual ingesting water at the radionuclide concentrations measured at that location. Those radionuclides added to Sawmill Creek by ANL-E wastewater,

TABLE 4.20

Radiological Airborne Releases from Building 350, 2003

Direction	Distance to Perimeter (m)	Dose[a] (mrem/yr)	Distance to Nearest Resident (m)	Dose[a] (mrem/yr)
N	1,700	2.2×10^{-4}	2,200	1.5×10^{-4}
NNE	1,800	2.5×10^{-4}	3,200	1.1×10^{-4}
NE	2,200	1.9×10^{-4}	3,100	1.1×10^{-4}
ENE	2,000	2.2×10^{-4}	3,100	1.1×10^{-4}
E	1,700	2.3×10^{-4}	2,500	1.0×10^{-4}
ESE	900	4.6×10^{-4}	3,000	8.5×10^{-5}
SE	900	3.5×10^{-4}	3,000	7.7×10^{-5}
SSE	700	6.0×10^{-4}	2,700	1.1×10^{-4}
S	600	3.7×10^{-4}	2,700	7.3×10^{-5}
SSW	400	8.3×10^{-4}	2,500	1.4×10^{-4}
SW	600	8.8×10^{-4}	2,700	1.4×10^{-4}
WSW	800	3.4×10^{-4}	2,100	9.4×10^{-5}
W	900	3.5×10^{-4}	2,200	1.1×10^{-4}
WNW	1,000	1.9×10^{-4}	2,100	7.3×10^{-5}
NW	1,900	9.2×10^{-5}	2,400	6.7×10^{-5}
NNW	1,900	1.3×10^{-4}	2,200	1.1×10^{-4}

[a] Source terms:
neptunium-237 = 9.4×10^{-10} Ci
uranium-234 = 1.2×10^{-5} Ci
uranium-238 = 1.2×10^{-5} Ci
plutonium-238 = 4.8×10^{-8} Ci
plutonium-239 = 2.5×10^{-6} Ci
plutonium-240 = 3.2×10^{-7} Ci
plutonium-241 = 4.1×10^{-6} Ci
plutonium-242 = 4.9×10^{-10} Ci.

their net concentrations in the creek, and the corresponding dose rates (if water at these concentrations was used as the sole water supply by an individual for an entire year) are given in Table 4.28. The dose rates were all well below the standards for the general population. It should be emphasized that Sawmill Creek is not used for drinking, swimming, or boating. Inspection of the area shows that there are fish in the stream; however, they do not constitute a significant source of food for any individual. Figure 4.8 is a plot showing the estimated dose a hypothetical individual would receive if ingesting Sawmill Creek water since 1986.

As indicated in Table 4.7, occasional Sawmill Creek samples (fewer than 10%) contained traces of cesium-137, plutonium-238, curium-242 and 244, or californium-249 and 252;

TABLE 4.21

Maximum Perimeter and Individual Doses
from Building 350 Air Emissions, 2003
(dose in mrem/yr)

Pathway	Perimeter (600 m SW)	Individual (2,200 m N)
Ingestion	7.2×10^{-6}	1.3×10^{-6}
Inhalation	8.7×10^{-4}	1.5×10^{-4}
Air immersion	4.4×10^{-13}	7.6×10^{-14}
Ground surface	9.5×10^{-8}	1.7×10^{-8}
Total	8.8×10^{-4}	1.5×10^{-4}
Radionuclide		
Neptunium-237	1.0×10^{-7}	1.7×10^{-8}
Uranium-234	3.5×10^{-4}	6.0×10^{-5}
Uranium-238	3.1×10^{-4}	5.3×10^{-5}
Plutonium-238	3.4×10^{-6}	5.8×10^{-7}
Plutonium-239	1.9×10^{-4}	3.2×10^{-5}
Plutonium-240	2.4×10^{-5}	4.1×10^{-6}
Plutonium-241	4.7×10^{-6}	8.1×10^{-7}
Plutonium-242	3.5×10^{-8}	6.0×10^{-9}
Total	8.8×10^{-4}	1.5×10^{-4}

however, the averages were only slightly greater than the detection limit. The annual dose to an individual consuming water at these concentrations can be calculated with the same method used for those radionuclides more commonly found in creek water; this method of averaging, however, probably overestimates the true concentration. Annual doses range from 3×10^{-4} to 6×10^{-6} mrem/yr for these radionuclides.

DOE Order 5400.5[8] requires an evaluation of the dose to aquatic organisms from liquid effluents. The dose limit is 1 rad/day or 365 rad/yr. The location that could result in the highest dose to aquatic organisms is in Sawmill Creek downstream of the point where ANL-E discharges its treated wastewater. Inspection of the creek at this location indicates the presence of small bluegill and carp (about 100 g [4 oz] each). The aquatic dose assessment of these species was conducted using the DOE Technical Standard, *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota*.[19] The assessment used the general screening approach, which compares maximum water and sediment radionuclide concentrations with biota concentration guides (BCGs). Maximum water concentrations for hydrogen-3, strontium-90,

TABLE 4.22

Radiological Airborne Releases from Building 375 (IPNS), 2003

Direction	Distance to Perimeter (m)	Dose[a] (mrem/yr)	Distance to Nearest Resident (m)	Dose[a] (mrem/yr)
N	1,600	1.0×10^{-1}	3,200	2.8×10^{-2}
NNE	1,700	1.3×10^{-1}	3,100	3.7×10^{-2}
NE	1,700	1.3×10^{-1}	2,700	4.9×10^{-2}
ENE	1,500	1.4×10^{-1}	2,500	5.6×10^{-2}
E	600	5.5×10^{-1}	2,500	5.2×10^{-2}
ESE	600	4.8×10^{-1}	2,500	3.9×10^{-2}
SE	600	3.5×10^{-1}	2,500	2.6×10^{-2}
SSE	600	5.4×10^{-1}	3,000	3.0×10^{-2}
S	800	2.1×10^{-1}	3,000	2.1×10^{-2}
SSW	800	3.6×10^{-1}	3,500	2.4×10^{-2}
SW	800	3.9×10^{-1}	4,000	2.1×10^{-2}
WSW	1,500	6.4×10^{-2}	2,700	2.1×10^{-2}
W	2,200	4.5×10^{-2}	2,700	2.8×10^{-2}
WNW	1,500	5.0×10^{-2}	2,600	1.7×10^{-2}
NW	2,200	2.7×10^{-2}	2,500	2.1×10^{-2}
NNW	1,800	5.8×10^{-2}	2,200	4.0×10^{-2}

[a] Source terms: carbon-11 = 2205.4 Ci
argon-41 = 88.0 Ci.

plutonium-239, and americium-241 were obtained from Table 4.7, while maximum sediment concentrations for cesium-137, plutonium-239, and americium-241 were obtained from Table 4.10. Summing the ratios of their respective BCGs for each radionuclide resulted in a dose estimate of 0.0034 rad/yr to aquatic biota. This is well below the 365 rad/yr limit in DOE Order 5400.5 and demonstrates compliance with the limit.

Sawmill Creek flows into the Des Plaines River. The flow rate of Sawmill Creek (see Section 1.6) is about 0.28 m^3/s (10 ft^3/s); the flow rate of the Des Plaines River in the vicinity of ANL-E is about 25 m^3/s (900 ft^3/s). Applying this ratio to the concentration of radionuclides in Sawmill Creek listed in Table 4.28, the dose to a hypothetical individual ingesting water from the Des Plaines River at Lemont would be about 0.0002 mrem/yr. Significant additional dilution occurs further downstream. Very few people, either directly or indirectly, use the Des Plaines River as a source of drinking water. If 100 people used Des Plaines River water at the hypothetical concentration at Lemont, the estimated population dose would be about 10^{-5} person-rem.

TABLE 4.23

Maximum Perimeter and Individual Doses from Building 375 (IPNS) Air Emissions, 2003 (dose in mrem/yr)

Pathway	Perimeter (600 m E)	Individual (2,500 m ENE)
Ingestion	–[a]	–
Inhalation	2.3×10^{-2}	2.3×10^{-3}
Air immersion	5.1×10^{-1}	5.1×10^{-2}
Ground surface	1.9×10^{-2}	2.4×10^{-3}
Total	5.6×10^{-1}	5.6×10^{-2}
Radionuclide		
Carbon-11	5.3×10^{-1}	5.2×10^{-2}
Argon-41	2.7×10^{-2}	3.2×10^{-3}
Total	5.6×10^{-1}	5.6×10^{-2}

[a] A dash indicates no exposure by this pathway.

4.7.3. External Direct Radiation Pathway

The TLD measurements given in Section 4.5 were used to calculate the radiation dose from external sources. Above-background doses attributable to ANL-E operations were found at the southern boundary near the Waste Storage Facility (Location 7I).

At Location 7I, the fence-line dose from ANL-E was 103 ± 23 mrem/yr. Approximately 300 m (960 ft) south of the fence line (grid 6I), the measured dose was 97 ± 11 mrem/yr, slightly higher than the off-site average (87 ± 5 mrem/yr). No individuals live in this area. The closest residents are about 1.6 km (1 mi) south of the fence line. At this distance, the calculated dose rate from the Waste Storage Facility would be 0.001 mrem/yr, if the energy of the radiation was that of a 0.66-MeV cesium-137 gamma ray, and approximately 0.003 mrem/yr, if the energy was that of a 1.33-MeV cobalt-60 gamma ray.

At the fence line, where higher doses were measured, the land is wooded and unoccupied. All of these dose calculations are based on full-time, outdoor exposure. Actual exposures to individuals would be substantially less because some of the individuals are indoors (which provides shielding) or away from their dwellings for part of the time. In addition to the permanent resident in the area, occasionally visitors may conduct activities around ANL-E that

TABLE 4.24

Radiological Airborne Releases from Building 411/415 (APS), 2003

Direction	Distance to Perimeter (m)	Dose[a] (mrem/yr)	Distance to Nearest Resident (m)	Dose[a] (mrem/yr)
N	1,500	4.7×10^{-4}	2,000	2.6×10^{-4}
NNE	1,600	5.1×10^{-4}	2,100	2.9×10^{-4}
NE	2,200	2.7×10^{-4}	3,100	1.3×10^{-4}
ENE	2,500	2.0×10^{-4}	3,300	1.1×10^{-4}
E	1,600	4.4×10^{-4}	3,400	8.8×10^{-5}
ESE	1,500	4.1×10^{-4}	3,500	6.6×10^{-5}
SE	400	3.7×10^{-3}	3,000	5.7×10^{-5}
SSE	400	5.8×10^{-3}	3,000	9.4×10^{-5}
S	350	4.2×10^{-3}	2,500	1.0×10^{-4}
SSW	400	6.1×10^{-3}	2,800	1.2×10^{-4}
SW	550	3.8×10^{-3}	3,000	1.1×10^{-4}
WSW	800	9.1×10^{-4}	1,400	2.9×10^{-4}
W	800	1.2×10^{-3}	1,500	3.3×10^{-4}
WNW	500	1.7×10^{-3}	1,400	2.2×10^{-4}
NW	350	3.4×10^{-3}	1,600	1.9×10^{-4}
NNW	1,500	3.2×10^{-4}	2,000	1.8×10^{-4}

[a] Source terms: carbon-11 = 0.15 Ci (estimated)
nitrogen-13 = 10.71 Ci (estimated)
oxygen-15 = 1.16 Ci (estimated).

could result in exposure to radiation from this site. Examples of these activities could be cross-country skiing, horseback riding, or running in the fire lane next to the perimeter fence. If the individual spent 10 minutes per week adjacent to the 317 Area, the dose would be 0.001 mrem/yr at the 317 Area fence (Location 7I) from ANL-E operations.

4.7.4. Dose Summary

The total effective dose equivalent received by off-site residents during 2003 was a combination of the individual doses received through the separate pathways. Radionuclides that contributed through the air pathway are hydrogen-3, carbon-11, nitrogen-13, oxygen-15, argon-41, krypton-85, radon-220 (plus daughters), and actinides. The highest dose was approximately 0.057 mrem/yr to individuals living east of the site if they were outdoors at that location during the entire year. The total annual population dose to the entire area within an 80-km (50-mi) radius was 3.7 person-rem. The dose pathways are presented in Table 4.29 and are compared with the applicable standards.

TABLE 4.25

Maximum Perimeter and Individual Doses
from Building 411/415 (APS) Air Emissions, 2003
(dose in mrem/yr)

Pathway	Perimeter (400 m SSW)	Individual (1,500 m W)
Ingestion	–[a]	–
Inhalation	1.8×10^{-4}	9.8×10^{-6}
Air immersion	5.9×10^{-3}	3.2×10^{-4}
Ground surface	1.0×10^{-4}	6.8×10^{-6}
Total	6.1×10^{-3}	3.3×10^{-4}
Radionuclide		
Carbon-11	8.7×10^{-5}	5.7×10^{-6}
Nitrogen-13	5.7×10^{-3}	3.2×10^{-4}
Oxygen-15	3.9×10^{-4}	8.8×10^{-6}
Total	6.1×10^{-3}	3.3×10^{-4}

[a] A dash indicates no exposure by this pathway.

To receive the maximum public dose, a hypothetical individual would need to live at the point of maximum air and direct radiation exposure and use only water from Sawmill Creek below the ANL-E wastewater discharge. This is a very conservative and unlikely situation. To put the maximum individual dose of 0.080 mrem/yr attributable to ANL-E operations into perspective, comparisons can be made with annual average doses (360 mrem) from natural or accepted sources of radiation received by an average American who could be living anywhere in the United States. These values are listed in Table 4.30. These site-related doses are in addition to the background doses. The magnitude of the doses received from ANL-E operations is insignificant compared with these sources. Therefore, the monitoring program results establish that the radioactive emissions from ANL-E are very low and do not endanger the health or safety of those living in the vicinity of the site.

TABLE 4.26

Population Dose within 80 km
(50 mi), 2003

Radionuclide	Person-rem
Hydrogen-3	0.15
Carbon-11	2.95
Nitrogen-13	<0.01
Oxygen-15	<0.01
Argon-41	0.53
Krypton-85	<0.01
Antimony-125	<0.01
Iodine-125	<0.01
Iodine-129	<0.01
Cesium-134	<0.01
Cesium-137	<0.01
Europium-154	<0.01
Europium-155	<0.01
Radon-220	<0.01
Uranium-234	0.02
Uranium-238	0.02
Neptunium-237	<0.01
Plutonium-238	<0.01
Plutonium-239	0.01
Plutonium-240	<0.01
Plutonium-241	<0.01
Plutonium-242	<0.01
Americium-241	<0.01
Americium-243	<0.01
Curium-244	<0.01
Total	3.7
Natural	2.7×10^6

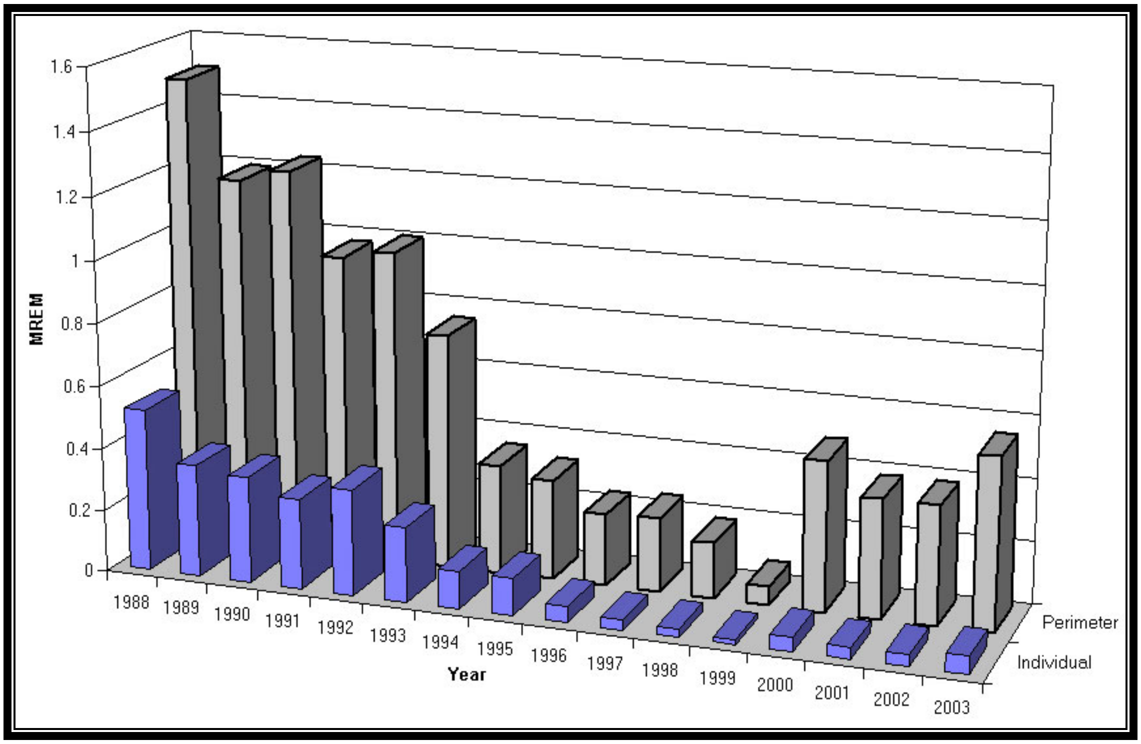


FIGURE 4.6 Individual and Perimeter Doses from Airborne Radioactive Emissions

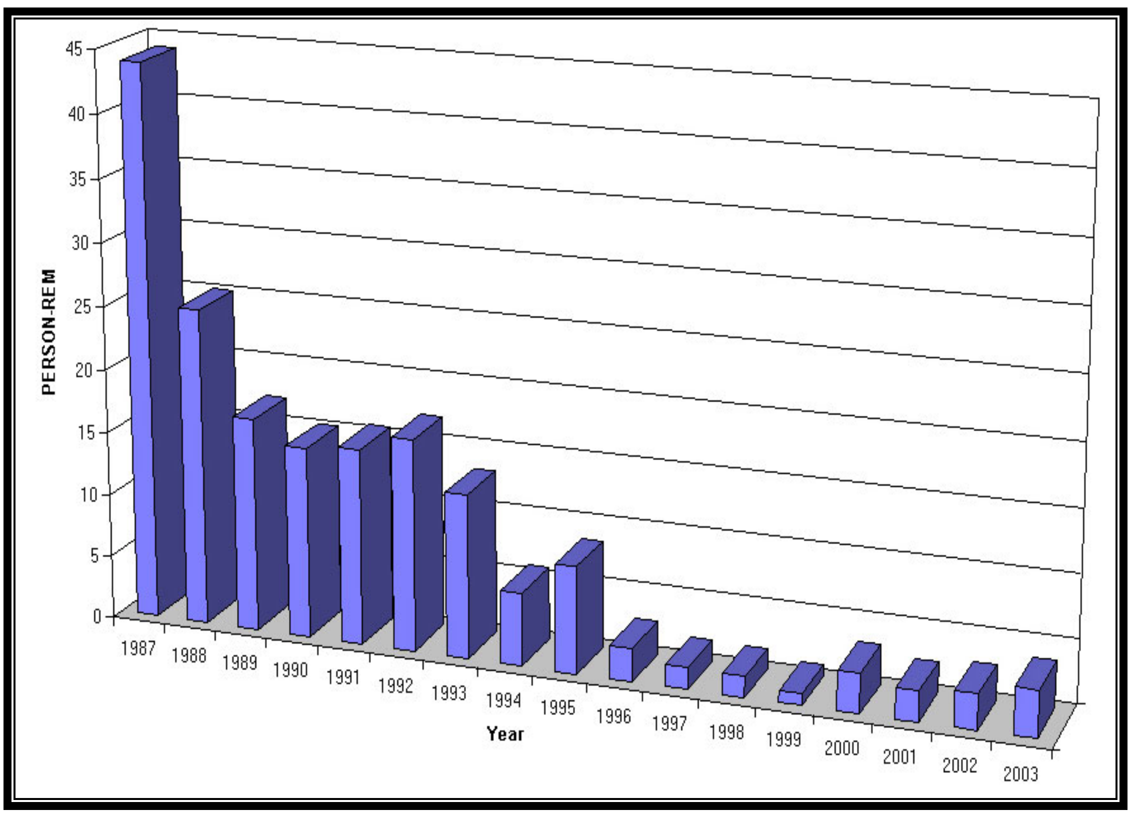


FIGURE 4.7 Population Dose from Airborne Radioactive Emissions

TABLE 4.27

50-Year Committed Effective Dose Equivalent (CEDE) Conversion Factors (rem/µCi)

Nuclide	Ingestion	Inhalation
Hydrogen-3	6.3×10^{-5}	9.6×10^{-5}
Beryllium-7	–[a]	2.7×10^{-4}
Carbon-11	–	8.0×10^{-6}
Strontium-90	0.13	1.32
Cesium-137	0.05	0.032
Lead-210	–	13.2
Radium-226	1.1	–
Thorium-228	–	310
Thorium-230	–	260
Thorium-232	–	1100
Uranium-234	0.26	130
Uranium-235	0.25	120
Uranium-238	0.23	120
Neptunium-237	3.9	–
Plutonium-238	3.8	–
Plutonium-239	4.3	330
Americium-241	4.5	–
Curium-242	0.11	–
Curium-244	2.3	–
Californium-249	4.6	–
Californium-252	0.94	–

[a] A dash indicates that a value is not required.

TABLE 4.28

Radionuclide Concentrations and Dose Estimates for Sawmill Creek Water, 2003

Radionuclide	Total Released (Ci)	Net Avg. Concentration (pCi/L)	Dose (mrem)
Hydrogen-3	0.080	22	0.0010
Strontium-90	0.0005	0.21	0.020
Plutonium-239	<0.0001	0.0003	0.0009
Americium-241	<0.0001	0.00004	0.0001
Total	0.080		0.022

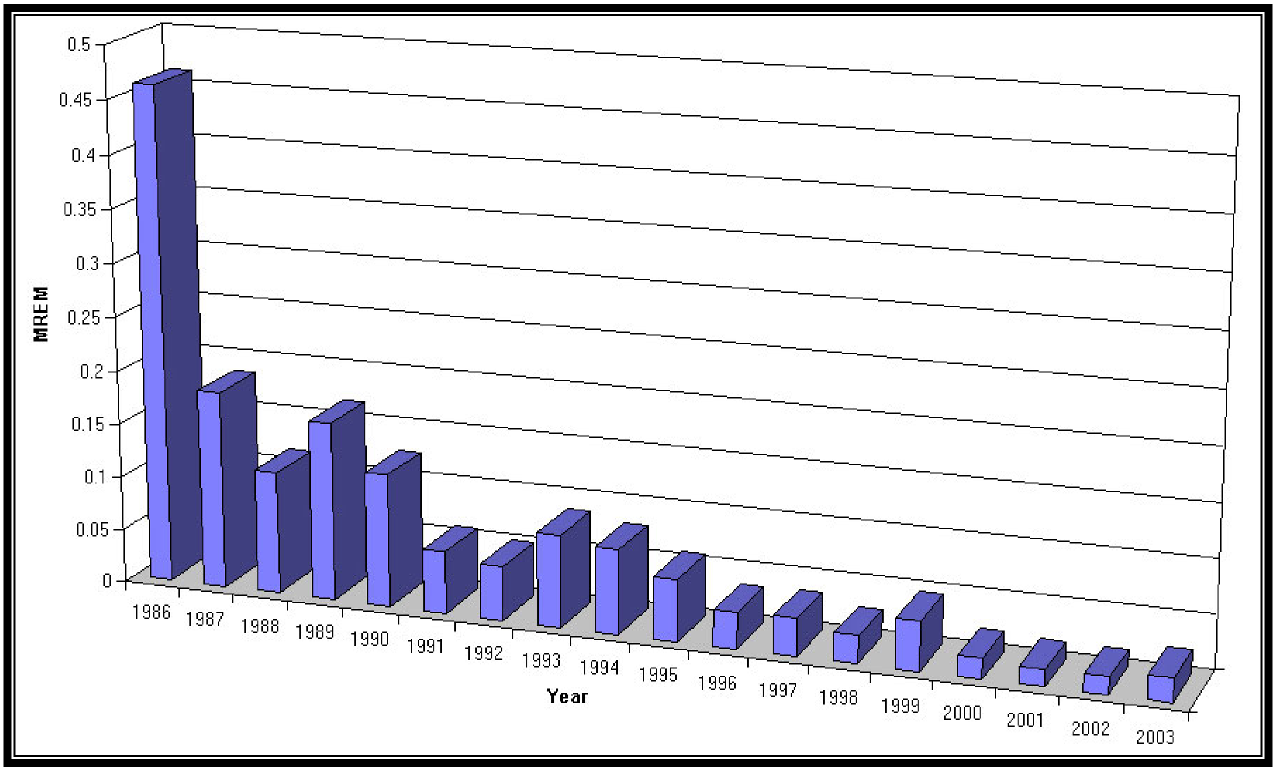


FIGURE 4.8 Comparison of Dose Estimate from Ingestion of Sawmill Creek Water

TABLE 4.29

Summary of the Estimated Dose to a Hypothetical Individual, 2003 (mrem/yr)

Pathway	ANL-E Estimate	Applicable Standard
Air total	0.057	None
Water	0.022	4 (EPA)[a]
Direct radiation	0.001	25 (NRC)
Maximum dose	0.080	100 (DOE)

[a] The 4-mrem/yr EPA value is not an applicable standard since it applies to community water systems.[20] It is used here for illustrative purposes.

TABLE 4.30

Annual Average Dose Equivalent in the U.S. Population[a]

Source	Dose (mrem)
Natural	
Radon	200
Internal (potassium-40 and radium-226)	39
Cosmic	28
Terrestrial	28
Medical	
Diagnostic x-rays	39
Nuclear medicine	14
Consumer products	
Domestic water supplies, building materials, etc.	10
Occupational (medical radiology, industrial radiography, research, etc.)	1
Nuclear fuel cycle	<1
Fallout	<1
Other miscellaneous sources	<1
Total	360

[a] National Council on Radiation Protection and Measurements Report No. 93.[17]

5. ENVIRONMENTAL NONRADIOLOGICAL PROGRAM INFORMATION

5. ENVIRONMENTAL NONRADIOLOGICAL PROGRAM INFORMATION

The nonradiological monitoring program primarily involves the collection and analysis of surface water and groundwater samples from numerous locations throughout the site. Chapter 3 provides a detailed discussion of the environmental monitoring program. The amount of nonradiological pollutants released to the air from ANL-E is extremely small (see Table 2.4), except for the conventional air pollutants emitted from the boiler house while burning coal. This unit is equipped with dedicated monitoring equipment for sulfur dioxide and opacity while burning coal. No exceedances were noted during 2003 over a period of 2,870 hours of coal-burning operation of Boiler No. 5, the coal-burning boiler (see Section 2.1.2). No other air monitoring for nonradiological pollutants is performed, except for landfill gas monitoring (see Section 2.1.2).

Surface water samples for nonradiological chemical analyses are collected from NPDES-permitted outfalls and Sawmill Creek.[21] Analyses conducted on the samples from the NPDES outfalls vary, depending on the permit-mandated monitoring requirements for each outfall. The results of the analyses are compared with the permit limits for each outfall to determine whether they comply with the permit. In addition to being published in this report, the NPDES monitoring results are transmitted monthly to the IEPA in an official DMR.

In addition to the permit-required monitoring, other analyses are conducted on samples collected from the combined wastewater outfall (NPDES Outfall 001) to provide a more complete evaluation of the impact of the wastewater on the environment. Water samples from Sawmill Creek are also collected and analyzed for a number of inorganic constituents. The results of these additional analyses of the main outfall and receiving streams are then compared with IEPA General Effluent Standards and Stream Quality Standards listed in IAC, Title 35, Subtitle C, Chapter I.[22]

5.1. National Pollutant Discharge Elimination System Monitoring Results

5.1.1. Influent Monitoring

Since 1989, analyses of the laboratory wastewater influent have shown the presence of a variety of VOCs with variable concentrations. Although disposing of waste chemicals to the drain is not authorized, residual VOCs are released to the laboratory sewer from laboratory-related activities such as rinsing glassware. Also, VOCs are known to be discharged into the laboratory sewer from the 317/319 Lift Station, which pumps contaminated groundwater generated by ANL-E's RCRA corrective actions. Table 5.1 gives the results of the analysis of laboratory wastewater influent.

The 2003 results for laboratory influent wastewater are quite similar to those from 1997 through 2002 with the exception of acetone. The average acetone level was substantially greater in 2003 (117 μg/L) than in 2002 (18 μg/L). Table 5.1 gives the 2003 results for the most

TABLE 5.1

Laboratory Influent Wastewater, 2003
(concentrations in µg/L)

Month	Acetone	Chloroform	Bromodi-chloroethane	Dibromo-chloromethane	Bromoform
January	4	1	1	<1	<1
February	73	13	2	1	<1
March	7	4	2	1	<1
April	17	4	3	1	1
May	<1	4	2	1	<1
June	747	5	3	1	<1
July	<1	4	2	1	<1
August	90	5	3	1	<1
September	192	21	3	2	4
October	22	5	3	2	<1
November	10	6	3	1	<1
December	4	6	3	1	<1
Average	117	7	3	1	<3

common compounds detected. Bromoform, bromodichloromethane, chloroform, and dibromochloromethane are halomethanes that are produced as the result of contact of the chlorinated water supply with organic chemicals. Research activity may account for the presence of other volatiles.

As in previous years, acetone was detected in 10 samples and levels ranged up to 747 µg/L. The yearly average was greater than the past five years (Figure 5.1). Infrequent trace levels of other chemicals, that is, 2-butanone, acetaldehyde, ethanol, 1-propanol, 2-propanol, 1-butanol, ethyl acetate, toluene, and tetrahydrofuran, were also noted but not shown in Table 5.1.

Figures 5.1 and 5.2 present comparisons of the 1992 through 2003 laboratory influent wastewater results for the two more common VOCs, acetone and chloroform. The presence of acetone is likely due to laboratory activities such as rinsing glassware. Disposing of hazardous chemicals down laboratory drains is not authorized at ANL-E. ANL-E conducts a waste generator education program as part of its site safety awareness training program, in which proper handling and disposal of chemicals are explained. However, normal use of certain chemicals, such as acetone, often results in the discharge of small amounts into the sewer. The decrease in influent concentrations of acetone and chloroform over the past several years shows the effectiveness of educational efforts related to waste disposal and pollution prevention.

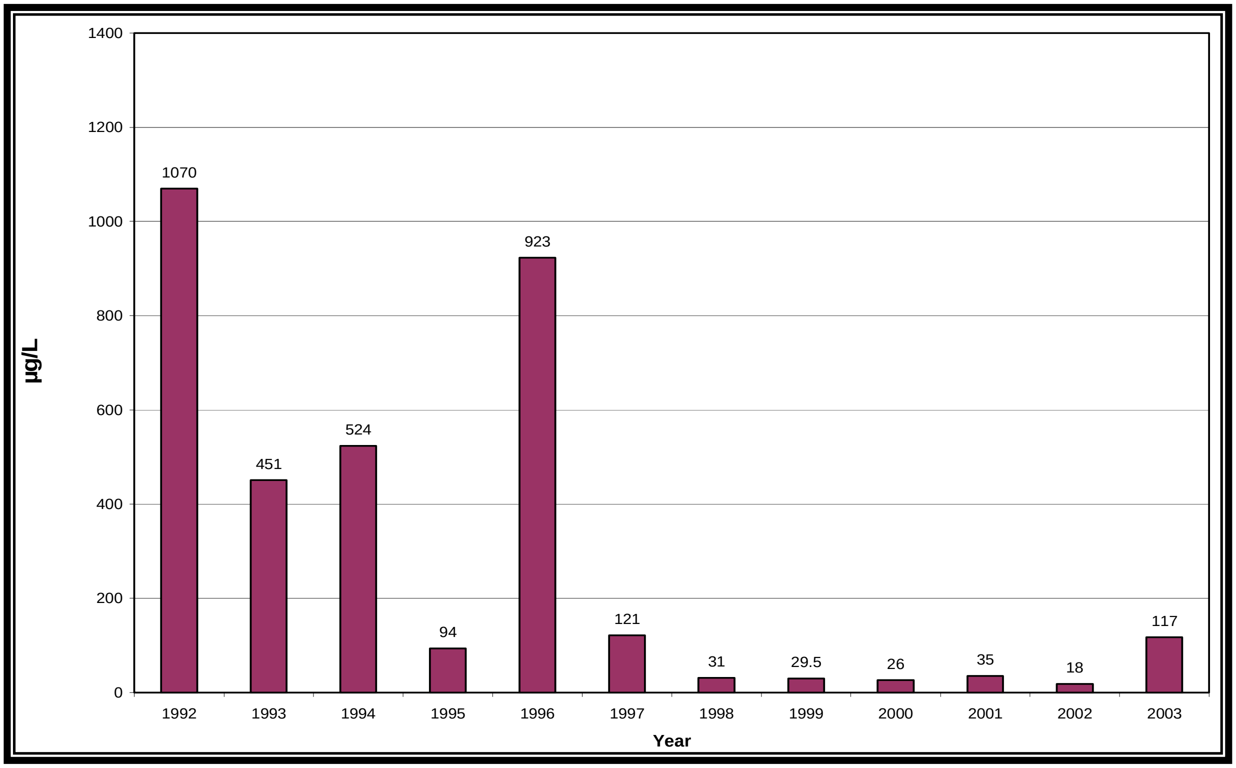


FIGURE 5.1 Average Acetone Levels in Laboratory Influent Wastewater, 1992 to 2003

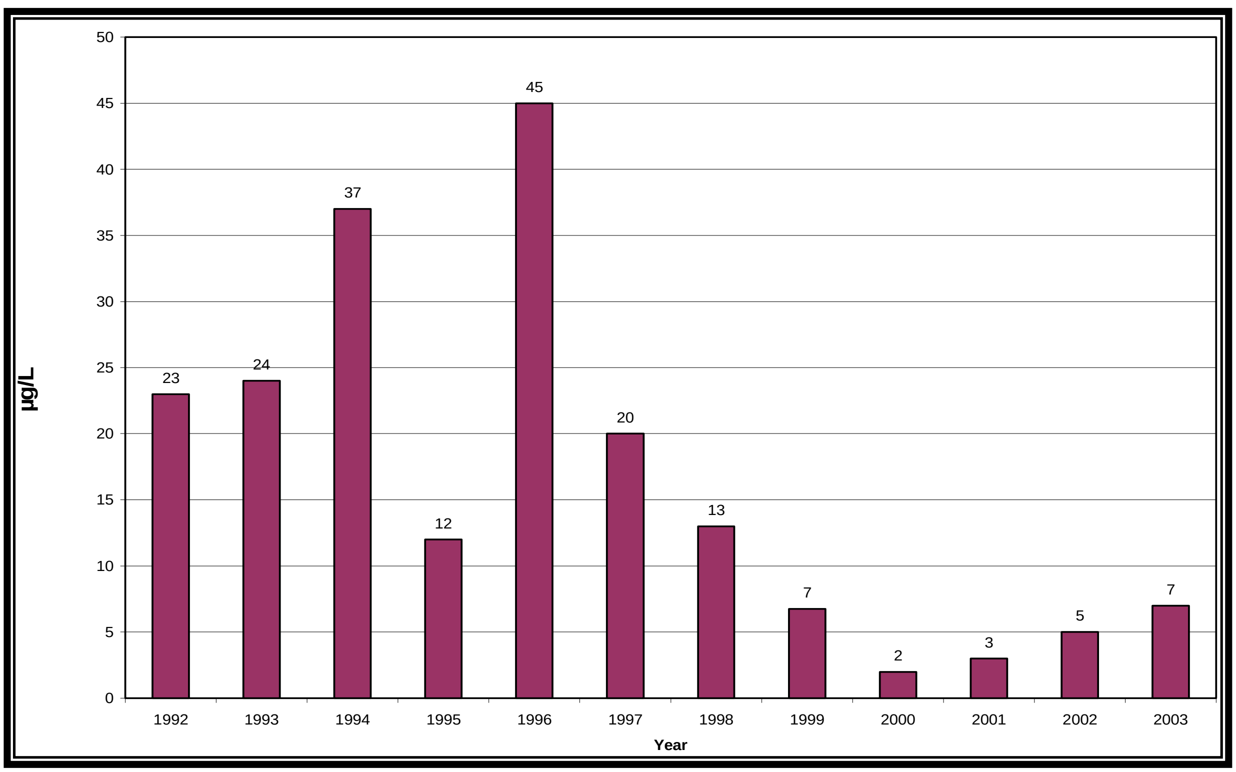


FIGURE 5.2 Average Chloroform Levels in Laboratory Influent Wastewater, 1992 to 2003

5.1.2. Effluent Monitoring

Section 2.2 of Chapter 2 describes the outfalls on the ANL-E site; Table 2.5 lists all the outfalls. In general, the outfalls fall into two groups: those that have some type of process wastewater discharge and those that contain only storm water runoff following a rain event. The sampling requirements of the process wastewater outfalls depend on the nature of the activity generating the wastewater. This section discusses those requirements and the results of the monitoring. The storm water outfalls are listed in the permit, but they do not require routine monitoring of the discharges.

Effluent samples are collected from ANL-E point-source discharges (outfalls) as specified by the NPDES Permit. The permit specifies the frequency of sample collection and the specific parameters to be monitored for each individual outfall. Sample collection, preservation, holding times, and analytical methods are specified by the EPA as codified in 40 CFR Part 136, Tables 1B and 2.[23]

The NPDES outfall locations are shown in Figure 5.3. Outfalls 001A and 001B, the two internal monitoring points representing the effluent from the sanitary system and laboratory system, respectively, are both located at the WTP. Their flows combine to form Outfall 001, which also is located at the treatment facility. The combined stream flows through an outfall pipe that discharges into Sawmill Creek approximately 1,100 m (3,500 ft) south of the treatment plant.

In addition to the main wastewater outfalls, a small amount of process wastewater, primarily cooling tower blowdown and cooling water, is discharged directly to small streams and ditches throughout the site. This wastewater does not contain significant amounts of contaminants and does not require treatment before discharge. These discharge points are included in the site NPDES Permit as separate regulated outfalls. Most of the cooling tower-associated discharges have been rerouted to the ANL-E sewer system.

5.1.2.1. Sample Collection

All samples are collected in specially cleaned and labeled bottles with appropriate preservatives added. Custody seals and chain of custody sheets also are used. All samples are analyzed within the required holding time. Samples are collected at Locations 001A, 001B, and 001 on a weekly basis, consistent with permit requirements. Similarly, samples are collected at the other locations in accordance with the NPDES Permit.

5.1.2.2. Sample Analyses — NPDES

NPDES sample analyses were performed in accordance with standard operating procedures (SOPs) that were issued as controlled documents. These SOPs cite protocols that can be found in 40 CFR Part 136, “Test Procedures for the Analysis of Pollutants under the Clean

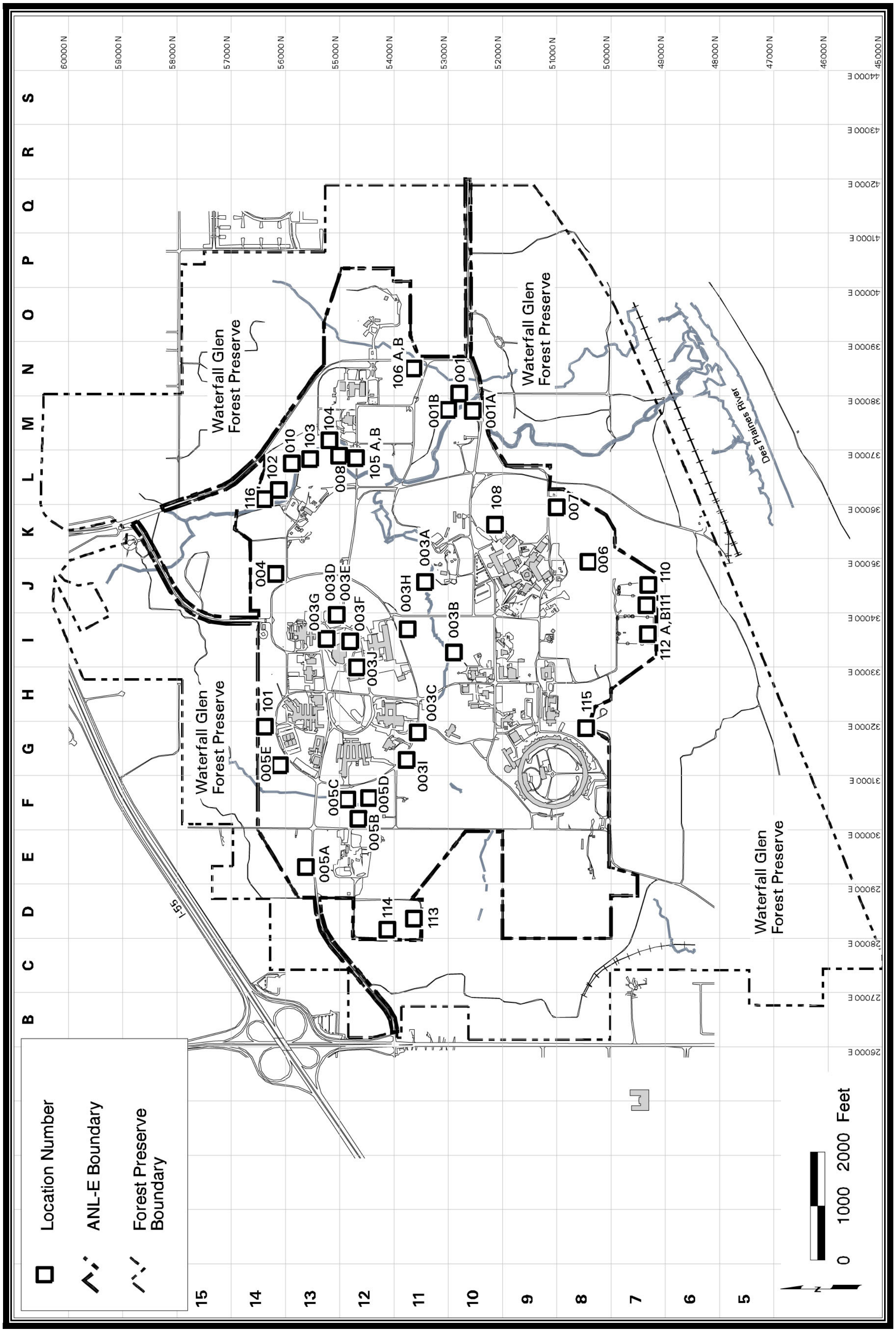


FIGURE 5.3 NPDES Outfall Locations

Water Act."[23] Six metal analyses were performed by using inductively coupled plasma atomic emission spectroscopy. Mercury was determined by cold vapor atomic absorption spectroscopy. Hexavalent chromium determination and chemical oxygen demand (COD) were performed by using a colorimetric technique. BOD_5 was determined by using a dissolved oxygen probe. TSS, TDS, and oils and grease were determined gravimetrically. Sulfate determination was performed by using a turbidimetric technique; chloride was determined by titrimetry. Ammonia nitrogen was determined by distillation, followed by an ion-selective electrode measurement. VOC concentrations were determined by using a purge and trap sample pretreatment, followed by gas chromatography-mass spectroscopy detection. The PCB Aroclor-1260® concentrations were determined by solvent extraction, followed by gas chromatography-electron capture detection. Beta radioactivity was performed by using a gas flow proportional counting technique. Hydrogen-3 concentrations were determined by distillation, followed by a beta liquid scintillation counting technique.

NPDES Outfall 001B is sampled and analyzed semiannually for priority pollutant compounds. VOCs were determined by using a purge and trap sample pretreatment, followed by gas chromatography-mass spectroscopy detection. Semivolatile organic compounds (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. Thirteen metals were determined by graphite furnace atomic absorption and inductively coupled plasma atomic emission spectroscopy. Cyanide and phenol were determined by distillation, followed by a spectrophotometric measurement.

NPDES Outfall 001 is sampled and analyzed annually during June for acute aquatic toxicity parameters. NPDES Outfalls 003H, 003I, 003J, 004, 006, and 115 are tested in July and August for acute aquatic toxicity. An off-site contract laboratory performs both the sample collection and analyses. The testing is performed by diluting a series of ANL-E effluent samples with Sawmill Creek receiving water, into which species of fish and invertebrates are introduced. Survival is measured over two to four days, and statistically significant mortality is reported as a function of effluent concentration.

5.1.2.3. Results

During 2003, approximately 99% of all NPDES analyses were in compliance with their applicable permit limits. Specific limit exceedances are discussed later in this section, as well as in Chapter 2. A discussion of the analytical results for each outfall follows.

5.1.2.4. Wastewater Treatment Facility Outfalls

Outfall 001A. This outfall consists of treated sanitary wastewater. Until fall of 2001, it also consisted of various wastewater streams from the boiler house area, including coal pile storm water runoff. These wastewater streams are now directed to the DuPage County system. The effectiveness of the sanitary wastewater treatment systems is evaluated by weekly monitoring for BOD_5, pH, and TSS. The limits for BOD_5 are a monthly average of 10 mg/L and a maximum value of 20 mg/L. The permit limits for TSS are a maximum concentration of 24 mg/L and a monthly average of 12 mg/L. The pH must range between values of 6 and 9. One exceedance of the maximum limit for BOD_5 was noted in 2003. The cause of the exceedance was not identified.

The permit requires weekly monitoring for total chromium, copper, iron, lead, manganese, zinc, and oil and grease. Table 5.2 gives the effluent limits for these parameters and monitoring results. Two limits are listed; one is a maximum limit for any single sample, and the other is for the average of all samples collected during the month. The constituents in Table 5.2 are present in the coal pile runoff. As of fall 2001, coal pile runoff is discharged to the laboratory sewage system. No limits were exceeded during 2003.

Outfall 001B. This outfall consists of processed wastewater from the laboratory wastewater system and the coal pile runoff. The permit requires that weekly samples be collected and analyzed for BOD_5, TSS, mercury, pH, and COD.

The limits established for BOD_5 are a daily maximum of 20 mg/L and a 30-day average of 10 mg/L. The permit also contains BOD_5 mass loading limits of 52 kg/day (114 lb/day) as a daily maximum and 26 kg/day (57 lb/day) as a 30-day average. The mass loading represents the weight of material discharged per day and is a function of concentration and flow. The daily maximum concentration limit for TSS is 24 mg/L; the 30-day average is 12 mg/L. The TSS mass loading limits are 62 maximum and 31 average kg/day (136 and 68 lb/day), respectively. One exceedance of the TSS mass loading limit was noted in 2003. This is believed to have been the result of a reduced clarifier retention time due to an excessive precipitation event on July 15, 2003.

TABLE 5.2

Outfall 001A Effluent Limits and Monitoring Results, 2003
(concentrations in mg/L)

Constituent	Minimum	Average	Average Limit	Maximum	Maximum Limit
Chromium	–[a]	<0.015	1.0	<0.015	2.0
Copper	<0.015	0.019	0.50	0.038	1.0
Iron	0.030	0.080	2.0	0.229	4.0
Lead	–	<0.10	0.20	<0.10	0.40
Manganese	<0.010	<0.023	1.0	0.149	2.0
Zinc	0.054	0.099	1.0	0.178	2.0
Oil and grease	–	<5.0	15.0	<5.0	30.0

[a] A dash indicates that there is no minimum value.

The daily maximum concentration limit for mercury is 0.006 mg/L; the 30-day average is 0.003 mg/L. The corresponding loading values are 0.02 kg/day (0.034 lb/day) and 0.01 kg/day (0.017 lb/day). No exceedances of the mercury loading and concentration limits were noted during 2003. The values obtained in 2003 ranged from less than 0.0001 to 0.0002 mg/L.

No concentration limits have been established for COD. The once-per-week grab samples give a rough indication of the organic and inorganic oxygen-consuming contents of this effluent stream. The values obtained in 2003 ranged from less than 10 to 21 mg/L.

A special condition at Location 001B requires monitoring for the 124 priority pollutants listed in the permit during the months of June and December. The June sampling is to be conducted at the same time that aquatic toxicity testing of Outfall 001 is conducted. Samples were collected on June 24, 2003, and December 2, 2003, and analyzed within the required holding times.

Analysis of these samples indicated that very small amounts of a few chemicals were present. The results for SVOCs, PCBs, and pesticides were all less than the detection limits. The results for metals were similar to concentrations historically found in ANL-E–treated drinking water. Very low levels of copper (0.015 and 0.017 mg/L), zinc (0.05 and 0.07 mg/L), and phenols (0.006 and 0.022 mg/L) were noted in the June and December samples. The samples contained some VOCs at very low levels. The majority of compounds detected were halomethanes, which are found in chlorinated drinking water. Table 5.3 lists the concentrations of volatile organics identified in these samples. Currently, no permit limits or effluent standards are available for these compounds for comparison with these results.

Outfall 001. After the treatment processes, the effluents from both the laboratory and sanitary WTP are combined to form one point-source discharge. The combined effluent flows through a 1,100-m (3,500-ft) outfall pipe where it is eventually discharged into Sawmill Creek.

Samples of the combined effluent are collected weekly or monthly as grab samples or 24-hour composite samples as specified in the NPDES Permit. The samples are analyzed for a variety of metals, ammonia nitrogen, chlorides, sulfates, TDS, pH, and beta radioactivity. The permit requires analysis of the combined effluent once a week for TDS, chloride, and sulfate. Table 5.4 gives the results, limits, and number of exceedances.

TABLE 5.3

Outfall 001B Effluent Priority Pollutant Monitoring Results, 2003 (concentrations in μg/L)

Compound	Concentration in June Sample	Concentration in December Sample
Bromodichloromethane	2	2
Bromoform	1	<1
Chloroform	3	6
Dibromochloromethane	1	1

One exceedance of the TDS limit was noted during 2003. The elevated TDS level occurred during the 2003 heating season. It is believed to be related to the combination of reduced flows, boiler blowdown, and increases in TDS

TABLE 5.4

Outfall 001 Monitoring Results and Effluent Limits, 2003
(concentrations in mg/L)

Constituent	Minimum	Average	Maximum	Limit	Exceedances
Chloride	97	191	445	500	0
Copper	<0.015	<0.018	0.029	0.051	0
TDS	518	707	1,163	1,000	1
Ammonia nitrogen	<0.01	0.4	1.5	10.0 (Nov.–March)	0
				3.0 (April–Oct.)	

concentrations from road salt. For the past several years, chemical analysis for chloride has indicated a close relationship between TDS levels and chloride levels. Figure 5.4 shows the results of TDS and chloride analyses for 1995 through 2003. Elevated TDS levels prior to 1997 are attributed to high TDS levels (800 mg/L) in ANL-E's domestic source water (i.e., groundwater, at that time).

In 1997, Lake Michigan water, which is characterized by low TDS levels (200 to 400 mg/L), became ANL-E's domestic source water. Figure 5.5 shows that average TDS levels at Outfall 001 have substantially decreased since the introduction of Lake Michigan water.

The permit requires that a biological toxicity screening test be performed on wastewater from Outfall 001 in June of each year. The toxicity testing is run on two trophic levels of aquatic species for acute toxicity. The 2003 testing was conducted on samples collected June 23 through 27; the water flea (*Ceriodaphnia dubia*) and fathead minnow (*Pimephales promelas*) were used.

No toxicity was observed to the fathead minnow or to the water flea. The concentration of wastewater that produces 50% mortality in the test population (i.e., the median lethal concentration [LC_{50}]) for both species is greater than 100%; that is, the pure, undiluted effluent is not toxic to these species. Tables 5.6 and 5.7 summarize the results of the toxicity tests from 2000 to 2003.

The permit also requires that weekly pH, ammonia nitrogen, dissolved iron, manganese, and zinc measurements be made. Monthly monitoring for lead, hexavalent and trivalent chromium, and beta radioactivity is required. No exceedances of these parameters were noted in 2003. In addition to the outfalls at the WTP, a number of other outfalls are monitored. The sampling requirements and effluent limits for these outfalls are described in Table 5.5.

Special Condition No. 9 of the NPDES Permit requires acute toxicity testing of the effluent from Outfalls 003H, 003I, 003J, 004, 006, and 115. The testing is performed on the fathead minnow and the water flea. The testing is performed during the months of July and August. These outfalls were sampled during the periods of July 21 to 25 and August 25 to 29, 2003. The results are summarized in Tables 5.6 and 5.7. The results are discussed by month below.

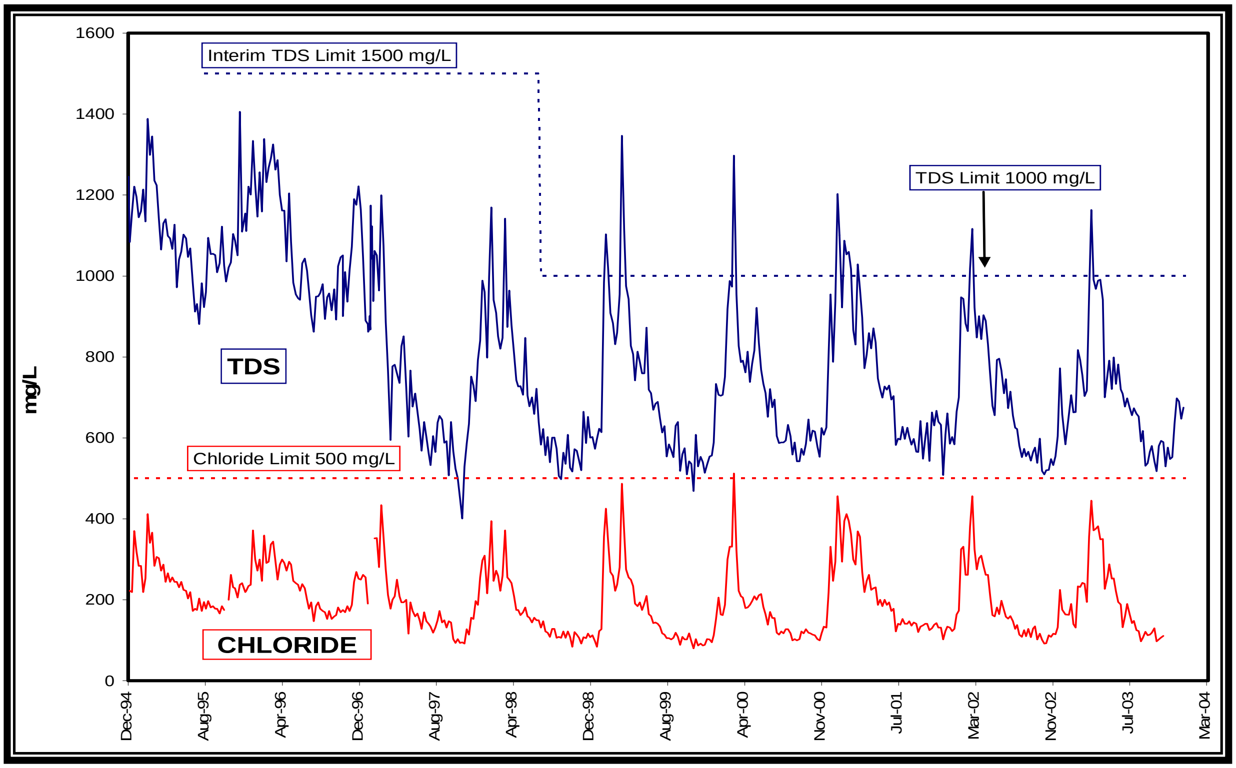


FIGURE 5.4 Total Dissolved Solids and Chloride in Outfall 001 Water, 1995 to 2003

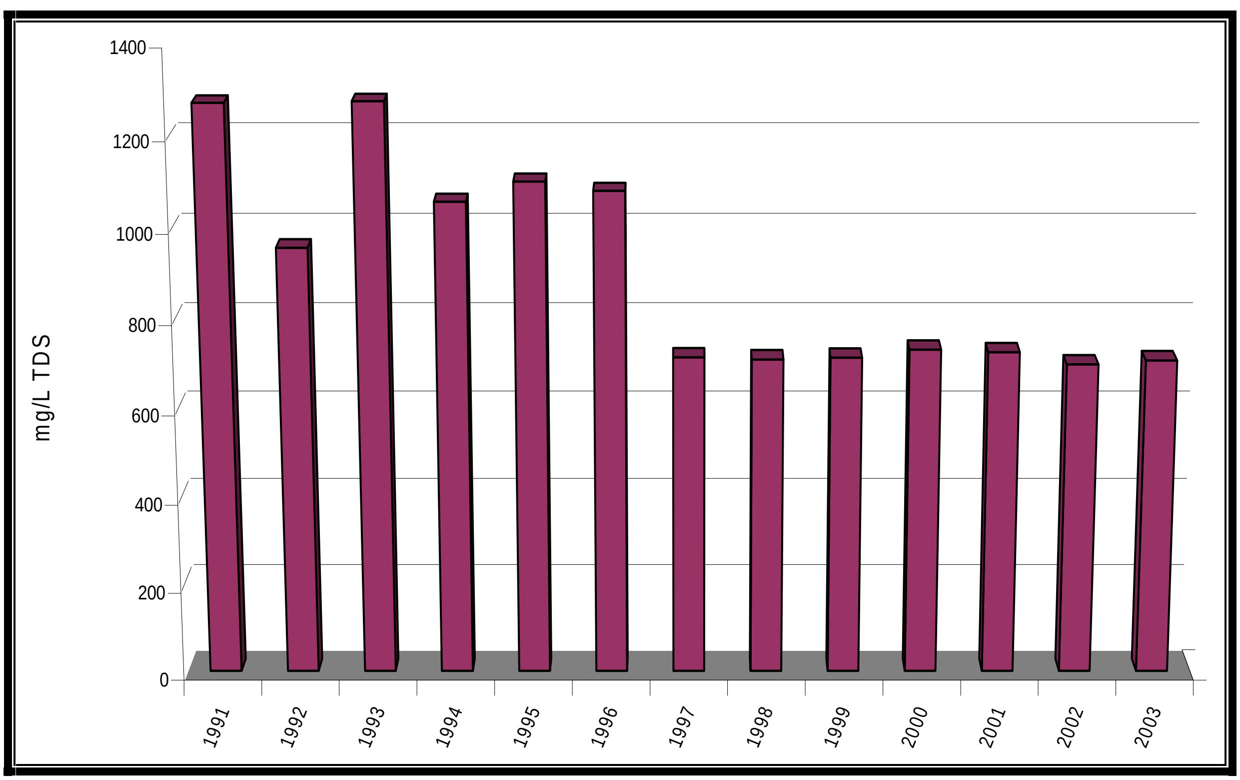


FIGURE 5.5 Average TDS Concentrations at NPDES Outfall 001, 1991 to 2003

TABLE 5.5

Summary of Monitored NPDES Outfalls, 2003

Discharge Location	No. of Samples	Permit Constituent	Limit 30-Day Average	Limit Daily Maximum	No. Exceeding Limit
003A	0	Flow	None		0
		pH	6–9		0
		TSS	15	30	0
		TRC[a]	0.05		0
003B	12	Flow	None		0
		pH	6–9		0
		Temperature	<2.8°C rise		0
003C	12	Flow	None		0
		pH	6–9		0
003D	12	Flow	None		0
		pH	6–9		0
		Temperature	<2.8°C rise		0
003E	11	Flow	None		0
		pH	6–9		0
		Temperature	<2.8°C rise		0
003F	9	Flow	None		0
		pH	6–9		0
		Temperature	<2.8°C rise		0
		TDS	Monitor only		NA[b]
003G	12	Flow	None		0
		pH	6–9		0
		Temperature	<2.8°C rise		0
003H	12	Flow	None		0
		pH	6–9		0
		Temperature	<2.8°C rise		0
		TDS	Monitor only		NA
003I	12	Flow	None		0
		pH	6–9		0
		Temperature	<2.8°C rise		0
		TDS	Monitor only		NA
		Oil and grease	Monitor only		NA
003J	11	Flow	None		0
		pH	6–9		0
		Temperature	<2.8°C rise		0
		TDS	Monitor only		NA

TABLE 5.5 (Cont.)

Discharge Location	No. of Samples	Permit Constituent	Limit		No. Exceeding Limit
			30-Day Average	Daily Maximum	
004	10	Flow	None		0
		pH	6–9		0
		TSS	15	30	0
005C	12	Flow	None		0
		pH	6–9		0
		Temperature	<2.8°C rise		0
		Oil and grease	Monitor only		NA
005E	12	Flow	None		0
		pH	6–9		0
006	12	Flow	None		0
		pH	6–9		0
		TSS	15	30	0
		TDS	Monitor only		NA
		Temperature	<2.8°C rise		0
007	11	Flow	None		0
	11	pH	6–9		0
	11	Temperature	<2.8°C rise		0
	37	TRC	0.05		0
	11	Oil and grease	Monitor only		NA
008	10	Flow	None		0
		pH	6–9		0
		VOC	Monitor only		NA
010	0	Flow	None		0
		pH	6–9		0
		TSS	15	30	0
		Total iron	2	4	0
		Dissolved iron		1.0	0
		Lead		0.1	0
		Zinc		1.0	0
		Manganese		1.0	0
		Hexavalent chromium	0.011	0.016	0
		Trivalent chromium	0.519	2.0	0
		Copper	0.031	0.051	0
		Oil and grease	15	30	0
108	12	Flow	None		0
		pH	6–9		0
		Temperature	<2.8°C rise		0

TABLE 5.5 (Cont.)

			Limit		
Discharge Location	No. of Samples	Permit Constituent	30-Day Average	Daily Maximum	No. Exceeding Limit
111	2	Flow	None		0
		Hydrogen-3	Monitor only		NA
112A	2	Flow	None		0
		Hydrogen-3	Monitor only		NA
112B	2	Flow	None		0
		Hydrogen-3	Monitor only		NA
113	5	Flow	None		0
		Hydrogen-3	Monitor only		NA
		PCB 1260	Monitor only		NA
		Lead, copper, nickel, zinc	Monitor only		NA
114	5	Flow	None		0
		Hydrogen-3	Monitor only		NA
		PCB 1260	Monitor only		NA
		Lead, copper, nickel, zinc	Monitor only		NA
115	12	Flow	None		0
		pH	6–9		0
		Temperature	<2.8°C rise		0
		TDS	Monitor only		NA
116	12	Flow	None		0
		pH	6–9		0
		TRC	0.05		0

[a] TRC = total residual chlorine.

[b] NA = not applicable.

July 2003 — Effluents from Outfalls 003H, 003I, 003J, 004, and 006 exhibited no acute toxicity. Outfall 115 was acutely toxic toward the water flea with an LC_{50} value of 57%. The toxicity levels at Outfall 115 toward the water flea were similar to those observed in July 2002. The toxicant at Outfall 115 was unidentified.

August 2003 — Effluents from Outfalls 003H, 003J, 004, 006, and 115 were not acutely toxic toward the water flea and fathead minnows. Effluent from Outfall 003I was acutely toxic toward the water flea with an LC_{50} value of 82%. The toxicity levels at Outfall 003I toward the

TABLE 5.6

Water Flea, 48-Hour Acute Toxicity Results — LC_{50}, 2000 to 2003

NPDES Outfall	2000 (%) June/July	2000 (%) August	2001 (%) June/July	2001 (%) August	2002 (%) June/July	2002 (%) August	2003 (%) June/July	2003 (%) August
001	100	NA[a]	>100	NA	>100	NA	>100	NA
003H	100	>100	>100	>100	>100	>100	>100	>100
003I	>100	>100	**71**[b]	>100	>100	**88**	>100	**82**
003J	>100	**<20**	**<20**	>100	**<20**	**<20**	>100	>100
004	>100	>100	>100	>100	>100	>100	>100	>100
006	>100	**30**	**40**	**60**	>100	>100	>100	>100
115	**29**	**<20**	**64**	>100	>100	>100	**57**	>100

[a] NA = not applicable.

[b] Bold percentage represents acute toxicity.

TABLE 5.7

Fathead Minnow, 96-Hour Acute Toxicity Results — LC_{50}, 2000 to 2003

NPDES Outfall	2000 (%) June/July	2000 (%) August	2001 (%) June/July	2001 (%) August	2002 (%) June/July	2002 (%) August	2003 (%) June/July	2003 (%) August
001	>100	NA[a]	>100	NA	>100	NA	>100	NA
003H	>100	>100	>100	>100	>100	>100	>100	>100
003I	>100	>100	>100	>100	>100	>100	>100	>100
003J	>100	**40**[b]	<20	>100	**30**	**45**	>100	>100
004	>100	>100	>100	>100	>100	>100	>100	>100
006	>100	>100	>100	>100	>100	>100	>100	>100
115	>100	>100	>100	>100	>100	>100	>100	>100

[a] NA = not applicable.

[b] Bold percentage represents acute toxicity.

water flea were similar to those observed in August 2002. The toxicant at Outfall 003I was unidentified.

5.2. Additional Effluent Monitoring

To characterize the wastewater from the ANL-E site more fully, composite samples of the combined effluent from the WTP were collected each week and analyzed for the constituents shown in Table 5.8. The results were then compared with IEPA General Effluent Limits found in 35 IAC, Subtitle C, Part 304.[24]

5.2.1. Sample Collection

Samples for analysis of inorganic constituents were collected daily from Outfall 001 located at the WTP by using a refrigerated time-proportional sampler. A portion of the sample was transferred to a clean bottle, a security seal was affixed, and chain of custody was maintained. Five daily samples were composited on an equal volume basis to produce a weekly sample that was then analyzed. Fifteen metals were determined by inductively coupled plasma emission spectroscopy and graphite furnace atomic absorption spectroscopy. Mercury was analyzed using cold vapor atomic absorption spectroscopy, and fluoride was determined by a specific ion electrode.

TABLE 5.8

Chemical Constituents in Effluents from the ANL-E Wastewater Treatment Plant, 2003

		Concentration (mg/L)			
Constituent	No. of Samples	Average	Minimum	Maximum	Limit
Arsenic	53			< 0.0030[a]	0.25
Barium	53	0.0183	0.0125	0.0253	2.0
Beryllium	53			< 0.0002	–[b]
Cadmium	53	< 0.0002	< 0.0002	0.0003	0.15
Chromium	53			<0.0240	1.0
Cobalt	53	0.0165	< 0.016	0.0277	–
Copper	53	0.0190	< 0.0150	0.0311	0.5
Fluoride	53	0.9328	0.613	1.1770	15.0
Iron	53	0.0383	< 0.0200	0.1581	2.0
Lead	53			0.0020	0.2
Manganese	53	0.0133	< 0.0100	0.0335	1.0
Mercury	53	< 0.0001	< 0.0001	0.0003	0.0005
Nickel	53			< 0.0200	1.0
Silver	53			< 0.0010	0.1
Thallium	53			< 0.0020	–
Vanadium	53			0.0320	–
Zinc	53	0.0943	0.0494	0.1659	1.0
pH	53	NA[c]	6.69	7.70	6.0–9.0

[a] If all values were less than the detection limit for a constituent, only the detection limit value is given.

[b] A dash indicates that there is no effluent limit for this constituent.

[c] NA = not applicable.

5.2.2. Results

Table 5.8 gives the results for 2003. None of the annual average results exceeded General Effluent Limits.[24]

5.3. Sawmill Creek

Sawmill Creek is a small natural stream that is fed primarily by storm water runoff. During periods of low precipitation, the creek above ANL-E has a very low flow. At these times, a major portion of the water in Sawmill Creek south of the site consists of ANL-E wastewater and discharges to assorted storm drains. To determine the impact ANL-E wastewaters have on Sawmill Creek, samples of the creek downstream of all ANL-E discharge points were collected and analyzed. The results were then compared with IEPA General Use Water Quality Standards found in 35 IAC, Subtitle C, Part 302.[25]

5.3.1. Sample Collection

A time-proportional sampler was used to collect a daily sample at a point well downstream of the combined wastewater discharge point where thorough mixing of the ANL-E effluent and Sawmill Creek water is assured. Samples were collected in precleaned, labeled bottles and security seals were used. After pH measurement, the daily samples were acidified and then combined into equal volume weekly composites and analyzed for the same set of inorganic constituents as those in Table 5.8.

Fifteen metals were determined by inductively coupled plasma emission spectroscopy and graphite furnace atomic absorption spectroscopy. Mercury was analyzed with cold vapor atomic absorption spectroscopy. Fluoride was determined by a specific ion electrode.

5.3.2. Results

The results obtained for 2003 are shown in Table 5.9. None of the annual average results exceeded General Use Water Quality Standards.[25]

TABLE 5.9

Chemical Constituents in Sawmill Creek, Location 7M,[a] 2003

Constituent	No. of Samples	Concentrations (mg/L) Average	Minimum	Maximum	Limit
Arsenic	53			< 0.003[b]	0.36[c]
Barium	53	0.0288	0.0141	0.0644	5.0
Beryllium	53			< 0.0002	–[d]
Cadmium	53			< 0.0002	0.03
Chromium	53			< 0.024	3.6
Cobalt	53	0.0171	< 0.016	0.043	–
Copper	53	0.0170	< 0.015	0.032	0.041[c]
Fluoride	53	0.7258	0.2600	1.077	1.4
Iron	53	0.0544	< 0.020	0.153	1.0
Lead	53			< 0.002	0.3[c]
Manganese	53	0.0195	< 0.01	0.1110	1.0
Mercury	53	< 0.0001	< 0.0001	0.0002	0.0026[c]
Nickel	53	< 0.020	< 0.020	0.0212	1.0
Silver	53			<0.001	0.005
Thallium	53			< 0.002	–
Vanadium	53			< 0.032	–
Zinc	53	0.0557	0.0120	0.194	1.0
pH	53	NA[e]	6.28	7.77	6.5–9.0

[a] Location 7M is 15 m (50 ft) downstream from the ANL-E wastewater outfall.

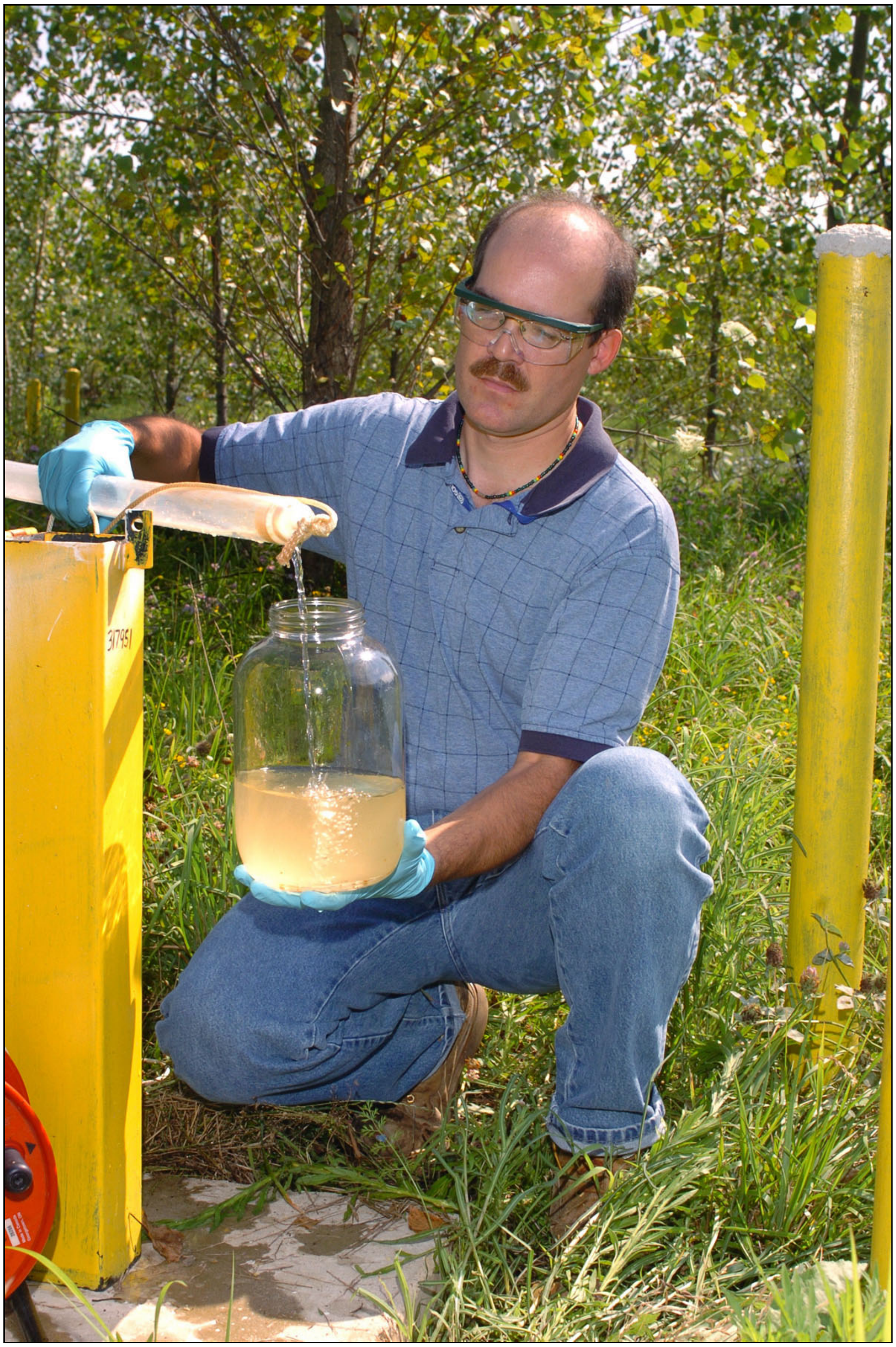
[b] If all values were less than the detection limit for a constituent, only the detection limit is given.

[c] The acute standard for the chemical constituent is listed.

[d] A dash indicates that there is no effluent limit for this constituent.

[e] NA = not applicable.

6. GROUNDWATER PROTECTION



6. GROUNDWATER PROTECTION

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, from a series of groundwater monitoring wells located near several sites that have the potential for affecting groundwater, and other monitoring wells on and off the ANL-E site. Regulations establishing comprehensive WQSs 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 450.1,[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. Information generated by this program is also included in this report.

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 range of approximately 200 to 400 mg/L. In addition, Lake Michigan water is lower in bicarbonate, which makes it less corrosive on the piping system. The former potable wells, however, are maintained as a backup in the case of loss of Lake Michigan water.

6.1.1. 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. Radium and uranium were analyzed by ion-exchange separations followed by gamma and alpha spectrometry, respectively. The results are presented in Table 6.2.

VOC samples were collected quarterly, analyzed for SDWA volatile compounds, and quantified by EPA Method 524.2,[27] which includes purge and trap pretreatment, followed by gas chromatography-mass spectroscopy detection. The reporting limit is the Practical Quantification Limit (PQL), which is defined as 10 times the method detection limit.

All radiological results were within their normal range of concentrations as compared with previous results. No VOCs were detected.

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[c]	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.
[c] Well not operational.

6.1.2. 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 hydrogen-3 as tritiated water appeared to have migrated through the glacial drift to the dolomite aquifer and was drawn into the wells. Well 1, which is about 200 m (650 ft) north of the wastewater treatment area, had higher hydrogen-3 concentrations than Well 2, which is about 300 m (1,000 ft) from the treatment area. Hydrogen-3 is only occasionally identified at concentrations just above the detection limit because of dilution and radioactive decay. Although the normal subsurface water flow gradient is toward the south-southeast, the cone of depression created by pumping these wells while they were still in use 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. ANL-E was concerned that the direction of subsurface migration of radionuclides, particularly hydrogen-3, could change 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 seven forest preserve wells was established to monitor the magnitude and direction of hydrogen-3 movement in this area. The well locations are shown in Figure 6.l. Samples were collected quarterly and analyzed for hydrogen-3. Table 6.3 shows the results for 2003. Hydrogen-3 was noted at very low levels in only the two on-site wells nearest the 570 Area Pond.

TABLE 6.2

Radioactivity in ANL-E Former Water Supply Wells, 2003
(concentrations in pCi/L)

Type of Activity	Location	No. of Samples	Average	Minimum	Maximum
Alpha	Well 1	4	3.1	2.5	4.6
	Well 3	4	2.6	1.6	4.1
	Well 4	4	3.6	2.8	4.0
Beta	Well 1	4	7.1	5.9	8.3
	Well 3	4	9.1	8.6	9.5
	Well 4	4	9.3	7.0	10.7
Hydrogen-3	Well 1	4	< 100	< 100	< 100
	Well 3	4	< 100	< 100	104
	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]	–	1.0
	Well 3	1	–	–	1.3
	Well 4	1	–	–	0.6
Radium-228	Well 1	1	–	–	2.8
	Well 3	1	–	–	0.8
	Well 4	1	–	–	0.7
Uranium-234	Well 1	1	–	–	0.56
	Well 3	1	–	–	0.21
	Well 4	1	–	–	0.17
Uranium-235	Well 1	1	–	–	0.01
	Well 3	1	–	–	< 0.01
	Well 4	1	–	–	< 0.01
Uranium-238	Well 1	1	–	–	0.35
	Well 3	1	–	–	0.13
	Well 4	1	–	–	0.08

[a] A dash indicates that for a single result, the value is placed in the maximum column.

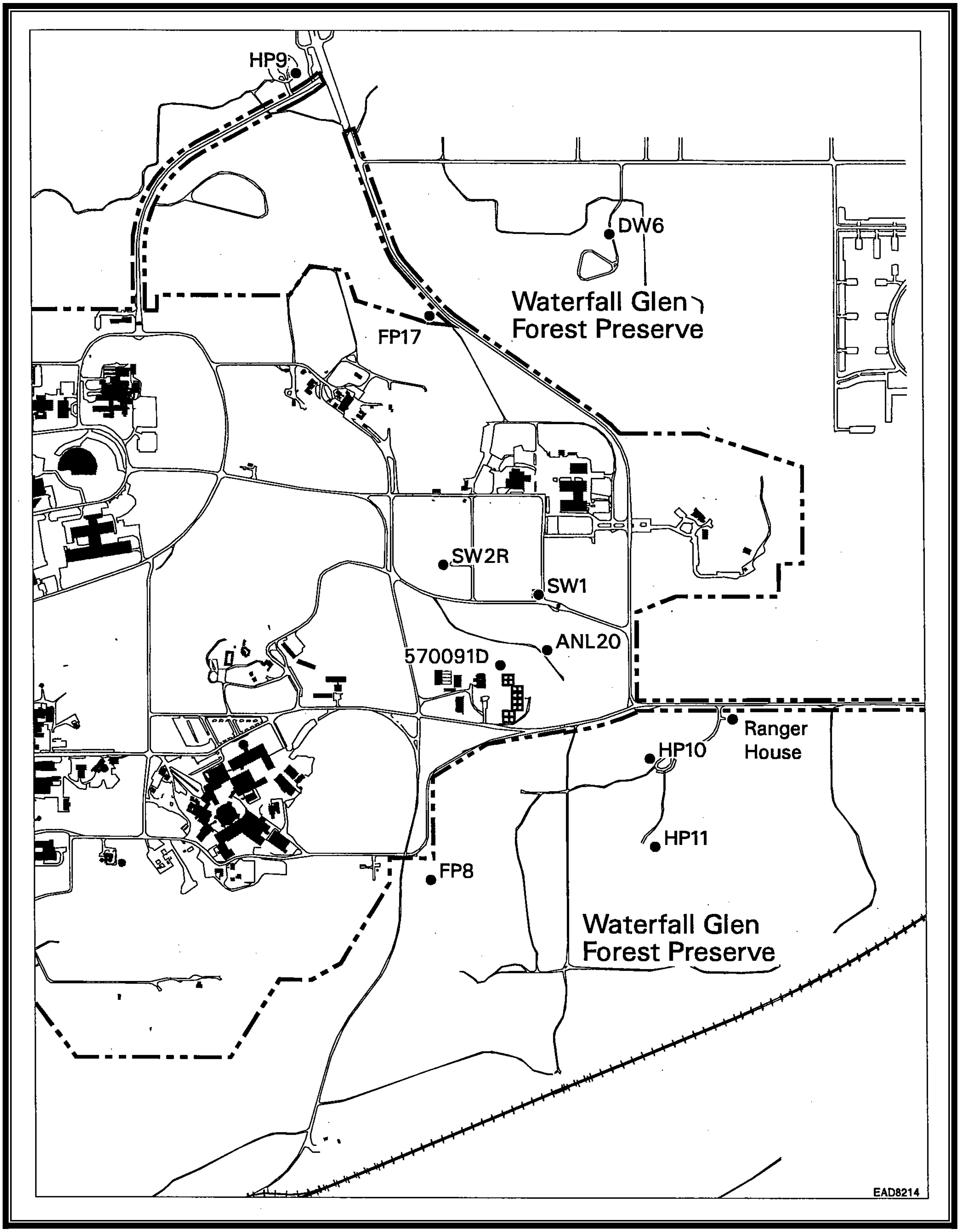


FIGURE 6.1 East Area/Forest Preserve Monitoring Wells

TABLE 6.3

Hydrogen-3 in Dolomite Wells, 2003
(concentrations in pCi/L)

Well	Date Collected			
	02/03/03	04/24/03	07/24/03	11/10/03
Waterfall Glen				
DW 6	<100	<100	<100	<100
HP 9	<100	<100	<100	<100
HP 10	<100	<100	<100	<100
HP 11	<100	<100	<100	<100
FP 8	<100	<100	<100	<100
FP 17	<100	<100	<100	<100
Ranger House	<100	<100	<100	<100
ANL-E				
5700910	<100	163	119	163
ANL-20	<100	103	176	<100
SW2R	<100	<100	<100	<100
Trip Blank	<100	<100	<100	<100

6.2. Groundwater Monitoring at 317/319/ENE Landfill Areas

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 and demolition debris during the 1950s, to a former 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 ENE 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. To aid the reader, results presented in the well tables that exceed State of Illinois' Class I Groundwater Quality Standards are in bold type.

The ANL-E ERP was responsible for achieving compliance with all applicable environmental requirements related to assessing and cleaning up releases of hazardous materials from inactive waste sites. This program was completed on September 30, 2003. However, seven SWMUs could not be remediated to free release status and continue to be monitored as part of the LTS Program (refer to Chapter 3). LTS Areas that continue to be routinely monitored for groundwater releases include the 317 and 319 Areas, ENE Landfill Area, and off-site seeps.

Efforts are underway for the data from the LTS program to be integrated with the ANL-E Sitewide Environmental Groundwater Monitoring and Surveillance Program data during 2004.

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 includes the North Vault, an in-ground storage vault that was emptied in May 2001 and has remained empty since. The Deep Vault was demolished and backfilled during 2002. The area also contains a small building used for decontamination of metal objects, such as lead bricks, tools, and metal objects. 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 north half of the 317 Area. The contaminants are primarily VOCs such as cleaning solvents. The groundwater below this area also contains concentrations of these chemicals. General features in the 317/319 Area are identified in Figure 6.2.

The groundwater below the 317/319 Area exists in several shallow (3 to 16 m [10 to 50 ft]) sand and gravel units up to 6-m (20-ft) thick within the glacial drift, as well as in the upper portions of the dolomite bedrock. There are no known consumers of this groundwater downgradient of the ANL-E site.

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, although strontium-90 was noted one quarter in a well south of the 319 Area. 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 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 applicable standards. Since their discovery, these seeps have been monitored on a regular basis (see Section 6.2.6). A characterization study was completed in 1998 to identify the source and

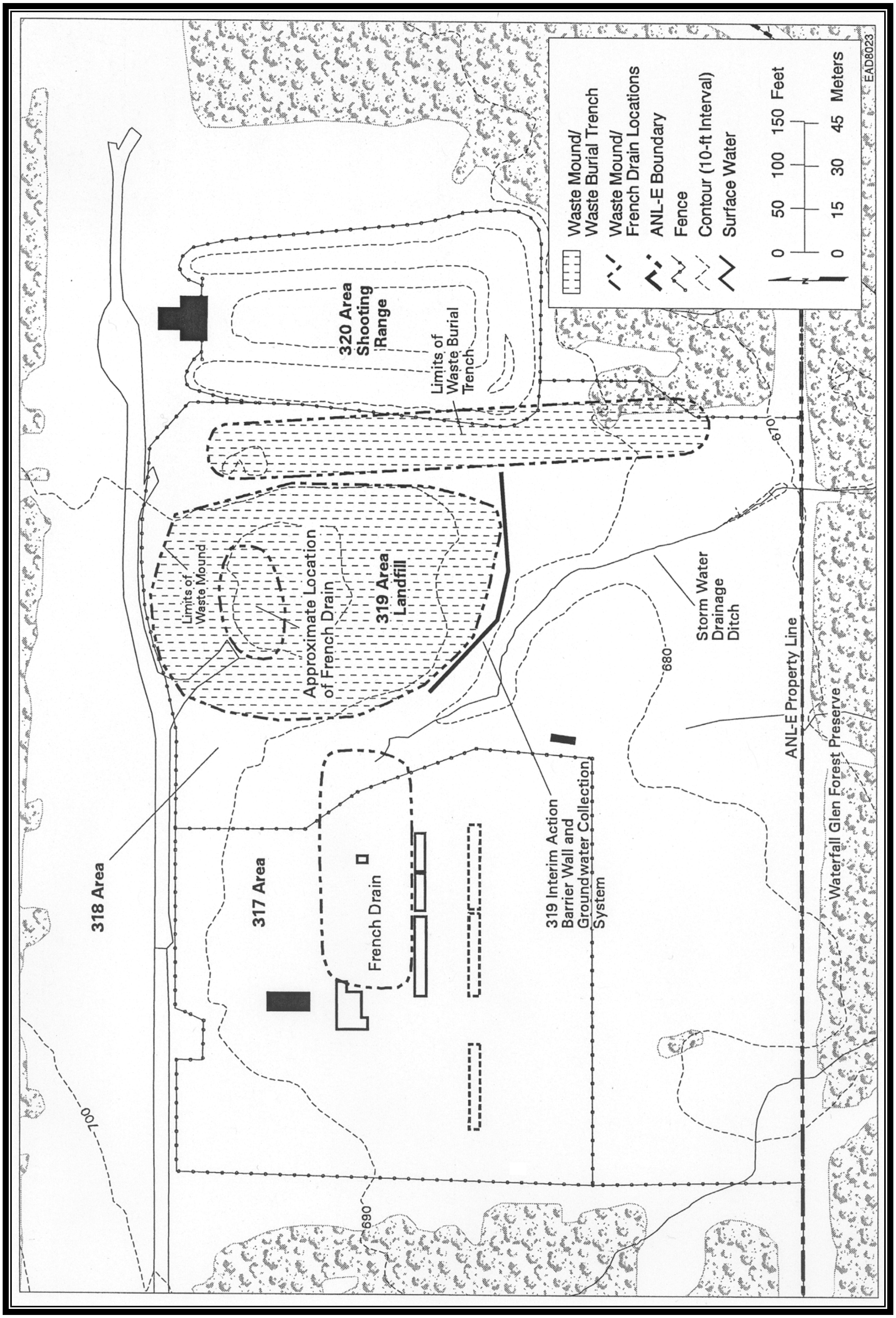


FIGURE 6.2 Locations of Components within the 317/319/ENE Area

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 known extent of contaminated groundwater covers much of the area from the 317 French Drain and 319 Landfill, southeast to the seeps.

Cleanup of the 317 and 319 Areas has been under way since the late 1980s. It has been carried out as a series of interrelated actions that ultimately removed or contained 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, capping of the 319 Landfill, demolition of five waste storage vaults contaminated with radioactive materials, sealing of an underground drainage system, installation of 15 groundwater extraction wells south of the 317 Area, construction of a concrete cover over a region containing buried compressed gas cylinders (318 Area), treating highly contaminated soil near the former French drain, and phytoremediation of residual soil and groundwater contamination. Sampling and analysis of groundwater and surface water are ongoing as part of the LTS program and routine environmental monitoring program.

The North Vault was repaired because ANL-E has decided to continue storing waste in the vault. Part of the north wall of the vault was rebuilt, and new roof covers were fabricated.

In 1999, the IEPA approved the installation of a phytoremediation system in the 317 Area. Phytoremediation involves the use of trees to remove contaminated groundwater by evapotranspiration and 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 downgradient of the 317 French Drain and the former 319 Landfill are in place and will be monitored over the next several years for their ability to remediate those areas.

The results of the required routine monitoring of the groundwater collection systems in the 317 and 319 Areas, the phytoremediation system, and the monitoring of the off-site groundwater seeps continue to be transmitted to the IEPA on a quarterly basis through the submittal of Quarterly Progress Reports. The data of this monitoring are too voluminous to include in this report; however, the general conclusions are discussed below as part of the ANL-E LTS program (see Sections 6.2.4, 6.2.5, and 6.2.6).

6.2.2. Groundwater Monitoring at the 317 and 319 Areas

Groundwater monitoring in the 317 and 319 Areas as part of the sitewide monitoring and surveillance program has been conducted since 1986. Wells 319011, 317021, and 319031 were installed in September 1986; Well 317061 was originally installed in August 1987 but replaced in May 2000; Wells 317101 and 317111 were installed in September 1988; and Wells 319032 and 317052 were installed in June 1989 (Figure 6.3). These wells were all completed in the glacial drift. Wells 317121D and 319131D were installed in November 1989 and reach the dolomite aquifer at about 20 m (64 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 Wells 317052, 319031, 319032, and 317021. Groundwater in the dolomite bedrock aquifer is monitored at Wells 317121D and 319131D. Table 6.4 lists well data for these areas. These wells are not used to monitor the progress of remediation systems, but rather serve the 317/319 Area as a whole. 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.

The ERP collects groundwater data from an extensive network of wells located throughout the 317 and 319 Areas. These data are transmitted to the IEPA quarterly and are presented in Sections 6.2.3 and 6.2.4. To monitor the performance of the various remedial actions constructed in the 317 and 319 Areas, samples are collected on a quarterly basis. The purpose of this monitoring is to track the movement of contaminated groundwater and to determine the rate at which contaminant levels are decreasing. Monitoring results in 2003 indicate that the two groundwater collection systems south of the 319 Landfill and south of the 317 Area are effectively preventing off-site migration of contaminated groundwater. The analysis of groundwater samples for contaminants reveals that high concentrations of VOCs are present in groundwater in the immediate vicinity of the former 317 Area French Drain. Concentrations of up to 300,000 μg/L of chlorinated VOCs (i.e., carbon tetrachloride) were detected. However, at the ANL-E fence line, near the groundwater collection wells, the level of contamination is much lower; the highest concentration noted in 2003 was 340 μg/L of 1,1,1-trichloroethane. This groundwater is being collected by the extraction system so that it does not migrate off site.

Plant tissue monitoring at the phytoremediation system indicates that the trees are indeed taking up the organic materials and breaking them down within the trees. The effect of the trees on groundwater movement was also measured; however, the trees are not full grown, so that their effect was not great enough to be easily measured. Long-term monitoring of this system will determine its effectiveness at removing groundwater and degrading contaminants.

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 drift 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, following recovery, by bailing with a dedicated Teflon bailer. The field parameters for these samples (pH, specific conductance, redox potential, and temperature) are measured statically. For

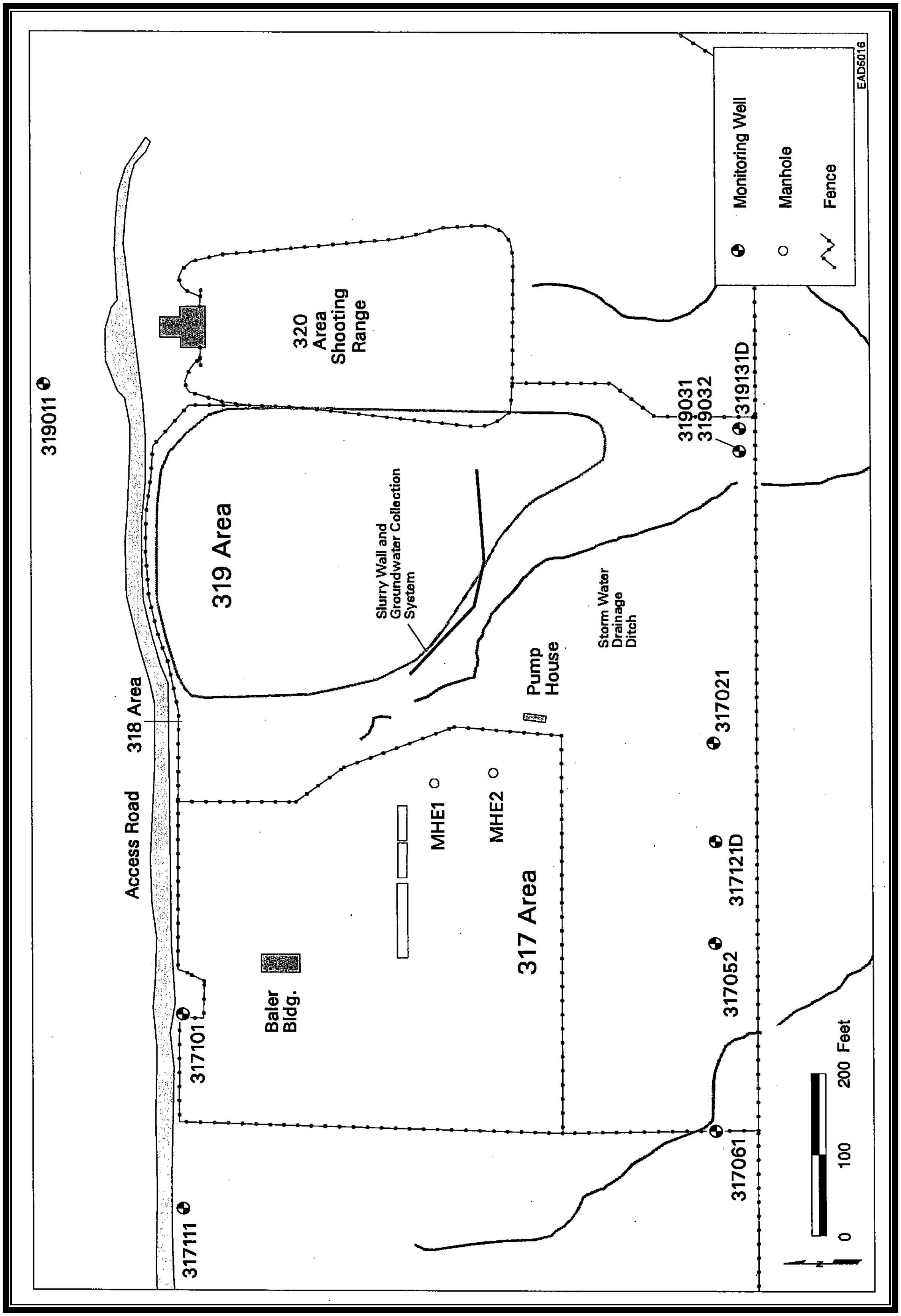


FIGURE 6.3 Monitoring and Characterization Wells in the 317 and 319 Areas, 2003

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	6/89
317052	4.27	208.3	207.1–204.0	0.05/PVC	6/89
317061[b]	10.36	207.6	197.3–199.7	0.05/PVC	5/00
317101	11.89	211.0	202.2–199.1	0.05/PVC	9/88
317111	11.89	210.3	201.4–198.4	0.05/PVC	9/88
317121D[c]	24.08	207.6	185.0–183.5	0.15/CS	11/89
319131D	21.03	203.5	184.0–182.5	0.15/CS	11/89

[a] Inner diameter (m)/well material (PVC = polyvinyl chloride; CS = carbon steel).

[b] Well was replaced when original well was damaged and became inoperable.

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

those wells 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, 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 prepared.

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 EQO, Analytical Services (EQO-AS). These SOPs reference protocols in SW-846.[5] Fifteen metals were routinely measured using 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 spectroscopy 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.

The 317 and 319 Area groundwater radiological analyses were performed using SOPs written, reviewed, and issued as controlled documents by members of EQO-AS. 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 6.13. 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 10 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, 319031, and 319131D usually dry up after one well volume is removed. Therefore, field parameters were measured on one well volume. Similar to past years, Well 319031 was dry each quarter. Well 319011 was dry all but the fourth quarter. Conductivity was elevated in Wells 317101 and 317111. This is probably related to the fact that chloride levels in these two wells are elevated. Both wells are located near a road that is salted during the winter.

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 6.14 and 6.15. The groundwater that is mentioned is not used as a source of domestic water supply. In 2003, 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 the third quarter at dolomite Well 317121D and chloride at Wells 317101 and 317111. Historically, elevated pH values at Well 317121D have been reported. Chloride levels ranged from 213 to 826 mg/L and may be due to road salt usage near the wells. Barium was noted each quarter at very low levels in each of the wells. Barium levels ranged from 0.03 to 0.12 mg/L. Elevated manganese was noted only one quarter in

TABLE 6.5

Groundwater Monitoring Results,
300 Area Well 317021, 2003

Parameter	Unit	Date of Sampling 9/08/2003	11/06/2003
Water elevation[a]	m	198.81	198.12
Temperature	°C	13.5	10.7
pH	pH	7.01	7.46
Redox	mV	-2	-26
Conductivity	µmhos/cm	733	726
Chloride[b]	mg/L	21	18
Arsenic[b]	mg/L	< 0.003	< 0.003
Barium[b]	mg/L	0.0408	0.0453
Beryllium[b]	mg/L	< 0.0002	< 0.0002
Cadmium[b]	mg/L	< 0.0002	< 0.0002
Chromium[b]	mg/L	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016
Copper[b]	mg/L	< 0.015	< 0.015
Iron[b]	mg/L	< 0.02	< 0.02
Lead[b]	mg/L	< 0.002	< 0.002
Manganese[b]	mg/L	< 0.01	< 0.01
Mercury[b]	mg/L	< 0.0001	< 0.0001
Nickel[b]	mg/L	< 0.02	0.0266
Silver[b]	mg/L	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032
Zinc[b]	mg/L	< 0.008	< 0.008
Cesium-137	pCi/L	< 2.0	< 2.0
Hydrogen-3	pCi/L	< 100	106
Strontium-90	pCi/L	< 0.25	< 0.25
1,1,1-Trichloroethane	µg/L	5.0	7.0
1,1-Dichloroethane	µg/L	1.0	3.0

[a] Well point elevation = 197.27 m (MSL); ground surface elevation = 209.17 m (MSL); casing material = PVC.

[b] Filtered sample.

TABLE 6.6

Groundwater Monitoring Results, 300 Area Well 317052, 2003

Parameter	Unit	Date of Sampling 5/07/2003	9/08/2003	11/06/2003
Water elevation[a]	m	206.33	204.55	205.07
Temperature	°C	9.7	15.0	12.9
pH	pH	7.25	7.02	7.27
Redox	mV	-13	-3	-18
Conductivity	µmhos/cm	724	829	904
Chloride[b]	mg/L	20	13	36
Arsenic[b]	mg/L	< 0.003	< 0.003	< 0.003
Barium[b]	mg/L	0.0336	0.0422	0.0468
Beryllium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002
Cadmium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002
Chromium[b]	mg/L	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016	< 0.016
Copper[b]	mg/L	< 0.015	< 0.015	< 0.015
Iron[b]	mg/L	< 0.02	< 0.02	< 0.02
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	< 0.01	0.0114	< 0.01
Mercury[b]	mg/L	< 0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	< 0.02	< 0.02	0.0302
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	< 0.008	0.0103	< 0.008
Alpha	pCi/L	1.257	–[c]	–
Beta	pCi/L	2.405	–	–
Cesium-137	pCi/L	< 2.0	< 2.0	< 2.0
Hydrogen-3	pCi/L	< 100	< 100	226
Strontium-90	pCi/L	< 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.

[c] A dash indicates that no samples were collected.

TABLE 6.7

Groundwater Monitoring Results, 300 Area Well 317061, 2003

		Date of Sampling				
Parameter	Unit	3/17/2003	5/05/2003	5/05/2003	9/04/2003	11/20/2003
Water elevation[a]	m	197.54	198.09	198.09	198.14	197.79
Temperature	°C	11.6	12.3	12.3	11.2	10.9
pH	pH	7.25	7.02	7.02	7.11	7.01
Redox	mV	-12	-2	-2	-7	-9
Conductivity	µmhos/cm	1,009	732	732	780	928
Chloride[b]	mg/L	22	18	13	16	13
Arsenic[b]	mg/L	0.015	0.0073	0.0066	0.0090	0.0079
Barium[b]	mg/L	0.0572	0.0579	0.0401	0.0598	0.0601
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	< 0.024	< 0.024	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016	< 0.016	< 0.016	< 0.016
Copper[b]	mg/L	< 0.015	< 0.015	< 0.015	< 0.015	< 0.015
Iron[b]	mg/L	0.3111	< 0.02	< 0.02	< 0.02	< 0.02
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	0.0158	0.0179	< 0.01	0.0164	0.0187
Mercury[b]	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	0.0303	< 0.02	0.0556	< 0.02	0.0395
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	0.0153	< 0.008	< 0.008	< 0.008	< 0.008
Cesium-137	pCi/L	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Hydrogen-3	pCi/L	< 100	< 100	< 100	< 100	< 100
Strontium-90	pCi/L	< 0.25	< 0.25	< 0.25	< 0.25	< 0.25

[a] Well point elevation = 197.26 m (MSL); ground surface elevation = 207.62 m(MSL); casing material = PVC.

[b] Filtered sample.

TABLE 6.8

Groundwater Monitoring Results, 300 Area Well 317101, 2003

		Date of Sampling			
Parameter	Unit	3/24/2003	5/05/2003	9/08/2003	11/6/2003
Water elevation[a]	m	201.32	201.31	201.54	201.39
Temperature	°C	13.0	12.6	12.6	11.7
pH	pH	7.06	6.97	7.01	6.90
Redox	mV	0	1	0	-2
Conductivity	µmhos/cm	2,130	2,090	2,480	2,330
Chloride[b]	mg/L	323	734	684	534
Arsenic[b]	mg/L	< 0.003	< 0.003	< 0.003	< 0.003
Barium[b]	mg/L	0.0637	0.0925	0.1068	0.1017
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	< 0.024	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016	< 0.016	< 0.016
Copper[b]	mg/L	< 0.015	< 0.015	< 0.015	< 0.015
Iron[b]	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	0.0336	0.0316	0.0308	0.0402
Mercury[b]	mg/L	0.0002	< 0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	0.0267	< 0.02	0.0257	0.0315
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	0.0081	0.0109	0.0104	< 0.008
Cesium-137	pCi/L	< 2.0	< 2.0	< 2.0	< 2.0
Hydrogen-3	pCi/L	121	< 100	< 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.

TABLE 6.9

Groundwater Monitoring Results, 300 Area Well 317111, 2003

		Date of Sampling			
Parameter	Unit	3/17/2003	5/05/2003	9/04/2003	11/06/2003
Water elevation[a]	m	198.66	198.56	198.81	198.64
Temperature	°C	11.9	12.1	11.8	10.6
pH	pH	7.23	6.93	7.03	6.92
Redox	mV	-9	5	-3	-3
Conductivity	μmhos/cm	1,360	1,435	1,115	1,583
Chloride[b]	mg/L	213	390	227	260
Arsenic[b]	mg/L	< 0.003	< 0.003	< 0.003	< 0.003
Barium[b]	mg/L	0.0848	0.1183	0.0920	0.1064
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	< 0.024	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016	< 0.016	< 0.016
Copper[b]	mg/L	< 0.015	< 0.015	< 0.015	< 0.015
Iron[b]	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	0.0243	< 0.01	< 0.01	< 0.01
Mercury[b]	mg/L	< 0.0001	0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	0.0261	< 0.02	< 0.02	0.0327
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	< 0.008	< 0.008	< 0.008	< 0.008
Cesium-137	pCi/L	< 2.0	< 2.0	< 2.0	< 2.0
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.

TABLE 6.10

Groundwater Monitoring Results, 300 Area Well 317121D, 2003

Parameter	Unit	Date of Sampling 3/24/2003	5/08/2003	9/03/2003	11/06/2003
Water elevation[a]	m	186.42	187.92	186.37	186.30
Temperature	°C	12.1	11.5	13.0	10.7
pH	pH	7.01	7.46	9.70	7.63
Redox	mV	-2	-23	-150	-36
Conductivity	µmhos/cm	826	735	402	710
Chloride[b]	mg/L	74	66	51	64
Arsenic[b]	mg/L	< 0.003	< 0.003	< 0.003	< 0.003
Barium[b]	mg/L	0.0283	0.0299	0.0689	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	< 0.024	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016	< 0.016	< 0.016
Copper[b]	mg/L	< 0.015	< 0.015	< 0.015	< 0.015
Iron[b]	mg/L	< 0.02	0.0316	< 0.02	0.0963
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	< 0.01	< 0.01	< 0.01	0.0114
Mercury[b]	mg/L	< 0.0001	0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	< 0.02	< 0.02	< 0.02	0.0307
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	< 0.008	< 0.008	< 0.008	< 0.008
Alpha	pCi/L	–[c]	0.77	–	–
Beta	pCi/L	–	7.79	–	–
Cesium-137	pCi/L	< 2.0	< 2.0	< 2.0	< 2.0
Hydrogen-3	pCi/L	178	178	142	202
Strontium-90	pCi/L	< 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.

[c] A dash indicates that no samples were collected.

TABLE 6.11

Groundwater Monitoring Results,
300 Area Well 319011, 2003

Parameter	Unit	Date of Sampling 11/06/2003
Water elevation[a]	m	198.23
Temperature	°C	10.3
pH	pH	7.05
Redox	mV	-12
Conductivity	µmhos/cm	943
Chloride[b]	mg/L	37
Arsenic[b]	mg/L	< 0.003
Barium[b]	mg/L	0.0364
Beryllium[b]	mg/L	< 0.0002
Cadmium[b]	mg/L	< 0.0002
Chromium[b]	mg/L	< 0.024
Cobalt[b]	mg/L	< 0.016
Copper[b]	mg/L	< 0.015
Iron[b]	mg/L	< 0.02
Lead[b]	mg/L	< 0.002
Manganese[b]	mg/L	0.0242
Mercury[b]	mg/L	0.0001
Nickel[b]	mg/L	0.0270
Silver[b]	mg/L	< 0.001
Thallium[b]	mg/L	< 0.002
Vanadium[b]	mg/L	< 0.032
Zinc[b]	mg/L	< 0.008
Cesium-137	pCi/L	< 2.0
Hydrogen-3	pCi/L	131
Strontium-90	pCi/L	< 0.25

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

[b] Filtered sample.

TABLE 6.12

Groundwater Monitoring Results, 300 Area Well 319032, 2003

Parameter	Unit	Date of Sampling 9/08/2003	11/06/2003
Water elevation[a]	m	197.15	196.97
Temperature	°C	11.6	10.4
pH	pH	7.08	7.34
Redox	mV	-3	-17
Conductivity	μmhos/cm	984	921
Chloride[b]	mg/L	14	12
Arsenic[b]	mg/L	< 0.003	< 0.003
Barium[b]	mg/L	0.0398	0.0400
Beryllium[b]	mg/L	< 0.0002	< 0.0002
Cadmium[b]	mg/L	< 0.0002	< 0.0002
Chromium[b]	mg/L	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	0.0176
Copper[b]	mg/L	< 0.015	< 0.015
Iron[b]	mg/L	< 0.02	< 0.02
Lead[b]	mg/L	< 0.002	< 0.002
Manganese[b]	mg/L	< 0.01	< 0.01
Mercury[b]	mg/L	< 0.0001	< 0.0001
Nickel[b]	mg/L	< 0.02	0.0274
Silver[b]	mg/L	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032
Zinc[b]	mg/L	0.0154	0.0131
Cesium-137	pCi/L	< 2.0	< 2.0
Hydrogen-3	pCi/L	228	324
Strontium-90	pCi/L	< 0.25	< 0.25
1,4-Dioxane	μg/L	11	18

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

[b] Filtered sample.

TABLE 6.13

Groundwater Monitoring Results, 300 Area Well 319131D, 2003

		Date of Sampling			
Parameter	Unit	3/24/2003	5/07/2003	9/03/2003	11/06/2003
Water elevation[a]	m	184.31	184.47	184.30	184.30
Temperature	°C	12.9	11.8	14.8	10.6
pH	pH	7.32	7.18	7.52	7.42
Redox	mV	-20	-2	-25	-18
Conductivity	µmhos/cm	1,102	918	927	910
Chloride[b]	mg/L	54	64	61	51
Arsenic[b]	mg/L	< 0.003	< 0.003	< 0.003	< 0.003
Barium[b]	mg/L	0.0657	0.0714	0.0729	0.0754
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	< 0.024	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016	< 0.016	< 0.016
Copper[b]	mg/L	< 0.015	< 0.015	< 0.015	< 0.015
Iron[b]	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Mercury[b]	mg/L	< 0.0001	0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	0.0291	< 0.02	0.0204	< 0.02
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	0.0091	< 0.008	0.0084	< 0.008
Alpha	pCi/L	–[c]	1.2	–	–
Beta	pCi/L	–	4.2	–	–
Cesium-137	pCi/L	< 2.0	< 2.0	< 2.0	< 2.0
Hydrogen-3	pCi/L	1,166	551	998	964
Strontium-90	pCi/L	< 0.25	< 0.25	< 0.25	< 0.25

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

[b] Filtered sample.

[c] A dash indicates that no samples were collected.

TABLE 6.14

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

TABLE 6.15

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-ethyhexyl)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		

Wells 317052, 317111, 317121D, 319011 and each quarter in Wells 317061 and 317101. Manganese levels ranged from less than 0.01 to 0.04 mg/L. Elevated nickel levels were noted at least one quarter in eight of the wells, and levels ranged from less than 0.02 to 0.06 mg/L. Low levels of zinc were noted at least one quarter in Wells 317052, 317061, 317101, 319032, and 319131D. Zinc levels ranged from less than 0.008 to 0.02 mg/L. Mercury was noted at very low levels in Wells 317101, 317121D, 319011, and 319131D. Mercury levels in these wells ranged from less than 0.0001 to 0.0001 mg/L. Arsenic was noted each quarter in Well 317061 at levels ranging from 0.006 to 0.015 mg/L. Low levels of iron were noted one quarter in Well 317061 and two quarters in Well 317121D. Iron levels ranged from less than 0.02 to 0.31 mg/L.

Organic Parameters. No elevated levels, with respect to the WQSs for organics, were noted with the exception of Wells 317021 and 319032. Well 317021 continues to show persistent but very low VOC levels of the same contaminants as in previous years. As in 2001 and 2002, 1,4-dioxane was the only VOC noted each quarter sampled in Well 319032. The continued reduction in frequency and concentration of VOCs appears to be a result of the extensive remedial actions in the 317 and 319 Areas completed during the last few years. It should be noted that monitoring conducted by the corrective actions group, presented in Sections 6.2.3 and 6.2.4, routinely detects orders of magnitude higher concentrations of VOCs than those described above; many results are well in excess of WQSs. These samples are collected near areas where waste was placed in the ground and where active remediation is being conducted. Higher concentrations at these locations are expected at this point in time.

Once during the year, the wells were sampled and analyzed for SVOCs, PCBs, pesticides, and herbicides. None of these parameters were found in 2003.

Figure 6.4 shows selected VOC results for Well 317021 since 1988. The major components are 1,1,1-trichloroethane (TCA) and 1,1-dichloroethane (DCA); 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 consistent until 1991, at which time a trend of increasing, then decreasing concentrations can be observed. Since early 1998, the level of contamination has dropped dramatically. The well is immediately below a former discharge line that was known to be contaminated from leaks in the system. The sewer line was permanently closed in 1986 and sealed in 1997. A groundwater collection system in the vicinity of this well was installed in late 1997.

Manholes E1 and E2, in the 317 Area were sampled monthly and analyzed for VOCs. The results are presented in Table 6.16. Contributors of groundwater into Manholes E1 and E2 include an average of 555 L/day (146 gal/day) from the 319 Area groundwater collection system, an average of 4,210 L/day (1,108 gal/day) from the 317 Area groundwater collection system, and groundwater from existing 317 Area foundation drains around the storage vault.

Manhole 1E receives water from the 317 Area foundation drains around the storage vault. The combined flow of water from the 317 Area groundwater collection system and the 319 Area groundwater collection system is pumped to Manhole 2E. Because of a combination of factors, flows from both areas have decreased since 1999. Flows from the 319 Area collection system have decreased about 84% (3,529 L/day to 555 L/day). This decrease can be mainly attributed to a considerable drop in groundwater extraction rates due to the addition of the 319 Landfill Cap installed during summer 1999. The flows from the 317 Area groundwater collection system fluctuated since 1999 but continue to decrease. Flows ranged from 29,840 L/day (7,880 gal/day) in 1999, 14,987 L/day (3,958 gal/day) in 2000, 24,465 L/day (6,461 gal/day) in 2001, 17,613 L/day (4,649 gal/day) in 2002, and 4,210 L/day (1,108 gal/day) in 2003. Flows from the 317 Area are influenced by the increased uptake of groundwater by the phytoremediation system and changes in seasonal precipitation.

In general, VOC concentrations in Manholes E1 and E2 decreased from levels noted in previous years (see Figure 6.5). The decrease is mainly associated with remediation activities in the 317 and 319 Areas. A soil remediation project in the 317 French Drain Area in 1998 resulted in the removal of approximately 80% of the VOCs from several locations within the 317 French Drain Area. As previously mentioned, the addition of the 319 Landfill Cap in summer of 1999 has decreased leachate production in this area and has resulted in a substantial decrease in the amount of water pumped to Manhole E2 from the 319 Area groundwater collection system. These activities probably account for the decrease in VOC concentrations in Manhole E2 from

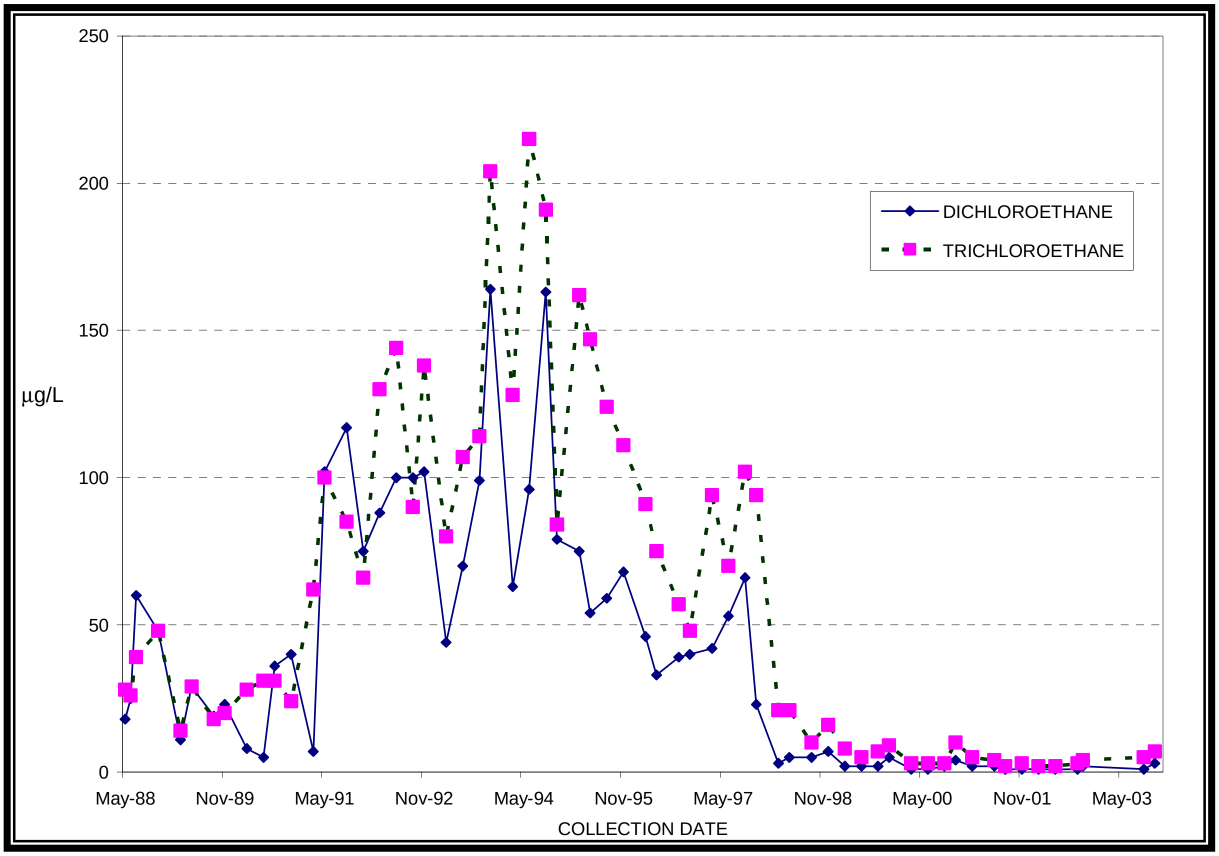


FIGURE 6.4 Concentrations of 1,1-Dichloroethane and 1,1,1-Trichloroethane in Well 317021

TABLE 6.16

Volatile Organic Compounds in the 317 Area: Manholes E1 and E2, 2003
(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
01/09/03	22	4	14	4	23	24	5	7	89	97	71	7	151	151
02/05/03	68	23	15	13	30	17	12	6	23	51	127	79	51	79
03/11/03	18	6	6	4	14	16	4	2	65	85	23	11	72	108
04/03/03	41	6	6	8	6	2	3	0	6	10	64	27	5	6
05/12/03	23	5	27	7	14	16	3	3	30	40	80	9	44	58
06/03/03	135	2	27	1	23	3	7	1	19	19	156	2	19	12
07/22/03	37	4	18	4	9	7	5	5	14	18	66	5	15	18
08/11/03	251	4	60	4	50	3	16	1	9	2	422	4	15	4
09/08/03	18	2	4	1	11	7	2	0	31	31	14	1	34	32
10/21/03	230	2	46	1	43	12	18	4	30	60	320	1	37	71
11/13/03	216	4	21	2	21	11	6	4	19	54	193	3	26	66
12/10/03	139	12	24	3	19	10	6	3	18	20	143	10	24	26

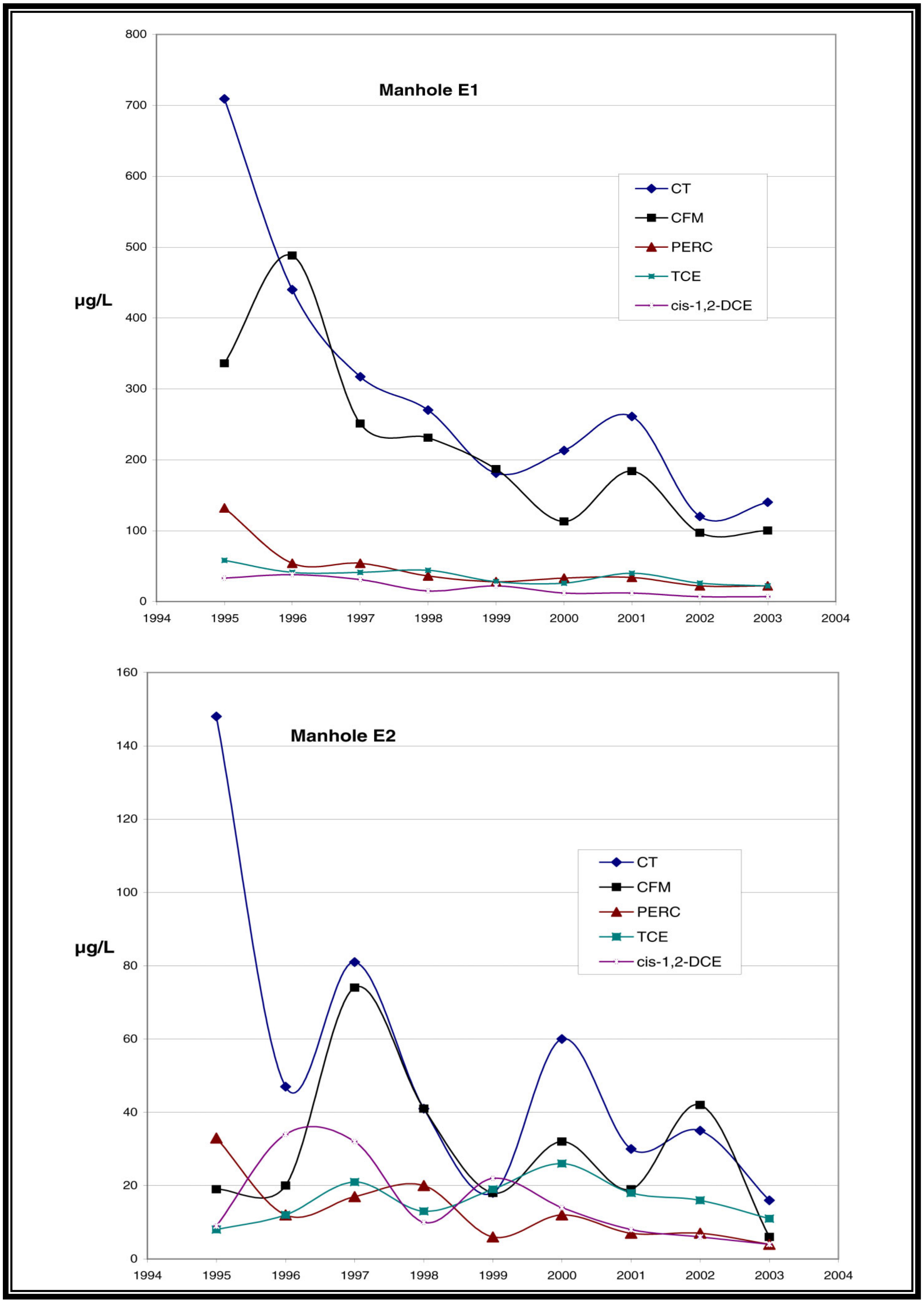


FIGURE 6.5 Manholes E1 and E2 Annual Average Groundwater Concentrations, 1995 to 2003

levels noted in previous years (see Figure 6.5). Decreases in VOC concentrations in Manhole 1E may be associated with the substantial increase of groundwater extraction from the 317 Area groundwater collection system as well as the removal of contaminated groundwater by evapotranspiration and contaminant degradation in the soil. Figures 6.6 to 6.12 compare the major VOC concentrations in Manholes E1 and E2. The TCA and DCA levels in both manholes parallel each other (see Figures 6.11 and 6.12).

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, 319032, and 319131D. The results are presented in Tables 6.5 to 6.13. Hydrogen-3 was noted at very low levels and only during one quarter in Wells 317101 (121 pCi/L) and 319011 (131 pCi/L). These wells are at the north perimeter of the 317 and 319 Areas, respectively. Evidence of possible off-site migration of radionuclides is noted by the low concentrations of hydrogen-3 in wells located near the south perimeter fence in the 317 and 319 Areas. Well 319032 was dry two quarters. As noted in previous years, hydrogen-3 was detected in Wells 317021, 317052, 317121D, 319032, and 319131D. Hydrogen-3 was detected in Wells 317121D (four quarters), 319032 (two quarters), 319131D (four quarters), 317021 (one quarter), and 317052 (one quarter). Hydrogen-3 levels in the wells along the south perimeter fence were well below the WQS of 20,000 pCi/L and ranged from less than 100 to 1,166 pCi/L.

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 addition to VOCs, the manhole water is analyzed for hydrogen-3 and gamma-ray–emitting radionuclides. Table 6.17 gives the hydrogen-3 results. Although the hydrogen-3 concentrations are relatively high, the volume is fairly low. Because hydrogen-3 concentrations are generally higher in Manhole 2E, the source of the hydrogen-3 appears to be from the 319 Area groundwater pumping system. No gamma-ray–emitting radionuclides were detected in any samples.

6.2.3. Phytoremediation Groundwater Monitoring

The soil treatment action completed in 1998 resulted in the removal of approximately 80% of the subsurface contaminants. In 1999, the final action to complete the corrective action in the 317 and 319 Areas was deployment of phytoremediation, a natural process by which woody and herbaceous plants extract pore water and entrained chemical substances from subsurface soils, degrade and/or sequester them, and transpire water vapor and some volatile constituents into the atmosphere. To monitor the source term, a number of monitoring wells were installed in the phyto plantation area to measure the progress of the removal of the contaminants from the subsurface. The monitoring wells are shown in Figure 6.13.

Samples are collected quarterly from the phyto wells and analyzed for VOCs and hydrogen-3. Table 6.18 gives the analytical results only for wells for which measurable concentrations were obtained. Wells that were dry or contained levels of organics that were all

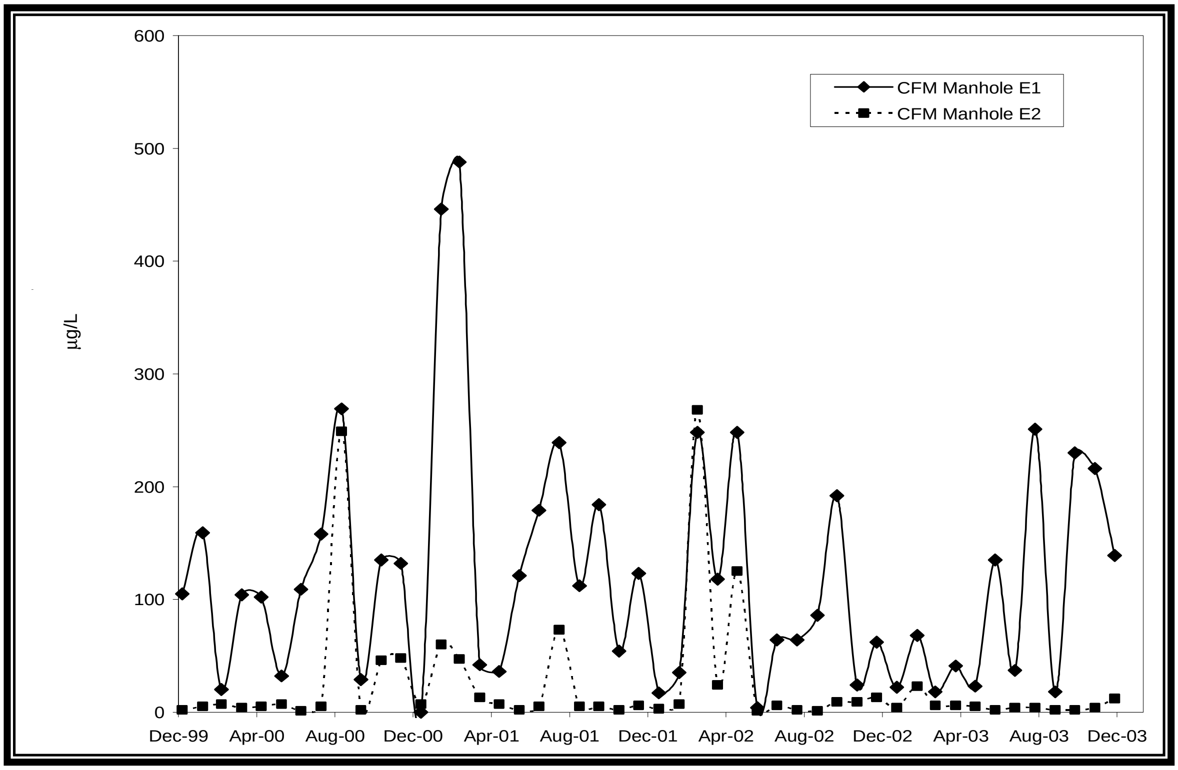


FIGURE 6.6 Manholes E1 and E2 Chloroform Levels, 2000 to 2003

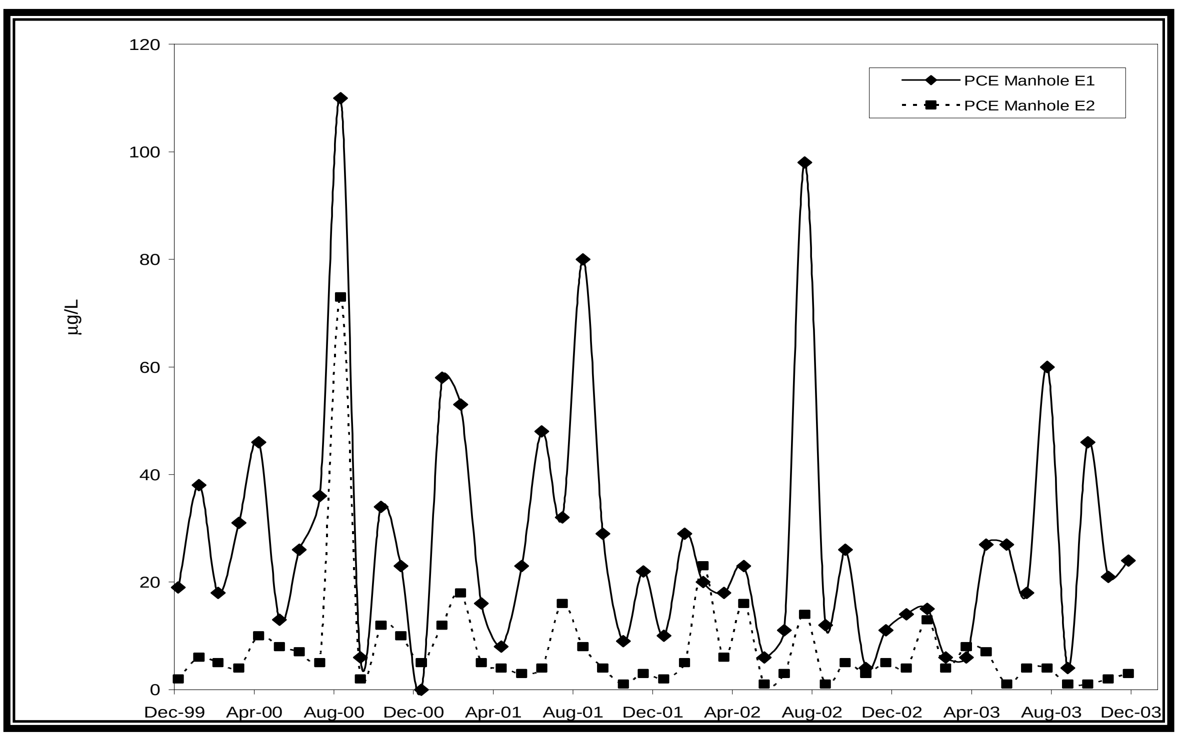


FIGURE 6.7 Manholes E1 and E2 Tetrachloroethene Levels, 2000 to 2003

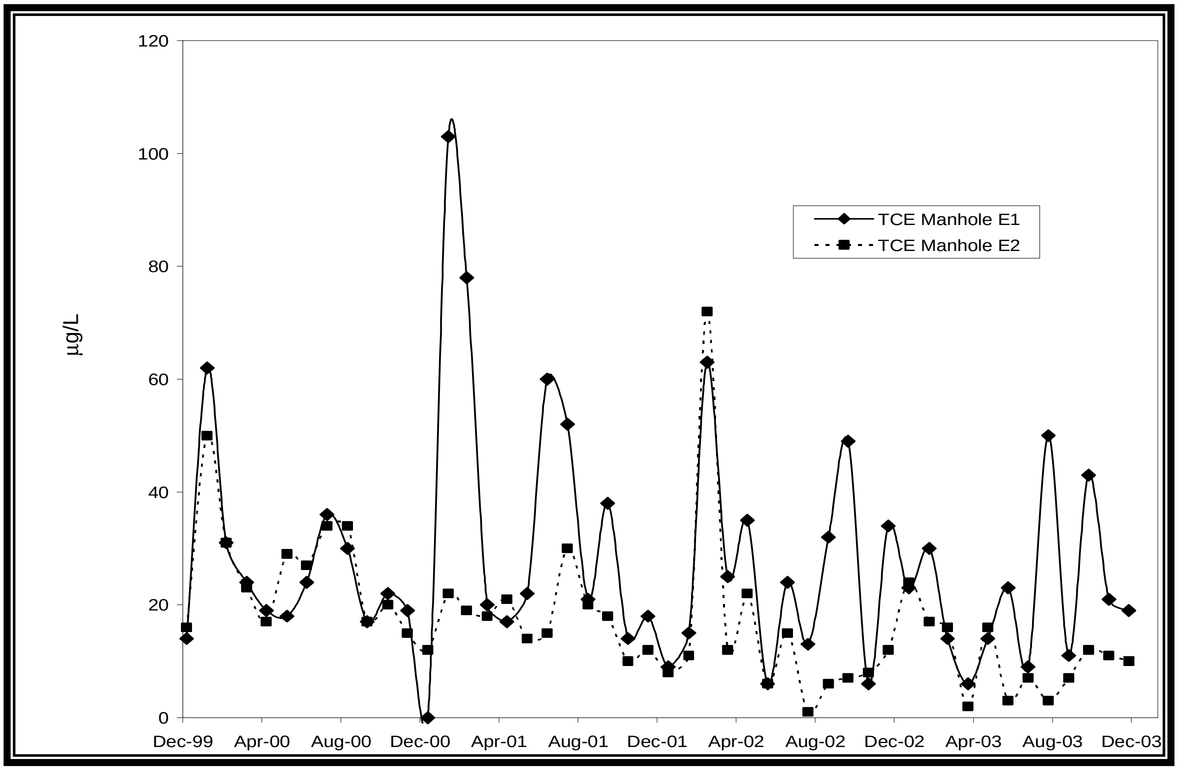


FIGURE 6.8 Manholes E1 and E2 Trichloroethene Levels, 2000 to 2003

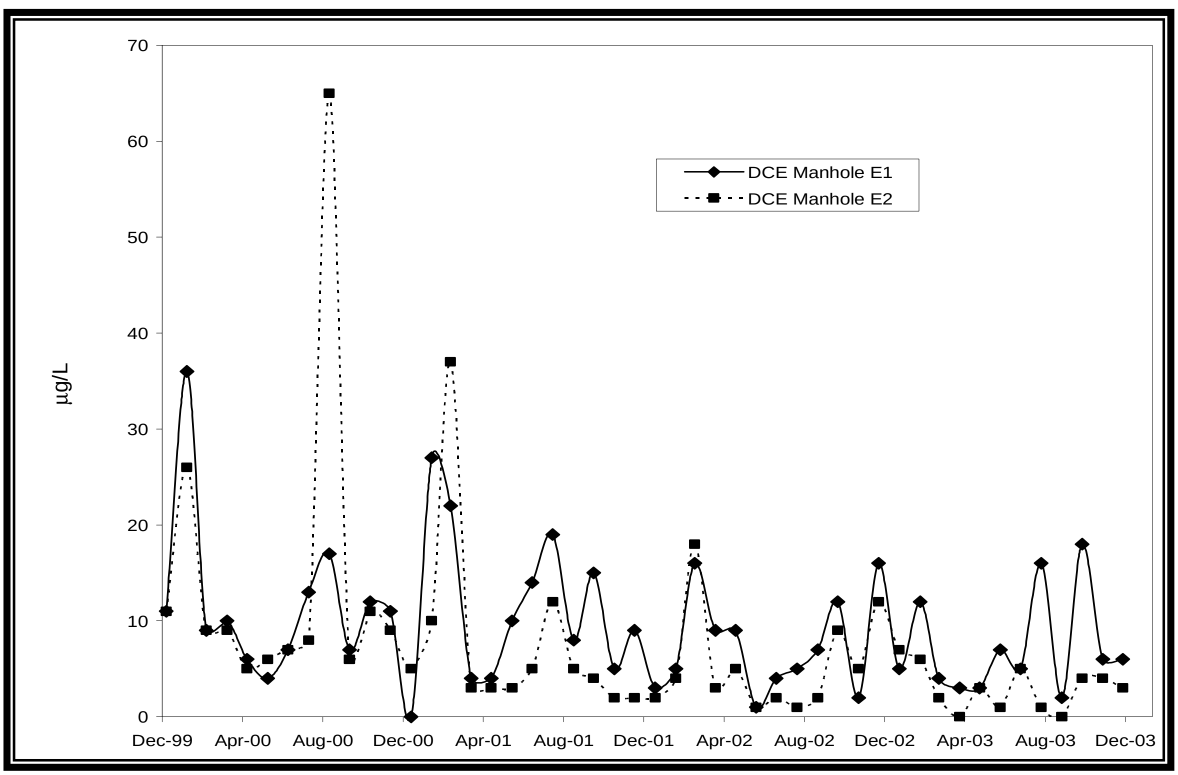


FIGURE 6.9 Manholes E1 and E2 *cis*-1,2-Dichloroethene Levels, 2000 to 2003

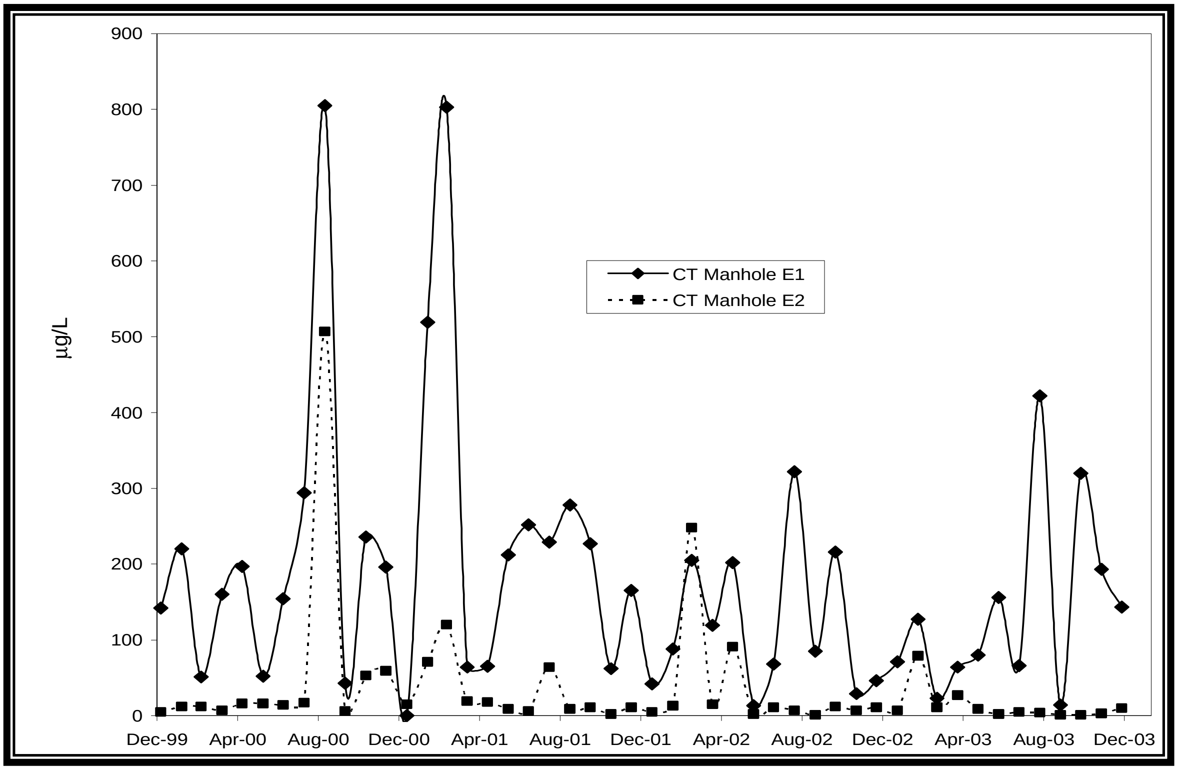


FIGURE 6.10 Manholes E1 and E2 Carbon Tetrachloride Levels, 2000 to 2003

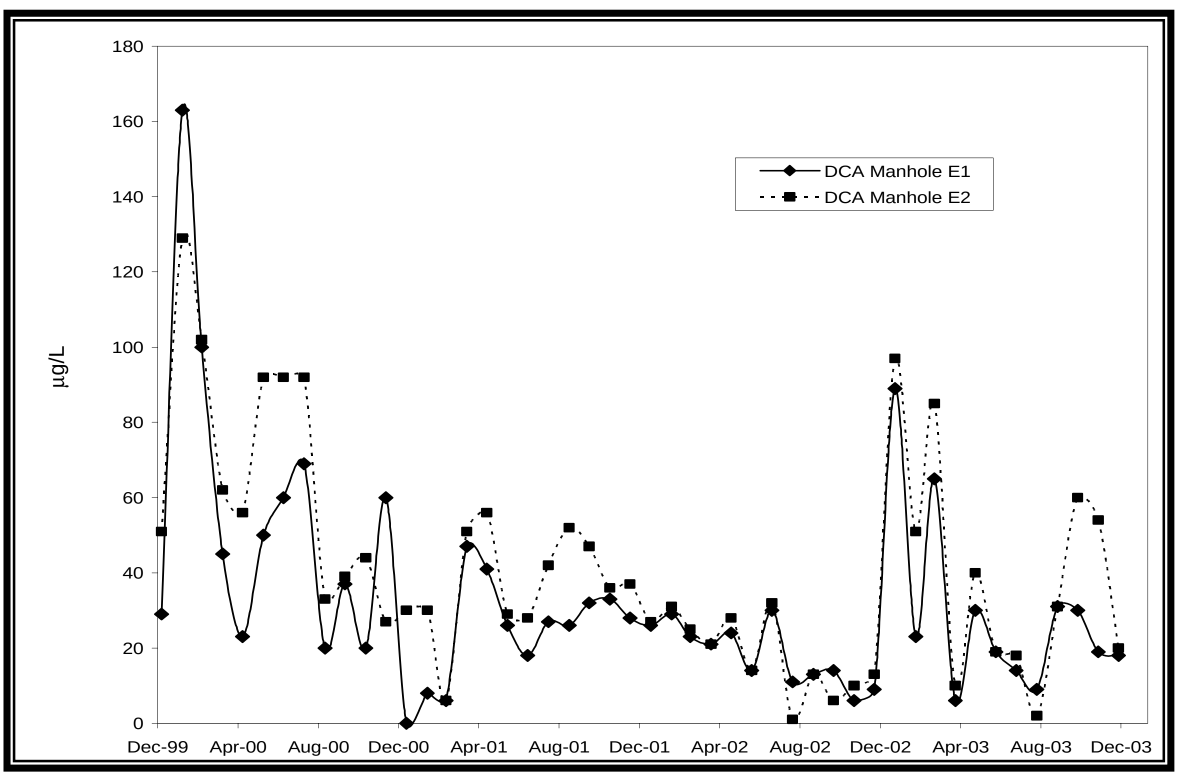


FIGURE 6.11 Manholes E1 and E2 1,1-Dichloroethane Levels, 2000 to 2003

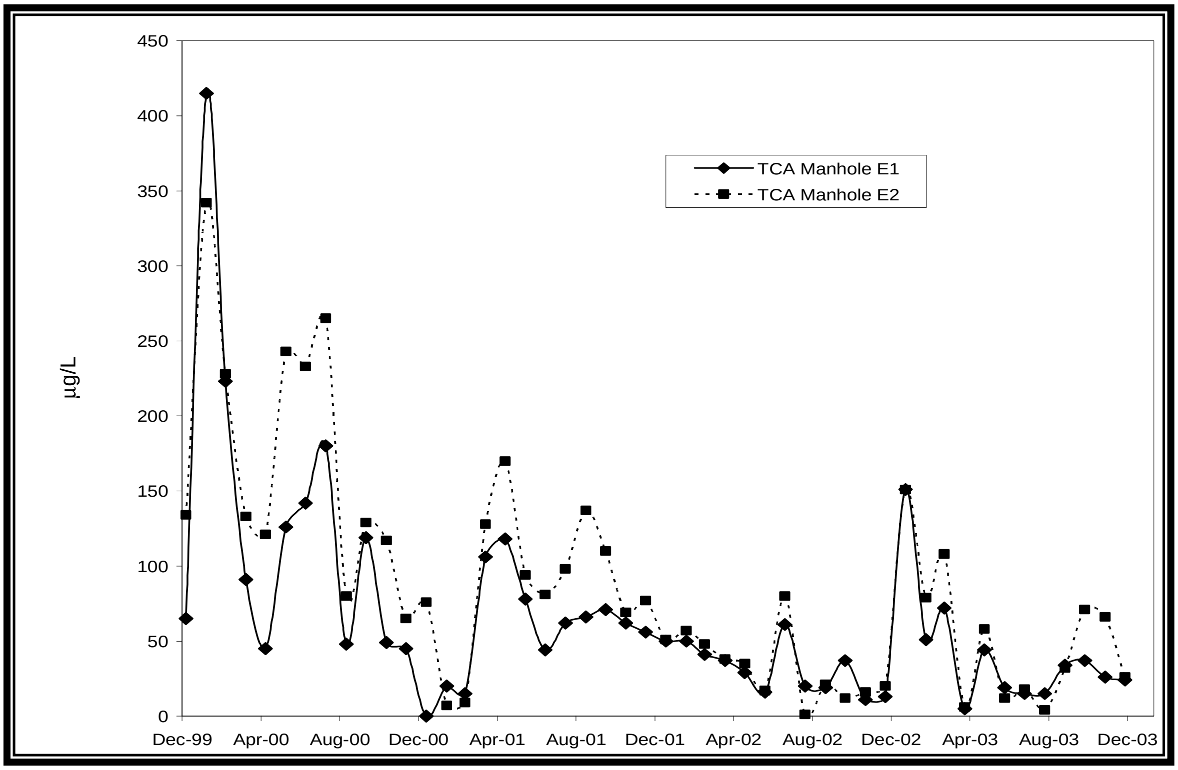


FIGURE 6.12 Manholes E1 and E2 1,1,1-Trichloroethane Levels, 2000 to 2003

below the quantification limit were excluded. The results in the table are the annual average of the quarterly results, and those values that exceed the applicable standards are indicated in bold type.

Most of the monitoring results are from within the 317 Area French Drain. Although portions of the area were treated using a soil mixing process with zero-valent iron addition, this treatment was effective at removing about 80% of the VOCs. The data in Table 6.18 indicate that small pockets of elevated VOCs remain to be treated by the phytoremediation process. For example, the areas around Wells 317151, 317181, 317321, and 317331 appear to be concentrations of elevated levels of a number of VOCs. Although the concentrations of a significant number of the VOCs are substantially above the standards, which are the targets for cleanup, examination of the individual quarterly results indicate that the concentrations of a number of VOCs are gradually decreasing as a result of natural attenuation.

6.2.4 Extraction Well Monitoring

Part of the groundwater management system in the 317/319 Area was to install 25 extraction wells to intercept the flow of contaminated groundwater off the ANL-E site. A line of extraction wells was installed near the 317 Area south fence and south of the 319 Area landfill. The wells were installed at approximately 10-m (30-ft) intervals at a depth of 10 to 15 m (30 to 50 ft) in the shallow porous zones. The discharges from the extraction wells are routed to a pump house where the water is pumped to a lift station. The groundwater is then transferred by force main to the ANL-E laboratory WTP. The location of the extraction wells is shown in Figure 6.14.

TABLE 6.17

Hydrogen-3 Concentrations in Manhole Water Samples, 2003
(concentrations in pCi/L)

Date Collected	Manhole 1E	Manhole 2E
01/09/03	8,042	10,650
02/05/03	7,601	15,280
03/11/03	1,872	2,660
04/03/03	1,421	1,613
05/12/03	1,743	1,825
06/03/03	1,918	2,323
07/22/03	4,005	4,206
08/11/03	602	3,517
09/08/03	536	367
10/21/03	2,954	4,995
11/13/03	1,685	4,235
12/10/03	989	1,037

Monitoring of the individual extraction well's water is conducted annually to determine the level of contaminants in the groundwater near the ANL-E property line and the magnitude of their concentrations. Samples are analyzed for VOCs and selected radionuclides. The concentrations of most of the monitoring parameters are below the laboratory detection limits. To provide a comparison of concentrations to the same parameters measured in the phytoremediation in wells, the range of concentrations for each parameter is presented in Table 6.19.

Examination of Table 6.19 shows that typically, only one or two extraction wells had VOC concentrations that exceeded the standards (cleanup levels). In addition, the magnitude of any exceedances was orders of magnitude lower than the measured concentrations in the phytoremediation wells (See Section 6.2.3.). The extraction wells appear to be effective at preventing migration of contaminated groundwater from leaving the ANL-E site.

In addition to the VOCs, the extraction well water was also analyzed for gross alpha, gross beta, gamma-ray emitters, isotopic uranium, plutonium-238 and 239, and hydrogen-3. All the radiological constituents, except hydrogen-3, were not detected or were within their normal ambient concentrations. The hydrogen-3 concentrations ranged from 103 to 123,100 pCi/L; most of the elevated hydrogen-3 concentrations were from the extraction wells just south of the 319 Landfill. Although some of these concentrations exceed the Class 1 Ground Water Quality Standard for hydrogen-3, concentrations in the past have been much higher.

6.2.5 ENE Landfill Groundwater Monitoring

In September 2001, ANL-E completed the remediation of the ENE Landfill by consolidating all the waste and constructing a cap over all the waste material. Five wells were installed (ENE031, ENE041, ENE051, ENE061, and ENE071) to facilitate monitoring of the groundwater around the landfill. Two of the wells (ENE061 and ENE071) were installed upgradient of the landfill and the other three wells (ENE031, ENE041, and ENE051) were

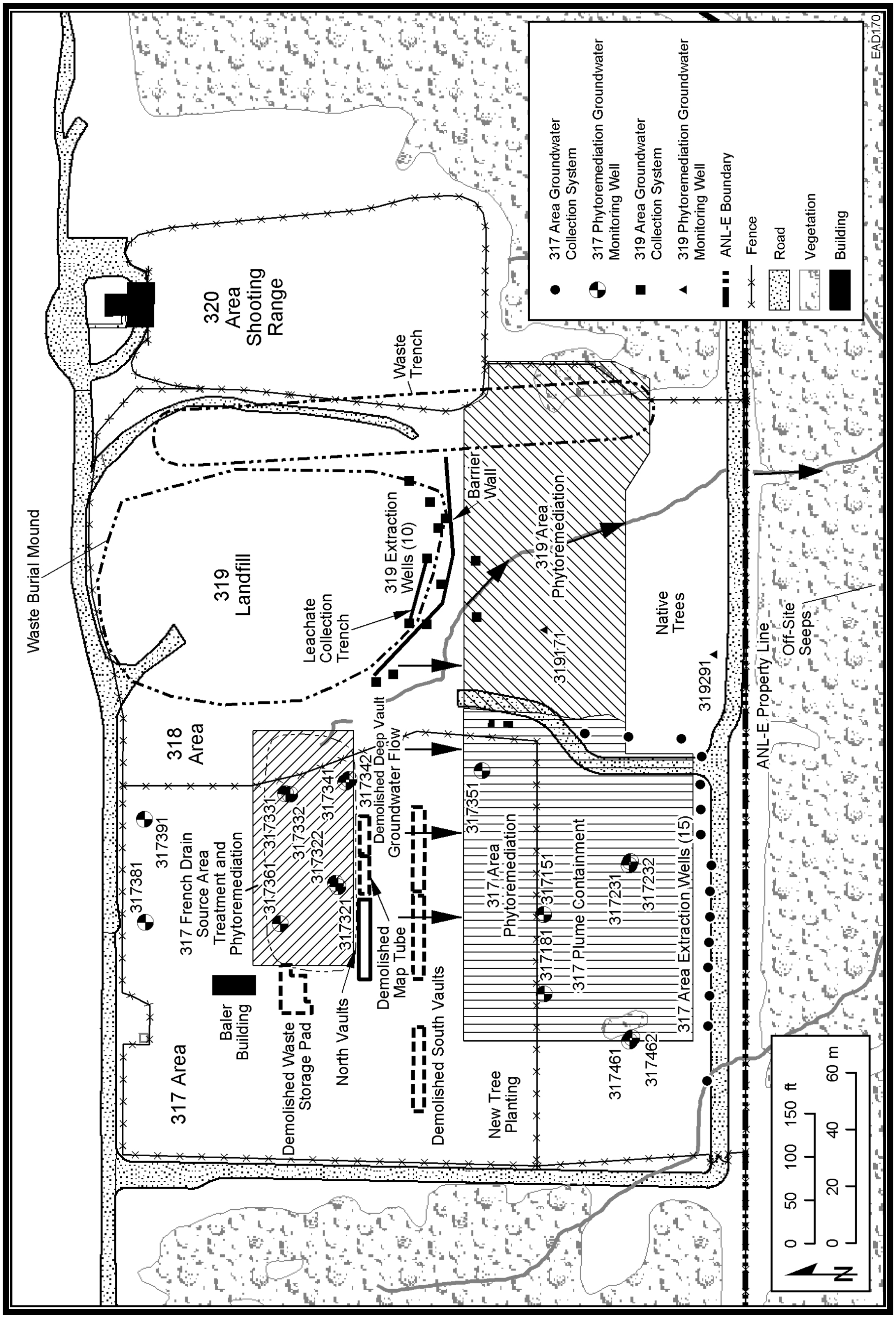


FIGURE 6.13 Phytoremediation Monitoring Wells

TABLE 6.18

Annual Average Concentrations of Phytoremediation Well Water Constituents, 2003

Parameter	317151	317181	317321	317322	317331	317332	317341	317342	317351	317462	Standard
VOC (µg/L)											
1,1,1-Trichloroethane	**12,500**[a]	**11,800**	ND[b]	ND	**122,500**	**5,510**	ND	**1,000**	19	**225**	200
1,1,2-Trichloloethane	ND	ND	ND	**21**	ND	**1.1**	ND	ND	ND	ND	0.5
1,1-Dichloroethane	**1,750**	**5,800**	ND	**1,675**	**14,100**	**1,730**	17	**1,150**	ND	**2,280**	700
1,1-Dichloroethene	ND	**150**	**9.4**	**410**	**2,770**	**67**	ND	**20**	ND	**21**	7
1,2-Dichloroethane	**145**	**238**	**290**	ND	**5,125**	**130**	3.2	**50**	ND	**100**	5
Benzene	ND	ND	**14,450**	**655**	**540**	**15.5**	ND	**5.6**	ND	**8.1**	5
Carbon tetrachloride	ND	ND	**94**	2.5	**300,000**	**940**	2.1	ND	**88**	ND	5
Chloroform	**112**	**140**	**77,600**	**3,380**	**1,060**	**21**	**10.3**	**3.5**	**187**	**1.5**	0.2
cis-1,2-Dichloroethene	**140**	**755**	**330**	**20,670**	**13,650**	**606**	6.2	**90**	3	18	70
Methylene chloride	**395**	**340**	**13,950**	**2,035**	**4,610**	**62**	ND	**32**	**19**	**240**	5
Tetrachloroethene	ND	**418**	**1,170**	**1,600**	**450**	1.2	1.4	1.4	**390**	ND	5
Trichloroethene	**950**	**780**	**37,400**	**730**	**31,600**	**495**	ND	**69**	**23**	**28**	5
Vinyl chloride	ND	**74**	ND	**521**	ND	**16**	0.4	**8.3**	ND	**5.2**	2
Radioactivity (pCi/L)											
Hydrogen-3	1,120	670	1,140	786	362	337	547	781	1634	518	20,000

[a] Bold type indicates that the value exceeds applicable standards.

[b] ND = nondetect.

TABLE 6.19

Range of VOC Concentrations in the Extraction Well Water, 2003

Parameter	Range (µg/L)	Standard
1,1,1-Trichloroethane	0.2 to 715	200
1,1-Dichloroethane	ND[a] to 510	700
1,1-Dichloroethene	ND to 12	700
1,2-Dichloroethene	ND to 13	5
1,4-Dioxane	ND to 114	1
2-Butanone	ND to 6	NA[b]
2-Heptanone	ND to 10	NA
4-Heptanone	ND to 84	NA
Acetone	ND to 1352	700
Benzene	ND to 0.5	NA
Carbon disulfide	ND to 11	NA
Carbon tetrachloride	ND to 3	5
Chloroethane	ND to 47	NA
Chloroform	ND to 8	0.2
Chloromethane	ND to 1	NA
cis-1,2-Dichloroethene	ND to 126	70
Methylene chloride	ND to 13	5
Tetrachloroethene	ND to 5	5
Tetrahydrofuran	ND to 19	NA
Trichloroethene	ND to 85	5
Xylene (total)	ND to 0.7	5

[a] ND = nondetect.

[b] NA = not applicable.

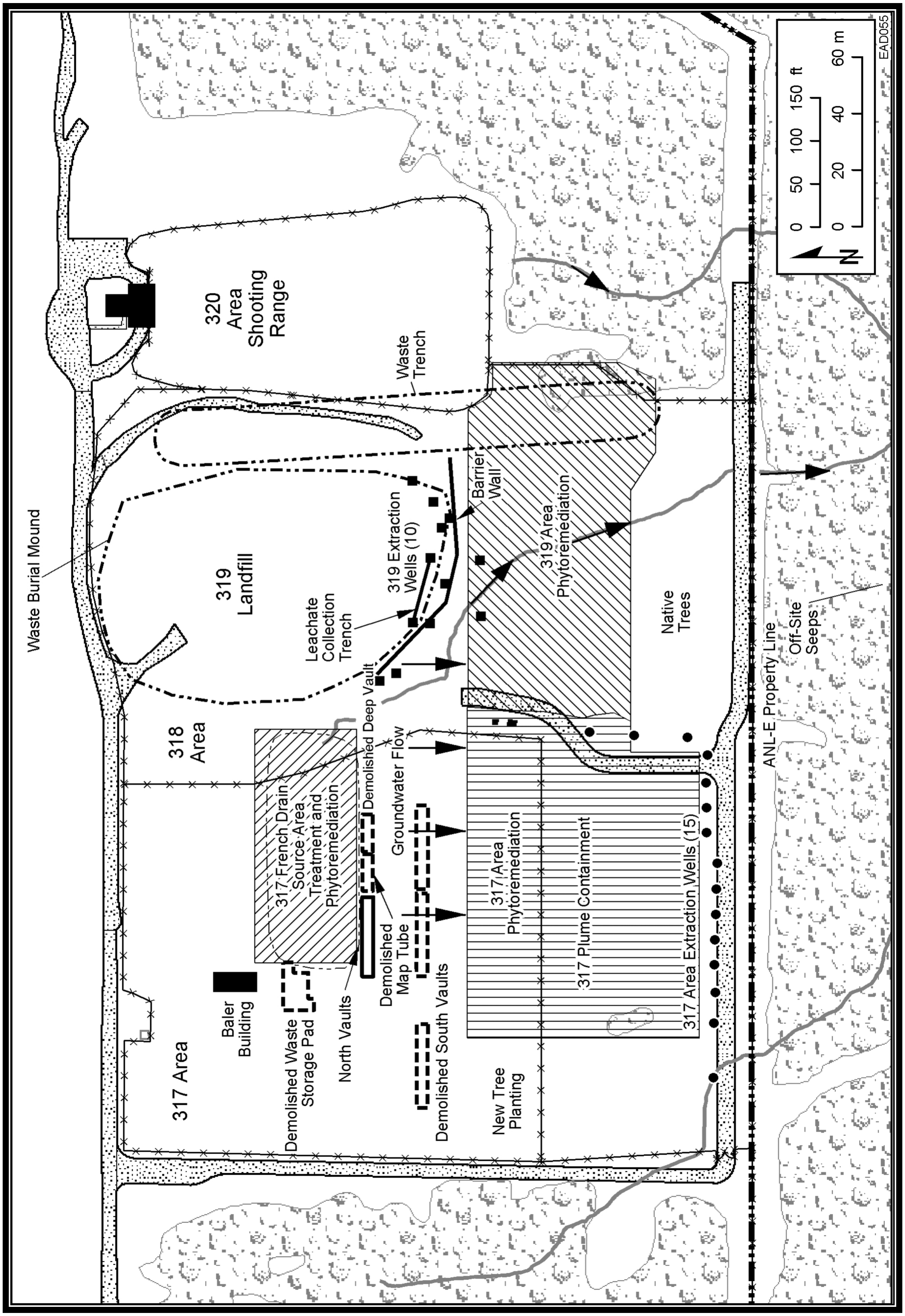


FIGURE 6.14 Extraction Wells

installed immediately downgradient of the landfill. Four other wells (ENE011, ENE012, ENE013D, and ENE021D) were installed as part of the 317/319/ENE RCRA Facility Investigation (RFI) in 1996 and are located south and east of the landfill. The well locations are shown in Figure 6.15.

The purpose of the groundwater monitoring at the ENE landfill is to determine if chemical contaminants found in the landfill exceeded the levels found in 35 IAC Part 742. Filtered and unfiltered samples were collected quarterly from the wells installed in 2001 and analyzed for metals, VOCs, and hydrogen-3. Samples were also collected quarterly from the wells installed in 1996 but only analyzed for hydrogen-3. Except for the results of the hydrogen-3 analyses of the 1996 wells, the annual average of metals for the four quarterly results are presented in Table 6.20. Average results that exceed the standard are indicated in bold type. Wells ENE061 and ENE071 were dry throughout the year.

The only exceedances of the cleanup standards were for three parameters in the unfiltered samples collected from well ENE041 — iron, lead, and manganese — and are probably related to elevated turbidity levels in the well water. All other metals concentrations are within the established standards. The hydrogen-3 concentrations are well below the 20,000 pCi/L Class 1 Ground Water Quality Standard, and no VOCs were detected in any samples during 2003. The hydrogen-3 concentrations in Wells ENE011, ENE012, and ENE021D were all less than the detection limit of 100 pCi/L, and the average hydrogen-3 concentration in well ENE013D was 115 pCi/L in 2003. Monitoring at the ENE Landfill will be conducted for a minimum of 15 years as required by the landfill closure permit issued by the IEPA.

6.2.6. 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 and are considered clean background seeps. The locations are shown in Figure 6.16. The seeps are in ravines that are located in a pristine, heavily wooded section of the forest preserve. The ravines carry storm water drainage from the 317 and 319 Areas. Storm water flow has eroded the soil deep enough to expose a shallow sandy layer containing groundwater. Water emanating from the exposed sandy layer 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.

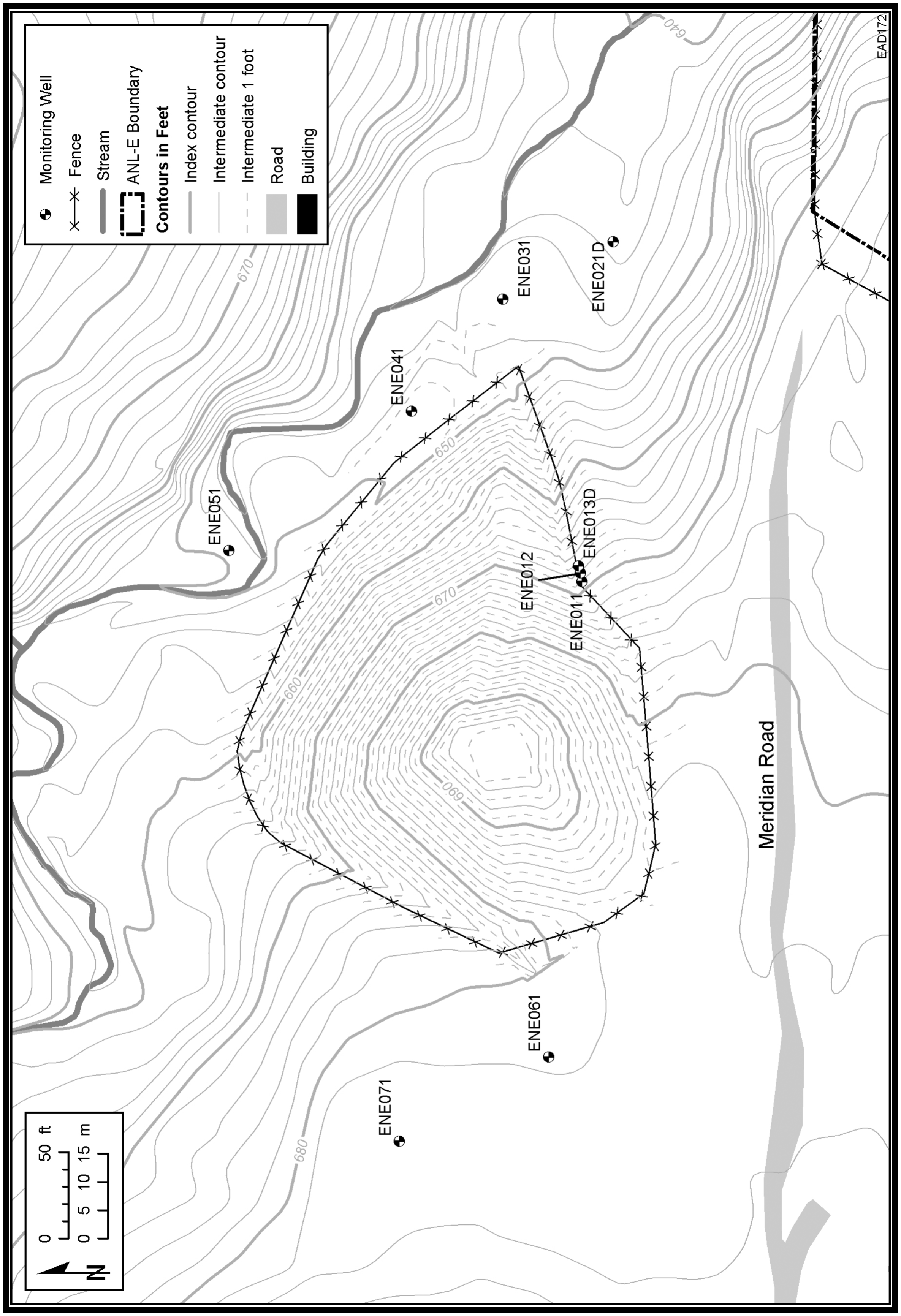


FIGURE 6.15 ENE Area Groundwater Monitoring Wells

TABLE 6.20

Annual Average Concentration of ENE Landfill Well Water Constituents, 2003

Metals (mg/L)	Well ENE031 (Unfiltered)	Well ENE031 (Filtered)	Well ENE041 (Unfiltered)	Well ENE041 (Filtered)	Well ENE051 (Unfiltered)	Well ENE051 (Filtered)	Standard
Aluminum	<0.2	<0.2	10.5	<0.2	0.21	<0.2	50
Antimony	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	0.006
Arsenic	<0.01	<0.01	0.034	<0.01	<0.01	<0.01	0.05
Barium	<0.1	<0.1	0.14	<0.1	<0.1	<0.1	2
Beryllium	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	0.004
Cadmium	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.005
Calcium	101	101	1,220	83	110	105	NA[a]
Chromium	<0.01	<0.01	0.026	<0.01	<0.01	<0.01	0.1
Cobalt	<0.01	<0.01	0.017	<0.01	<0.01	<0.01	1.0
Copper	<0.01	<0.01	0.052	<0.01	<0.01	<0.01	0.65
Iron	1.2	0.64	**70**[b]	<0.1	1.2	0.30	5
Lead	<0.007	<0.007	**0.015**	<0.007	<0.007	<0.007	0.0075
Magnesium	60	59	702	65	54	52	NA
Manganese	0.12	0.12	**1.5**	0.003	0.054	0.040	0.15
Mercury	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.002
Nickel	<0.05	<0.05	0.05	<0.05	<0.05	<0.05	0.1
Potassium	4.5	4.4	10.0	2.6	4.6	4.5	NA
Selenium	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	0.05
Silver	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.05
Sodium	57	57	25	27	103	103	NA
Thallium	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.002
Vanadium	<0.01	<0.01	0.041	<0.01	<0.01	<0.01	NA
Zinc	<0.01	<0.01	0.069	0.021	<0.01	0.016	5
Radioactivity (pCi/L)							
Hydrogen-3	289		1,766		261		20,000

a NA = not applicable.

b Bold type indicates that the value exceeds applicable standards.

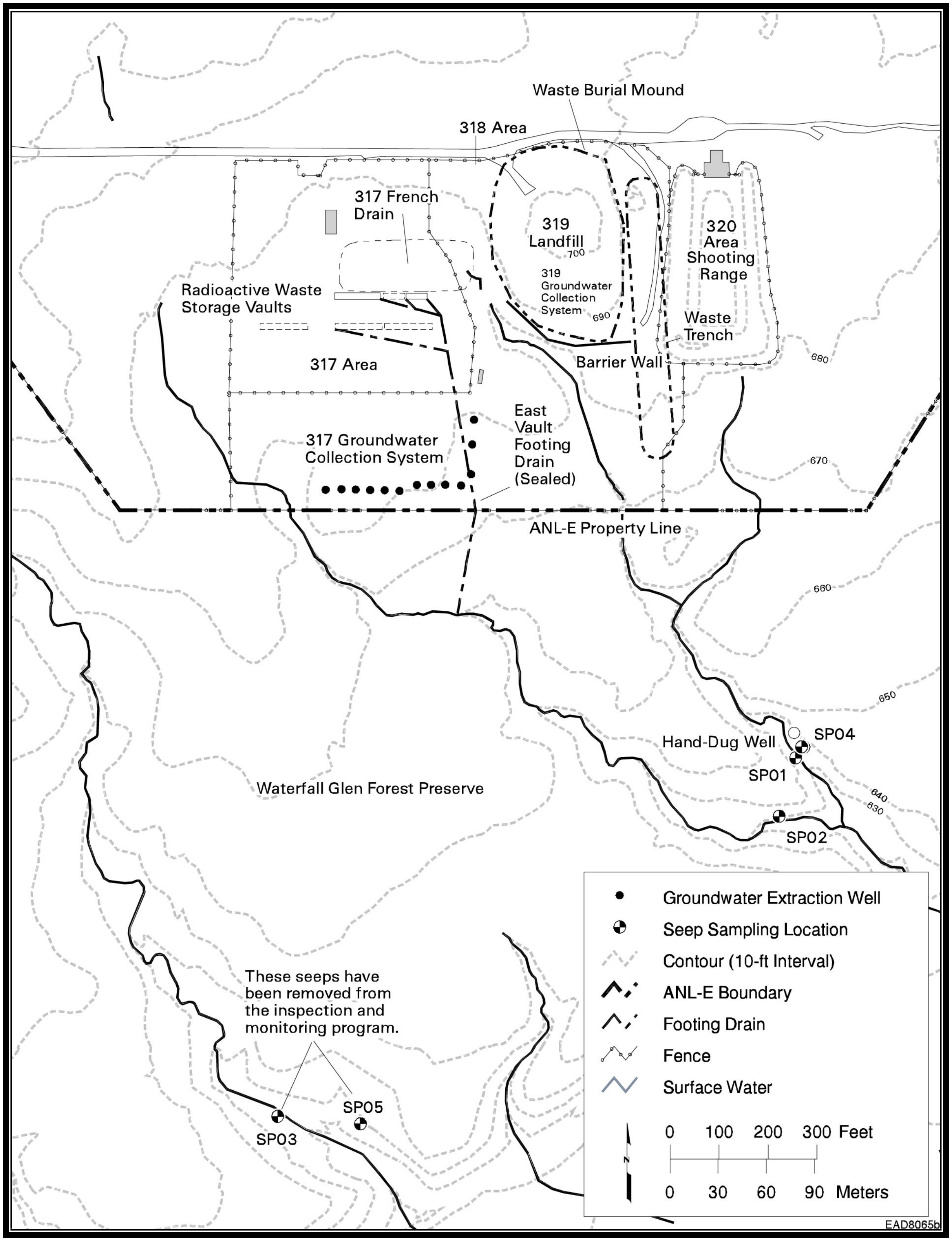


FIGURE 6.16 Seep Locations South of the 317/319 Area

Initial 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 1998 Site Environmental Report.[15]

During 2003, Seeps SP01, SP02, and SP04 were sampled quarterly for VOCs and hydrogen-3. VOCs were noted in each seep each quarter, except for SP02 during the second quarter. As in previous years, Seep SP04 showed the highest levels of all three VOCs (carbon tetrachloride, chloroform, and tetrachloroethene) each quarter. The data are presented in Table 6.21. The hydrogen-3 and VOC results are consistent with past data, which indicates a gradual decline in concentrations, with the exception of chloroform in SP04, since measurements began in 1996 (see Figures 6.17 and 6.18).

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 finding suggests that any subsurface contaminant movement has not extended to this location and indicates a western limit to movement.

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 received waste from 1966 until September 1992 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. 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, 1999-107-SP, 1999-476-SP, and 2002-194-SP. On March 25, 2003, the IEPA notified DOE that all future groundwater activities at the 800 Area Landfill will be carried out under the corrective action provisions (Section V) of ANL-E’s RCRA Part B Permit.

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. Available documentation indicates that 109,000 L (29,000 gal) of liquid waste was placed in this

TABLE 6.21

Contaminant Concentrations in Seep Water, 2000 to 2003

Site	Date Collected	Hydrogen-3 (pCi/L)	Carbon Tetrachloride (µg/L)	Chloroform (µg/L)	Tetrachloroethene (µg/L)
SP01	03/21/00	706	5	2	<1
	06/07/00	1,425	6[a]	2	<1
	08/21/00	1,178	8	2	<1
	11/03/00	1,120	7	2	<1
	01/31/01	640	5	1	<1
	05/15/01	633	7	1	<1
	09/07/01	555	4	1	<1
	11/02/01	645	6	2	<1
	01/28/02	614	2	<1	<1
	04/18/02	383	2	1	<1
	07/30/02	242	4	2	<1
	11/13/02	250	7	4	<1
	03/25/03	203	<1	<1	<1
	05/13/03	128	3	1	<1
	08/14/03	187	<1	1	<1
	12/8/03	198	<1	1	<1
SP02	03/21/00	1,998	1	<1	<1
	06/07/00	1,124	1	<1	<1
	08/21/00	625	3	<1	<1
	11/03/00	1,348	2	<1	<1
	01/31/01	1,383	2	<1	<1
	05/15/01	340	2	<1	<1
	09/07/01	619	2	<1	<1
	11/02/01	626	2	<1	<1
	01/28/02	572	7	2	<1
	04/18/02	274	<1	<1	<1
	07/30/02	188	1	<1	<1
	11/13/02	326	1	<1	<1
	03/25/03	361	<1	<1	<1
	05/13/03	256	1	<1	<1
	08/14/03	273	<1	<1	<1
	12/8/03	248	1	1	<1
SP04	03/21/00	Dry	Dry	Dry	Dry
	06/07/00	1,043	**179**	18	7
	08/21/00	435	**301**	28	9
	11/03/00	323	**194**	23	6
	01/31/01	418	**221**	22	6
	05/15/01	124	**208**	25	7
	09/07/01	117	**145**	54	7
	11/02/01	183	**148**	23	6
	01/28/02	409	**152**	20	5
	04/18/02	< 100	**143**	20	7
	07/30/02	< 100	**180**	26	6
	11/13/02	116	**118**	43	6
	3/25/03	Dry	Dry	Dry	Dry
	5/13/03	<100	39	10	2
	8/14/03	<100	137	33	4
	12/8/03	Dry	Dry	Dry	Dry

[a] Bold type indicates that the value exceeds the State of Illinois Groundwater Quality Standard.

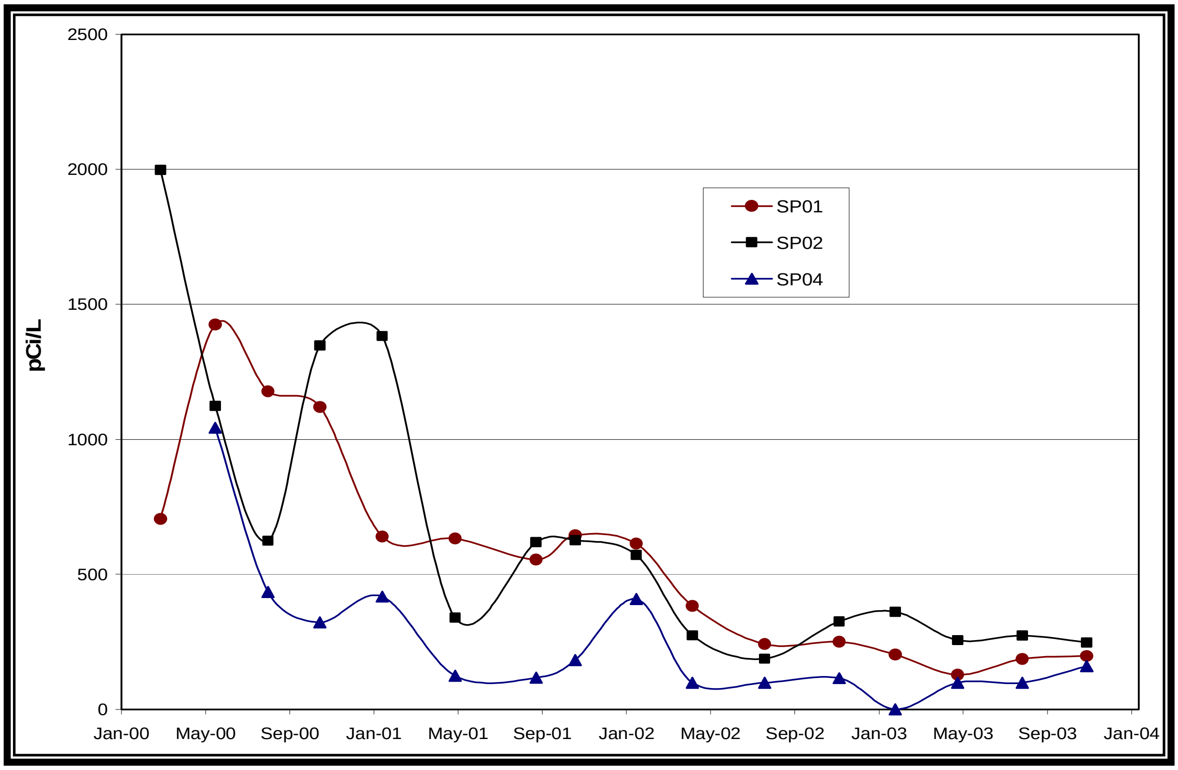


FIGURE 6.17 Hydrogen-3 Concentrations in Seep Water, 2000 to 2003

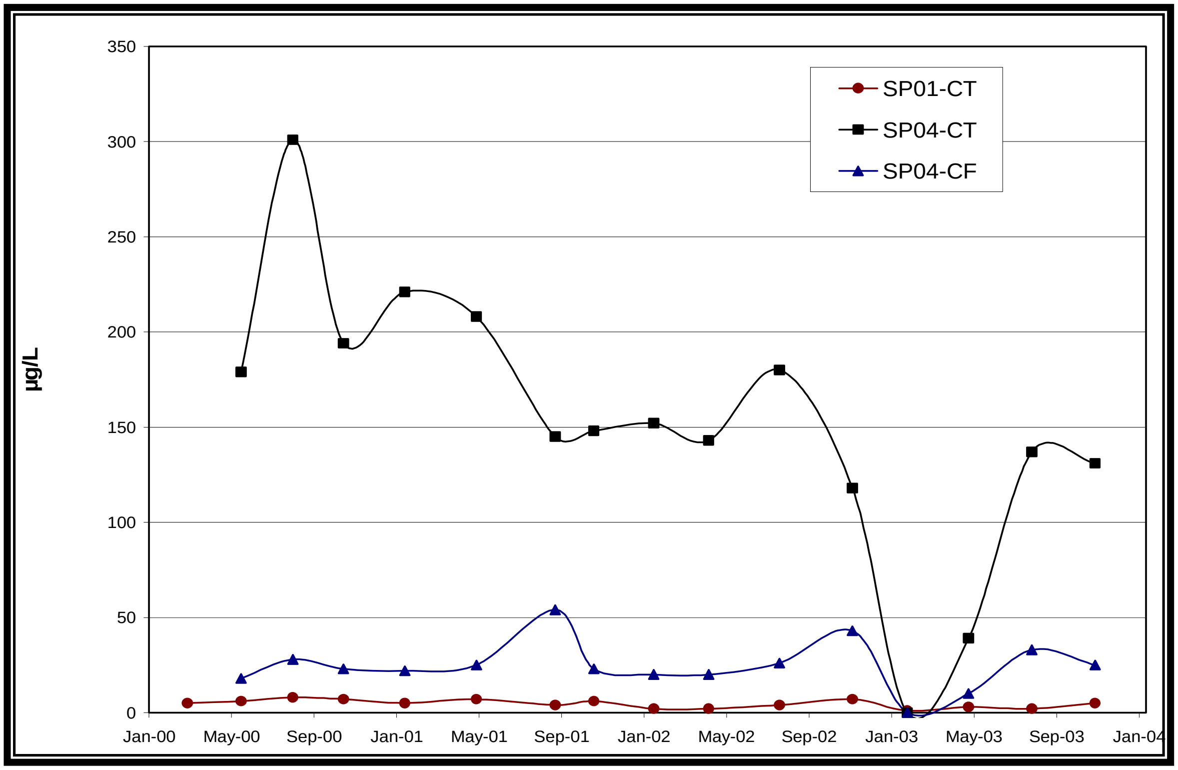


FIGURE 6.18 Carbon Tetrachloride and Chloroform Concentrations in Seep Water, 2000 to 2003

drain. Most of this material was used oil or used machining coolant (oil water emulsion). Some of the wastes disposed of in this manner would currently be defined as hazardous wastes. The presence of volatile and other toxic organic compounds has been confirmed by extensive characterization activities conducted at the landfill. Measurable amounts of these materials were identified in leachate but not in 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 6.19 and Table 6.22).

In late spring of 1999, an environmental remediation project was completed that resulted in the extension of the landfill cap in the north portion of the landfill to cover some recently identified waste material. As part of this project, the landfill cap, perimeter road, and fence were moved 15 m (50 ft) north, and monitoring wells 800161, 800162, and 800163D were replaced. The sampling of the replacement wells — 800381, 800382, and 800383D — commenced in July 1999.

IEPA Supplemental Permit No. 1999-107-SP, effective June 16, 1999, provided for (1) the installation and addition of 3 new upgradient groundwater monitoring wells (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 6.22 provides information on these wells, and Figure 6.19 shows their locations. Wells 800272 and 800311 have been dry since installation. Well 800321 was dry the first, second, and fourth quarters.

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 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. Beginning in April 2003, Well 800191 utilized a low-flow technology for groundwater sampling. Wells 800281 and 800381 utilized low-flow technology beginning October 2003.

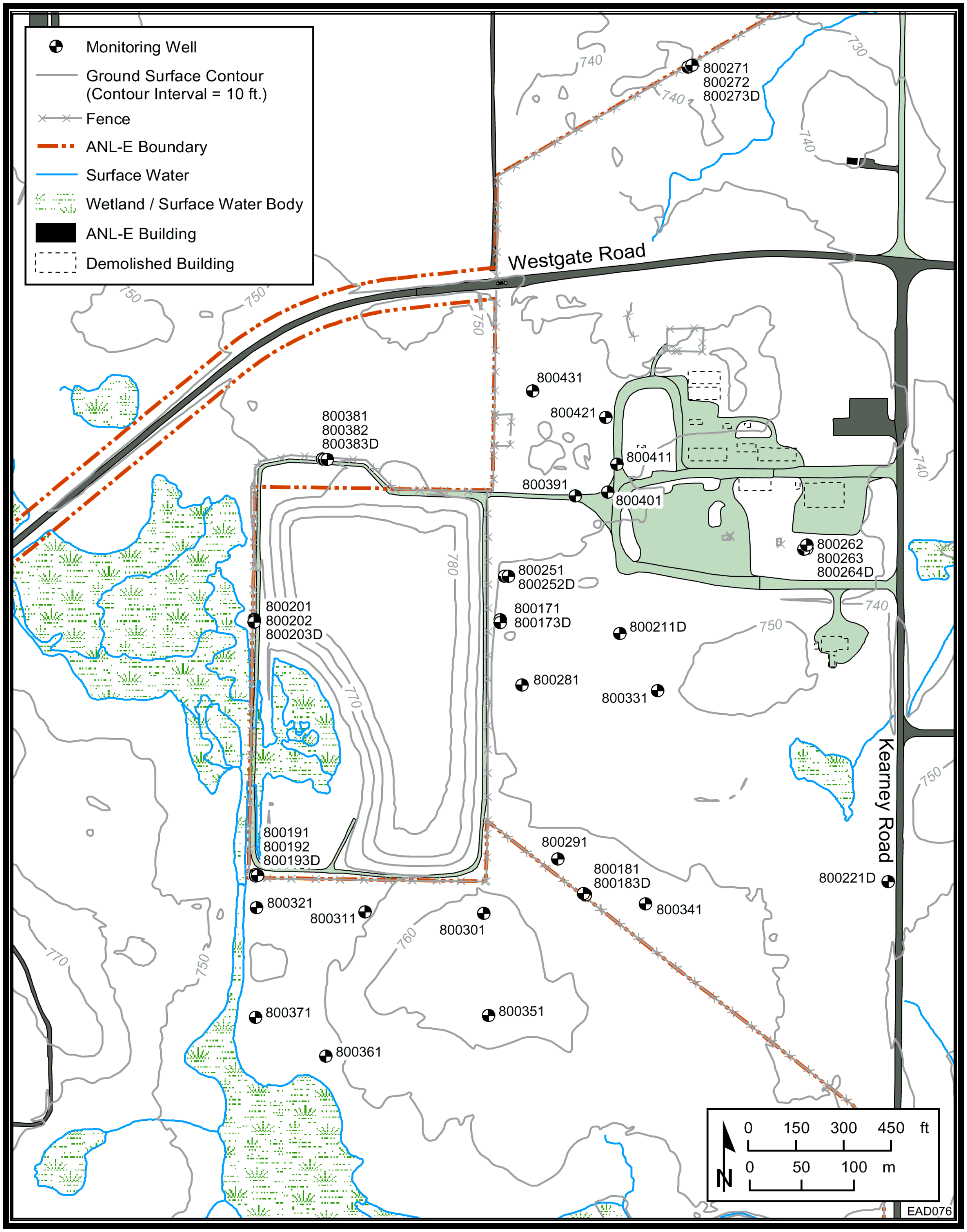


FIGURE 6.19 Active Monitoring Wells in the 800 Area

TABLE 6.22

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
800171	7.62	228.11	222.32–220.80	0.05/SS	10/92
800173D	39.62	228.41	192.13–189.09	0.05/SS	10/92
800181	10.67	230.52	221.37–219.85	0.05/SS	10/92
800183D	49.99	230.37	183.43–180.38	0.05/SS	10/92
800191	4.63	227.38	224.43–222.90	0.05/SS	10/92
800192	18.29	227.40	210.63–209.11	0.05/SS	10/92
800193D	46.02	227.37	184.40–181.35	0.05/SS	10/92
800201	10.67	227.93	218.78–217.26	0.05/SS	10/92
800202	18.38	227.92	211.07–209.54	0.05/SS	10/92
800203D	38.40	227.92	192.63–189.59	0.05/SS	9/92
800271	4.57	225.61	223.18–221.65	0.05/SS	8/99
800272	13.72	225.61	213.42–211.90	0.05/SS	8/99
800273D	37.49	225.61	191.78–188.73	0.05/SS	8/99
800281	3.96	227.65	225.52–224.00	0.05/SS	9/99
800291	7.01	230.49	225.00–223.48	0.05/SS	9/99
800301	7.62	232.53	226.51–224.99	0.05/SS	9/99
800311	13.72	227.41	217.35–214.31	0.05/SS	9/99
800321	4.27	227.93	225.26–223.66	0.05/SS	9/99
800331	5.18	227.93	224.27–222.75	0.05/SS	9/99
800341	3.96	229.97	227.53–226.01	0.05/SS	9/99
800351	11.89	232.75	223.91–220.86	0.05/SS	9/99
800361	7.01	227.53	222.12–220.60	0.05/SS	9/99
800371	9.75	227.50	219.27–217.83	0.05/SS	9/99
800381[c]	7.31	231.11	227.44–224.40	0.05/SS	6/99
800382[c]	19.20	231.18	215.33–212.28	0.05/SS	6/99
800383D[c]	44.50	231.24	190.39–187.35	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.

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 EQO-AS. These SOPs reference protocols in SW-846.[5] Fifteen metals were routinely determined and analyzed by using 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. 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-846[5] procedures were specified and used. Cyanide and phenol were determined by distillation followed by a spectrophotometric measurement. 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 EQO-AS. Hydrogen-3 was determined by distillation followed by a beta liquid scintillation counting technique. Cesium-137 was determined by gamma-ray spectrometry.

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 6.23 to 6.46. All radiological and inorganic analysis 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. 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 10 μg/L.

The IEPA has mandated that ANL-E utilize the Illinois Groundwater Quality Standards for Class I: Potable Resource Groundwater, 35 IAC Part 620.410 for comparison with groundwater quality results for all unfiltered parameters.

In general, groundwater quality at the 800 Area Landfill appears to be related to the level of turbidity of the sample. An evaluation of sampling options is being conducted to determine the

TABLE 6.23

Groundwater Monitoring Results, Sanitary Landfill Well 800381, 2003

Parameter	Unit	Date of Sampling			
		1/08/2003	4/10/2003	7/08/2003	10/08/2003
Water elevation[a]	m	226.36	226.41	227.14	226.70
Temperature	°C	12.2	10.9	13.1	13.8
pH	pH	6.81	7.05	7.00	7.05
Redox	mV	9	-2	1	-7
Conductivity	µmhos/cm	1,426	1,310	1,370	1,361
Chloride[b]	mg/L	36	35	36	42
Sulfate[b]	mg/L	103	196	103	312
TDS[b]	mg/L	994	1,274	994	1,266
Cyanide (total)[c]	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Arsenic[c]	mg/L	–[d]	**0.0697**[e]	–	–
Barium[c]	mg/L	–	0.2099	–	–
Boron[c]	mg/L	–	0.4427	–	–
Cadmium[c]	mg/L	–	0.0015	–	–
Chromium[c]	mg/L	–	**0.2923**	–	–
Cobalt[c]	mg/L	–	0.0686	–	–
Copper[c]	mg/L	–	0.2145	–	–
Iron[c]	mg/L	–	**136.9**	–	–
Lead[c]	mg/L	–	**0.0484**	–	–
Manganese[c]	mg/L	–	**3.166**	–	–
Mercury[c]	mg/L	–	< 0.0001	–	–
Nickel[c]	mg/L	–	**0.1573**	–	–
Selenium[c]	mg/L	–	< 0.003	–	–
Silver[c]	mg/L	–	< 0.001	–	–
Zinc[c]	mg/L	–	0.3446	–	–
Ammonia nitrogen[b]	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Arsenic[b]	mg/L	0.0154	0.0061	0.0154	< 0.003
Barium[b]	mg/L	0.0502	0.0384	0.0502	0.0487
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	< 0.024	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016	< 0.016	< 0.016
Copper[b]	mg/L	< 0.015	< 0.015	< 0.015	< 0.015
Iron[b]	mg/L	0.6683	< 0.02	0.6683	0.2853
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	0.1934	0.3258	0.1934	0.1767
Mercury[b]	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	0.0205	0.0354	0.0205	< 0.02
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	< 0.008	0.0226	< 0.008	0.0243
Nitrate[c]	mg/L	–	< 0.1	–	–
Phenols[c]	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Cesium-137[c]	pCi/L	–	< 2.0	–	–
Hydrogen-3[c]	pCi/L	< 100	< 100	< 100	< 100
Chloride[c]	mg/L	–	38	–	–
Fluoride[c]	mg/L	–	0.412	–	–
Sulfate[c]	mg/L	–	228	–	–
TOCs[c]	mg/L	2.5	4.1	2.5	3.1
TOCs[c]	mg/L	2.5	4.2	2.5	3.1
TOCs[c]	mg/L	2.6	4.1	2.6	3.1
TOCs[c]	mg/L	2.5	4.1	2.5	3.1
TOXs[c]	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
TOXs[c]	mg/L	< 0.02	< 0.02	< 0.02	< 0.02

[a] Well point elevation = 224.40 m (MSL); ground surface elevation = 231.11 m (MSL); casing material = stainless steel.
[b] Filtered sample.
[c] Unfiltered sample.
[d] A dash indicates that no samples were collected.
[e] Bold type indicates that the unfiltered sample value exceeds the State of Illinois Groundwater Quality Standard.

TABLE 6.24

Groundwater Monitoring Results, Sanitary Landfill Well 800382, 2003

Parameter	Unit	Date of Sampling 1/08/2003	4/10/2003	7/08/2003	10/08/2003
Water elevation[a]	m	218.93	218.58	218.94	218.31
Temperature	°C	11.2	12.9	11.9	13.6
pH	pH	7.04	7.21	7.01	6.99
Redox	mV	-6	-11	-3	-7
Conductivity	µmhos/cm	1,059	799	880	847
Chloride[b]	mg/L	80	84	102	80
Sulfate[b]	mg/L	69	55	64	75
TDS[b]	mg/L	696	657	825	782
Cyanide (total)[c]	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Arsenic[c]	mg/L	–[d]	0.0131	–	–
Barium[c]	mg/L	–	0.6608	–	–
Boron[c]	mg/L	–	1.204	–	–
Cadmium[c]	mg/L	–	0.0036	–	–
Chromium[c]	mg/L	–	**2.305**[e]	–	–
Cobalt[c]	mg/L	–	0.1857	–	–
Copper[c]	mg/L	–	0.5113	–	–
Iron[c]	mg/L	–	**437.9**	–	–
Lead[c]	mg/L	–	**0.2363**	–	–
Manganese[c]	mg/L	–	**4.143**	–	–
Mercury[c]	mg/L	–	< 0.0001	–	–
Nickel[c]	mg/L	–	**1.525**	–	–
Selenium[c]	mg/L	–	< 0.003	–	–
Silver[c]	mg/L	–	0.0021	–	–
Zinc[c]	mg/L	–	1.281	–	–
Ammonia nitrogen[b]	mg/L	0.23	0.34	0.27	0.32
Arsenic[b]	mg/L	< 0.003	< 0.003	< 0.003	< 0.003
Barium[b]	mg/L	0.1088	0.1209	0.1309	0.1244
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	< 0.024	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016	< 0.016	< 0.016
Copper[b]	mg/L	< 0.015	< 0.015	< 0.015	< 0.015
Iron[b]	mg/L	0.4911	0.4021	0.1645	0.3727
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	0.1075	0.109	0.1155	0.1092
Mercury[b]	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	< 0.02	< 0.02	0.0274	< 0.02
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	< 0.008	< 0.008	0.0085	< 0.008
Nitrate[c]	mg/L	–	< 0.1	–	–
Phenols[c]	mg/L	0.0051	< 0.005	< 0.005	< 0.005
Hydrogen-3[c]	pCi/L	< 100	< 100	< 100	< 100
Chloride[c]	mg/L	–	90	–	–
Fluoride[c]	mg/L	–	0.29	–	–
Sulfate[c]	mg/L	–	68	–	–
TOCs[c]	mg/L	2.7	2.7	2.7	2.8
TOCs[c]	mg/L	2.7	2.7	2.7	2.8
TOCs[c]	mg/L	2.7	2.8	2.7	2.8
TOCs[c]	mg/L	2.7	2.8	2.7	2.8
TOXs[c]	mg/L	0.088	0.031	0.057	< 0.02
TOXs[c]	mg/L	0.063	0.058	0.033	< 0.02

[a] Well point elevation = 212.28 m (MSL); ground surface elevation = 231.18 m (MSL); casing material = stainless steel.
[b] Filtered sample.
[c] Unfiltered sample.
[d] A dash indicates that no samples were collected.
[e] Bold type indicates that the unfiltered sample value exceeds the State of Illinois Groundwater Quality Standard.

TABLE 6.25

Groundwater Monitoring Results, Sanitary Landfill Well 800383D, 2003

		Date of Sampling			
Parameter	Unit	1/08/2003	4/10/2003	7/08/2003	10/08/2003
Water elevation[a]	m	193.01	192.65	192.75	192.62
Temperature	°C	11.4	12.7	12.1	11.9
pH	pH	7.11	7.09	6.87	6.90
Redox	mV	-7	-4	7	3
Conductivity	µmhos/cm	1,318	960	1,058	1,037
Chloride[b]	mg/L	119	136	146	112
Sulfate[b]	mg/L	151	138	123	190
TDS[b]	mg/L	834	815	909	912
Cyanide (total)[c]	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Arsenic[c]	mg/L	–[d]	0.0054	–	–
Barium[c]	mg/L	–	0.0831	–	–
Boron[c]	mg/L	–	0.2221	–	–
Cadmium[c]	mg/L	–	< 0.0002	–	–
Chromium[c]	mg/L	–	0.071	–	–
Cobalt[c]	mg/L	–	< 0.016	–	–
Copper[c]	mg/L	–	< 0.015	–	–
Iron[c]	mg/L	–	**9.655**[e]	–	–
Lead[c]	mg/L	–	0.0046	–	–
Manganese[c]	mg/L	–	**0.28**	–	–
Mercury[c]	mg/L	–	< 0.0001	–	–
Nickel[c]	mg/L	–	0.0204	–	–
Selenium[c]	mg/L	–	< 0.003	–	–
Silver[c]	mg/L	–	< 0.001	–	–
Zinc[c]	mg/L	–	0.0326	–	–
Ammonia nitrogen[b]	mg/L	0.62	0.69	0.67	0.71
Arsenic[b]	mg/L	< 0.003	< 0.003	< 0.003	< 0.003
Barium[b]	mg/L	0.0663	0.0745	0.0688	0.0721
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	< 0.024	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016	< 0.016	< 0.016
Copper[b]	mg/L	< 0.015	< 0.015	< 0.015	< 0.015
Iron[b]	mg/L	1.257	1.603	1.2498	0.6824
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	0.0482	0.0516	0.0471	0.0427
Mercury[b]	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	< 0.008	< 0.008	0.0082	< 0.008
Nitrate[c]	mg/L	–	< 0.1	–	–
Phenols[c]	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Hydrogen-3[c]	pCi/L	< 100	< 100	< 100	< 100
Chloride[c]	mg/L	–	135	–	–
Fluoride[c]	mg/L	–	0.462	–	–
Sulfate[c]	mg/L	–	133	–	–
TOCs[c]	mg/L	1.5	1.7	1.6	1.7
TOCs[c]	mg/L	1.5	1.7	1.5	1.7
TOCs[c]	mg/L	1.5	1.7	1.5	1.7
TOCs[c]	mg/L	1.4	1.7	1.5	1.8
TOXs[c]	mg/L	0.04	0.032	0.028	< 0.02
TOXs[c]	mg/L	0.024	0.024	0.028	0.12

[a] Well point elevation = 187.35 m (MSL); ground surface elevation = 231.24 m (MSL); casing material = stainless steel.
[b] Filtered sample.
[c] Unfiltered sample.
[d] A dash indicates that no samples were collected.
[e] Bold type indicates that the unfiltered sample value exceeds the State of Illinois Groundwater Quality Standard.

TABLE 6.26

Groundwater Monitoring Results, Sanitary Landfill Well 800171, 2003

Parameter	Unit	Date of Sampling			
		1/06/2003	4/09/2003	7/07/2003	10/07/2003
Water elevation[a]	m	225.17	226.61	224.84	224.79
Temperature	°C	9.4	10.1	13.3	12.3
pH	pH	6.89	6.90	7.03	7.00
Redox	mV	6	8	7	0
Conductivity	µmhos/cm	1,272	702	969	990
Chloride[b]	mg/L	15	12	10	13
Sulfate[b]	mg/L	108	80	88	143
TDS[b]	mg/L	789	627	718	792
Cyanide (total)[c]	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Arsenic[c]	mg/L	–[d]	0.0037	–	–
Barium[c]	mg/L	–	0.1184	–	–
Boron[c]	mg/L	–	0.4427	–	–
Cadmium[c]	mg/L	–	< 0.0002	–	–
Chromium[c]	mg/L	–	0.0946	–	–
Cobalt[c]	mg/L	–	< 0.016	–	–
Copper[c]	mg/L	–	< 0.015	–	–
Iron[c]	mg/L	–	**17.72**[e]	–	–
Lead[c]	mg/L	–	**0.0095**	–	–
Manganese[c]	mg/L	–	**1.024**	–	–
Mercury[c]	mg/L	–	< 0.0001	–	–
Nickel[c]	mg/L	–	< 0.02	–	–
Selenium[c]	mg/L	–	< 0.003	–	–
Silver[c]	mg/L	–	< 0.001	–	–
Zinc[c]	mg/L	–	0.0515	–	–
Ammonia nitrogen[b]	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Arsenic[b]	mg/L	< 0.003	< 0.003	< 0.003	< 0.003
Barium[b]	mg/L	0.057	0.0445	0.0502	0.0686
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	< 0.024	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016	< 0.016	< 0.016
Copper[b]	mg/L	< 0.015	< 0.015	< 0.015	< 0.015
Iron[b]	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	0.0914	0.0557	0.261	0.2188
Mercury[b]	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	< 0.02	0.0233	0.025	0.0546
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	0.0084	< 0.008	0.0221	0.0168
Nitrate[c]	mg/L	–	0.26	–	–
Phenols[c]	mg/L	< 0.005	< 0.005	< 0.005	0.0052
Cesium-137	pCi/L	–	< 2.0	–	–
Hydrogen-3[c]	pCi/L	136	< 100	155	< 100
Chloride[c]	mg/L	–	18	–	–
Fluoride[c]	mg/L	–	0.244	–	–
Sulfate[c]	mg/L	–	78	–	–
TOCs[c]	mg/L	2.3	3.1	2.5	2.4
TOCs[c]	mg/L	2.4	3.0	2.6	2.4
TOCs[c]	mg/L	2.3	3.0	2.6	2.5
TOCs[c]	mg/L	2.4	3.0	2.6	2.5
TOXs[c]	mg/L	0.034	< 0.02	< 0.02	< 0.02
TOXs[c]	mg/L	0.028	< 0.02	< 0.02	< 0.02

[a] Well point elevation = 220.80 m (MSL); ground surface elevation = 228.11 m (MSL); casing material = stainless steel.
[b] Filtered sample.
[c] Unfiltered sample.
[d] A dash indicates that no samples were collected.
[e] Bold type indicates that the unfiltered sample value exceeds the State of Illinois Groundwater Quality Standard.

TABLE 6.27

Groundwater Monitoring Results, Sanitary Landfill Well 800173D, 2003

		Date of Sampling			
Parameter	Unit	1/06/2003	4/09/2003	7/07/2003	10/07/2003
Water elevation[a]	m	191.94	191.69	192.01	191.85
Temperature	°C	9.8	11.0	13.2	12.3
pH	pH	7.07	6.80	6.78	7.19
Redox	mV	-6	13	10	-12
Conductivity	µmhos/cm	1,469	1,011	1,286	1,078
Chloride[b]	mg/L	187	166	238	229
Sulfate[b]	mg/L	96	111	139	111
TDS[b]	mg/L	856	757	944	948
Cyanide (total)[c]	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Arsenic[c]	mg/L	–[d]	0.0053	–	–
Barium[c]	mg/L	–	0.0834	–	–
Boron[c]	mg/L	–	0.2062	–	–
Cadmium[c]	mg/L	–	< 0.0002	–	–
Chromium[c]	mg/L	–	0.0616	–	–
Cobalt[c]	mg/L	–	< 0.016	–	–
Copper[c]	mg/L	–	< 0.015	–	–
Iron[c]	mg/L	–	3.786	–	–
Lead[c]	mg/L	–	< 0.002	–	–
Manganese[c]	mg/L	–	0.0819	–	–
Mercury[c]	mg/L	–	< 0.0001	–	–
Nickel[c]	mg/L	–	< 0.02	–	–
Selenium[c]	mg/L	–	< 0.003	–	–
Silver[c]	mg/L	–	< 0.001	–	–
Zinc[c]	mg/L	–	< 0.008	–	–
Ammonia nitrogen[b]	mg/L	0.77	0.91	0.87	0.96
Arsenic[b]	mg/L	0.004	0.0031	0.0043	0.0053
Barium[b]	mg/L	0.0827	0.0785	0.0877	0.0892
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	< 0.024	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	0.0349	< 0.016	< 0.016
Copper[b]	mg/L	< 0.015	< 0.015	< 0.015	< 0.015
Iron[b]	mg/L	2.668	0.9288	2.6508	2.4888
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	0.0651	0.0638	0.0773	0.0659
Mercury[b]	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	< 0.02	0.0233	< 0.02	< 0.02
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	< 0.008	0.0099	< 0.008	< 0.008
Nitrate[c]	mg/L	–	< 0.1	–	–
Phenols[c]	mg/L	< 0.005	0.016	< 0.005	0.0061
Cesium-137[c]	pCi/L	–	< 2.0	–	–
Hydrogen-3[c]	pCi/L	< 100	< 100	< 100	< 100
Chloride[c]	mg/L	–	184	–	–
Fluoride[c]	mg/L	–	0.499	–	–
Sulfate[c]	mg/L	–	95	–	–
TOCs[c]	mg/L	5.2	4.4	4.4	5.8
TOCs[c]	mg/L	5.1	4.4	4.4	5.4
TOCs[c]	mg/L	5.1	4.4	4.5	5.3
TOCs[c]	mg/L	5.2	4.4	4.5	5.3
TOXs[c]	mg/L	0.038	< 0.02	0.040	0.024
TOXs[c]	mg/L	0.04	< 0.02	0.039	0.023

[a] Well point elevation = 189.09 m (MSL); ground surface elevation = 228.41 m (MSL); casing material = stainless steel.
[b] Filtered sample.
[c] Unfiltered sample.
[d] A dash indicates that no samples were collected.

TABLE 6.28

Groundwater Monitoring Results, Sanitary Landfill Well 800181, 2003

		Date of Sampling		
Parameter	Unit	4/09/2003	07/14/2003	7/14/2003
Water elevation[a]	m	224.16	221.41	221.41
Temperature	°C	9.7	13.1	13.1
pH	pH	7.47	7.72	7.72
Redox	mV	-26	-30	-30
Conductivity	µmhos/cm	676	667	667
Chloride[b]	mg/L	14	8	8
Sulfate[b]	mg/L	79	133	132
TDS[b]	mg/L	555	557	602
Cyanide (total)[c]	mg/L	< 0.01	< 0.01	< 0.01
Arsenic[c]	mg/L	0.0102	–[d]	–
Barium[c]	mg/L	0.0886	–	–
Boron[c]	mg/L	0.0950	–	–
Cadmium[c]	mg/L	< 0.0002	–	–
Chromium[c]	mg/L	0.0916	–	–
Cobalt[c]	mg/L	< 0.016	–	–
Copper[c]	mg/L	< 0.015	–	–
Iron[c]	mg/L	**10.96**[e]	–	–
Lead[c]	mg/L	0.0073	–	–
Manganese[c]	mg/L	**0.243**	–	–
Mercury[c]	mg/L	< 0.0001	–	–
Nickel[c]	mg/L	0.0217	–	–
Selenium[c]	mg/L	< 0.003	–	–
Silver[c]	mg/L	< 0.001	–	–
Zinc[c]	mg/L	0.0487	–	–
Ammonia nitrogen[b]	mg/L	< 0.05	< 0.05	< 0.05
Arsenic[b]	mg/L	0.0072	0.0052	< 0.003
Barium[b]	mg/L	0.0207	0.0207	0.0273
Beryllium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002
Cadmium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002
Chromium[b]	mg/L	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016	< 0.016
Copper[b]	mg/L	< 0.015	< 0.015	< 0.015
Iron[b]	mg/L	< 0.02	< 0.02	< 0.02
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	< 0.01	< 0.01	< 0.01
Mercury[b]	mg/L	< 0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	< 0.02	< 0.02	< 0.02
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	< 0.008	0.0117	0.0084
Nitrate[c]	mg/L	0.15	–	–
Phenols[c]	mg/L	< 0.005	< 0.005	< 0.005
Hydrogen-3[c]	pCi/L	< 100	< 100	115
Chloride[c]	mg/L	15	–	–
Fluoride[c]	mg/L	0.366	–	–
Sulfate[c]	mg/L	76	–	–
TOCs[c]	mg/L	3.7	2.6	2.6
TOCs[c]	mg/L	3.7	2.5	2.5
TOCs[c]	mg/L	3.7	2.5	2.6
TOCs[c]	mg/L	3.7	2.5	2.5
TOXs[c]	mg/L	< 0.02	< 0.02	< 0.02
TOXs[c]	mg/L	< 0.02	< 0.02	< 0.02

[a] Well point elevation = 219.85 m (MSL); ground surface elevation = 230.52 m (MSL); casing material = stainless steel.

[b] Filtered sample.

[c] Unfiltered sample.

[d] A dash indicates that no samples were collected.

[e] Bold type indicates that the unfiltered sample value exceeds the State of Illinois Groundwater Quality Standard.

TABLE 6.29

Groundwater Monitoring Results, Sanitary Landfill Well 800183D, 2003

		Date of Sampling				
Parameter	Unit	1/22/2003	1/22/2003	4/09/2003	7/14/2003	10/15/2003
Water elevation[a]	m	191.97	191.97	191.85	191.99	191.90
Temperature	°C	7.4	7.4	11.2	13.0	12.0
pH	pH	7.25	7.25	6.98	7.14	7.11
Redox	mV	-13	-13	2	-11	-9
Conductivity	µmhos/cm	1,152	1,152	908	980	985
Chloride[b]	mg/L	87	98	99	126	95
Sulfate[b]	mg/L	161	151	151	166	137
TDS[b]	mg/L	785	782	791	928	895
Cyanide (total)[c]	mg/L	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Arsenic[c]	mg/L	–[d]	–	< 0.003	–	–
Barium[c]	mg/L	–	–	0.0477	–	–
Boron[c]	mg/L	–	–	0.2327	–	–
Cadmium[c]	mg/L	–	–	< 0.0002	–	–
Chromium[c]	mg/L	–	–	0.0611	–	–
Cobalt[c]	mg/L	–	–	< 0.016	–	–
Copper[c]	mg/L	–	–	< 0.015	–	–
Iron[c]	mg/L	–	–	0.9273	–	–
Lead[c]	mg/L	–	–	< 0.002	–	–
Manganese[c]	mg/L	–	–	0.0157	–	–
Mercury[c]	mg/L	–	–	< 0.0001	–	–
Nickel[c]	mg/L	–	–	< 0.02	–	–
Selenium[c]	mg/L	–	–	< 0.003	–	–
Silver[c]	mg/L	–	–	< 0.001	–	–
Zinc[c]	mg/L	–	–	< 0.008	–	–
Ammonia nitrogen[b]	mg/L	0.89	0.85	0.93	0.087	0.94
Arsenic[b]	mg/L	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
Barium[b]	mg/L	0.0476	0.0482	0.0482	0.0442	0.0493
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	< 0.024	< 0.024	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016	0.0751	< 0.016	< 0.016
Copper[b]	mg/L	< 0.015	< 0.015	< 0.015	< 0.015	< 0.015
Iron[b]	mg/L	0.6008	0.6174	0.6678	0.2475	0.6772
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	0.0147	0.0154	0.0109	0.0162	< 0.01
Mercury[b]	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	< 0.02	< 0.02	0.0217	< 0.02	< 0.02
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	< 0.008	< 0.008	< 0.008	< 0.008	< 0.008
Nitrate[c]	mg/L	–	–	< 0.1	–	–
Phenols[c]	mg/L	< 0.005	< 0.005	0.0052	< 0.005	< 0.005
Hydrogen-3[c]	pCi/L	< 100	< 100	162	< 100	< 100
Chloride[c]	mg/L	–	–	117	–	–
Fluoride[c]	mg/L	–	–	0.477	–	–
Sulfate[c]	mg/L	–	–	139	–	–
TOCs[c]	mg/L	2.0	2.0	2.2	2.0	2.4
TOCs[c]	mg/L	2.0	2.0	2.3	2.0	2.4
TOCs[c]	mg/L	2.0	2.1	2.2	2.1	2.4
TOCs[c]	mg/L	2.0	2.0	2.2	2.1	2.4
TOXs[c]	mg/L	0.083	< 0.02	< 0.02	0.026	< 0.02
TOXs[c]	mg/L	0.088	0.034	< 0.02	0.021	< 0.02

[a] Well point elevation = 180.38 m (MSL); ground surface elevation = 230.37 m (MSL); casing material = stainless steel.

[b] Filtered sample.

[c] Unfiltered sample.

[d] A dash indicates that no samples were collected.

TABLE 6.30

Groundwater Monitoring Results, Sanitary Landfill Well 800191, 2003

Parameter	Unit	Date of Sampling 1/07/2003	4/29/2003	7/23/2003	10/20/2003
Water elevation[a]	m	225.27	225.30	225.23	225.13
Temperature	°C	9.9	11.0	15.5	13.3
pH	pH	6.85	6.90	6.88	6.91
Redox	mV	7	6	5	0
Conductivity	µmhos/cm	1,821	1,327	1,470	1,554
Chloride[b]	mg/L	228	279	267	238
Sulfate[b]	mg/L	128	215	233	96
TDS[b]	mg/L	1,075	1,266	1,225	1,142
Cyanide (total)[c]	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Arsenic[c]	mg/L	–[d]	< 0.003	–	–
Barium[c]	mg/L	–	0.0799	–	–
Boron[c]	mg/L	–	0.1521	–	–
Cadmium[c]	mg/L	–	< 0.0002	–	–
Chromium[c]	mg/L	–	< 0.024	–	–
Cobalt[c]	mg/L	–	< 0.016	–	–
Copper[c]	mg/L	–	0.0523	–	–
Iron[c]	mg/L	–	**7.438**[e]	–	–
Lead[c]	mg/L	–	0.0041	–	–
Manganese[c]	mg/L	–	**1.445**	–	–
Mercury[c]	mg/L	–	< 0.0001	–	–
Nickel[c]	mg/L	–	< 0.02	–	–
Selenium[c]	mg/L	–	< 0.003	–	–
Silver[c]	mg/L	–	< 0.001	–	–
Zinc[c]	mg/L	–	0.0215	–	–
Ammonia nitrogen[b]	mg/L	0.23	0.35	0.51	0.66
Arsenic[b]	mg/L	< 0.003	< 0.003	< 0.003	< 0.003
Barium[b]	mg/L	0.0711	0.0564	0.0551	0.0736
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	< 0.024	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016	< 0.016	< 0.016
Copper[b]	mg/L	< 0.015	< 0.015	< 0.015	< 0.015
Iron[b]	mg/L	0.9534	0.8212	2.102	3.4852
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	1.333	1.419	1.0546	1.0028
Mercury[b]	mg/L	< 0.0001	0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	< 0.02	< 0.02	< 0.02	0.0285
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	0.0102	0.0084	0.0108	< 0.008
Nitrate[c]	mg/L	–	< 0.1	–	–
Phenols[c]	mg/L	< 0.005	< 0.005	0.018	< 0.005
Cesium-137[c]	pCi/L	–	< 2.0	–	–
Hydrogen-3[c]	pCi/L	< 100	< 100	153	151
Chloride[c]	mg/L	–	**296**	–	–
Fluoride[c]	mg/L	–	0.43	–	–
Sulfate[c]	mg/L	–	192	–	–
TOCs[c]	mg/L	6.8	6.2	6.4	9.4
TOCs[c]	mg/L	6.7	6.3	6.5	9.2
TOCs[c]	mg/L	6.7	6.4	6.5	9.3
TOCs[c]	mg/L	6.8	6.4	6.5	9.4
TOXs[c]	mg/L	0.038	0.022	0.039	0.029
TOXs[c]	mg/L	0.054	0.039	0.039	0.030

[a] Well point elevation = 222.90 m (MSL); ground surface elevation = 227.38 m (MSL); casing material = stainless steel.

[b] Filtered sample.

[c] Unfiltered sample.

[d] A dash indicates that no samples were collected.

[e] Bold type indicates that the unfiltered sample value exceeds the State of Illinois Groundwater Quality Standard.

TABLE 6.31

Groundwater Monitoring Results, Sanitary Landfill Well 800192, 2003

		Date of Sampling			
Parameter	Unit	1/07/2003	4/23/2003	7/29/2003	10/21/2003
Water elevation[a]	m	218.62	219.63	218.62	218.91
Temperature	°C	11.2	11.3	12.5	12.4
pH	pH	6.71	6.69	6.90	6.98
Redox	mV	16	18	3	–1
Conductivity	µmhos/cm	1,515	1,039	1,180	1,161
Chloride[b]	mg/L	67	75	91	57
Sulfate[b]	mg/L	343	315	397	369
TDS[b]	mg/L	1,118	1,102	1,216	1,080
Cyanide (total)[c]	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Arsenic[c]	mg/L	–[d]	**0.1341**[e]	–	–
Barium[c]	mg/L	–	**3.602**	–	–
Boron[c]	mg/L	–	1.06	–	–
Cadmium[c]	mg/L	–	< 0.0002	–	–
Chromium[c]	mg/L	–	**0.2073**	–	–
Cobalt[c]	mg/L	–	0.0590	–	–
Copper[c]	mg/L	–	0.0278	–	–
Iron[c]	mg/L	–	**359.5**	–	–
Lead[c]	mg/L	–	**0.0087**	–	–
Manganese[c]	mg/L	–	**0.5449**	–	–
Mercury[c]	mg/L	–	< 0.0001	–	–
Nickel[c]	mg/L	–	0.0959	–	–
Selenium[c]	mg/L	–	< 0.003	–	–
Silver[c]	mg/L	–	0.0033	–	–
Zinc[c]	mg/L	–	0.0707	–	–
Ammonia nitrogen[b]	mg/L	0.48	0.33	0.87	1.1
Arsenic[b]	mg/L	< 0.003	< 0.003	< 0.003	< 0.003
Barium[b]	mg/L	0.3863	0.4918	0.4380	0.4920
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	< 0.024	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016	< 0.016	< 0.016
Copper[b]	mg/L	< 0.015	< 0.015	< 0.015	< 0.015
Iron[b]	mg/L	0.0308	6.074	0.1027	2.6613
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	0.1654	0.2036	0.1727	0.245
Mercury[b]	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	< 0.02	0.0280	< 0.02	< 0.02
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	< 0.008	0.008	0.0081	< 0.008
Nitrate[c]	mg/L	–	< 0.1	–	–
Phenols[c]	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Cesium-137[c]	pCi/L	–	< 2.0	–	–
Hydrogen-3[c]	pCi/L	352	372	1,688	406
Chloride[c]	mg/L	–	78	–	–
Fluoride[c]	mg/L	–	0.479	–	–
Sulfate[c]	mg/L	–	352	–	–
TOCs[c]	mg/L	7.2	16.0	34.0	20.0
TOCs[c]	mg/L	7.2	16.0	34.0	21.0
TOCs[c]	mg/L	7.2	16.0	34.0	21.0
TOCs[c]	mg/L	7.3	16.0	34.0	20.0
TOXs[c]	mg/L	0.028	0.058	0.044	0.039
TOXs[c]	mg/L	< 0.02	0.055	0.094	0.044

[a] Well point elevation = 209.11 m (MSL); ground surface elevation = 227.40 m (MSL); casing material = stainless steel.

[b] Filtered sample.

[c] Unfiltered sample.

[d] A dash indicates that no samples were collected.

[e] Bold type indicates that the unfiltered sample value exceeds the State of Illinois Groundwater Quality Standard.

TABLE 6.32

Groundwater Monitoring Results, Sanitary Landfill Well 800193D, 2003

Parameter	Unit	Date of Sampling 1/07/2003	4/15/2003	7/29/2003	10/21/2003	10/21/2003
Water elevation[a]	m	192.13	192.01	192.01	191.92	191.92
Temperature	°C	11.4	12.7	12.2	11.6	11.6
pH	pH	7.05	6.84	7.16	6.93	6.93
Redox	mV	-3	11	-11	2	2
Conductivity	µmhos/cm	1,322	975	1,068	1,116	1,116
Chloride[b]	mg/L	103	102	245	130	158
Sulfate[b]	mg/L	220	156	195	163	171
TDS[b]	mg/L	841	862	956	941	892
Cyanide (total)[c]	mg/L	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Arsenic[c]	mg/L	–[d]	< 0.003	–	–	–
Barium[c]	mg/L	–	0.0557	–	–	–
Boron[c]	mg/L	–	0.211	–	–	–
Cadmium[c]	mg/L	–	< 0.0002	–	–	–
Chromium[c]	mg/L	–	0.0536	–	–	–
Cobalt[c]	mg/L	–	< 0.016	–	–	–
Copper[c]	mg/L	–	< 0.015	–	–	–
Iron[c]	mg/L	–	1.354	–	–	–
Lead[c]	mg/L	–	< 0.002	–	–	–
Manganese[c]	mg/L	–	0.0213	–	–	–
Mercury[c]	mg/L	–	< 0.0001	–	–	–
Nickel[c]	mg/L	–	< 0.02	–	–	–
Selenium[c]	mg/L	–	< 0.003	–	–	–
Silver[c]	mg/L	–	< 0.001	–	–	–
Zinc[c]	mg/L	–	< 0.008	–	–	–
Ammonia nitrogen[b]	mg/L	0.65	0.48	0.72	0.82	0.68
Arsenic[b]	mg/L	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
Barium[b]	mg/L	0.0593	0.0590	0.0559	0.0670	0.0670
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	< 0.024	< 0.024	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016	< 0.016	< 0.016	< 0.016
Copper[b]	mg/L	< 0.015	< 0.015	< 0.015	< 0.015	< 0.015
Iron[b]	mg/L	1.317	0.9857	0.6333	1.0884	1.0750
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	0.0223	0.0221	0.0212	0.0239	0.0246
Mercury[b]	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	< 0.02	< 0.02	< 0.02	0.0323	0.0254
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	< 0.008	< 0.008	0.0083	> 0.008	< 0.008
Nitrate[c]	mg/L	–	< 0.1	–	–	–
Phenols[c]	mg/L	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Hydrogen-3[c]	pCi/L	< 100	< 100	< 100	< 100	< 100
Chloride[c]	mg/L	–	105	–	–	–
Fluoride[c]	mg/L	–	0.511	–	–	–
Sulfate[c]	mg/L	–	176	–	–	–
TOCs[c]	mg/L	2.2	2.4	2.8	2.9	3.4
TOCs[c]	mg/L	2.3	2.4	2.8	2.9	3.5
TOCs[c]	mg/L	2.3	2.4	2.8	2.9	3.4
TOCs[c]	mg/L	2.2	2.4	2.8	2.9	3.4
TOXs[c]	mg/L	0.043	< 0.02	0.030	< 0.02	< 0.02
TOXs[c]	mg/L	0.023	0.029	0.038	< 0.02	0.053

[a] Well point elevation = 181.35 m (MSL); ground surface elevation = 227.37 m (MSL); casing material = stainless steel.
[b] Filtered sample.
[c] Unfiltered sample.
[d] A dash indicates that no samples were collected.

TABLE 6.33

Groundwater Monitoring Results, Sanitary Landfill Well 800201, 2003

		Date of Sampling				
Parameter	Unit	1/06/2003	4/15/2003	7/08/2003	7/08/2003	10/08/2003
Water elevation[a]	m	222.94	222.98	223.39	223.39	223.14
Temperature	°C	9.4	13.7	11.8	11.8	11.2
pH	pH	6.90	6.84	7.10	7.10	6.90
Redox	mV	3	10	-1	-1	2
Conductivity	µmhos/cm	1,102	841	904	904	838
Chloride[b]	mg/L	12	12	14	13	10
Sulfate[b]	mg/L	58	49	73	63	70
TDS[b]	mg/L	725	714	731	722	712
Cyanide (total)[c]	mg/L	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Arsenic[c]	mg/L	–[d]	0.0118	–	–	–
Barium[c]	mg/L	–	0.2914	–	–	–
Boron[c]	mg/L	–	0.1667	–	–	–
Cadmium[c]	mg/L	–	0.0002	–	–	–
Chromium[c]	mg/L	–	**0.1225**[e]	–	–	–
Cobalt[c]	mg/L	–	< 0.016	–	–	–
Copper[c]	mg/L	–	< 0.015	–	–	–
Iron[c]	mg/L	–	**14.96**	–	–	–
Lead[c]	mg/L	–	0.0063	–	–	–
Manganese[c]	mg/L	–	**0.6571**	–	–	–
Mercury[c]	mg/L	–	< 0.0001	–	–	–
Nickel[c]	mg/L	–	0.0434	–	–	–
Selenium[c]	mg/L	–	< 0.003	–	–	–
Silver[c]	mg/L	–	< 0.001	–	–	–
Zinc[c]	mg/L	–	0.0471	–	–	–
Ammonia nitrogen[b]	mg/L	3.6	3.8	2.7	3.0	6.5
Arsenic[b]	mg/L	0.0049	0.0053	0.0042	0.0031	0.0061
Barium[b]	mg/L	0.2595	0.2682	0.2531	0.2489	0.2654
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	< 0.024	< 0.024	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016	< 0.016	< 0.016	< 0.016
Copper[b]	mg/L	< 0.015	< 0.015	< 0.015	< 0.015	< 0.015
Iron[b]	mg/L	1.116	1.894	1.6374	1.2057	2.4410
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	0.3964	0.323	0.3414	0.3620	0.3511
Mercury[b]	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	< 0.02	0.0227	< 0.02	< 0.02	< 0.02
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	0.0272	0.0181	0.0197	0.0307	0.0270
Nitrate[c]	mg/L	–	< 0.1	–	–	–
Phenols[c]	mg/L	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Hydrogen-3[c]	pCi/L	< 100	< 100	< 100	< 100	< 100
Chloride[c]	mg/L	–	12	–	–	–
Fluoride[c]	mg/L	–	0.38	-	–	–
Sulfate[c]	mg/L	–	48	–	–	–
TOCs[c]	mg/L	29.0	31.0	29.0	30.0	30.0
TOCs[c]	mg/L	29.0	31.0	29.0	30.0	30.0
TOCs[c]	mg/L	29.0	31.0	29.0	30.0	30.0
TOCs[c]	mg/L	29.0	31.0	29.0	31.0	30.0
TOXs[c]	mg/L	< 0.02	0.044	< 0.02	< 0.02	< 0.02
TOXs[c]	mg/L	0.021	0.023	< 0.02	< 0.02	< 0.02

[a] Well point elevation = 217.26 m (MSL); ground surface elevation = 227.93 m (MSL); casing material = stainless steel.

[b] Filtered sample.

[c] Unfiltered sample.

[d] A dash indicates that no samples were collected.

[e] Bold type indicates that the unfiltered sample value exceeds the State of Illinois Groundwater Quality Standard.

TABLE 6.34

Groundwater Monitoring Results, Sanitary Landfill Well 800202, 2003

		Date of Sampling			
Parameter	Unit	1/06/2003	4/15/2003	7/08/2003	10/07/2003
Water elevation[a]	m	217.35	217.33	217.59	217.41
Temperature	°C	9.6	11.6	11.6	11.3
pH	pH	7.07	7.01	7.06	7.16
Redox	mV	-5	3	-4	-9
Conductivity	µmhos/cm	1,049	759	866	805
Chloride[b]	mg/L	19	20	24	20
Sulfate[b]	mg/L	70	69	91	70
TDS[b]	mg/L	649	663	651	639
Cyanide (total)[c]	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Arsenic[c]	mg/L	–[d]	0.0067	–	–
Barium[c]	mg/L	–	0.273	–	–
Boron[c]	mg/L	–	0.1043	–	–
Cadmium[c]	mg/L	–	< 0.0002	–	–
Chromium[c]	mg/L	–	0.0495	–	–
Cobalt[c]	mg/L	–	< 0.016	–	–
Copper[c]	mg/L	–	< 0.015	–	–
Iron[c]	mg/L	–	**9.622**	–	–
Lead[c]	mg/L	–	< 0.002	–	–
Manganese[c]	mg/L	–	0.1424	–	–
Mercury[c]	mg/L	–	< 0.0001	–	–
Nickel[c]	mg/L	–	< 0.02	–	–
Selenium[c]	mg/L	–	< 0.003	–	–
Silver[c]	mg/L	–	< 0.001	–	–
Zinc[c]	mg/L	–	< 0.008	–	–
Ammonia nitrogen[b]	mg/L	1.9	2.1	2.1	2.1
Arsenic[b]	mg/L	< 0.003	< 0.003	< 0.003	< 0.003
Barium[b]	mg/L	0.2041	0.1896	0.1926	0.1997
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	< 0.024	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016	< 0.016	< 0.016
Copper[b]	mg/L	< 0.015	< 0.015	< 0.015	< 0.015
Iron[b]	mg/L	5.597	5.239	5.395	5.371
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	0.1144	0.1099	0.1136	0.1020
Mercury[b]	mg/L	< 0.0001	< 0.0001	< 0.0001	0.0001
Nickel[b]	mg/L	< 0.02	0.0229	< 0.02	< 0.02
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	< 0.008	< 0.008	< 0.008	< 0.008
Nitrate[c]	mg/L	–	< 0.1	–	–
Phenols[c]	mg/L	0.0076	< 0.005	< 0.005	< 0.005
Hydrogen-3[c]	pCi/L	< 100	< 100	< 100	< 100
Chloride[c]	mg/L	–	22	–	–
Fluoride[c]	mg/L	–	0.313	–	–
Sulfate[c]	mg/L	–	54	–	–
TOCs[c]	mg/L	11.0	13.0	12.0	12.0
TOCs[c]	mg/L	11.0	13.0	11.0	12.0
TOCs[c]	mg/L	11.0	13.0	12.0	12.0
TOCs[c]	mg/L	11.0	12.0	11.0	12.0
TOXs[c]	mg/L	< 0.02	< 0.02	< 0.02	0.031
TOXs[c]	mg/L	< 0.02	< 0.02	< 0.02	< 0.02

[a] Well point elevation = 209.54 m (MSL); ground surface elevation = 227.92 m (MSL); casing material = stainless steel.
[b] Filtered sample.
[c] Unfiltered sample.
[d] A dash indicates that no samples were collected.
[e] Bold type indicates that the unfiltered sample value exceeds the State of Illinois Groundwater Quality Standard.

TABLE 6.35

Groundwater Monitoring Results, Sanitary Landfill Well 800203D, 2003

		Date of Sampling			
Parameter	Unit	1/06/2003	4/15/2003	7/08/2003	10/07/2003
Water elevation[a]	m	191.98	192.00	192.02	191.94
Temperature	°C	10.4	12.3	11.8	11.9
pH	pH	7.16	6.86	7.06	7.23
Redox	mV	-9	8	-2	-14
Conductivity	µmhos/cm	1,076	839	886	799
Chloride[b]	mg/L	62	106	85	66
Sulfate[b]	mg/L	49	46	55	51
TDS[b]	mg/L	645	674	645	648
Cyanide (total)[c]	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Arsenic[c]	mg/L	–[d]	0.0064	–	–
Barium[c]	mg/L	–	0.1351	–	–
Boron[c]	mg/L	–	0.199	–	–
Cadmium[c]	mg/L	–	< 0.0002	–	–
Chromium[c]	mg/L	–	0.0565	–	–
Cobalt[c]	mg/L	–	0.0723	–	–
Copper[c]	mg/L	–	< 0.015	–	–
Iron[c]	mg/L	–	6.203	–	–
Lead[c]	mg/L	–	0.0025	–	–
Manganese[c]	mg/L	–	0.1153	–	–
Mercury[c]	mg/L	–	< 0.0001	–	–
Nickel[c]	mg/L	–	< 0.02	–	–
Selenium[c]	mg/L	–	< 0.003	–	–
Silver[c]	mg/L	–	< 0.001	–	–
Zinc[c]	mg/L	–	0.0252	–	–
Ammonia nitrogen[b]	mg/L	1.7	1.7	1.6	1.8
Arsenic[b]	mg/L	< 0.003	0.0038	< 0.003	0.0032
Barium[b]	mg/L	0.1173	0.121	0.1243	0.1275
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	< 0.024	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	0.0757	0.7431	0.0769	0.0976
Copper[b]	mg/L	< 0.015	< 0.015	< 0.015	< 0.015
Iron[b]	mg/L	1.081	0.8974	0.7944	0.9805
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	0.0376	0.0353	0.0378	0.0287
Mercury[b]	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	< 0.02	< 0.02	< 0.02	0.0243
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	< 0.008	< 0.008	0.0082	< 0.008
Nitrate[c]	mg/L	–	< 0.1	–	–
Phenols[c]	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Hydrogen-3[c]	pCi/L	< 100	< 100	< 100	< 100
Chloride[c]	mg/L	–	116	–	–
Fluoride[c]	mg/L	–	0.446	–	–
Sulfate[c]	mg/L	–	54	–	–
TOCs[c]	mg/L	4.6	5.1	4.5	4.9
TOCs[c]	mg/L	4.5	5.2	4.4	4.8
TOCs[c]	mg/L	4.6	5.1	4.4	4.8
TOCs[c]	mg/L	4.5	5.1	4.4	4.8
TOXs[c]	mg/L	0.022	0.025	< 0.02	0.10
TOXs[c]	mg/L	0.035	< 0.02	< 0.02	0.18

[a] Well point elevation = 189.59 m (MSL); ground surface elevation = 227.92 m (MSL); casing material = stainless steel.

[b] Filtered sample.

[c] Unfiltered sample.

[d] A dash indicates that no samples were collected.

TABLE 6.36

Groundwater Monitoring Results, Sanitary Landfill Well 800271, 2003

		Date of Sampling			
Parameter	Unit	1/14/2003	4/21/2003	7/07/2003	10/07/2003
Water elevation[a]	m	223.09	223.51	223.79	223.24
Temperature	°C	7.0	7.1	13.0	13.6
pH	pH	7.06	7.14	7.27	7.34
Redox	mV	-9	-9	-11	-18
Conductivity	µmhos/cm	687	439	576	559
Chloride[b]	mg/L	2	2	2	1
Sulfate[b]	mg/L	58	56	55	58
TDS[b]	mg/L	420	410	412	401
Cyanide (total)[c]	mg/L	0.011	< 0.01	< 0.01	< 0.01
Arsenic[c]	mg/L	–[d]	< 0.003	–	–
Barium[c]	mg/L	–	0.1117	–	–
Boron[c]	mg/L	–	0.2784	–	–
Cadmium[c]	mg/L	–	0.0003	–	–
Chromium[c]	mg/L	–	0.056	–	–
Cobalt[c]	mg/L	–	0.0352	–	–
Copper[c]	mg/L	–	0.0891	–	–
Iron[c]	mg/L	–	**86.34**[e]	–	–
Lead[c]	mg/L	–	**0.0391**	–	–
Manganese[c]	mg/L	–	**1.211**	–	–
Mercury[c]	mg/L	–	< 0.0001	–	—
Nickel[c]	mg/L	–	0.0848	–	–
Selenium[c]	mg/L	–	< 0.003	–	–
Silver[c]	mg/L	–	< 0.001	–	–
Zinc[c]	mg/L	–	0.2481	–	–
Ammonia nitrogen[b]	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Arsenic[b]	mg/L	< 0.003	< 0.003	< 0.003	< 0.003
Barium[b]	mg/L	0.0192	0.0139	0.0143	0.0181
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	< 0.024	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016	< 0.016	< 0.016
Copper[b]	mg/L	< 0.015	< 0.015	< 0.015	< 0.015
Iron[b]	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	< 0.01	< 0.01	< 0.01	0.0116
Mercury[b]	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	< 0.02	0.0347	< 0.02	0.0350
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	< 0.008	< 0.008	0.0163	< 0.008
Nitrate[c]	mg/L	–	< 0.1	–	–
Phenols[c]	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Hydrogen-3[c]	pCi/L	< 100	< 100	< 100	< 100
Chloride[c]	mg/L	–	2	–	–
Fluoride[c]	mg/L	–	0.135	–	–
Sulfate[c]	mg/L	–	44	–	–
TOCs[c]	mg/L	1.4	1.7	1.3	1.5
TOCs[c]	mg/L	1.4	1.6	1.2	1.4
TOCs[c]	mg/L	1.4	1.8	1.3	1.4
TOCs[c]	mg/L	1.4	1.8	1.3	1.4
TOXs[c]	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
TOXs[c]	mg/L	0.024	< 0.02	< 0.02	< 0.02

[a] Well point elevation = 221.65 m (MSL); ground surface elevation = 223.18 m (MSL); casing material = stainless steel.

[b] Filtered sample.

[c] Unfiltered sample.

[d] A dash indicates that no samples were collected.

[e] Bold type indicates that the unfiltered sample value exceeds the State of Illinois Groundwater Quality Standard.

TABLE 6.37

Groundwater Monitoring Results, Sanitary Landfill Well 800273D, 2003

		Date of Sampling				
Parameter	Unit	1/14/2003	4/21/2003	4/21/2003	7/07/2003	10/07/2003
Water elevation[a]	m	192.26	192.28	192.28	192.31	192.16
Temperature	°C	8.0	11.0	11.0	13.5	11.7
pH	pH	7.14	6.89	6.89	6.93	7.01
Redox	mV	-6	6	6	2	-3
Conductivity	µmhos/cm	1,188	808	808	963	874
Chloride[b]	mg/L	79	83	91	103	83
Sulfate[b]	mg/L	132	115	127	150	133
TDS[b]	mg/L	749	710	709	781	755
Cyanide (total)[c]	mg/L	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Arsenic[c]	mg/L	–[d]	0.0032	0.0045	–	–
Barium[c]	mg/L	–	0.0439	0.0435	–	–
Boron[c]	mg/L	–	0.2077	0.1838	–	–
Cadmium[c]	mg/L	–	< 0.0002	< 0.0002	–	–
Chromium[c]	mg/L	–	0.0371	< 0.024	–	–
Cobalt[c]	mg/L	–	< 0.016	< 0.016	–	–
Copper[c]	mg/L	–	< 0.015	< 0.015	–	–
Iron[c]	mg/L	–	1.303	1.33	–	–
Lead[c]	mg/L	–	< 0.002	< 0.002	–	–
Manganese[c]	mg/L	–	0.0106	0.0110	–	–
Mercury[c]	mg/L	–	< 0.0001	< 0.0001	–	–
Nickel[c]	mg/L	–	< 0.02	< 0.02	–	–
Selenium[c]	mg/L	–	< 0.003	< 0.003	–	–
Silver[c]	mg/L	–	< 0.001	< 0.001	–	–
Zinc[c]	mg/L	–	< 0.008	< 0.008	–	–
Ammonia nitrogen[b]	mg/L	0.7	0.48	0.49	0.69	0.81
Arsenic[b]	mg/L	0.0044	< 0.003	0.003	0.0037	0.0031
Barium[b]	mg/L	0.0483	0.0456	0.0475	0.0438	0.0449
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	< 0.024	< 0.024	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016	< 0.016	< 0.016	< 0.016
Copper[b]	mg/L	< 0.015	< 0.015	< 0.015	< 0.015	< 0.015
Iron[b]	mg/L	1.417	1.267	1.283	1.2204	0.9269
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	0.0108	0.0101	0.0109	< 0.01	< 0.01
Mercury[b]	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	< 0.008	< 0.008	< 0.008	< 0.008	< 0.008
Nitrate[c]	mg/L	–	< 0.1	< 0.1	–	–
Phenols[c]	mg/L	< 0.005	0.033	< 0.005	< 0.005	< 0.005
Hydrogen-3[c]	pCi/L	< 100	< 100	< 100	< 100	< 100
Chloride[c]	mg/L	–	72	84	–	–
Fluoride[c]	mg/L	–	0.4	0.43	–	–
Sulfate[c]	mg/L	–	136	149	–	–
TOCs[c]	mg/L	1.1	1.2	1.3	1.3	1.4
TOCs[c]	mg/L	1.1	1.2	1.3	1.2	1.3
TOCs[c]	mg/L	1.1	1.2	1.3	1.2	1.3
TOCs[c]	mg/L	1.1	1.2	1.3	1.2	1.3
TOXs[c]	mg/L	0.029	0.023	0.03	0.023	< 0.02
TOXs[c]	mg/L	0.043	< 0.02	< 0.02	< 0.02	< 0.02

[a] Well point elevation = 188.73 m (MSL); ground surface elevation = 225.61 m (MSL); casing material = stainless steel.

[b] Filtered sample.

[c] Unfiltered sample.

[d] A dash indicates that no samples were collected.

TABLE 6.38

Groundwater Monitoring Results, Sanitary Landfill
Well 800281, 2003

		Date of Sampling		
Parameter	Unit	01/22/03	04/23/03	10/15/03
Water elevation[a]	m	225.35	225.61	224.51
Temperature	°C	7.9	11.5	9.2
pH	pH	6.92	6.89	6.85
Redox	mV	5	7	4
Conductivity	µmhos/cm	918	1,093	1,454
Chloride[b]	mg/L	77	79	61
Sulfate[b]	mg/L	172	159	107
TDS[b]	mg/L	1,101	1,084	974
Cyanide (total)[c]	mg/L	< 0.01	< 0.01	< 0.01
Arsenic[c]	mg/L	< 0.003	–[d]	–
Barium[c]	mg/L	0.1216	–	–
Boron[c]	mg/L	0.3124	–	–
Cadmium[c]	mg/L	< 0.0002	–	–
Chromium[c]	mg/L	**0.2035**[e]	–	–
Cobalt[c]	mg/L	< 0.016	–	–
Copper[c]	mg/L	0.0290	–	–
Iron[c]	mg/L	**19.67**	–	–
Lead[c]	mg/L	**0.0082**	–	–
Manganese[c]	mg/L	**0.5067**	–	–
Mercury[c]	mg/L	< 0.0001	–	–
Nickel[c]	mg/L	0.0562	–	–
Selenium[c]	mg/L	< 0.003	–	–
Silver[c]	mg/L	< 0.001	–	–
Zinc[c]	mg/L	0.0613	–	–
Ammonia nitrogen[b]	mg/L	< 0.05	< 0.05	0.12
Arsenic[b]	mg/L	< 0.003	< 0.003	< 0.003
Barium[b]	mg/L	0.0852	0.0575	0.0927
Beryllium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002
Cadmium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002
Chromium[b]	mg/L	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016	< 0.016
Copper[b]	mg/L	< 0.015	< 0.015	< 0.015
Iron[b]	mg/L	< 0.02	< 0.02	< 0.02
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	0.6129	0.5349	1.3063
Mercury[b]	mg/L	< 0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	0.1292	0.0263	0.0650
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	0.0094	0.0117	0.0279
Nitrate[c]	mg/L	< 0.1	–	–
Phenols[c]	mg/L	< 0.005	< 0.005	< 0.005
Hydrogen-3[c]	pCi/L	247	317	397
Chloride[c]	mg/L	84	–	–
Fluoride[c]	mg/L	0.228	–	–
Sulfate[c]	mg/L	190	–	–
TOCs[c]	mg/L	2.8	2.5	3.9
TOCs[c]	mg/L	2.9	2.4	3.7
TOCs[c]	mg/L	2.8	2.5	3.8
TOCs[c]	mg/L	3.0	2.4	3.6
TOXs[c]	mg/L	0.034	0.024	0.038
TOXs[c]	mg/L	0.039	0.021	0.028

[a] Well point elevation = 224.00 m (MSL); ground surface elevation = 227.65 m (MSL); casing material = stainless steel.

[b] Filtered sample.

[c] Unfiltered sample.

[d] A dash indicates that no samples were collected.

[e] Bold type indicates that the unfiltered sample value exceeds the State of Illinois Groundwater Quality Standard.

TABLE 6.39

Groundwater Monitoring Results, Sanitary Landfill Well 800291, 2003

		Date of Sampling			
Parameter	Unit	1/21/2003	4/28/2003	7/14/2003	10/15/2003
Water elevation[a]	m	225.59	225.61	227.05	226.38
Temperature	°C	9.5	9.8	9.9	10.4
pH	pH	7.08	6.92	7.15	7.10
Redox	mV	-4	4	-7	-8
Conductivity	µmhos/cm	1,072	813	919	920
Chloride[b]	mg/L	6	8	8	6
Sulfate[b]	mg/L	222	167	166	178
TDS[b]	mg/L	784	776	861	795
Cyanide (total)[c]	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Arsenic[c]	mg/L	–[d]	0.006	–	–
Barium[c]	mg/L	–	0.0991	–	–
Boron[c]	mg/L	–	0.1455	–	–
Cadmium[c]	mg/L	–	< 0.0002	–	–
Chromium[c]	mg/L	–	0.2909	–	–
Cobalt[c]	mg/L	–	< 0.016	–	–
Copper[c]	mg/L	–	0.0258	–	–
Iron[c]	mg/L	–	**26.97**[e]	–	–
Lead[c]	mg/L	–	**0.0122**	–	–
Manganese[c]	mg/L	–	**0.6144**	–	–
Mercury[c]	mg/L	–	< 0.0001	–	–
Nickel[c]	mg/L	–	< 0.02	–	–
Selenium[c]	mg/L	–	< 0.003	–	–
Silver[c]	mg/L	–	< 0.001	–	–
Zinc[c]	mg/L	–	0.0931	–	–
Ammonia nitrogen[b]	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Arsenic[b]	mg/L	< 0.003	< 0.003	< 0.003	< 0.003
Barium[b]	mg/L	0.0262	0.0250	0.0288	0.0272
Beryllium[b]	mg/L	< 0.0002	0.0003	< 0.0002	< 0.0002
Cadmium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium[b]	mg/L	< 0.024	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016	< 0.016	< 0.016
Copper[b]	mg/L	< 0.015	< 0.015	< 0.015	< 0.015
Iron[b]	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	0.1761	0.1073	0.1613	0.1695
Mercury[b]	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	< 0.008	0.0107	0.0099	< 0.008
Nitrate[c]	mg/L	–	< 0.1	–	–
Phenols[c]	mg/L	0.007	0.018	< 0.005	0.0072
Hydrogen-3[c]	pCi/L	< 100	< 100	< 100	< 100
Chloride[c]	mg/L	–	8	–	–
Fluoride[c]	mg/L	–	0.351	–	–
Sulfate[c]	mg/L	–	165	–	–
TOCs[c]	mg/L	2.2	2.5	2.2	2.4
TOCs[c]	mg/L	2.3	2.7	2.1	2.3
TOCs[c]	mg/L	2.1	2.5	2.1	2.3
TOCs[c]	mg/L	2.2	2.8	2.0	2.2
TOXs[c]	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
TOXs[c]	mg/L	< 0.02	< 0.02	< 0.02	0.054

[a] Well point elevation = 223.48 m (MSL); ground surface elevation = 230.49 m (MSL); casing material = stainless steel.
[b] Filtered sample.
[c] Unfiltered sample.
[d] A dash indicates that no samples were collected.
[e] Bold type indicates that the filtered sample value exceeds the State of Illinois Groundwater Quality Standard.

TABLE 6.40

Groundwater Monitoring Results, Sanitary Landfill Well 800301, 2003

		Date of Sampling			
Parameter	Unit	1/15/2003	4/22/2003	7/21/2003	10/22/2003
Water elevation[a]	m	226.45	225.97	225.78	225.57
Temperature	°C	9.7	9.6	11.7	10.1
pH	pH	7.06	7.00	7.03	7.16
Redox	mV	-3	1	-3	-10
Conductivity	µmhos/cm	1,041	751	953	862
Chloride[b]	mg/L	6	7	7	5
Sulfate[b]	mg/L	130	127	201	185
TDS[b]	mg/L	659	681	816	792
Cyanide (total)[c]	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Arsenic[c]	mg/L	–[d]	**0.0663**[e]	–	–
Barium[c]	mg/L	–	0.3018	–	–
Boron[c]	mg/L	–	0.5351	–	–
Cadmium[c]	mg/L	–	0.0014	–	–
Chromium[c]	mg/L	–	**0.1018**	–	–
Cobalt[c]	mg/L	–	0.0705	–	–
Copper[c]	mg/L	–	0.2209	–	–
Iron[c]	mg/L	–	**191.2**	–	–
Lead[c]	mg/L	–	**0.2112**	–	–
Manganese[c]	mg/L	–	**3.793**	–	–
Mercury[c]	mg/L	–	< 0.0001	–	–
Nickel[c]	mg/L	–	**0.1611**	–	–
Selenium[c]	mg/L	–	< 0.003	–	–
Silver[c]	mg/L	–	< 0.001	–	–
Zinc[c]	mg/L	–	0.5104	–	–
Ammonia nitrogen[b]	mg/L	< 0.05	< 0.05	< 0.05	0.26
Arsenic[b]	mg/L	< 0.003	0.0042	< 0.003	< 0.003
Barium[b]	mg/L	0.0324	0.0310	0.0313	0.0283
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	< 0.024	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016	< 0.016	< 0.016
Copper[b]	mg/L	< 0.015	< 0.015	< 0.015	< 0.015
Iron[b]	mg/L	0.0355	< 0.02	0.0428	0.0551
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	0.0856	0.0929	0.1447	0.1649
Mercury[b]	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	< 0.02	< 0.02	< 0.02	0.0377
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	0.0188	0.0093	< 0.008	0.0143
Nitrate[c]	mg/L	–	< 0.1	–	–
Phenols[c]	mg/L	< 0.005	0.0067	0.0058	< 0.005
Hydrogen-3[c]	pCi/L	< 100	< 100	< 100	< 100
Chloride[c]	mg/L	–	7	–	–
Fluoride[c]	mg/L	–	0.287	–	–
Sulfate[c]	mg/L	–	159	–	–
TOCs[c]	mg/L	1.7	2.4	1.7	1.5
TOCs[c]	mg/L	1.6	2.6	1.5	1.6
TOCs[c]	mg/L	1.6	2.5	1.5	1.6
TOCs[c]	mg/L	1.7	2.6	1.5	1.6
TOXs[c]	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
TOXs[c]	mg/L	< 0.02	< 0.02	< 0.02	< 0.02

[a] Well point elevation = 224.99 m (MSL); ground surface elevation = 232.53 m (MSL); casing material = stainless steel.

[b] Filtered sample.

[c] Unfiltered sample.

[d] A dash indicates that no samples were collected.

[e] Bold type indicates that the filtered sample value exceeds the State of Illinois Groundwater Quality Standard.

TABLE 6.41

Groundwater Monitoring Results,
Sanitary Landfill Well 800321, 2003

Parameter	Unit	Date of Sampling 7/22/2003
Water elevation[a]	m	224.87
Temperature	°C	11.6
pH	pH	6.82
Redox	mV	8
Conductivity	µmhos/cm	2,390
Chloride[b]	mg/L	51
Sulfate[b]	mg/L	2,035
TDS[b]	mg/L	3,129
Cyanide (total)[c]	mg/L	< 0.01
Arsenic[c]	mg/L	–[d]
Barium[c]	mg/L	–
Boron[c]	mg/L	–
Cadmium[c]	mg/L	–
Chromium[c]	mg/L	–
Cobalt[c]	mg/L	–
Copper[c]	mg/L	–
Iron[c]	mg/L	–
Lead[c]	mg/L	–
Manganese[c]	mg/L	–
Mercury[c]	mg/L	–
Nickel[c]	mg/L	–
Selenium[c]	mg/L	–
Silver[c]	mg/L	–
Zinc[c]	mg/L	–
Ammonia nitrogen[b]	mg/L	< 0.05
Arsenic[b]	mg/L	< 0.003
Barium[b]	mg/L	0.0112
Beryllium[b]	mg/L	< 0.0002
Cadmium[b]	mg/L	< 0.0002
Chromium[b]	mg/L	< 0.024
Cobalt[b]	mg/L	< 0.016
Copper[b]	mg/L	< 0.015
Iron[b]	mg/L	< 0.02
Lead[b]	mg/L	< 0.002
Manganese[b]	mg/L	0.0175
Mercury[b]	mg/L	< 0.0001
Nickel[b]	mg/L	< 0.02
Silver[b]	mg/L	< 0.001
Thallium[b]	mg/L	< 0.002
Vanadium[b]	mg/L	< 0.032
Zinc[b]	mg/L	0.0199
Nitrate[c]	mg/L	–
Phenols[c]	mg/L	< 0.005
Hydrogen-3[c]	pCi/L	< 100
Chloride[c]	mg/L	–
Fluoride[c]	mg/L	–
Sulfate[c]	mg/L	–
TOCs[c]	mg/L	1.4
TOCs[c]	mg/L	1.4
TOCs[c]	mg/L	1.3
TOCs[c]	mg/L	1.3
TOXs[c]	mg/L	< 0.02
TOXs[c]	mg/L	< 0.02

[a] Well point elevation = 223.66 m (MSL); ground surface elevation = 227.93 m (MSL); casing material = stainless steel.

[b] Filtered sample.

[c] Unfiltered sample.

[d] A dash indicates that no samples were collected.

TABLE 6.42

Groundwater Monitoring Results, Sanitary Landfill Well 800331, 2003

		Date of Sampling			
Parameter	Unit	1/21/2003	4/28/2003	7/15/2003	10/20/2003
Water elevation[a]	m	224.08	225.40	225.58	224.37
Temperature	°C	8.7	8.5	11.7	13.0
pH	pH	7.14	7.49	7.18	7.34
Redox	mV	-7	-25	-12	-20
Conductivity	µmhos/cm	913	674	788	798
Chloride[b]	mg/L	5	6	6	4
Sulfate[b]	mg/L	169	173	156	163
TDS[b]	mg/L	663	681	677	634
Cyanide (total)[c]	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Arsenic[c]	mg/L`	–[d]	< 0.003	–	–
Barium[c]	mg/L	–	0.0415	–	–
Boron[c]	mg/L	–	0.0744	–	–
Cadmium[c]	mg/L	–	< 0.0002	–	–
Chromium[c]	mg/L	–	< 0.024	–	–
Cobalt[c]	mg/L	–	< 0.016	–	–
Copper[c]	mg/L	–	< 0.015	–	–
Iron[c]	mg/L	–	0.3181	–	–
Lead[c]	mg/L	–	< 0.002	–	–
Manganese[c]	mg/L	–	0.0177	–	–
Mercury[c]	mg/L	–	< 0.0001	–	–
Nickel[c]	mg/L	–	< 0.02	–	–
Selenium[c]	mg/L	–	< 0.003	–	–
Silver[c]	mg/L	–	< 0.001	–	–
Zinc[c]	mg/L	–	< 0.008	–	–
Ammonia nitrogen[b]	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Arsenic[b]	mg/L	< 0.003	< 0.003	< 0.003	< 0.003
Barium[b]	mg/L	0.0521	0.0421	0.0424	0.0485
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	< 0.024	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016	< 0.016	< 0.016
Copper[b]	mg/L	< 0.015	< 0.015	< 0.015	< 0.015
Iron[b]	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Mercury[b]	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	< 0.02	< 0.02	< 0.02	0.0341
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	0.0201	< 0.008	0.0147	0.0202
Nitrate[c]	mg/L	–	< 0.1	–	–
Phenols[c]	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Hydrogen-3[c]	pCi/L	< 100	< 100	< 100	< 100
Chloride[c]	mg/L	–	6	–	–
Fluoride[c]	mg/L	–	0.383	–	–
Sulfate[c]	mg/L	–	166	–	–
TOCs[c]	mg/L	1.4	1.3	1.4	1.6
TOCs[c]	mg/L	1.3	1.3	1.4	1.6
TOCs[c]	mg/L	1.3	1.3	1.4	1.6
TOCs[c]	mg/L	1.3	1.3	1.4	1.6
TOXs[c]	mg/L	0.022	< 0.02	< 0.02	< 0.02
TOXs[c]	mg/L	< 0.02	< 0.02	< 0.02	< 0.02

[a] Well point elevation = 222.75 m (MSL); ground surface elevation = 227.93 m (MSL); casing material = stainless steel.

[b] Filtered sample.

[c] Unfiltered sample.

[d] A dash indicates that no samples were collected.

TABLE 6.43

Groundwater Monitoring Results, Sanitary Landfill Well 800341, 2003

Parameter	Unit	Date of Sampling 1/20/2003	4/28/2003	7/22/2003	10/15/2003
Water elevation[a]	m	226.82	228.45	229.03	227.69
Temperature	°C	8.7	7.1	12.1	13.3
pH	pH	7.21	7.29	7.16	7.45
Redox	mV	-10	-15	-12	-22
Conductivity	µmhos/cm	1,155	723	906	924
Chloride[b]	mg/L	11	13	14	10
Sulfate[b]	mg/L	253	211	364	266
TDS[b]	mg/L	797	751	844	786
Cyanide (total)[c]	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Arsenic[c]	mg/L	–[d]	< 0.003	–	–
Barium[c]	mg/L	–	0.0408	–	–
Boron[c]	mg/L	–	0.0857	–	–
Cadmium[c]	mg/L	–	< 0.0002	–	–
Chromium[c]	mg/L	–	< 0.024	–	–
Cobalt[c]	mg/L	–	< 0.016	–	–
Copper[c]	mg/L	–	< 0.015	–	–
Iron[c]	mg/L	–	2.015	–	–
Lead[c]	mg/L	–	0.0021	–	–
Manganese[c]	mg/L	–	0.0403	–	–
Mercury[c]	mg/L	–	< 0.0001	–	–
Nickel[c]	mg/L	–	< 0.02	–	–
Selenium[c]	mg/L	–	< 0.003	–	–
Silver[c]	mg/L	–	< 0.001	–	–
Zinc[c]	mg/L	–	0.0275	–	–
Ammonia nitrogen[b]	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Arsenic[b]	mg/L	< 0.003	< 0.003	< 0.003	< 0.003
Barium[b]	mg/L	0.0433	0.0347	0.0380	0.0413
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	< 0.024	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016	< 0.016	< 0.016
Copper[b]	mg/L	< 0.015	< 0.015	< 0.015	< 0.015
Iron[b]	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	0.0154	< 0.01	< 0.01	< 0.01
Mercury[b]	mg/L	< 0.0001	0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	0.0084	0.0137	0.0082	< 0.008
Nitrate[c]	mg/L	–	0.56	–	–
Phenols[c]	mg/L	0.04	< 0.005	< 0.005	< 0.005
Hydrogen-3[c]	pCi/L	< 100	< 100	< 100	117
Chloride[c]	mg/L	–	13	–	–
Fluoride[c]	mg/L	–	0.447	–	–
Sulfate[c]	mg/L	–	190	–	–
TOCs[c]	mg/L	2.0	2.3	1.4	2.6
TOCs[c]	mg/L	2.0	2.3	1.4	2.6
TOCs[c]	mg/L	2.0	2.2	1.4	2.6
TOCs[c]	mg/L	2.0	2.2	1.4	2.6
TOXs[c]	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
TOXs[c]	mg/L	< 0.02	< 0.02	< 0.02	< 0.02

[a] Well point elevation = 226.01 m (MSL); ground surface elevation = 229.97 m (MSL); casing material = stainless steel.
[b] Filtered sample.
[c] Unfiltered sample.
[d] A dash indicates that no samples were collected.
[e] Bold type indicates that the value exceeds the State of Illinois Groundwater Quality Standard.

TABLE 6.44

Groundwater Monitoring Results, Sanitary Landfill Well 800351, 2003

		Date of Sampling				
Parameter	Unit	1/15/2003	4/22/2003	4/22/2003	7/21/2003	10/13/2003
Water elevation[a]	m	225.02	224.75	224.75	224.86	224.73
Temperature	°C	8.1	10.4	10.4	11.0	10.2
pH	pH	7.04	7.05	7.05	7.30	7.40
Redox	mV	-2	-5	-5	-16	-17
Conductivity	µmhos/cm	943	660	660	715	707
Chloride[b]	mg/L	3	4	3	3	3
Sulfate[b]	mg/L	56	53	61	76	69
TDS[b]	mg/L	570	560	586	556	568
Cyanide (total)[c]	mg/L	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Arsenic[c]	mg/L	–[d]	0.0163	0.0234	–	–
Barium[c]	mg/L	–	0.2014	0.2478	–	–
Boron[c]	mg/L	–	0.2502	0.3211	–	–
Cadmium[c]	mg/L	–	0.0003	0.0005	–	–
Chromium[c]	mg/L	–	0.0576	0.0779	–	–
Cobalt[c]	mg/L	–	0.0257	0.0395	–	–
Copper[c]	mg/L	–	0.0729	0.0965	–	–
Iron[c]	mg/L	–	**65.19**[e]	**59.1**	–	–
Lead[c]	mg/L	–	**0.0332**	**0.0464**	–	–
Manganese[c]	mg/L	–	**1.092**	**1.658**	–	–
Mercury[c]	mg/L	–	< 0.0001	< 0.0001	–	–
Nickel[c]	mg/L	–	0.0644	0.0814	–	–
Selenium[c]	mg/L	–	< 0.003	< 0.003	–	–
Silver[c]	mg/L	–	< 0.001	< 0.001	–	–
Zinc[c]	mg/L	–	0.1792	0.2385	–	–
Ammonia nitrogen[b]	mg/L	0.19	< 0.05	< 0.05	0.11	0.20
Arsenic[b]	mg/L	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
Barium[b]	mg/L	0.0937	0.0935	0.0977	0.0835	0.0884
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	< 0.024	< 0.024	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016	< 0.016	< 0.016	< 0.016
Copper[b]	mg/L	< 0.015	< 0.015	< 0.015	< 0.015	< 0.015
Iron[b]	mg/L	< 0.02	< 0.02	< 0.02	0.0852	0.0361
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	0.0275	0.0284	0.0284	0.0279	0.0305
Mercury[b]	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	< 0.02	0.0201	0.0201	0.0371	0.0301
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	< 0.008	0.0135	0.0146	0.0149	0.016
Nitrate[c]	mg/L	–	< 0.1	< 0.1	–	–
Phenols[c]	mg/L	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Hydrogen-3[c]	pCi/L	< 100	< 100	< 100	< 100	< 100
Chloride[c]	mg/L	–	6	4	–	–
Fluoride[c]	mg/L	–	0.272	0.284	–	–
Sulfate[c]	mg/L	–	57	63	–	–
TOCs[c]	mg/L	1.5	1.5	1.8	1.5	1.8
TOCs[c]	mg/L	1.9	1.7	1.7	1.6	1.9
TOCs[c]	mg/L	1.5	1.5	1.6	1.5	1.7
TOCs[c]	mg/L	1.4	1.7	1.6	1.6	1.7
TOXs[c]	mg/L	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
TOXs[c]	mg/L	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02

[a] Well point elevation = 220.86 m (MSL); ground surface elevation = 232.75 m (MSL); casing material = stainless steel.
[b] Filtered sample.
[c] Unfiltered sample.
[d] A dash indicates that no samples were collected.
[e] Bold type indicates that the unfiltered sample value exceeds the State of Illinois Groundwater Quality Standard.

TABLE 6.45

Groundwater Monitoring Results, Sanitary Landfill Well 800361, 2003

Parameter	Unit	Date of Sampling 1/15/2003	4/22/2003	7/22/2003	10/21/2003
Water elevation[a]	m	221.95	221.73	222.32	221.91
Temperature	°C	10.8	9.9	11.1	11.2
pH	pH	6.91	6.97	7.30	7.08
Redox	mV	7	2	-15	-8
Conductivity	µmhos/cm	915	700	776	748
Chloride[b]	mg/L	11	12	11	9
Sulfate[b]	mg/L	129	153	222	178
TDS[b]	mg/L	588	646	763	677
Cyanide (total)[c]	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Arsenic[c]	mg/L	–[d]	0.0247	–	–
Barium[c]	mg/L	–	0.2426	–	–
Boron[c]	mg/L	–	0.4182	–	–
Cadmium[c]	mg/L	–	0.0009	–	–
Chromium[c]	mg/L	–	**0.1023**[e]	–	–
Cobalt[c]	mg/L	–	0.0605	–	–
Copper[c]	mg/L	–	0.1889	–	–
Iron[c]	mg/L	–	**144.3**	–	–
Lead[c]	mg/L	–	**0.0789**	–	–
Manganese[c]	mg/L	–	**2.65**	–	–
Mercury[c]	mg/L	–	< 0.0001	–	–
Nickel[c]	mg/L	–	**0.1352**	–	–
Selenium[c]	mg/L	–	< 0.003	–	–
Silver[c]	mg/L	–	< 0.001	–	–
Zinc[c]	mg/L	–	0.3767	–	–
Ammonia nitrogen[b]	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Arsenic[b]	mg/L	< 0.003	< 0.003	< 0.003	< 0.003
Barium[b]	mg/L	0.0314	0.0370	0.0257	0.0293
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	< 0.024	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016	< 0.016	< 0.016
Copper[b]	mg/L	< 0.015	< 0.015	< 0.015	< 0.015
Iron[b]	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	0.1094	0.1631	0.2113	0.1822
Mercury[b]	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	< 0.02	< 0.02	0.0229	0.0274
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	0.0087	0.0154	0.0135	0.0232
Nitrate[c]	mg/L	–	< 0.1	–	–
Phenols[c]	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Hydrogen-3[c]	pCi/L	< 100	< 100	< 100	< 100
Chloride[c]	mg/L	–	12	–	–
Fluoride[c]	mg/L	–	0.339	–	–
Sulfate[c]	mg/L	–	151	–	–
TOCs[c]	mg/L	1.6	1.8	1.5	1.7
TOCs[c]	mg/L	1.6	1.8	1.5	1.7
TOCs[c]	mg/L	1.6	1.8	1.5	1.8
TOCs[c]	mg/L	1.6	1.8	2.9	1.7
TOXs[c]	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
TOXs[c]	mg/L	< 0.02	< 0.02	< 0.02	0.05

[a] Well bottom elevation = 220.60 m (MSL); ground surface elevation = 227.53 m (MSL); casing material = stainless steel.

[b] Filtered sample.

[c] Unfiltered sample.

[d] A dash indicates that no samples were collected.

[e] Bold type indicates that the unfiltered sample value exceeds the State of Illinois Groundwater Quality Standard.

TABLE 6.46

Groundwater Monitoring Results, Sanitary Landfill Well 800371, 2003

Parameter	Unit	Date of Sampling				
		1/15/2003	4/22/2003	7/22/2003	10/13/2003	10/13/2003
Water elevation[a]	m	219.12	218.87	218.81	218.79	218.79
Temperature	°C	10.3	11.7	12.3	10.7	10.7
pH	pH	7.19	7.10	7.11	7.12	7.12
Redox	mV	-10	-6	-6	-8	-8
Conductivity	µmhos/cm	803	788	954	983	983
Chloride[b]	mg/L	2	3	3	2	2
Sulfate[b]	mg/L	46	100	194	222	241
TDS[b]	mg/L	496	725	881	921	912
Cyanide (total)[c]	mg/L	< 0.01	< 0.01	< 0.01	0.021	< 0.01
Arsenic[c]	mg/L	–[d]	0.0076	–	–	–
Barium[c]	mg/L	–	0.2202	–	–	–
Boron[c]	mg/L	–	0.2401	–	–	–
Cadmium[c]	mg/L	–	0.0008	–	–	–
Chromium[c]	mg/L	–	0.0334	–	–	–
Cobalt[c]	mg/L	–	0.0174	–	–	–
Copper[c]	mg/L	–	0.1191	–	–	–
Iron[c]	mg/L	–	**59.35**[e]	–	–	–
Lead[c]	mg/L	–	**0.0381**	–	–	–
Manganese[c]	mg/L	–	**1.119**	–	–	–
Mercury[c]	mg/L	–	< 0.0001	–	–	–
Nickel[c]	mg/L	–	0.0713	–	–	–
Selenium[c]	mg/L	–	< 0.003	–	–	–
Silver[c]	mg/L	–	< 0.001	–	–	–
Zinc[c]	mg/L	–	0.3021	–	–	–
Ammonia nitrogen[b]	mg/L	0.39	0.27	0.30	0.44	0.38
Arsenic[b]	mg/L	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
Barium[b]	mg/L	0.0849	0.0931	0.0673	0.0551	0.0550
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	< 0.024	< 0.024	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016	< 0.016	< 0.016	< 0.016
Copper[b]	mg/L	< 0.015	< 0.015	< 0.015	< 0.015	< 0.015
Iron[b]	mg/L	< 0.02	< 0.02	< 0.02	0.0266	0.1007
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	0.0852	0.1408	0.1067	0.0730	0.0678
Mercury[b]	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	< 0.02	< 0.02	< 0.02	0.0398	< 0.02
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	< 0.008	0.0230	0.0149	0.0128	0.0209
Nitrate[c]	mg/L	–	< 0.1	–	–	–
Phenols[c]	mg/L	< 0.005	< 0.005	< 0.005	< 0.005	0.010
Hydrogen-3[c]	pCi/L	< 100	< 100	< 100	< 100	< 100
Chloride[c]	mg/L	–	4	–	–	–
Fluoride[c]	mg/L	–	0.435	–	–	–
Sulfate[c]	mg/L	–	115	–	–	–
TOCs[c]	mg/L	1.5	1.6	1.5	1.7	1.6
TOCs[c]	mg/L	1.4	1.8	1.5	1.7	1.6
TOCs[c]	mg/L	1.4	1.6	1.4	1.6	1.6
TOCs[c]	mg/L	1.5	1.7	1.4	1.6	1.6
TOXs[c]	mg/L	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
TOXs[c]	mg/L	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02

[a] Well point elevation = 217.83 m (MSL); ground surface elevation = 227.50 m (MSL); casing material = stainless steel.
[b] Filtered sample.
[c] Unfiltered sample.
[d] A dash indicates that no samples were collected.
[e] Bold type indicates that the unfiltered sample value exceeds the State of Illinois Groundwater Quality Standard.

effect of reduced turbidity on measured parameter levels. The application of a clay cap to the landfill, which was completed in October 1993, may mediate any migration of contaminants from the glacial drift. Comparison of a number of years of monitoring results indicates that several parameters consistently exceed the WQSs at selected wells.

The most common constituents at levels above the WQS (see Table 6.14) in the shallow wells are iron, manganese, and lead. Figure 6.20 shows the trend for manganese WQS exceedances for the shallow wells monitored as part of the IEPA-approved groundwater monitoring program for the 800 Area Landfill. Results represent unfiltered parameters. The manganese and iron WQSs were exceeded in 12 shallow wells, and the lead WQS was exceeded in nine shallow wells. The chromium WQS was exceeded in five shallow wells, nickel in three shallow wells, TDS and arsenic in two shallow wells, and chloride in only one shallow well. As noted in previous years, the intermediate wells have fewer exceedances. Iron exceeded the WQS in all three intermediate wells, and chromium, lead, and manganese exceeded the WQS in two intermediate wells. Arsenic and barium exceeded the WQS in Well 800192 and nickel exceeded the WQS in Well 800382. The results for the deep wells show no exceedances except for iron and manganese in Well 800383D.

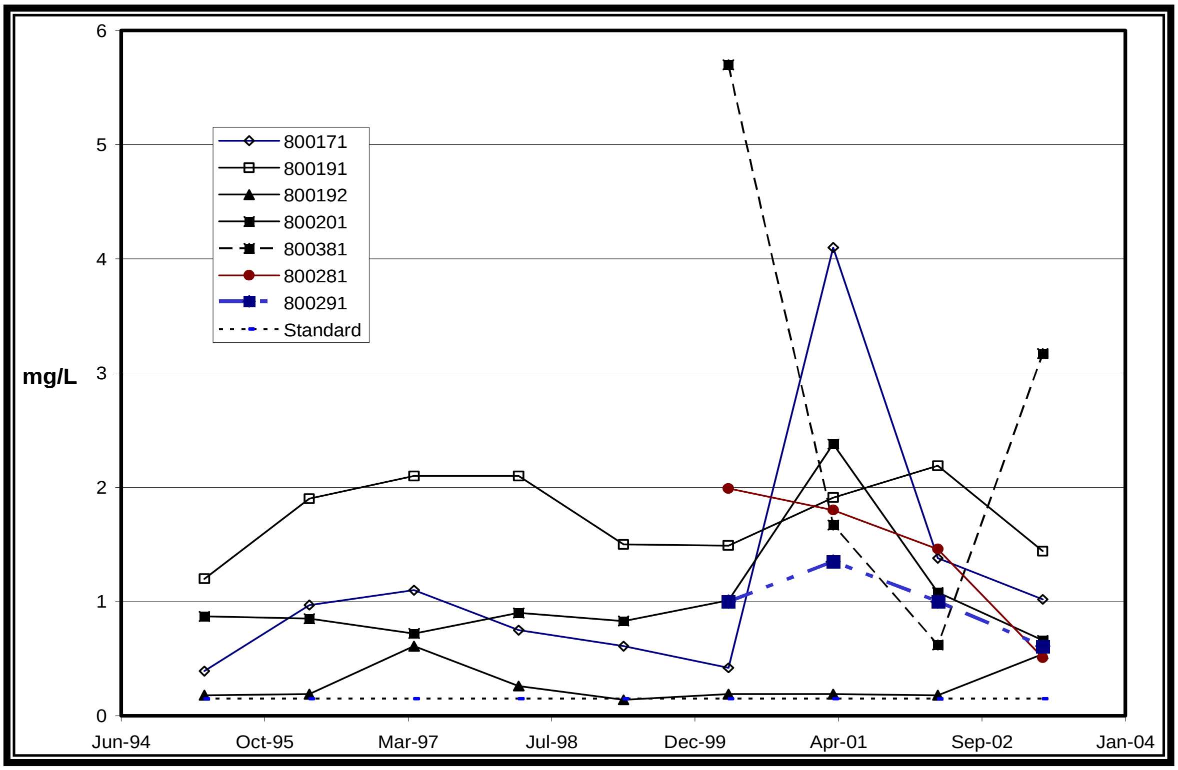


FIGURE 6.20 800 Well Manganese Results

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 are 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. As noted in past years, manganese is the most persistent elevated parameter noted in the shallow wells. Manganese concentrations were elevated in eight of the 16 shallow wells during at least one quarter of the year. Elevated levels were noted each quarter in Wells 800191, 800201, and 800381. Manganese levels ranged from 0.16 to 1.4 mg/L. Chloride concentrations were elevated each quarter in Well 800191 and levels ranged from 238 to 288 mg/L. TDS was elevated in Wells 800191, 800321, and 800381, except for the first quarter. Levels ranged from 1,216 to 3,129 mg/L. Sulfate was elevated only during the third quarter in Wells 800321 and 800381.

Historically, fewer parameters are noted infrequently in the intermediate wells. Elevated levels of manganese are noted each quarter in the three intermediate wells. Manganese levels in these wells ranged from 0.17 to 0.20 mg/L. Iron concentrations were elevated in Wells 800192 and 800202, and TDS concentrations were elevated in Well 800192 only during the third quarter.

No elevated concentrations of any parameter were noted in the deep wells, except for elevated chloride levels in Well 800173D in the third and fourth quarters.

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.

Unfiltered Inorganic Parameters. These parameters are measured unfiltered 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. Boron, cadmium, cobalt, copper, cyanide, fluoride, mercury, nickel, nitrate as nitrogen, selenium, silver, sulfate, and zinc were all less than the WQS. Iron, lead, and manganese results are similar to those noted in previous years.

Barium concentrations exceeded the WQS (2 mg/L) in only Well 800192, and chloride exceeded the WQS (200 mg/L) in only Well 800191. TDS exceeded the WQS in only Wells 800191 and 800381.

Arsenic concentrations exceeded the WQS (0.05 mg/L) in Wells 800192, 800301, and 800381. Arsenic levels ranged from 0.07 to 0.13 mg/L.

Chromium and nickel concentrations were inconsistent with past results. Chromium concentrations exceeded or met the WQS (0.1 mg/L) in Wells 800192, 800201, 800281, 800301, 800361 800381, and 800382. Chromium levels ranged from 0.102 to 2.3 mg/L. Nickel concentrations exceeded the WQS (0.1 mg/L) in Wells 800301, 800361, 800381, and 800382. Nickel levels ranged from 0.14 to 1.5 mg/L.

Results for iron exceedances of the WQS were similar to those noted in 2002. Iron concentrations exceeded the WQS (5 mg/L) in Wells 800271 (upgradient), 800171, 800181, 800191, 800192, 800201, 800202, 800281, 800291, 800301, 800351, 800361, 800371, 800381, 800382, and 800383D. The iron levels ranged from 9.6 to 438 mg/L. These elevated levels are likely to be the result of suspended soil particles in the sample.

Lead concentrations exceeded the WQS (0.0075 mg/L) in Wells 800271 (upgradient), 800171, 800192, 800281, 800291, 800301, 800351, 800361, 800371, 800381, and 800382. Lead levels ranged from 0.0082 to 0.2363 mg/L. These elevated levels are also likely to be the result of suspended soil particles in the sample.

Results for manganese exceedances of the WQS were similar to those noted in 2002. Manganese concentrations exceeded the WQS (0.15 mg/L) in Wells 800271 (upgradient), 800171, 800181, 800191, 800192, 800201, 800281, 800291, 800301, 800351, 800361, 800371, 800381, 800382, and 800383D. Manganese levels in these wells ranged from 0.24 to 4.1 mg/L. Elevated manganese levels are noted across the ANL-E site.

Organic Parameters. Each well was sampled quarterly and analyzed for VOCs. As in 2002, VOCs were not detected in any wells in 2003.

Radioactive Constituents. Samples collected from the 800 Area Landfill monitoring wells were also analyzed for hydrogen-3. The results are shown in Tables 6.23 to 6.46. Although the disposal of radioactive materials was prohibited in the sanitary landfill, concentrations of hydrogen-3 were detected only one quarter in Wells 800181, 800183D, and 800341; two quarters in Well 800171, and detected each quarter in Well 800281. These wells are located east and southeast of the landfill. Hydrogen-3 has been consistently noted in Well 800281. In Wells 800181 and 800341, hydrogen-3 was detected at a level near detection and only during the third and fourth quarters. Also, hydrogen-3 was detected in deep Well 800183D (162 pCi/L) for the first time, but only during the second quarter.

Hydrogen-3 was noted two quarters in Well 800191 and four quarters in Well 800192. These wells are located south and at the southwest corner of the landfill area. Hydrogen-3 has been consistently noted in Well 800192.

As previously mentioned, the general groundwater flow direction in the shallow glacial drift is to the southeast with a minor component to the west. Seasonal variations are known to exist as evidenced by the inconsistent presence of water in Well 800321. The wells in the southwest corner of the landfill area are adjacent to a stream that may be influencing subsurface water flow on the western side of the landfill area. For those wells with measurable levels of hydrogen-3, the samples were also analyzed for gamma-ray–emitting radionuclides. All results were below the detection limit and are summarized in the 2003 annual summary assessment of the groundwater monitoring program for the 800 Area Landfill sent to the IEPA in July 2004.

6.4. CP-5 Reactor Area

The CP-5 reactor was 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 have been 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 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 deep well was installed during June 1997 to determine whether there had been any vertical migration of hydrogen-3 to the dolomite from the CP-5 reactor.

The yard area surrounding the CP-5 reactor structure was classified as a SWMU and was therefore investigated for groundwater releases under the RCRA Part B Permit requirements. As part of this investigation, Wells 330051 and 330052 were installed in May 2000 northeast of the CP-5 complex. To improve the understanding and delineation of the CP-5 hydrogeology and groundwater flow directions, the ERP installed five additional wells during February 2003 in the drift surrounding the CP-5 study area. Also, Wells 330021 and 330031 were abandoned and replaced with new wells with shorter screens, allowing monitoring of the saturated zones within the drift. These seven additional wells were incorporated into the ANL-E routine groundwater monitoring program during the second quarter of 2003. Data collection from the combined old and new wells will allow determination of groundwater flow directions within the drift and determination of the extent of potential metals and radionuclide contamination. A review of the analytical results in the past indicated that for some parameters, all or most of the results had been less than the detection limits. Therefore, it was decided, beginning in the third quarter, to no longer conduct analyses for VOCs, semivolatiles, PCBs, pesticides, and herbicides. Table 6.47 characterizes all wells in this area (see Figure 6.21 for locations).

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 330 Area are presented in Tables 6.48 to 6.56. All radiological and inorganic analysis results are shown in these tables.

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. Water from four wells (330051, 330061, 330081, and 330091) had elevated conductivity levels. The elevated conductivity levels in Wells 330051 and 330061 may be due to elevated chloride levels from road salt. The elevated levels in Wells 330081 and 330091 appear to be related to intrusion of chloride into the groundwater from a road salt storage facility near the wells.

TABLE 6.47

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[b]	5.8	227.75	226.3–221.7	0.05/SS	9/93
330031[b]	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
330021R	11.9	227.02	216.6–215.1	0.05/PVC	2/03
330031R	9.8	227.63	219.4–217.9	0.05/PVC	2/03
330051	10.7	223.09	217.5–216.0	0.05/PVC	5/00
330052[c]	7.0	226.71	221.2–219.7	0.05/PVC	5/00
330061	9.7	227.09	218.8–217.4	0.05/PVC	2/03
330071	8.8	226.63	219.3–217.8	0.05/PVC	2/03
330081	4.5	226.58	223.5–222.0	0.05/PVC	2/03
330091	3.8	227.05	224.7–223.3	0.05/PVC	2/03

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

[b] Well abandoned and replaced with new well.

[c] Well not sampled.

Filtered Routine Indicator Parameters/Metals. High levels of chloride were noted in Wells 330051, 330061, 330081, and 330091. Chloride levels in these wells ranged from 626 to 20,661 mg/L. As previously mentioned, it appears that road salt intrusion from roadways and a salt storage area are responsible for the elevated chloride levels associated with high conductivity of the water.

Barium, iron, manganese, nickel, and zinc are the most frequently noted parameters in wells in the CP-5 vicinity. It appears that these elevated levels are associated with disturbance of silt in the well bottom during sampling, thereby increasing the turbidity of the sample. ANL-E has determined that the use of low-flow sampling techniques results in low turbidity samples containing significantly reduced levels of these parameters.

Barium was noted each quarter in each well in the CP-5 monitoring network. Levels ranged from 0.04 to 0.27 mg/L. Iron was noted at least one quarter in six of the wells. Iron levels in all wells ranged from less than 0.002 to 31.45 mg/L. Manganese was noted each quarter in all the wells except Well 330011, and levels ranged from less than 0.01 to 5.9 mg/L. Nickel was noted each quarter in Wells 330021, 330031, 330061, 330081, 330091, and it was noted at least one quarter in the remaining wells. Nickel levels ranged from less than 0.02 to 4.8 mg/L. Zinc was noted at low levels in seven of the wells. Zinc levels in these wells ranged from less than 0.008 to 0.04 mg/L.

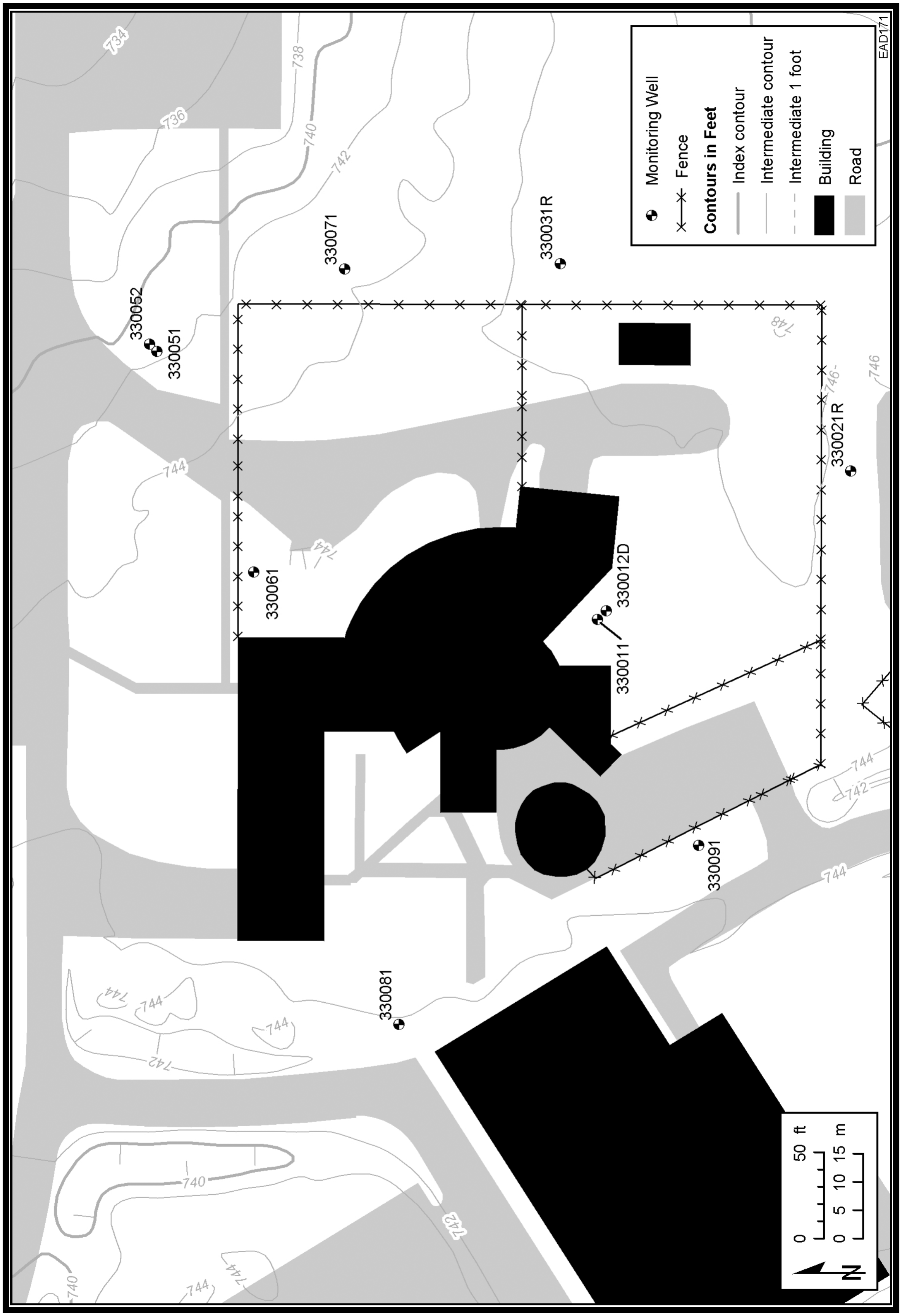


FIGURE 6.21 Active Monitoring Wells in the CP-5 Reactor Area

TABLE 6.48

Groundwater Monitoring Results, 300 Area Well 330011, 2003

		Date of Sampling			
Parameter	Unit	3/25/2003	6/23/2003	9/16/2003	11/20/2003
Water elevation[a]	m	222.98	224.46	224.11	225.17
Temperature	°C	12.6	13.4	15.5	15.5
pH	pH	7.08	6.31	7.04	7.18
Redox	mV	0	15	-3	-14
Conductivity	µmhos/cm	1,167	1,029	998	945
Chloride[b]	mg/L	79	54	38	26
Arsenic[b]	mg/L	< 0.003	< 0.003	< 0.003	< 0.003
Barium[b]	mg/L	0.0469	0.0524	0.0602	0.0553
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	< 0.024	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016	< 0.016	< 0.016
Copper[b]	mg/L	< 0.015	< 0.015	< 0.015	< 0.015
Iron[b]	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	< 0.01	< 0.01	0.6697	0.0231
Mercury[b]	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	0.0203	0.0219	< 0.02	< 0.02
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	< 0.008	< 0.008	< 0.008	< 0.008
Cesium-137	pCi/L	< 2.0	< 2.0	< 2.0	< 2.0
Hydrogen-3	pCi/L	1,321	1,320	775	5,207
Strontium-90	pCi/L	0.52	0.53	0.67	< 0.25
Dichlorofluoromethane	µg/L	1.0	–	–	–

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

[b] Filtered sample.

TABLE 6.49

Groundwater Monitoring Results, 300 Area Well 330021, 2003

		Date of Sampling			
Parameter	Unit	3/26/2003	6/23/2003	9/16/2003	11/20/2003
Water elevation[a]	m	219.21	225.92	220.76	227.64
Temperature	°C	11.4	11.8	13.5	12.9
pH	pH	7.04	6.86	7.23	7.13
Redox	mV	-1	-14	-12	-11
Conductivity	µmhos/cm	1,424	1,183	1,303	882
Chloride[b]	mg/L	95	149	151	99
Arsenic[b]	mg/L	< 0.003	< 0.003	< 0.003	< 0.003
Barium[b]	mg/L	0.1124	0.0510	0.0461	0.0286
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	< 0.024	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	0.0649	< 0.016	< 0.016
Copper[b]	mg/L	0.0951	< 0.015	< 0.015	< 0.015
Iron[b]	mg/L	< 0.02	31.45	0.5834	< 0.02
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	0.103	1.0548	0.4262	0.0246
Mercury[b]	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	0.0405	4.825	0.2825	0.1755
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	0.0377	0.0421	< 0.008	< 0.008
Cesium-137	pCi/L	8.5	< 2.0	3.9	< 2.0
Hydrogen-3	pCi/L	< 100	< 100	< 100	< 100
Strontium-90	pCi/L	< 0.25	< 0.25	< 0.25	0.29

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

[b] Filtered sample.

TABLE 6.50

Groundwater Monitoring Results, 300 Area Well 330031, 2003

		Date of Sampling		
Parameter	Unit	6/23/2003	9/16/2003	11/20/2003
Water elevation[a]	m	220.27	220.20	220.27
Temperature	°C	12.0	11.6	11.2
pH	pH	6.73	7.08	7.22
Redox	mV	-5	-5	-17
Conductivity	µmhos/cm	1,213	1,105	1,137
Chloride[b]	mg/L	86	106	102
Arsenic[b]	mg/L	< 0.003	< 0.003	< 0.003
Barium[b]	mg/L	0.0938	0.0806	0.0748
Beryllium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002
Cadmium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002
Chromium[b]	mg/L	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016	< 0.016
Copper[b]	mg/L	< 0.015	0.0165	< 0.015
Iron[b]	mg/L	< 0.02	< 0.02	< 0.02
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	0.0685	0.6655	0.0829
Mercury[b]	mg/L	< 0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	0.0315	0.0219	0.0227
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	< 0.008	0.0125	< 0.008
Cesium-137	pCi/L	< 2.0	7.9	< 2.0
Hydrogen-3	pCi/L	4244	5031	730
Strontium-90	pCi/L	< 0.25	< 0.25	0.55

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

[b] Filtered sample.

TABLE 6.51

Groundwater Monitoring Results, 300 Area Well 330012D, 2003

		Date of Sampling			
Parameter	Unit	3/25/2003	6/23/2003	9/16/2003	11/20/2003
Water elevation[a]	m	190.33	190.39	190.28	190.33
Temperature	°C	13.7	14.1	14.5	13.6
pH	pH	6.79	6.44	7.09	7.43
Redox	mV	7	7	-5	-24
Conductivity	μmhos/cm	1,118	916	881	910
Chloride[b]	mg/L	67	26	30	24
Arsenic[b]	mg/L	< 0.003	< 0.003	< 0.003	< 0.003
Barium[b]	mg/L	0.0519	0.0526	0.0540	0.0572
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	< 0.024	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016	< 0.016	< 0.016
Copper[b]	mg/L	< 0.015	0.018	< 0.015	< 0.015
Iron[b]	mg/L	< 0.02	0.0911	0.1745	0.239
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	0.0270	0.0557	0.0639	0.0488
Mercury[b]	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	0.0372	0.0247	< 0.02	0.0326
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	< 0.008	< 0.008	< 0.008	< 0.008
Cesium-137	pCi/L	< 2.0	< 2.0	< 2.0	< 2.0
Hydrogen-3	pCi/L	1,302	274	235	162
Strontium-90	pCi/L	0.99	0.63	0.51	0.39
Dichlorofluoromethane	μg/L	5.0	–[c]	–	–

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

[b] Filtered sample.

[c] A dash indicates that no samples were collected.

TABLE 6.52

Groundwater Monitoring Results, 300 Area Well 330051, 2003

		Date of Sampling			
Parameter	Unit	6/23/2003	9/16/2003	9/16/2003	11/20/2003
Water elevation[a]	m	217.66	217.62	217.62	218.28
Temperature	°C	12.5	13.8	13.8	13.7
pH	pH	6.41	6.81	6.81	7.02
Redox	mV	9	8	8	-5
Conductivity	µmhos/cm	2,580	2,530	2,530	2,680
Chloride[b]	mg/L	694	830	996	626
Arsenic[b]	mg/L	< 0.003	< 0.003	< 0.003	< 0.003
Barium[b]	mg/L	0.0913	0.0994	0.0971	0.0919
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	< 0.024	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016	< 0.016	< 0.016
Copper[b]	mg/L	< 0.015	< 0.015	< 0.015	< 0.015
Iron[b]	mg/L	0.0362	< 0.02	< 0.02	< 0.02
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	0.1661	0.1150	0.1182	0.2172
Mercury[b]	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	0.1124	< 0.02	0.0207	0.1227
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	< 0.008	0.0083	< 0.008	< 0.008
Cesium-137	pCi/L	3.9	< 2.0	< 2.0	< 2.0
Hydrogen-3	pCi/L	219	296	271	588
Strontium-90	pCi/L	< 0.25	< 0.25	< 0.25	< 0.25

[a] Well point elevation = 212.59 m (MSL); ground surface elevation = 223.09 m (MSL); casing material = stainless steel.

[b] Filtered sample.

TABLE 6.53

Groundwater Monitoring Results, 300 Area Well 330061, 2003

Parameter	Unit	Date of Sampling 6/23/2003	9/16/2003	11/19/2003	11/19/2003
Water elevation[a]	m	218.03	216.16	216.25	216.25
Temperature	°C	14.9	15.0	14.0	14.0
pH	pH	6.42	6.84	7.44	7.44
Redox	mV	10	9	-13	-13
Conductivity	µmhos/cm	3,440	3,100	3,250	3,250
Chloride[b]	mg/L	809	733	1037	989
Arsenic[b]	mg/L	< 0.003	< 0.003	< 0.003	< 0.003
Barium[b]	mg/L	0.0908	0.0770	0.0798	0.0803
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	< 0.024	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016	< 0.016	< 0.016
Copper[b]	mg/L	< 0.015	< 0.015	< 0.015	< 0.015
Iron[b]	mg/L	0.3580	0.5920	1.0005	0.8429
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	0.3165	0.1961	0.2789	0.2776
Mercury[b]	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	0.0301	0.0213	0.0446	0.0419
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	< 0.008	0.0118	0.0092	0.0080
Cesium-137	pCi/L	< 2.0	< 2.0	< 2.0	< 2.0
Hydrogen-3	pCi/L	1,287	1,265	1,393	1,357
Strontium-90	pCi/L	< 0.25	< 0.25	< 0.25	< 0.25

[a] Well point elevation = 213.93 m (MSL); ground surface elevation = 223.53 m (MSL); casing material = stainless steel.

[b] Filtered sample.

TABLE 6.54

Groundwater Monitoring Results, 300 Area Well 330071, 2003

Parameter	Unit	Date of Sampling 6/23/2003	9/16/2003	11/20/2003
Water elevation[a]	m	216.73	216.43	216.54
Temperature	°C	11.7	12.2	11.7
pH	pH	6.69	7.10	7.46
Redox	mV	-3	-8	-28
Conductivity	µmhos/cm	1,090	892	890
Chloride[b]	mg/L	21	11	9
Arsenic[b]	mg/L	< 0.003	< 0.003	< 0.003
Barium[b]	mg/L	0.1035	0.0704	0.0760
Beryllium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002
Cadmium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002
Chromium[b]	mg/L	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016	< 0.016
Copper[b]	mg/L	0.0171	< 0.015	< 0.015
Iron[b]	mg/L	< 0.02	< 0.02	< 0.02
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	0.399	0.2605	0.2149
Mercury[b]	mg/L	< 0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	0.0294	< 0.02	< 0.02
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	0.0099	< 0.008	< 0.008
Cesium-137	pCi/L	< 2.0	< 2.0	< 2.0
Hydrogen-3	pCi/L	532	585	327
Strontium-90	pCi/L	< 0.25	< 0.25	< 0.25

[a] Well point elevation = 214.37 m (MSL); ground surface elevation = 223.07 m (MSL); casing material = stainless steel.

[b] Filtered sample.

TABLE 6.55

Groundwater Monitoring Results, 300 Area Well 330081, 2003

Parameter	Unit	Date of Sampling		
		6/23/2003	9/16/2003	11/20/2003
Water elevation[a]	m	219.85	219.83	220.43
Temperature	°C	13.0	17.8	15.2
pH	pH	6.32	6.94	7.15
Redox	mV	14	-1	-12
Conductivity	µmhos/cm	5,120	4,530	3,600
Chloride[b]	mg/L	1,778	1,593	1,076
Arsenic[b]	mg/L	< 0.003	< 0.003	< 0.003
Barium[b]	mg/L	0.1836	0.1758	0.1236
Beryllium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002
Cadmium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002
Chromium[b]	mg/L	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016	< 0.016
Copper[b]	mg/L	< 0.015	< 0.015	< 0.015
Iron[b]	mg/L	< 0.02	0.2243	0.0205
Lead[b]	mg/L	< 0.002	< 0.002	< 0.002
Manganese[b]	mg/L	0.2037	0.3530	0.2752
Mercury[b]	mg/L	< 0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	0.0294	0.4468	0.3927
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	0.0086	< 0.008	< 0.008
Cesium-137	pCi/L	< 2.0	< 2.0	< 2.0
Hydrogen-3	pCi/L	184	248	216
Strontium-90	pCi/L	0.84	0.73	0.45

[a] Well point elevation = 218.53 m (MSL); ground surface elevation = 223.03 m (MSL); casing material = stainless steel.

[b] Filtered sample.

TABLE 6.56

Groundwater Monitoring Results, 300 Area Well 330091, 2003

		Date of Sampling		
Parameter	Unit	6/23/2003	9/16/2003	11/19/2003
Water elevation[a]	m	220.60	220.52	221.21
Temperature	°C	13.9	19.9	15.4
pH	pH	6.08	6.46	6.62
Redox	mV	27	28	15
Conductivity	µmhos/cm	2,070	29,800	3,290
Chloride[b]	mg/L	6,992	19,123	20,661
Arsenic[b]	mg/L	< 0.003	< 0.003	< 0.003
Barium[b]	mg/L	0.1358	0.2629	0.2695
Beryllium[b]	mg/L	< 0.0002	< 0.0002	< 0.0002
Cadmium[b]	mg/L	< 0.0002	< 0.0002	0.0026
Chromium[b]	mg/L	< 0.024	< 0.024	< 0.024
Cobalt[b]	mg/L	< 0.016	< 0.016	< 0.016
Copper[b]	mg/L	< 0.015	< 0.015	< 0.015
Iron[b]	mg/L	0.0322	0.0382	< 0.02
Lead[b]	mg/L	< 0.002	< 0.002	< 0.006
Manganese[b]	mg/L	4.1061	5.8651	5.7673
Mercury[b]	mg/L	< 0.0001	< 0.0001	< 0.0001
Nickel[b]	mg/L	0.0563	0.0511	0.0597
Silver[b]	mg/L	< 0.001	< 0.001	< 0.001
Thallium[b]	mg/L	< 0.002	< 0.002	< 0.002
Vanadium[b]	mg/L	< 0.032	< 0.032	< 0.032
Zinc[b]	mg/L	< 0.008	< 0.008	0.0088
Cesium-137	pCi/L	< 2.0	< 2.0	< 2.0
Hydrogen-3	pCi/L	1,076	1,161	1,163
Strontium-90	pCi/L	0.77	0.63	0.62

[a] Well point elevation = 219.74 m (MSL); ground surface elevation = 223.49 m (MSL); casing material = stainless steel.

[b] Filtered sample.

Organic Parameters. Each well was sampled and analyzed for VOCs only during the first and second quarters. Dichlorofluoromethane was noted at a very low level (1 µg/L) in Well 330011 and in Well 330012D (5 µg/L) during the first quarter.

Radioactive Constituents. Radionuclide levels in the original well network were similar to those noted from 2000 to 2003 (see Figures 6.22 and 6.23). Hydrogen-3 was detected each quarter in all wells except Well 330021. The levels of hydrogen-3 in these wells ranged from 162 to 5,207 pCi/L. These levels are well below the WQS (20,000 pCi/L). Strontium-90 was detected each quarter in Wells 330011, 330081, and 330091; three quarters in Well 330012D; and one quarter in Well 330031. The levels of strontium-90 in these wells ranged from less than 0.25 to 0.99 pCi/L. These levels are well below the WQS (8 pCi/L). Cesium-137 was detected infrequently in Wells 330021, 330031, and 330051. Cesium-137 levels in these wells ranged from less than 2 to 8.5 pCi/L.

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. The source of the strontium-90 is not known.

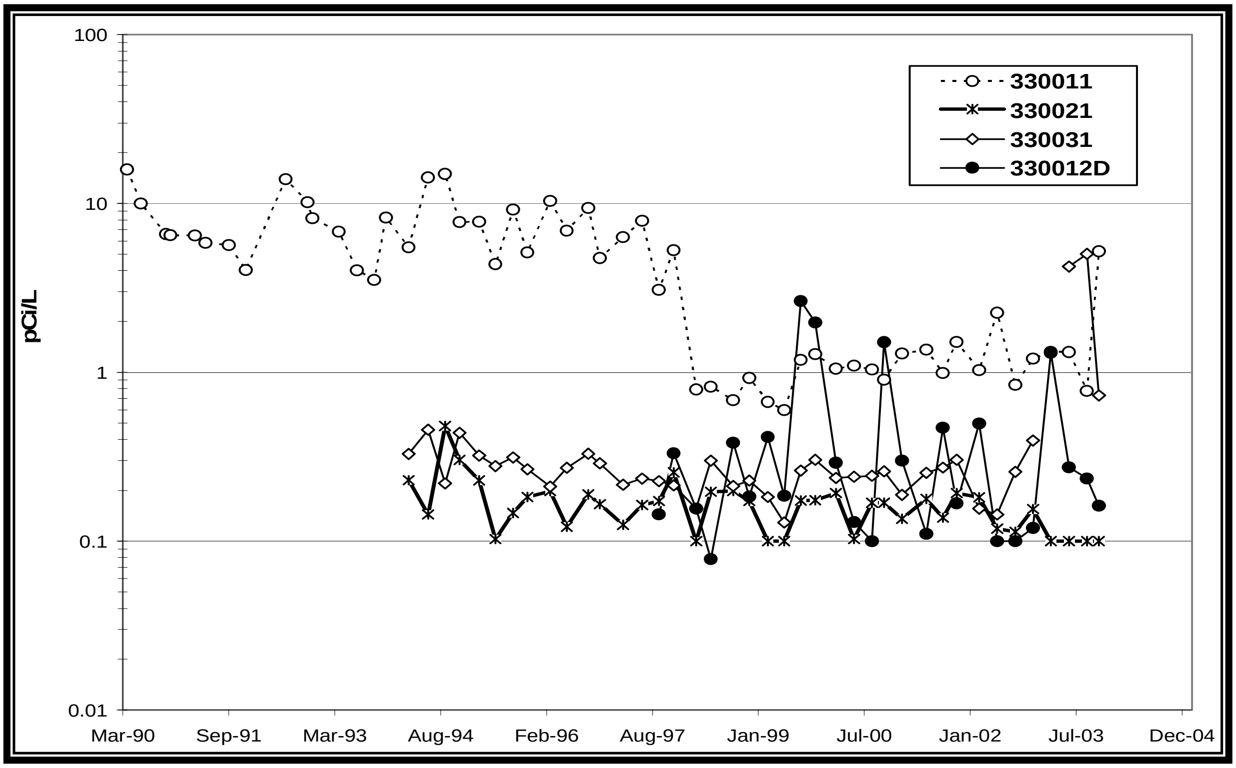


FIGURE 6.22 Hydrogen-3 Results in the CP-5 Monitoring Wells

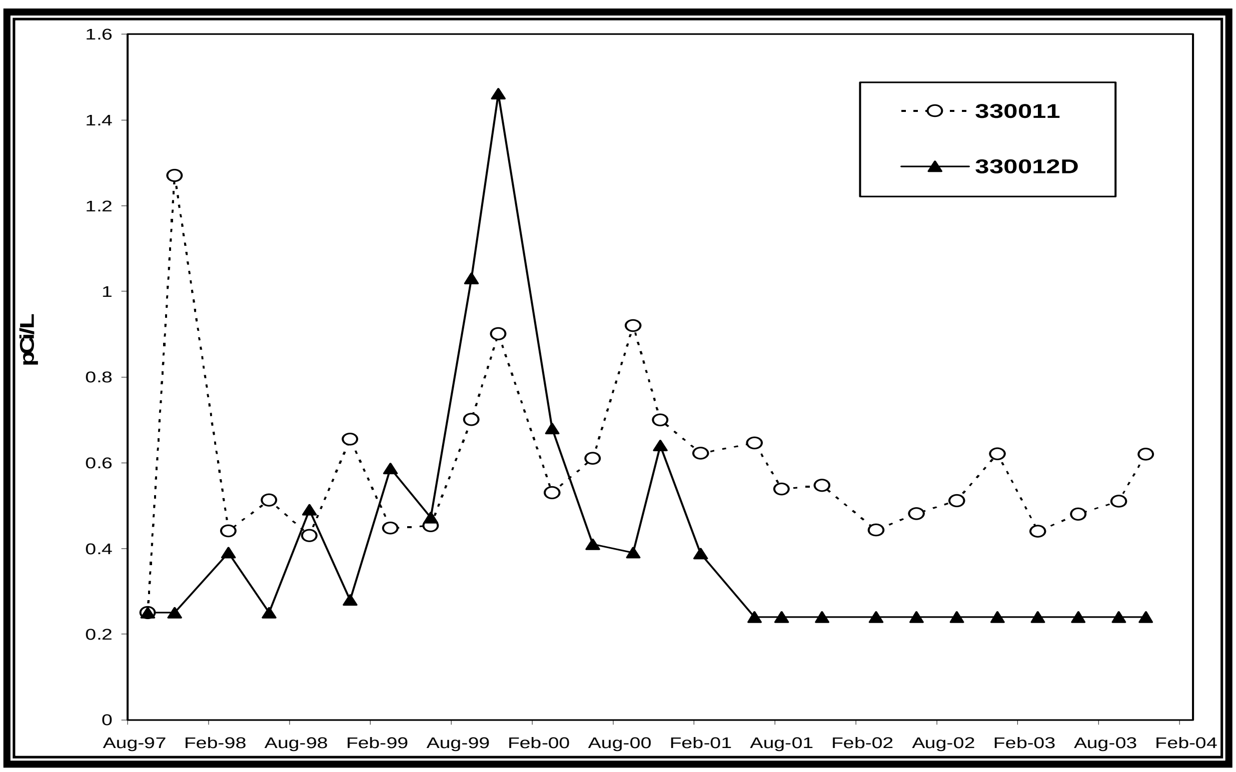


FIGURE 6.23 Strontium-90 Results in the CP-5 Monitoring Wells

7. QUALITY ASSURANCE

QA plans exist for both radiological and nonradiological analyses; these QA documents were prepared in accordance with DOE Order 414.1[29] and discuss who is responsible for QA and for auditing analyses. Both documents are supplemented by operating manuals.

7.1. Sample Collection

Many factors enter into an overall QA program other than the analytical quality control. Representative sampling is of prime importance. Appropriate sampling protocols are followed for each type of sampling being conducted. Water samples are pretreated in a manner designed to maintain the integrity of the analytical constituent. For example, samples for trace radionuclide analyses are acidified immediately after collection to prevent hydrolytic loss of metal ions and are filtered to reduce leaching from suspended solids.

The monitoring wells are sampled using the protocols listed in the *RCRA Ground-Water Monitoring Technical Enforcement Guidance Document*.[28] The volume of 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 that might restrict water movement in the screened area. For those wells in the glacial drift that do not recharge rapidly, the well is emptied, and the volume removed is compared with the calculated volume. In most cases, these volumes are nearly identical. The well is then sampled by bailing with a Teflon® bailer. If samples for parameters such as priority pollutants are collected, field parameters for these samples (pH, specific conductance, redox potential, and temperature) are measured per well volume while purging. For samples in the porous, saturated zone, which recharges rapidly, three well volumes are purged by using submersible pumps. If field parameters are measured, samples are collected as soon as these readings stabilize. All samples are placed in precleaned bottles, labeled, and preserved. All field measurement and sampling equipment is cleaned by field rinsing with Type II deionized water. The samples are transferred to the analytical laboratory via a computer floppy disk that generates a one-page list of all samples. This list acts as the chain of custody transfer document.

7.2. Radiochemical Analysis and Radioactivity Measurements

The documentation for radiological analyses is contained in the EQO-AS procedure manual. All nuclear instrumentation is calibrated with standard sources obtained from or traceable to the National Institute of Standards and Technology (NIST). The equipment is checked daily with secondary counting standards to ensure proper operation. Samples are periodically analyzed in duplicate or with the addition of known amounts of a radionuclide to check precision and accuracy. When a nuclide is not detected, the result is given as “less than” (<) the detection limit by the analytical method used. The detection limits are chosen so that the measurement uncertainty at the 95% confidence level is equal to the measured value. The air and water detection limits for all radionuclides for which measurements were made in 2003 are given in Table 7.1.

The relative error in a result decreases with increasing concentration. At a concentration equal to twice the detection limit, the error is approximately 50% of the measured value; at 10 times the detection limit, the error is approximately 10% at the 95% confidence level.

Average values are accompanied by a plus-or-minus (±) limit value. Unless otherwise stated, this value is the standard error at the 95% confidence level calculated from the standard deviation of the average. The ± limit value is a measure of the range in the concentrations encountered at that location; it does not represent the conventional uncertainty in the average of repeated measurements on the same or identical samples. Because many of the variations observed in environmental radioactivity are not random but occur for specific reasons (e.g., seasonal variations), samples collected from the same location at different times are not replicates. The more random the variation in activity at a particular location, the closer the confidence limits will represent the actual distribution of values at that location. The averages and confidence limits should be interpreted with this in mind. When a ± value accompanies an individual result in this report, it represents the statistical counting error at the 95% confidence level.

TABLE 7.1

Air and Water Detection Limits

Nuclide or Activity	Air (fCi/m^3)	Water (pCi/L)
Americium-241	–[a]	0.001
Beryllium-7	5	–
Californium-249	–	0.001
Californium-252	–	0.001
Cesium-137	0.1	2
Curium-242	–	0.001
Curium-244	–	0.001
Hydrogen-3	–	100
Lead-210	1	–
Neptunium-237	–	0.001
Plutonium-238	0.0001	0.001
Plutonium-239	0.0001	0.001
Radium-226	–	0.02
Radium-228	–	0.02
Strontium-89	0.1	2
Strontium-90	0.01	0.25
Thorium-228	0.001	–
Thorium-230	0.001	–
Thorium-232	0.001	–
Uranium-234	0.001	0.01
Uranium-235	0.001	0.01
Uranium-238	0.001	0.01
Uranium - natural	0.02	0.2
Alpha	0.2	0.2
Beta	0.5	1

[a] A dash indicates that a value is not required.

ANL-E continues to participate in the DOE Environmental Measurements Laboratory Quality Assurance Program (DOE-EML-QAP), which consists of semiannual distribution of three different sample matrices containing various combinations of radionuclides that are analyzed. Table 7.2 summarizes the results for 2003. In the table, the EML value, which is the result of duplicate determinations by that laboratory, is compared with the average value obtained in the ANL-E laboratory. Information that will assist in judging the quality of the results includes the fact that typical uncertainties for ANL-E's analyses are 2 to 50%, and that the uncertainties in the EML results are 1 to 30% (depending on the nuclide and the amount present). For most analyses for which the differences are large (> 20%), the concentrations were quite low and the differences were within the measurement uncertainties.

Overall, the ANL-E performance in the EML intercomparison studies on the three matrices resulted in more than 87% (46 out of 53) of the analysis being in the DOE-EML-QAP

TABLE 7.2

Summary of DOE-EML-QAP Samples, 2003

Matrix	Constituent	Date	Unit	EML	ANL-E	Ratio	Comments
Air filter	Manganese-54	March	Bq/filter	43.80	44.30	1.01	Acceptable
		Sept.		58.00	57.00	0.98	Acceptable
	Cobalt-60	March		33.50	34.70	1.04	Acceptable
		Sept.		55.10	59.00	1.07	Acceptable
	Strontium-90	March		2.80	2.80	1.00	Acceptable
		Sept.		2.06	1.40	0.68	Warning
	Cesium-137	March		99.70	103.00	1.03	Acceptable
		Sept.		54.80	57.00	1.04	Acceptable
	Uranium-234	March		0.240	0.240	1.00	Acceptable
		Sept.		0.401	0.240	0.60	Not acceptable
	Uranium-238	March		0.240	0.240	1.00	Acceptable
		Sept.		0.397	0.240	0.60	Not acceptable
	Plutonium-238	March		0.520	0.530	1.02	Acceptable
		Sept.		0.229	0.230	1.00	Acceptable
	Plutonium-239	March		0.330	0.340	1.03	Acceptable
		Sept.		0.401	0.380	0.95	Acceptable
	Americium-241	March		0.340	0.320	0.94	Acceptable
		Sept.		0.435	0.410	0.94	Acceptable
Soil	Potassium-40	March	Bq/kg	636.0	607.0	0.95	Acceptable
		Sept.		488.0	509.0	1.04	Acceptable
	Strontium-90	March		64.40	54.0	0.84	Acceptable
		Sept.		80.30	70.00	0.87	Acceptable
	Cesium-137	March		1450.0	1453.0	1.00	Acceptable
		Sept.		1973.0	2186.0	1.11	Acceptable
	Uranium-234	March		120.0	110.0	0.92	Acceptable
		Sept.		127.3	127.0	1.00	Acceptable
	Uranium-238	March		125.0	114.0	0.91	Acceptable
		Sept.		127.1	126.0	0.99	Acceptable
	Plutonium-238	Sept.		14.60	15.00	1.03	Acceptable
	Plutonium-239	March		23.40	26.00	1.11	Acceptable
		Sept.		30.40	33.00	1.09	Acceptable
	Americium-241	March		15.60	15.00	0.96	Acceptable
		Sept.		18.40	17.00	0.92	Acceptable
Water	Hydrogen-3	March	Bq/L	390.0	380.0	0.97	Acceptable
		Sept.		446.3	475.0	1.06	Acceptable
	Cobalt-60	March		234.0	236.0	1.01	Acceptable
		Sept.		513.0	511.0	1.00	Acceptable
	Strontium-90	March		4.34	4.20	0.97	Acceptable
		Sept.		7.04	6.20	0.88	Acceptable
	Cesium-134	March		30.50	27.8	0.91	Acceptable
		Sept.		63.00	55.0	0.87	Warning
	Cesium-137	March		63.8	60.3	0.94	Acceptable
		Sept.		80.3	79.0	0.98	Acceptable
	Uranium-234	March		2.05	2.20	1.07	Acceptable
		Sept.		2.79	1.80	0.64	Not acceptable

TABLE 7.2 (Cont.)

Matrix	Constituent	Date	Unit	EML	ANL-E	Ratio	Comments
Water (Cont.)	Uranium-238	March	Bq/L	2.16	2.20	1.02	Acceptable
		Sept.		2.80	1.80	0.64	Not acceptable
	Plutonium-238	March		3.33	3.40	1.02	Acceptable
		Sept.		2.07	1.80	0.87	Warning
	Plutonium-239	March		3.92	4.00	1.02	Acceptable
		Sept.		4.99	4.50	0.90	Acceptable
	Americium-241	March		2.13	2.20	1.03	Acceptable
		Sept.		8.76	8.20	0.94	Acceptable

acceptable range. Three samples fell within the warning category, while four results were not acceptable. The not-acceptable results were low uranium results in air and soil samples. This may be due to incomplete dissolution of the matrix. The ANL-E performance on these samples indicated that, for the most part, the reported results are accurate.

7.3. Chemical Analysis

The documentation for nonradiological analyses is contained in the EQO-AS Procedure Manual. All samples for NPDES and groundwater are collected and analyzed in accordance with EPA regulations found in 40 CFR Part 136,[23] EPA-600/4-84-017,[30] and SW-846.[5]

Standard reference materials traceable to the NIST exist for most inorganic analyses (see Table 7.3) and are replaced annually. Detection limits are determined with techniques listed in 40 CFR Part 136[23] and are given in Table 7.4. In general, the detection limit is the measure of the variability of a standard material measurement at 5 to 10 times the instrument detection limit as measured over an extended time period. Recovery of inorganic metals, as determined by "spiking" unknown solutions, must be within the range of 75 to 125%. The precision, as determined by analysis of duplicate samples, must be within 20%. These measurements must be taken for at least 10% of the samples. Comparison samples for organic constituents were formerly available from the EPA; they are now commercially available under the Cooperative Research and Development Agreement that exists between the EPA and commercial laboratories. In addition, standards are available that are certified by the American Association for Laboratory Accreditation, under a Memorandum of Understanding with the EPA. Many of these standards were used in this work. At least one standard mixture is analyzed each month; Tables 7.5 and 7.6 show the 2003 results for VOCs and SVOCs, respectively. The recoveries listed are those required by the respective methods.

TABLE 7.3

Standard Reference Materials Used for Inorganic Analysis

Constituent	Reference Material[a]
Antimony	VHG-ASBH-100
Arsenic	VHG-AASN-100
Barium	VHG-PBAN-100
Beryllium	VHG-ABEN-100
Boron	VHG-PBW-100
Cadmium	VHG-ACDN-100
Chromium	VHG-ACRH-100
Cobalt	VHG-PCON-100
Copper	VHG-ACUN-100
Iron	VHG-AFEN-100
Lead	VHG-APBN-100
Manganese	VHG-AMNN-100
Mercury	VHG-AHGN-100
Nickel	VHG-ANIN-100
Selenium	VHG-ASEN-100
Silver	VHG-AAGN-100
Thallium	VHG-ATLN-100
Vanadium	VHG-PVN-100
Zinc	VHG-AZNN-100
Sulfate	NIST-SRM 3181
Chloride	LABCHEM LC 13000-7
Fluoride	ORION 940907

[a] VHG = VHG Labs, Inc.; NIST-SRM = National Institute of Standards and Technology – Standard Reference Materials; LABCHEM = Labchem, Inc.; ORION = Orion, Inc.

TABLE 7.4

Detection Limit for Metals Analysis, 2003

	Detection Limit (mg/L)	
Constituent	AA[a]	ICP[b]
Antimony	0.0030	NA[c]
Arsenic	0.0030	0.076
Barium	NA	0.010
Beryllium	0.0002	0.010
Boron	NA	0.016
Cadmium	0.0002	0.015
Chromium	0.015	0.024
Cobalt	NA	0.016
Copper	0.010	0.015
Hexavalent chromium[d]	0.006	NA
Iron	0.040	0.020
Lead	0.0020	0.086
Manganese	0.015	0.010
Mercury	0.0001	NA
Nickel	0.030	0.020
Selenium	0.0030	0.121
Silver	0.0010	NA
Thallium	0.0020	0.082
Vanadium	NA	0.032
Zinc	0.010	0.008

[a] AA = atomic absorption spectroscopy.

[b] ICP = inductively coupled plasma-atomic emission spectroscopy.

[c] NA = not analyzed.

[d] Colorimetric measurement.

7.4. NPDES Analytical Quality Assurance

ANL-E conducts the majority of the analyses required for inclusion in the DMR. These analyses are conducted in accordance with EPA-approved methods set out in 40 CFR Part 136.[23] To demonstrate the capabilities of the ANL-E laboratory for these analyses, the EPA requires that ANL-E participate in the DMR-QA program. An EPA-accredited provider sends a series of intercomparison samples to ANL-E annually, and the ensuing analytical results are submitted to the provider for review. The proficiency of the laboratory is determined by comparing the analytical results for the submitted samples with the provider values. The ANL-E laboratory has consistently performed very well on these tests. In 2003, all results were acceptable, with the exception of mercury. A corrective action statement was prepared and forwarded to the EPA provider and the IEPA. The results of these analyses are shown in Table 7.7.

TABLE 7.5

Quality Check Sample Results: Volatile Analyses, 2003

Constituent	Recovery[a] (%)	Quality Limit (%)
Benzene	106	73–126
Bromobenzene	93	76–133
Bromodichloromethane	95	50–140
Bromoform	81	57–156
Butylbenzene	104	71–125
sec-Butylbenzene	101	71–145
t-Butylbenzene	99	69–134
Carbon tetrachloride	87	86–118
Chlorobenzene	105	80–137
Chloroform	104	68–120
o-Chlorotoluene	90	81–146
p-Chlorotoluene	86	73–144
1,2-Dibromo-3-chloropropane	71	36–154
Dibromochloromethane	85	68–130
1,2-Dibromoethane	99	75–149
Dibromomethane	104	65–143
1,2-Dichlorobenzene	95	59–174
1,3-Dichlorobenzene	102	84–143
1,4-Dichlorobenzene	104	58–172
1,1-Dichloroethane	107	71–142
1,2-Dichloroethane	99	70–134
1,1-Dichloroethene	99	18–209
cis-1,2-Dichloroethene	110	85–124
trans-1,2-Dichloroethene	106	67–141
1,2-Dichloropropane	106	19–179
1,3-Dichloropropane	101	73–145
1,1-Dichloropropene	101	71–133
Ethyl benzene	103	84–130
Isopropylbenzene	100	70–144
4-Isopropyltoluene	102	72–140
Methylene chloride	109	D–197[b]
n-Propylbenzene	95	78–139
1,1,1,2-Tetrachloroethane	91	88–133
Tetrachloroethene	91	84–132
Toluene	98	81–130
1,1,1-Trichloroethane	88	68–149
1,1,2-Trichloroethane	110	70–133
Trichloroethene	96	91–135
1,2,3-Trichloropropane	93	50–158
1,2,4-Trimethylbenzene	102	80–144
1,3,5-Trimethylbenzene	100	76–142
o-Xylene	99	79–141
p-Xylene	96	74–138

[a] Average of two determinations.

[b] D denotes that the compound was detected.

TABLE 7.6

Quality Check Sample Results:
Semivolatile Analyses, 2003

Constituent	Recovery[a] (%)	Quality Limit (%)
2-Fluorophenol[b]	65.7	21–100
Phenol-d5[b]	45.6	10–94
Phenol	48.9	17–100
2-Chlorophenol	68.2	36–120
1,3-Dichlorobenzene	59.2	33–95
1,4-Dichlorobenzene	57.8	37–106
n-Nitroso-n-Propylamine	34.0	24–198
Nitrobenzene-d5[b]	81.5	35–114
1,2,4-Trichlorobenzene	94.3	57–129
4-Chloro-3-Methylphenol	81.8	41–128
2-Fluorobiphenyl[b]	75.8	43–116
2-Methylnaphthalene	94.3	45–113
Acenaphthene	76.8	47–145
2,4-Dinitrotoluene	83.8	48–127
2,4,6-Tribromophenol[b]	94.3	10–123
Pentachlorophenol	78.0	38–152
Pyrene	100.0	70–100
Terphenyl-d14[b]	95.8	33–141

[a] Average of three determinations.

[b] Required surrogates.

TABLE 7.7

Summary of DMR-QA Intercomparison Samples, 2003

Analyte	Unit[a]	Reported Value	Assigned Value	Acceptance Limits	Performance Evaluation
Antimony	μg/L	221	233	156–284	Acceptable
Arsenic	μg/L	216	246	204–290	Acceptable
Barium	μg/L	419	414	358–474	Acceptable
Beryllium	μg/L	84.5	88.3	73.9–99.9	Acceptable
Boron	μg/L	454	438	349–569	Acceptable
Cadmium	μg/L	124	136	115–155	Acceptable
Chromium	μg/L	504	492	428–557	Acceptable
Cobalt	μg/L	322	301	264–338	Acceptable
Copper	μg/L	291	288	260–318	Acceptable
Iron	μg/L	590	594	523–674	Acceptable
Lead	μg/L	188	168	141–194	Acceptable
Manganese	μg/L	745	763	685 -848	Acceptable
Mercury	μg/L	2.60	5.03	3.68–6.36	Not acceptable
Nickel	μg/L	172	161	139–184	Acceptable
Selenium	μg/L	622	596	472–691	Acceptable
Silver	μg/L	278	274	235–314	Acceptable
Thallium	μg/L	391	417	335–485	Acceptable
Vanadium	μg/L	288	290	259–318	Acceptable
Zinc	μg/L	154	153	132–176	Acceptable
Biochemical oxygen demand	mg/L	59.9	45.7	22.9–68.5	Acceptable
Chemical oxygen demand	mg/L	67.0	73.7	52.8–88.4	Acceptable
Ammonia nitrogen	mg/L	4.94	4.76	3.64–5.85	Acceptable
Total residual chlorine	mg/L	1.49	1.42	1.13–1.71	Acceptable
Total cyanide	mg/L	0.380	0.417	0.286–0.539	Acceptable
pH	S.U.	8.77	8.80	8.54–9.06	Acceptable
Total phenolics	mg/L	0.160	0.267	0.140–0.395	Acceptable
Total suspended solids	mg/L	30.5	32.5	23.6–34.6	Acceptable
Grease and oil	mg/L	30.7	33.0	21.2–38.4	Acceptable
Fathead minnow acute toxicity	LC_{50}	34.2	29.2	7.40–51.0	Acceptable
Water flea toxicity	LC_{50}	16.7	50.2	4.37–96.1	Acceptable

[a] S.U. = standard unit; LC_{50} = the calculated effluent concentration at which 50% of the test organisms are killed in a specified time period.

8. APPENDIX

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