Argonne NATIONAL LABORATORY

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Site Environmental Report 2007
Argonne National Laboratory

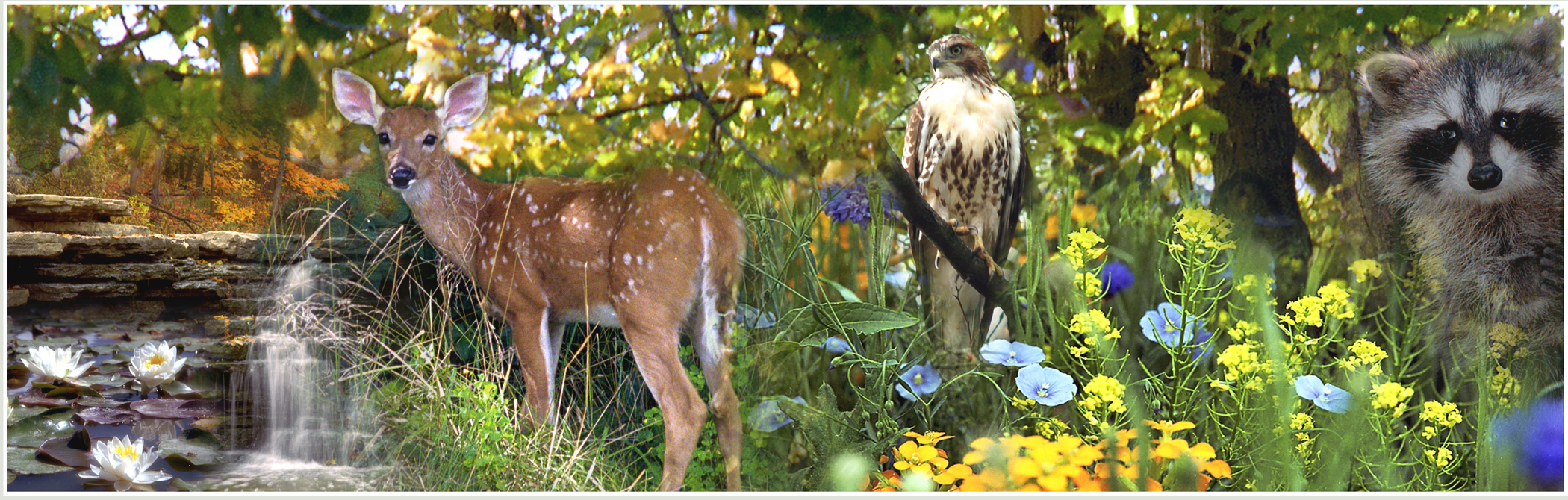
Argonne NATIONAL LABORATORY

ANL-08/05

Site Environmental Report

for Calendar Year 2007

Environment, Safety, and Health/Quality Assurance Division



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ANL-08/05

Argonne National Laboratory Site Environmental Report for Calendar Year 2007

Preceding Report in This Series: ANL-07/02

by
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Environment, Safety, and Health/Quality Assurance Division
Argonne National Laboratory

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A NOTE FROM THE AUTHORS

This Site Environmental Report (SER) was prepared by the Environment, Safety, and Health/Quality Assurance (EQO) Division at Argonne National Laboratory 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/.

The majority of the figures and tables were prepared by Jennifer Tucker of the Data Management Team. Some figures, however, were prepared by Brian Cantwell of the Ecological and Geographical Sciences Section of Argonne's Environmental Science Division. Sample collection and field measurements were conducted, under the direction of Larry Moos of the Environmental Monitoring and Surveillance Group, by:

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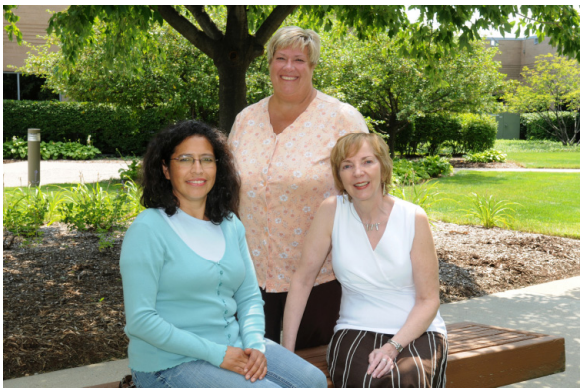

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ACHP	Advisory Council for Historic Preservation
ACM	Asbestos-Containing Material
AEA	Atomic Energy Act of 1954
ALARA	As Low As Reasonably Achievable
ALD	Associate Laboratory Director
AOC	Area of Concern
APES	Argonne Property Excess System
APS	Advanced Photon Source
Argonne	Argonne National Laboratory
ATLAS	Argonne Tandem Linac Accelerating System
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
CARB	California Air Resources Board
CCA	Compliance Commitment Agreement
CEDE	Committed Effective Dose Equivalent
CEMP	Comprehensive Emergency Management Plan
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
CHM	Chemistry Division
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
DMR	Discharge Monitoring Report
DOE	U.S. Department of Energy
DOE-ASO	DOE Argonne Site Office
EA	Environmental Assessment
ECR	Environmental Compliance Representative
EHS	Extremely Hazardous Substance
EIS	Environmental Impact Statement
EMS	Environmental Management System
ENE	East-Northeast
EO	Executive Order
EPA	U.S. Environmental Protection Agency

EPC	Environmental Planning and Compliance
EPCRA	Emergency Planning and Community Right to Know Act
EQO	Environment, Safety, and Health/Quality Assurance
EQO-AS	EQO, Analytical Services
ESA	Endangered Species Act of 1973
ESH	Environment, Safety, and Health
EVS	Environmental Science Division
FFCA	Federal Facility Compliance Act of 1992
FMS	Facilities Management and Services
FY	Fiscal Year
GMZ	Groundwater Management Zone
GQS	Groundwater Quality Standard
GRO	Groundwater Remediation Objective
HAP	Hazardous Air Pollutant
HSWA	Hazardous and Solid Waste Amendments of 1984
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
IPNS	Intense Pulsed Neutron Source
ISMS	Integrated Safety Management System
LEPC	Local Emergency Planning Committee
LLW	Low-Level Radioactive Waste
LTS	Long-Term Stewardship
LWTP	Laboratory Wastewater Treatment Plant
MAPEP	Mixed Analyte Performance Evaluation Program
MOU	Memorandum of Understanding
MSDS	Material Safety Data Sheet
MW	Mixed Waste
MY	Model Year
NBL	New Brunswick Laboratory
NEPA	National Environmental Policy Act of 1969
NESHAP	National Emission Standards for Hazardous Air Pollutants
NFA	No Further Action
NHPA	National Historic Preservation Act of 1966
NIST	National Institute of Standards and Technology
NPDES	National Pollutant Discharge Elimination System
NPL	National Priority List

NRHP	National Register of Historic Places
P2	Pollution Prevention
PA	Programmatic Agreement
PBT	Persistent, Bioaccumulative Toxic
PCB	Polychlorinated Biphenyl
PCE	Tetrachloroethene
PPOA	Pollution Prevention Opportunity Assessment
PQL	Practical Quantitation Limit
PSTP	Proposed Site Treatment Plan
QA	Quality Assurance
QC	Quality Control
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 of 1974
SER	Site Environmental Report
SERC	State Emergency Response Commission
SHPO	State Historic Preservation Office
SIP	State Implementation Plan
SME	Subject Matter Expert
SOP	Standard Operating Procedure
SPCC	Spill Prevention Control and Countermeasures
SVOC	Semivolatile Organic Compound
SWMU	Solid Waste Management Unit
SWPPP	Stormwater Pollution Prevention Plan
SWTP	Sanitary Wastewater Treatment Plant
TCA	1,1,1-Trichloroethane
TCE	Trichloroethene
TCS	Theory and Computing Sciences
TDS	Total Dissolved Solids
THM	Trihalomethanes
TLD	Thermoluminescent Dosimeter
TOC	Total Organic Carbon
TOX	Total Organic Halogens
TRC	Total Residual Chlorine
TRI	Toxic Release Inventory
TRU	Transuranic Waste
TSCA	Toxic Substances Control Act
TSD	Technical Services Division
TSS	Total Suspended Solids

USFWS	U.S. Fish and Wildlife Service
UST	Underground Storage Tank
VOC	Volatile Organic Compound
VOM	Volatile Organic Materials
WM	Waste Minimization
WMO	Waste Management Operations
WQS	Water Quality Standard
WSW	West-Southwest
WTP	Wastewater Treatment Plant
ZPR	Zero Power Reactor

ABSTRACT

This report discusses the status and the accomplishments of the environmental protection program at Argonne National Laboratory for calendar year 2007. The status of Argonne 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 Argonne operations on the environment, samples of environmental media collected on the site, at the site boundary, and off the Argonne 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 Argonne 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, Argonne, 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 Version 3 (Clean Air Act Assessment Package-1988) computer code, was used in preparing this report.

ABSTRACT

This report summarizes the ongoing environmental protection program activities conducted by Argonne National Laboratory (Argonne) in calendar year 2007. It includes descriptions of the site, Argonne missions and programs, the status of compliance with environmental regulations, environmental protection and restoration activities, and the environmental surveillance program. Members of the surveillance program regularly conduct monitoring for radiation, radioactive materials, and nonradiological constituents on the Argonne 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 Argonne's impact on the environment. The surveillance program supports the Argonne policy of protecting the public, employees, and the environment from harm that may result from Argonne activities, and reducing environmental impacts to the greatest degree practicable.

Executive Orders 13148 and 13423 and U.S. Department of Energy (DOE) Order 450.1 require that an Environmental Management System (EMS) be implemented at Argonne. In December 2005, the DOE Argonne Site Office (DOE-ASO) manager certified that the EMS had been implemented. Part of the implementation of the EMS was the integration of the EMS into the Integrated Safety Management System (ISMS).

Compliance Summary

Radionuclide emissions, the management of asbestos, and discharge of conventional air pollutants from Argonne facilities are regulated under the Clean Air Act (CAA). A number of airborne radiological emission points at Argonne are subject to National Emission Standards for Hazardous Air Pollutants (NESHAP) regulations for radionuclide releases from DOE facilities (Title 40 of the *Code of Federal Regulations*, Part 61, Subpart H [40 CFR Part 61, Subpart H]). All such air emission sources were evaluated to ensure that these requirements are being addressed properly. The estimated dose to the maximally exposed off-site individual for 2007 was 0.045 mrem/yr. This is 0.45% 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 Argonne, 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 NESHAP and Occupational Safety and Health Administration worker protection standards. Approximately 96.7 m^3 (3,414 ft^3) of ACM was removed and disposed of at off-site landfills in Illinois during 2007.

The Argonne site contains sources of conventional air pollutants, including a steam plant, gasoline and ethanol/gasoline blend fuel-dispensing facilities, an engine test facility, a surface treatment facility for etching research equipment, a number of diesel generators, and a wastewater treatment plant. The Illinois Environmental Protection Agency (IEPA) issued the final Argonne Clean Air Act Permit Program (CAAPP) Title V permit in April 2001 and renewed it in October 2006. 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 Argonne 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 6 months during 2007. During the period coal was burned, no exceedances were recorded.

The goals of the Clean Water Act (CWA) 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. The IEPA reissued the current permit effective September 1, 2005. During 2007, 23 exceedances of NPDES permit limits were reported out of approximately 1,700 measurements.

The IEPA issued a Resource Conservation and Recovery Act (RCRA) Part B permit on September 30, 1997, which became effective on November 4, 1997. The permit addresses 24 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 five SWMUs and two new AOC units were identified in recent years and are undergoing investigation. These seven units require monitoring as part of the Argonne Long-Term Stewardship (LTS) Program.

Argonne has prepared and implemented a sitewide underground storage tank (UST) compliance plan. The Argonne site contains 13 USTs, which are in compliance with UST regulations.

The only Toxic Substances Control Act (TSCA)-regulated compounds present in significant quantities at Argonne are polychlorinated biphenyls (PCBs) contained in electrical capacitors, power supplies, and small transformers. The Argonne 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.

In 2007, most projects requiring National Environmental Policy Act (NEPA) assessment were determined to be Categorical Exclusions. A supplement Environmental Assessment (EA) was completed for remote-handled transuranic waste. This analysis was performed so that transuranic waste could be characterized and disposed of offsite.

In 2007, a modification of the NPDES permit was submitted to the IEPA. This modification included changing two outfalls to stormwater only outfalls due to the removal of industrial discharges at these outfalls. Acceptance of the NPDES permit modification by the IEPA will demonstrate closure of a compliance agreement regarding total dissolved solids (TDS) at these two outfalls.

Environmental Surveillance Program

Airborne emissions of radioactive materials from Argonne were monitored during 2007. The effective dose equivalents were estimated at the site perimeter and to a hypothetical maximally exposed member of the public by using the U.S. Environmental Protection Agency's CAP-88 Version 3.0 (CAA Assessment Package-1988) computer code. The estimated maximum perimeter dose from airborne releases was 0.22 mrem/yr in the west-southwest direction, while the estimated maximum dose to a member of the public was 0.045 mrem/yr. 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 0.045 mrem/yr. The estimated population dose from releases to the approximately nine million people living within 80 km (50 mi) of the site was 7.78 person-rem.

Monitoring of radioactivity associated with particulates in ambient air was conducted for total alpha activity, total beta activity, and gamma-ray emitters at the Argonne site perimeter and at off-site locations. No statistically significant difference was identified between samples collected at the Argonne perimeter and samples collected off-site. Monitoring was not conducted for hazardous chemical constituents in ambient air.

The only detectable radionuclides in surface water due to Argonne 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 0.10 Ci of hydrogen-3. The other radionuclides released totaled less than 0.001 Ci. The hydrogen-3 was added to the wastewater as part of normal Argonne operations. The dose to a hypothetical individual using water from Sawmill Creek as his or her sole source of drinking water would be 0.013 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 Argonne 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 0.014 pCi/g) and americium-241 (up to 0.006 pCi/g) were detected in the sediment below the outfall and are attributed to past Argonne releases.

Dose rates from penetrating radiation (gamma rays) were measured at 17 perimeter and on-site locations and at 5 off-site locations in 2007 by using thermoluminescent dosimeters. The off-site results averaged 102 ± 13 mrem/yr, which is similar to the long-term average dose rate. At the south fence, radiation from a temporary storage facility for radioactive waste resulted in an average dose rate of 101 ± 9 mrem/yr for 2007, although no one occupies this area. The estimated dose rate 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 Argonne operations during 2007 were estimated by combining the exposures from inhalation, ingestion, and direct radiation pathways. The inhalation pathway would be primary. The highest estimated dose was approximately 0.059 mrem/yr to a hypothetical individual living east of the site, assuming that 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 Argonne 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 Argonne site in 2007. The former Argonne 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 (SDWA).

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

Argonne conducts an LTS program to operate and monitor environmental cleanup actions implemented in recent years. This program focuses primarily on several former waste management units in the 317, 319, and East-Northeast (ENE) areas at the extreme southern end of the site. Remedial actions managed by this program include inspection and maintenance of two landfill caps, operation and maintenance of two groundwater collection systems, a phytoremediation system, and a groundwater monitoring program. Monitoring of these systems indicates that significant contamination of groundwater exists below two of the waste units. High concentrations of VOCs are present in and downgradient of a former chemical waste disposal unit (French drain) in the 317 Area. Measurable levels of hydrogen-3 are found under the 319 Area Landfill, though these concentrations are currently much lower than in previous years. Very low concentrations of several VOCs are routinely found in several small off-site groundwater seeps in the Waterfall Glen Forest Preserve. Ongoing remedial actions should continue to reduce the concentrations of these contaminants in coming years. A Groundwater Management Zone (GMZ) has been established around the 317/319 Area to facilitate the remediation of contaminated groundwater. Monitoring of the GMZ perimeter wells indicates that the groundwater plume has not migrated beyond the original boundaries. Monitoring of the landfill in the ENE Area indicates that hazardous materials in the waste are not being released to the groundwater.

Twenty-one monitoring wells at the 800 Area Landfill were sampled on a quarterly basis and analyzed for hydrogen-3, metals, cyanide, phenols, total organic carbon (TOC), total organic halogens (TOX), and VOCs, and annually for semivolatile organic compounds (SVOCs), PCBs, pesticides, and herbicides. As in previous years, levels exceeding background concentrations for

ammonia, chloride, iron, lead, manganese, sulfate, TOC, and TDS were found in some wells. Above-background levels of hydrogen-3 were detected in several of the wells, with concentrations up to 409 pCi/L.

Nine monitoring wells are screened in the glacial drift and one in the dolomite adjacent to the Chicago Pile-Five (CP-5) reactor. These wells were sampled quarterly, and samples were analyzed for selected radionuclides and metals. Elevated levels of hydrogen-3 and strontium-90 were detected regularly; however, these concentrations are localized and not migrating.

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 means of 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 this annual report.

1. INTRODUCTION

1. INTRODUCTION

1.1. General

This annual report for calendar year 2007 of the Argonne National Laboratory (Argonne) 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 Argonne and the amounts, if any, added to the environment by Argonne operations. It also summarizes the compliance of Argonne operations with applicable environmental laws and regulations and highlights significant accomplishments and issues related to environmental protection and remediation. The report was prepared in accordance with the guidelines of DOE Orders 450.1[1] and 231.1A[2] and supplemental DOE guidance.

Argonne 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 Argonne operations is of special interest, because one important function of this program is verification of the adequacy of the site's pollution control systems.

Argonne is a DOE research and development (R&D) laboratory with several principal objectives. The Laboratory 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 2007 included safety studies for light-water reactors; high-temperature superconductivity experiments; development of electrochemical energy sources, including fuel cells and batteries for vehicles and energy storage; engineered nanomaterials; and studies to promote clean, efficient transportation.

Other R&D areas include 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 advanced computing technologies. 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 Argonne 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 Argonne site.

The principal nonnuclear activities at Argonne in 2007 that could have measurable impacts on the environment include the use of a coal-fired boiler (No. 5) and the discharge of wastewater from various sources.

1.2. Description of Site

Argonne 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 and the surrounding area that show some of the sampling locations associated with the monitoring program. Much of the 907-ha (2,240-acre) Waterfall Glen Forest Preserve surrounding the site was part of the Argonne 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 Argonne 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 Argonne 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 Argonne has experienced significant population growth in the past 40 years as large areas of farmland have been converted into housing. Table 1.1 gives the directional and 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,

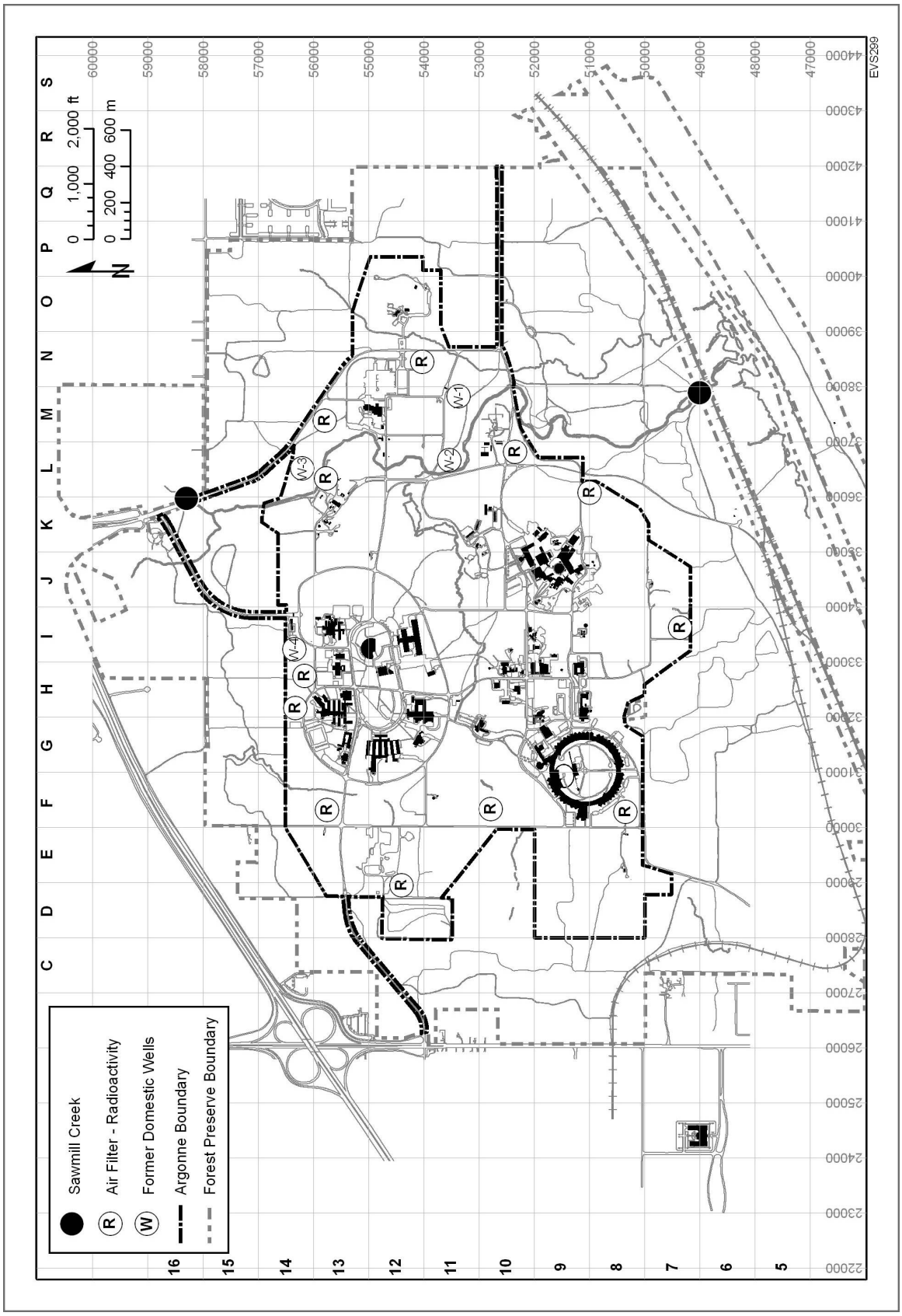

FIGURE 1.1 Sampling Locations at Argonne National Laboratory

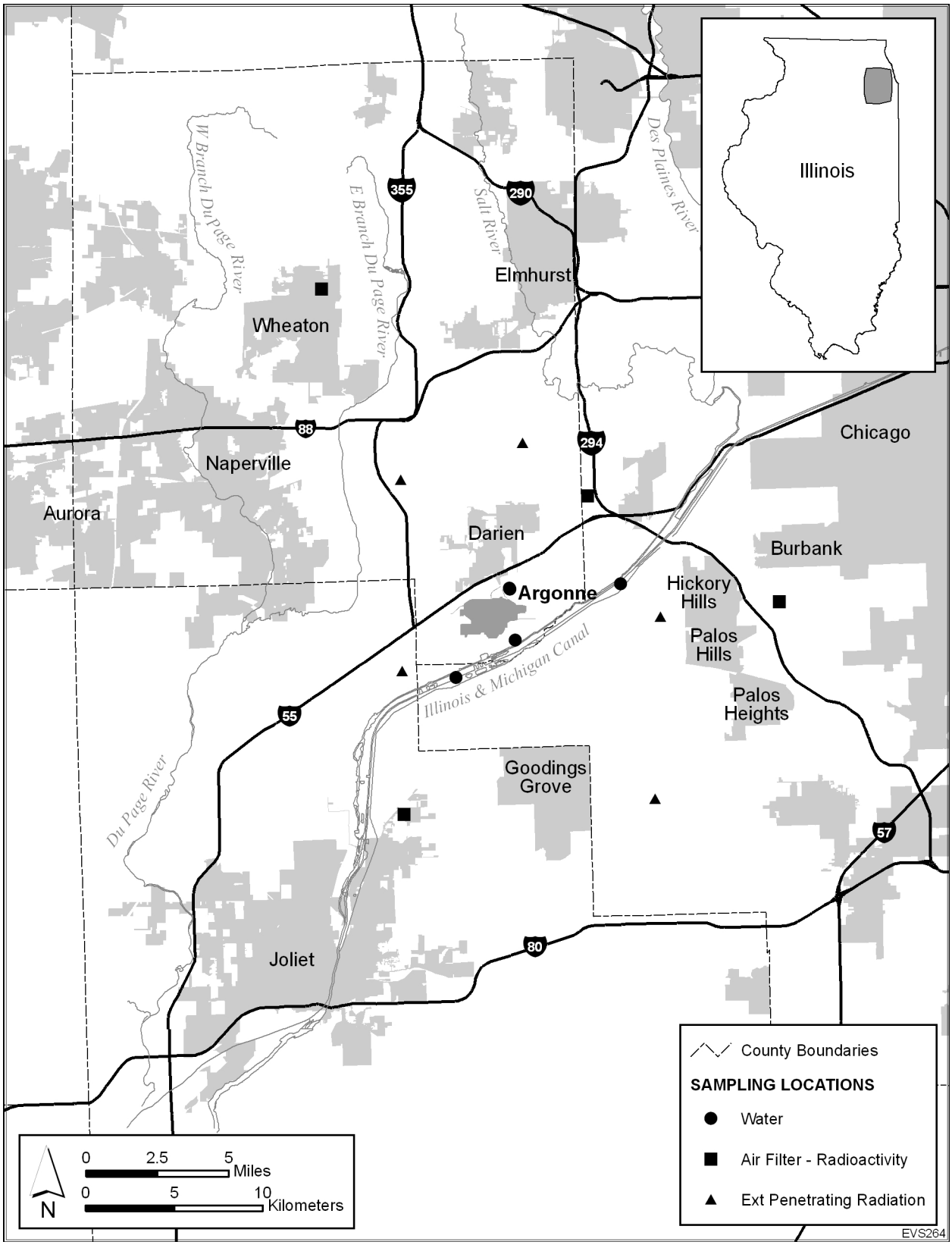

FIGURE 1.2 Sampling Locations near Argonne National Laboratory

TABLE 1.1

Population Distribution in the Vicinity of Argonne, 2005

Direction	Miles[a] 0 – 1	1 – 2	2 – 3	3 – 4	4 – 5	5 – 10	10 – 20	20 – 30	30 – 40	40 – 50
N	0	1,260	3,745	6,359	9,913	47,865	187,957	350,601	235,346	314,363
NNE	0	585	4,226	6,133	6,337	41,311	30,0391	488,056	106,733	1,177
NE	0	816	2,064	2,198	1,876	42,287	706,197	958,769	0	0
ENE	0	1,005	1,307	2,349	1,974	33,622	618,433	190,117	0	0
E	0	1,069	554	363	383	42,134	463,231	215,304	9,899	27,578
ESE	0	424	267	368	505	18,327	188,712	294,596	224,205	95,839
SE	0	193	269	456	939	23,793	111,879	101,003	32,401	17,261
SSE	0	406	396	1,004	1,448	10,466	43,222	1,873	13,635	16,443
S	0	582	2,280	2,129	1,399	9,998	37,982	3,641	36,598	37,792
SSW	0	484	2,307	2,621	1,047	22,183	108,907	14,750	16,781	7,838
SW	0	173	590	342	10	18,024	81,243	14,503	18,929	7,564
WSW	0	129	127	559	3,112	21,066	29,434	7,213	9,429	11,717
W	0	147	567	7,818	10,530	46,610	100,304	30,268	19,165	7,087
WNW	0	500	863	2,973	4,708	46,580	162,138	44,204	8,317	62,884
NW	0	687	2,377	7,248	7,979	47,247	86,635	130,674	27,822	21,825
NNW	0	1,074	2,700	6,124	9,714	34,933	222,946	267,024	183,404	138,432
Total	0	9,534	24,639	49,044	61,874	506,446	3,449,611	3,112,596	942,664	767,800
Cumulative totals[b]	0	9,534	34,173	83,217	145,091	651,537	4,101,148	7,213,744	8,156,408	8,924,208

[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.

centered on the IPNS (Location 9J in Figure 1.1), was prepared by the Risk Assessment and Safety Evaluation Group of the Environmental Science Division at Argonne and represents projections to 2005 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 2007 data were obtained from the on-site Argonne meteorological station. The 2007 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 each wind rose represents the percentage of observations of wind speed less than 2 m/s (4.5 mph) in all directions. The directions of the radii from the center represent the directions from which the wind blows. Sixteen radii are shown on each plot at 22.5º intervals; each radius represents the average wind speed for the direction covering 11.25º on either side of the radius. The annual average wind rose for 2007 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 2007 precipitation and temperature data. The monthly precipitation data for 2007 show differences from the Argonne historical average primarily in August. The annual total was 5% above the annual average for the Argonne data. The monthly temperatures were generally higher during the summer months when compared with the long-term monthly average. The 2007 annual monthly average was 5% higher than the long-term annual average. The climatology information was provided by the Atmospheric Research Section of the Environmental Science Division.

1.5. Geology

The geology of the Argonne 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.

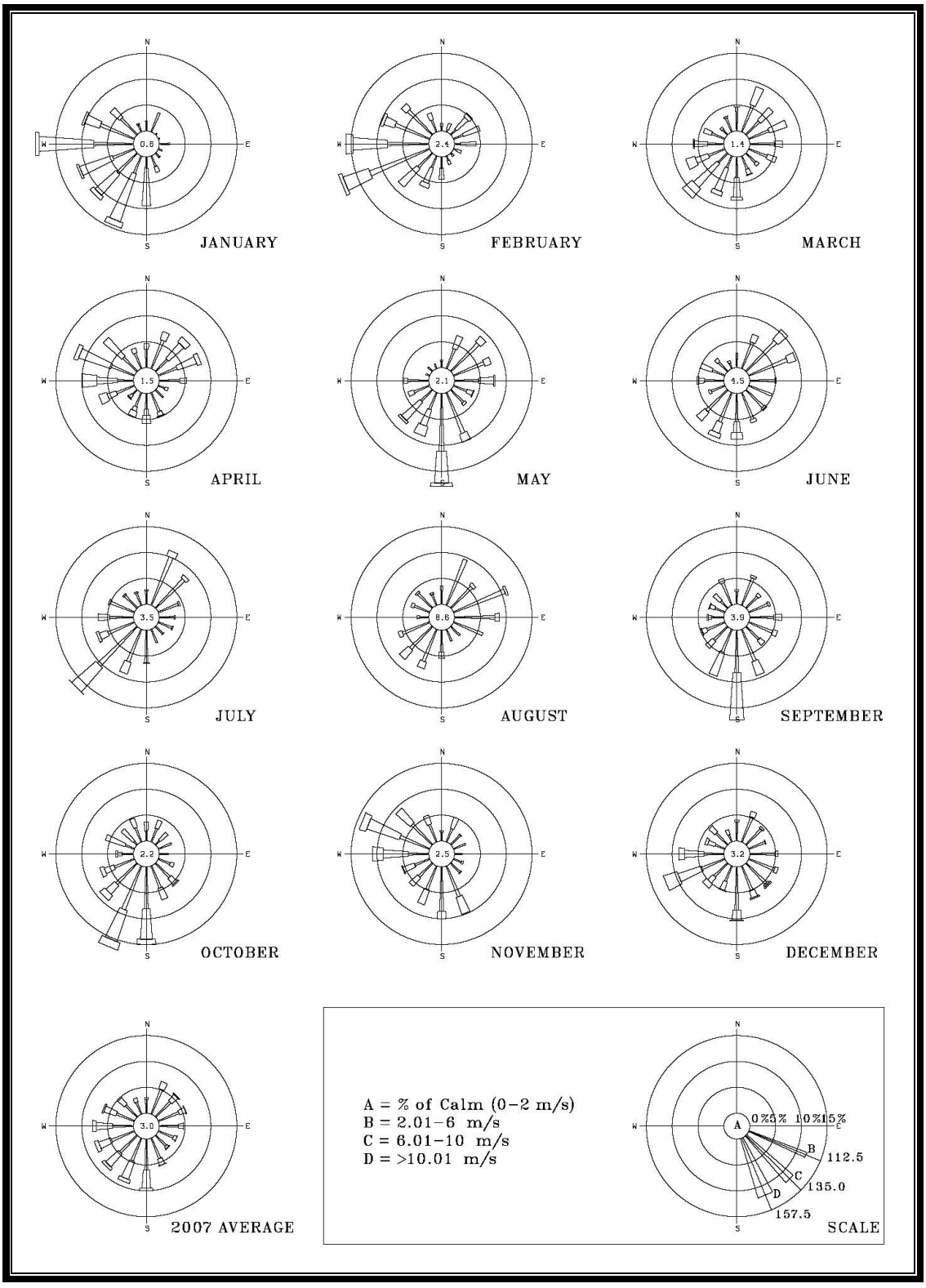

FIGURE 1.3 Monthly and Annual Wind Roses at Argonne National Laboratory, 2007

TABLE 1.2

Argonne Weather Summary, 2007

Month	Precipitation (cm) Argonne 2007	Precipitation (cm) Argonne Historical[a]		Temperature (°C) Argonne 2007	Temperature (°C) Argonne Historical[a]
January	8.76	4.29		–2.7	–4.7
February	4.27	4.19		–8.3	–1.9
March	9.35	6.05		5.9	3.1
April	8.16	8.34		8.4	9.4
May	4.24	9.69		17.9	14.0
June	9.17	8.52		22.6	20.7
July	8.58	10.55		22.8	23.1
August	23.75	10.34		24.0	22.1
September	3.88	8.28		20.3	18.2
October	4.80	8.07		15.2	11.4
November	4.22	8.87		5.5	4.4
December	8.71	4.58		–5.1	–2.9
Total	97.89	91.57	Monthly Average	10.5	10.0

[a] Averages were obtained from the Argonne meteorological tower by using data from the last 25 years (1983–2007).

The southern boundary of Argonne 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 Argonne 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 Argonne. 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 Argonne 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 Argonne. The upper aquifer is the Niagaran and Alexandrian dolomite, which is approximately 60 m (200 ft) thick in the Argonne 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 Argonne 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 nearby suburban areas, which began in 1992, is expected to relieve this overdraft problem. Argonne now obtains all of its domestic water from the DuPage Water Commission which obtains potable 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, 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 Argonne site is drained by Freund Brook. Two 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 Argonne are combined and discharged into Sawmill Creek at location 7M in Figure 1.1. In 2007, this effluent averaged 3.02 million L/day (0.80 million gal/day), which is similar to the averages for the last few years. The combined Argonne effluent consisted of 63% laboratory wastewater and 37% sanitary wastewater. The water flow in Sawmill Creek upstream of the wastewater outfall averaged about 33 million L/day (8.8 million gal/day) during 2007.

Sawmill Creek and the Des Plaines River upstream of Joliet, about 21 km (13 mi) southwest of Argonne, receive very little recreational or industrial use. A few people fish in these waters downstream of Argonne, and some duck hunting takes place on the Des Plaines River. Water from the Chicago Sanitary and Ship Canal is used by Argonne for cooling tower makeup water and by others for industrial purposes, such as hydroelectric generators and condensers. Argonne usage is approximately 1.7 million L/day (0.45 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 Argonne. 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 Argonne. In the vicinity of Argonne, only subsurface water (from both shallow and deep aquifers) and Lake Michigan water are used for drinking purposes.

The principal recreational area near Argonne 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 Argonne and the Des Plaines River. The preserves include the McGinnis and Saganashkee Sloughs, 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 Argonne site (Location 12O in Figure 1.1) is for use by Argonne and DOE employees. A

local municipality also has use of the park for athletic events. The park also contains a day-care center for children of Argonne and DOE employees.

1.9. Vegetation

Argonne 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, northwestern 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 Argonne 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 in these areas, in the absence of cultivation, is toward oak-hickory forest. Forest dominated by 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 Argonne 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 Argonne 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) that remain undeveloped at the Argonne 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 100 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 Argonne 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

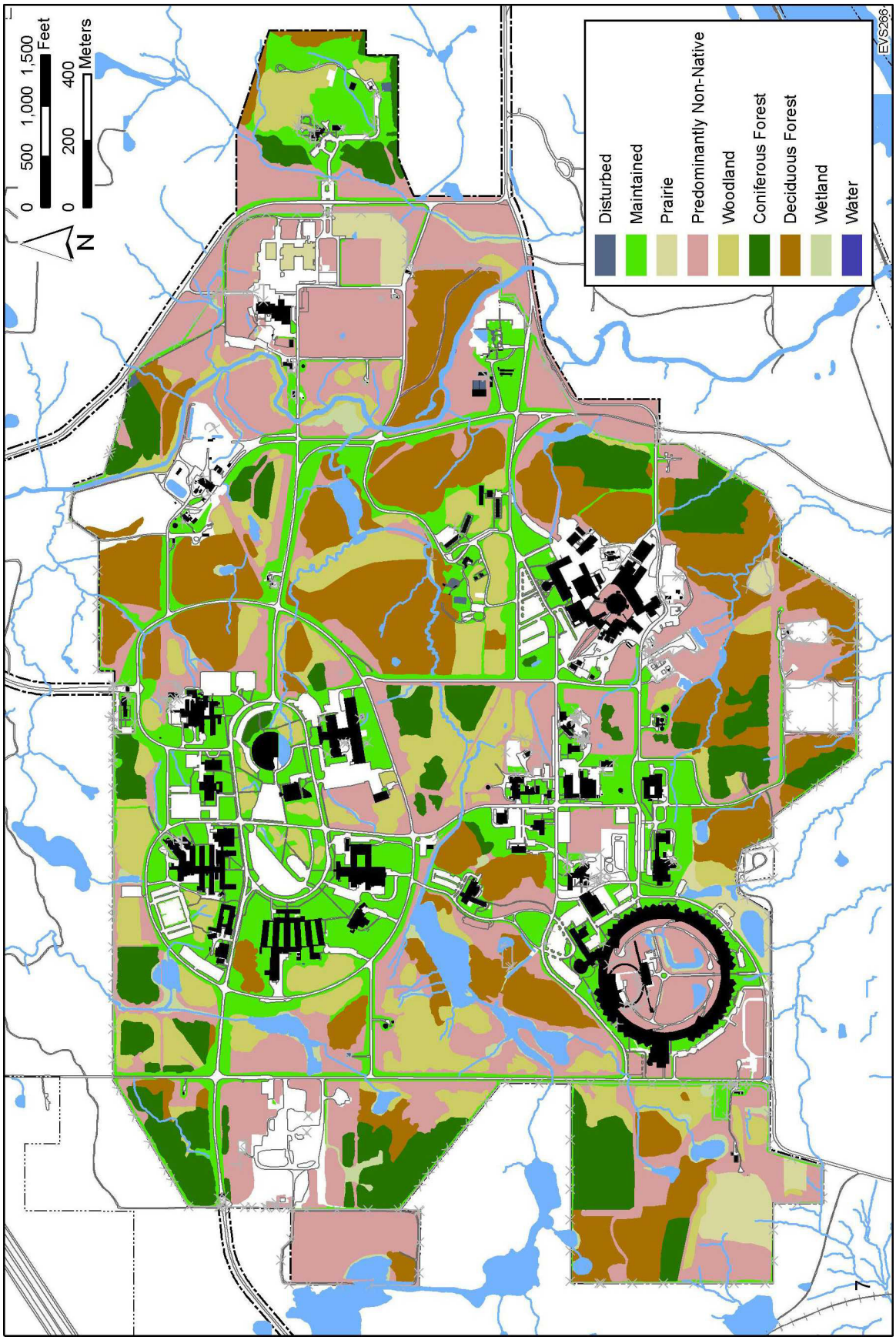

FIGURE 1.4 Argonne Vegetation Communities

also inhabits the Argonne 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.

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 Argonne 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 Argonne 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 Argonne streams, as "poor" in terms of the fish species present because of domestic and industrial pollution and stream modification.

1.11. Cultural Resources

Argonne, 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 Argonne area either by professional cultural resource investigators or through interviews of local artifact collectors by Argonne 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 Argonne. 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 Argonne, the 200 Area campus and the 300 Area reactor

development buildings, that are eligible for listing on the NRHP as historic districts, as well as several buildings that are individually eligible for listing on the NRHP.

1.12. Endangered Species

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

The Hine's emerald dragonfly (*Somatochlora hineana*), federally 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 federally and state listed as endangered, indicates that this species may occur in the area. The federally 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.

2. COMPLIANCE SUMMARY

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Argonne is a U.S. 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), the U.S. Army Corps of Engineers (COE), and the State Fire Marshal, as well as to numerous DOE Orders and Executive Orders (EOs). The status of Argonne during 2007 with regard to these authorities is discussed in this chapter.

The Atomic Energy Act of 1954 (AEA) was promulgated to assure the proper management of radioactive materials. Under the act, DOE regulates the control of radioactive materials under its authority. Sections of the act authorize DOE to set radiation protection standards for itself and its contractors. Accordingly, DOE promulgated a series of regulations (e.g., Title 10 of the *Code of Federal Regulations*, Parts 820, 830, and 835 [10 CFR Parts 820, 830, and 835], and DOE Orders 435.1, 450.1, and 5400.5) to protect public health and the environment from potential risks associated with radioactive materials. This Site Environmental Report (SER) is used to demonstrate compliance with these regulations and orders.

Argonne has made a commitment to comply with all applicable environmental requirements, as described in the following statement in Section 7.3 of the Argonne Policy Manual:

> Argonne activities (including experiments, facility operations, construction activities, and other activities) will be conducted in an environmentally safe and sound manner consistent with Argonne permit conditions. Argonne commits to continuous environmental improvement, pollution prevention and waste minimization, and compliance with all applicable requirements. To support this policy, Argonne is committed to leadership in environmental management by integrating environmental accountability into day-to-day activities and in long-term planning processes.

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 equipment and operations releasing certain hazardous air pollutants (HAPs). The program for compliance with the requirements of the CAA 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, Argonne 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. Argonne meets the definition of a major source because of potential emissions of oxides of nitrogen in excess of 90.72 t/yr (100 tons/yr), carbon

monoxide in excess of 90.72 t/yr (100 tons/yr), or sulfur dioxide in excess of 90.72 t/yr (100 tons/yr) at the Building 108 central heating plant.

The CAAPP permit renewal application was submitted to the IEPA on April 15, 2005. The final permit was approved and became effective October 17, 2006. One outstanding permit issue involved the delay of the California Air Resources Board (CARB) to certify Stage II vapor recovery equipment for use on E85 dispensing facilities. Argonne agreed to have such CARB-certified equipment installed within 180 days of it becoming commercially available in Illinois. As of the end of 2007, such equipment was not yet available for installation.

Facilities subject to Title V must characterize emissions of all regulated air pollutants, not only those that qualify as major sources. In addition to oxides of nitrogen and sulfur dioxide, Argonne 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 Argonne 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 2007, there was one construction permit issued for the replacement of the stoker/grate system for coal-fired Boiler No. 5. In addition, a notification to the IEPA and EPA was made, as required by the CAAPP permit for the use of new experimental fuel blends at the Transportation Research Facility.

2.1.1. National Emission Standards for Hazardous Air Pollutants

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

2.1.1.1. Asbestos Emissions

Many buildings on the Argonne 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 NESHAP.

Argonne maintains an asbestos abatement program designed to ensure compliance with these and other regulatory requirements. ACM is removed from buildings either by Argonne personnel or outside contractors licensed by the Illinois Department of Public Health. All removal work is performed in accordance with both NESHAP and Occupational Safety and Health Administration requirements governing worker safety at ACM removal sites.

Approximately 96.7 m^3 (3,414 ft^3) of ACM was generated from Argonne asbestos removal projects during 2007. The 85 small removal projects that were completed generated 29.7 m^3 (1,049 ft^3) of ACM waste. Ten large removal projects generated the remaining 67.0 m^3 (2,365 ft^3) of ACM waste. Table 2.1 provides asbestos abatement information for the large removal projects. The IEPA was notified during December 2007 that no more than 71 m^3 (2,500 ft^3) of ACM waste is expected to be generated from small-scale projects during 2008.

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. Until closure of the Argonne 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 NESHAP standard for radionuclide emissions from DOE facilities (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 recordkeeping. A number of emission points at Argonne 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 (Building 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.

The amount of radioactive material released to the atmosphere from Argonne emission 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 2007 was 0.045 mrem, which is less than 0.5% of the 10 mrem/yr EPA standard. Section 4.8.1 and the 2007 NESHAP report contain more detailed discussions of these emission points and compliance with the standard.

2.1.2. Conventional Air Pollutants

The Argonne site contains a number of sources of conventional air pollutants, including a steam plant, gasoline and ethanol/gasoline blend fuel-dispensing facilities, a dust collection system, an engine test facility, a surface treatment facility for etching research equipment, a number of diesel generators, and a wastewater treatment plant. These facilities are operated and the associated activities are conducted in compliance with applicable regulations and permit conditions.

TABLE 2.1

Asbestos Abatement Projects
DOE/IEPA Notification
January–December 2007

Completion Date	Asbestos Abatement Contractor	Notification Quantity ft	Notification Quantity ft^2	Notification Quantity ft^3	Material	Building	Disposal Quantity (ft^3)	Landfill
3/10/2007	Argonne Waste Management	0	500	0	Chiller and tank insulation	364	532	Environtech, Morris, IL
4/9/2007	Argonne Waste Management	0	400	0	Floor tile and mastic	350	36	Environtech, Morris, IL
6/22/2007	Argonne Waste Management	1,800	2,500	0	Floor tile and mastic, pipe insulation	301	532	Environtech, Morris, IL
6/27/2007	Argonne Waste Management	15	1,030	0	Floor tile and mastic, pipe insulation, ceiling tile	362	100[a]	Environtech, Morris, IL
8/27/2007	Argonne Waste Management	0	800	0	Linoleum sheeting mastic[b]	200	24[a]	Environtech, Morris, IL
10/12/2007	Argonne Waste Management	75	800	0	Floor tile and mastic, pipe insulation	205	69[c]	Energy Solutions, Clive, UT
10/13/2007	Argonne Waste Management	0	340	0	Floor tile and mastic[b]	214	44[a]	Environtech, Morris, IL
12/1/2007	Argonne Waste Management	0	500	0	Floor tile and mastic[b]	350	24[c]	Energy Solutions, Clive, UT
12/21/2007	Argonne Waste Management	0	800	50	Tank and pipe insulation	364	536[a]	Environtech, Morris, IL
3/31/2008[d]	Argonne Waste Management	9,370	125	0	Floor tile and mastic, pipe insulation	301	468[a]	Environtech, Morris, IL

[a] On-site pending shipment to Environtech.

[b] Courtesy notification, nonfriable material.

[c] On-site pending shipment to Energy Solutions.

[d] Project began 10/22/2007.

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 that is equipped to burn coal. The permit requires submission of a quarterly report listing any exceedances beyond emission limits for this boiler (30% opacity averaged over 6 min or 0.82 kg [1.8 lb] of sulfur dioxide per million Btu averaged over a 1-hour period). Table 2.2 gives the hours that Boiler No. 5 operated on low-sulfur coal during 2007, as well as the amount of low-sulfur coal burned. There were no exceedances at Boiler No. 5 in 2007.

An annual compliance certification must be submitted to the IEPA and EPA each May 1 for the previous calendar year, detailing any deviations from the Title V permit and subsequent corrective actions. During 2007, there was one deviation identified regarding compliance with the Title V permit. An engine at the Transportation Research Facility was operated on a fuel that was not listed on the permit. As directed by the IEPA, a notification of new fuel blends was transmitted to both the IEPA and EPA Region V. These new fuel blends would be used in compliance with the existing emissions limits for the engine testing facility.

TABLE 2.2

Boiler No. 5 Operation, 2007

Month	Operated (hours)	Low-Sulfur Coal Burned (tons)
January	563.0	1,818.9
February	672.0	2,305.9
March	528.3	1,693.2
April	720.0	2,265.6
May	56.5	138.1
June	0	0
July	0	0
August	0	0
September	0	0
October	0	0
November	0	0
December	493.5	1,737.0
Total	3,033.0	9,957.7

Landfill gas monitoring is conducted quarterly at the 800 Area Landfill via 4 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 provides information on whether methane is migrating from the landfill. In the last two quarters of 2007, methane was detected in two landfill perimeter gas sampling wells on the north side. The level detected (0.1%) was well below the action level of 2.5%.

A fuel-dispensing facility is at Building 46, Grounds and Transportation. Except for ethanol vapors from alternate-fuel usage, this facility has VOC emissions typical of any commercial gasoline service station.

Pursuant to *Illinois Administrative Code*, Title 35, Part 254 (35 IAC Part 254), Argonne submits an emissions report to the IEPA each May 1 for the previous year. The summary for 2007 is presented in Table 2.3.

2.1.3. Clean Fuel Fleet Program

Although reporting requirements for the Clean Fuel Fleet Program are still in effect under the CAA and 35 IAC Part 241, the IEPA indicated that it no longer wanted reports to be filed for model year (MY) 2007 (September 1, 2006–August 31, 2007) vehicles because all current MY vehicles meet clean fuel fleet standards. Because the requirements are still in effect, in lieu of a report, Argonne submitted a letter to the IEPA on October 2, 2007, certifying that all vehicles acquired in MY 2007 meet federal emission standards.

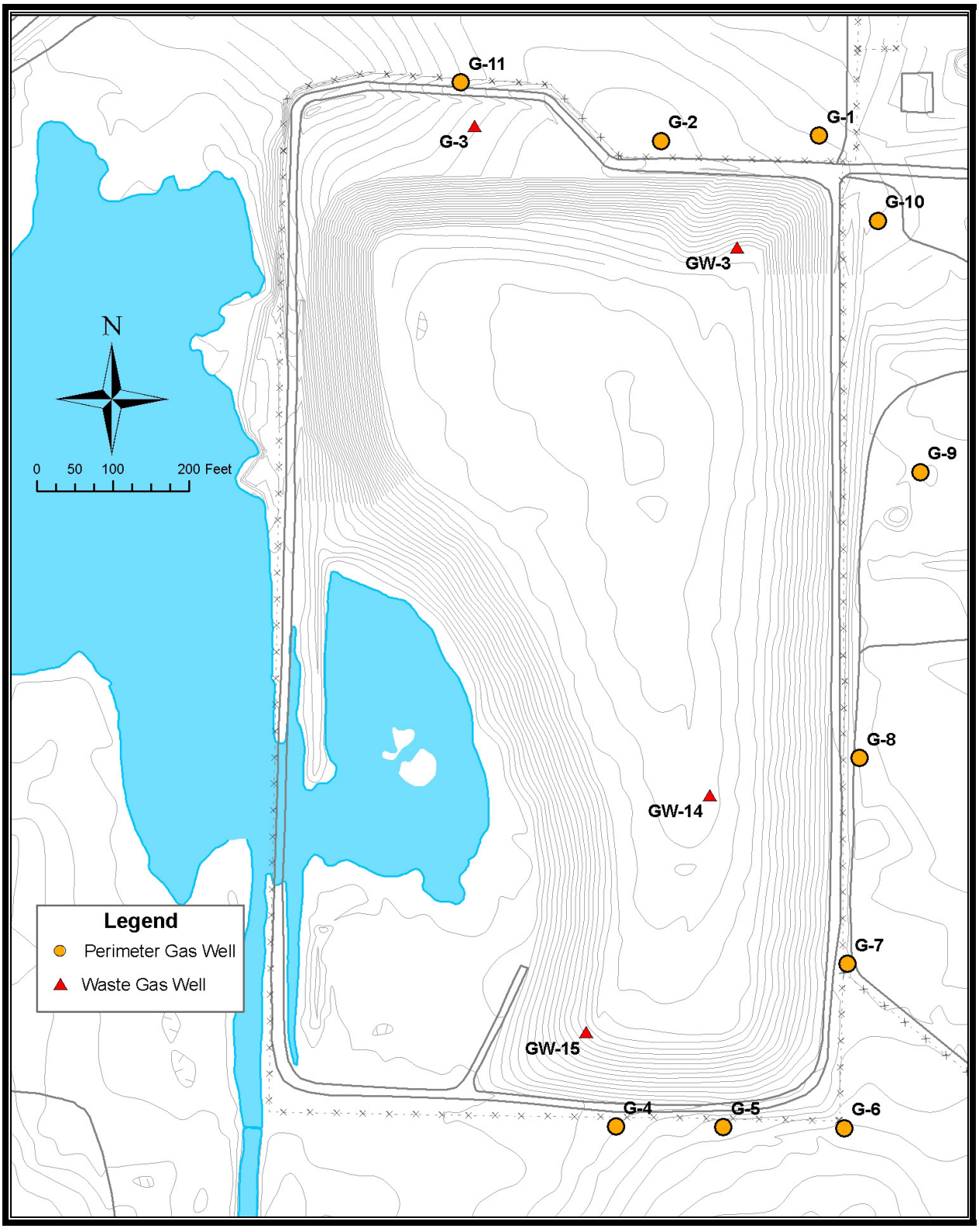

FIGURE 2.1 800 Area Landfill Gas Monitoring Wells

TABLE 2.3

2007 Annual Emissions Report: Emissions Summary[a]
Argonne CAAPP Permit No. 95090195

Building No. and Source	CO	NO_x	PM/PM_{10}	$PM_{2.5}$[b]	SO_2	VOM	HAP[c]	NH_3[b]	CO_2[d]	CH_4[d]	N_2O[d]
108: Boiler 1 (gas-fired)	20,424	24,315	1,848	462	146	1,337	–[e]	119	29,177,580	559	535
108: Boiler 2 (gas-fired)	5,151	6,132	466	117	37	337	–	30	7,357,945	141	135
108: Boiler 3 (gas-fired)	6,571	7,823	595	149	65	430	–	38	9,387,489	180	172
108: Boiler 4 (gas-fired)	16,807	20,008	1,521	380	120	1,100	–	98	24,009,649	460	440
108: Boiler 5 (gas-fired)	62	90	6	1	<1	4	–	<1	88,450	2	2
108: Boiler 5 (coal-fired)	23,871	109,516	3,159	319	212,168	362	13,041	5.6	32,023,537	597	398
200: Peak shaving generator	0[e]	0	0	0	0	0	–	0	0	0	0
202: Peak shaving generator	0	0	0	0	0	0	–	0	0	0	0
400: APS generator (Caterpillar)	191	995	35	35	82	27	–	0.8	23,430	<1	<1
400: APS generators - Kohler (2)	671	3,495	123	123	289	95	–	1.6	47,041	<1	<1
Transportation research facility	20,839	8,161	519	305	467	1,409	–	10.3	164,130	–	–
PCB tank cleanout	–	–	–	–	–	0	–	–	–	–	–
208: Surface preparation facility	–	–	<1	<1	–		0.6	–	–	–	–
46: Ethanol/gasoline storage	–	–	–	–	–	0.2	–	–	–	–	–
46: 10,000-gal gasoline storage	–	–	–	–	–	11.1	–	–	–	–	–
308: Alkali reaction booth (R)[f]	–	–	–	–	–	–	–	–	–	–	–
363: Central Shop dust collector	–	–	–	–	–	–	–	–	–	–	–
212: Building exhausts	–	–	–	–	–	–	–	–	–	–	–
368: Woodshop dust collector	–	–	–	–	–	–	–	–	–	–	–
108: Sulfuric acid storage	–	–	–	–	–	–	–	–	–	–	–
Torch Cut Pb-Based Paint	–	–	–	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–	–	–	–
206: Alkali reaction booth (R)	–	–	<1	–	–	–	–	–	–	–	–
306: Building vents (R)	–	–	<1	–	–	–	–	–	–	–	–
306: Vial crusher/chemical photooxidation unit (R)	–	–	–	–	–	0	–	–	–	–	–
306: Waste bulking sheds (R)	–	–	2.4	2.4	–	48.8	1.7	–	–	–	–

TABLE 2.3 (Cont.)

Building No. and Source	CO	NO_x	PM/PM_{10}	$PM_{2.5}$[b]	SO_2	VOM	HAP[c]	NH_3[b]	CO_2[d]	CH_4[d]	N_2O[d]
375: IPNS (R)	–	–	–	–	–	–	–	–	–	–	–
200: M-Wing hot cells (R)	–	–	–	–	–	–	–	–	–	–	–
400: APS facility (R)	–	70	–	–	–	–	–	–	–	–	–
212: Alpha gamma hot cell (R)	–	–	–	–	–	–	–	–	–	–	–
330: CP-5 D&D Project (R)	–	–	–	–	–	–	–	–	–	–	–
350: NBL P/U Hoods (R)	–	–	–	–	–	–	–	–	–	–	–
Lab rad hoods (R)	–	–	–	–	–	–	–	–	–	–	–
WMO Portable HEPA - (6) (R)	–	–	0	0	–	–	–	–	–	–	–
303: Mixed waste storage (R)	–	–	–	–	–	–	–	–	–	–	–
331: Rad waste facility (R)	–	–	–	–	–	–	–	–	–	–	–
595: Lab wastewater plant (R)	–	–	–	–	–	123	7.2	–	–	–	–
315: MACE project (R)	250	–	–	–	–	–	–	–	–	–	–
301: Hot cell D&D project (R)	–	–	–	–	–	–	–	–	–	–	–
Total (lb/yr)	94,837	180,604	8,273	1,894	213,374	5,286	13,050	303	102,279,250	1,940	1,682
Total (ton/yr)	47.4184	90.3019	4.1364	0.9469	106.6869	2.6428	6.5252	0.1517	51,139.6250	0.9698	0.8410
CAAPP Permit Limit (ton/yr)	(237.60)[g]	395.20	65.93	–	332.20	21.53	10.00	–	–	–	–

[a] Abbreviations: APS = Advanced Photo Source; CAAPP = Clean Air Act Permit Program; CO = carbon monoxide; CP-5 = Chicago Pile-Five; D&D = decontamination and decommissioning; HAP = hazardous air pollutant; HEPA = high-efficiency particulate air; IPNS = Intense Pulsed Neutron Source; MACE = melt attack and coolability experiment; N_2O = nitrous oxide; NBL = New Brunswick Laboratory; NH_2 = ammonia; NO_x = oxides of nitrogen; PB = lead; PCB = polychlorinated biphenyl; PM = particulate matter; PM_{10} = particulate matter less than 10 microns; $PM_{2.5}$ = particulate matter less than 2.5 microns; PO = plutonium; SO_2 = sulfur dioxide; U = uranium; VOM = volatile organic matter; WMO = Waste Management Operations.

[b] As of 2003, emissions of $PM_{2.5}$ and a precursor, ammonia, must be included in the Annual Emission Report.

[c] HAPS not included in VOM or particulates (hydrogen chloride, hydrogen fluoride, methyl chloroform, and methylene chloride).

[d] As of 2007, greenhouse gas emissions (CO_2,CH_4, and N_2O) are included on the Annual Emission Report per IEPA request.

[e] 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.

[f] (R) = radionuclide source regulated by NESHAP (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 the monitoring and control of toxic constituents in wastewater, the permitting of outfalls composed entirely of stormwater, 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 recordkeeping 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 Argonne is permitted by NPDES Permit No. IL 0034592. The IEPA issued a renewal permit effective September 1, 2005. The September 1, 2005, NPDES permit placed additional limits for total residual chlorine ([TRC] Outfalls H03, J03, 004, E05, 006, and 025), total suspended solids ([TSS] Outfalls B03, D03, E03, and H03), and total dissolved solids ([TDS] Outfalls H03, J03, 006, and 025). The current permit was issued on April 24, 2007, which added Outfall 028.

Wastewater at Argonne is generated by a number of activities and consists of sanitary wastewater (from restrooms, cafeteria sinks and sinks in certain buildings and laboratories), laboratory wastewater (from laboratory sinks and other industrial wastewater sewers), and stormwater. Water softener regenerant from boiler house activities is discharged into the DuPage County sewer system. Cooling water and cooling tower blowdown are generally sent to the laboratory wastewater sewer, although a small volume is still discharged into stormwater ditches

that are monitored as part of the NPDES permit. The permit authorizes the release of wastewater from 43 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 2.4 lists these outfalls, and Figure 2.2 shows the outfall locations.

2.2.1.1. NPDES Permit Activities

TDS analytical 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 four 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, (3) cooling water originating from the Sanitary and Ship Canal, and (4) road salt used sitewide for melting snow.

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 215,517 L/day (57,000 gal/day). To accomplish this, in 2000, Argonne 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 IEPA, and a new permit was issued in 2001 covering this discharge. 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 can reduce TDS concentrations at the combined Outfall 001 during the heating season.

Argonne submitted an application during 2007 to modify the NPDES permit (IL 0034592) and requested the following revisions:

1. Recharacterization of the Outfall H03 and Outfall J03 discharges as stormwater only,

2. Addition of the Theory and Computing Sciences (TCS) Building discharges,

3. Addition of Fire Protection Test and System Flush Water discharges, and

4. Recharacterization of Outfall E03 as stormwater only.

This modification package was submitted to the IEPA on August 13, 2007. To date, this modification request has not yet been approved by the IEPA.

TABLE 2.4

Characterization of NPDES Outfalls at Argonne, 2007[a]

Outfall Number	Description	Average 2007 Flow[b]
A01	Sanitary Treatment Plant	0.299
B01	Laboratory Treatment Plant	0.498
001	Combined outfall	0.740
B03	300 Area (condensate) and groundwater	0.011
C03	Building 205 footing tile drainage	0.017
D03/E03	Steam trench drainage (condensate)	0.015/0.0
F03	Building 201 fire pond overflow stormwater	Stormwater only
G03	North Building 201 storm sewer (condensate)	0.015
H03	Building 212 cooling tower blowdown	0.015
I03	Buildings 200 and 211 cooling tower blowdown	Stormwater only
J03	Building 213 and Building 213 parking lot stormwater	0.005
K03[c]	Stormwater, APS	Stormwater only
L03[c]	Stormwater, APS	Stormwater only
M03[c]	Stormwater, APS	Stormwater only
N03[c]	Stormwater, 212 East	Stormwater only
004	Building 203 cooling tower and Building 221 footing drainage and stormwater	0.051
A05	Westgate Road stormwater	Stormwater only
B05	800 Area east stormwater	Stormwater only
C05	Building 200 West	0.022
D05	Stormwater	Stormwater only
E05	Building 203 west footing drainage and condensate	0.003
006	Cooling tower blowdown and stormwater	0.077
007	Domestic cooling water for compressor and stormwater	0.022
008	Transportation and grounds stormwater	Stormwater only
011	North fence line marsh storm discharge	Stormwater only
012	100 Area stormwater discharge	Stormwater only
013	Southeast 100 Area stormwater	Stormwater only
014	Northern East Area stormwater discharge	Stormwater only
A15, B15	Building 40 stormwater discharge	Stormwater only
A16, B16	Southern East Area stormwater discharge	Stormwater only
018	Eastern 300 Area stormwater and cooling water	Stormwater only
020	Shooting range stormwater discharge	Stormwater only
021	319 Landfill and Northeast 317 Area	Stormwater only
A22	Southern 317 Area	Stormwater only
B22	Western 317 Area	Stormwater only
023	Southern and Eastern 800 Area Landfill stormwater runoff	Stormwater only
025	Buildings 314, 315, and 316 cooling water, eastern and southern APS area	0.002
026	Water Treatment Plant area stormwater	Stormwater only
027[c]	CNM fire suppression system water and stormwater	Stormwater only
028[d]	Stormwater from HTRL building area	Stormwater only

[a] Abbreviations: APS = Advanced Photon Source; CNM = Center for Nanoscale Materials; HTRL = Howard T. Ricketts Laboratory.

[b] Flow is measured in million gallons per day, except for outfalls with stormwater only.

[c] Outfall added by September 1, 2005, NPDES permit.

[d] Outfall added by April 24, 2007, NPDES permit modification.

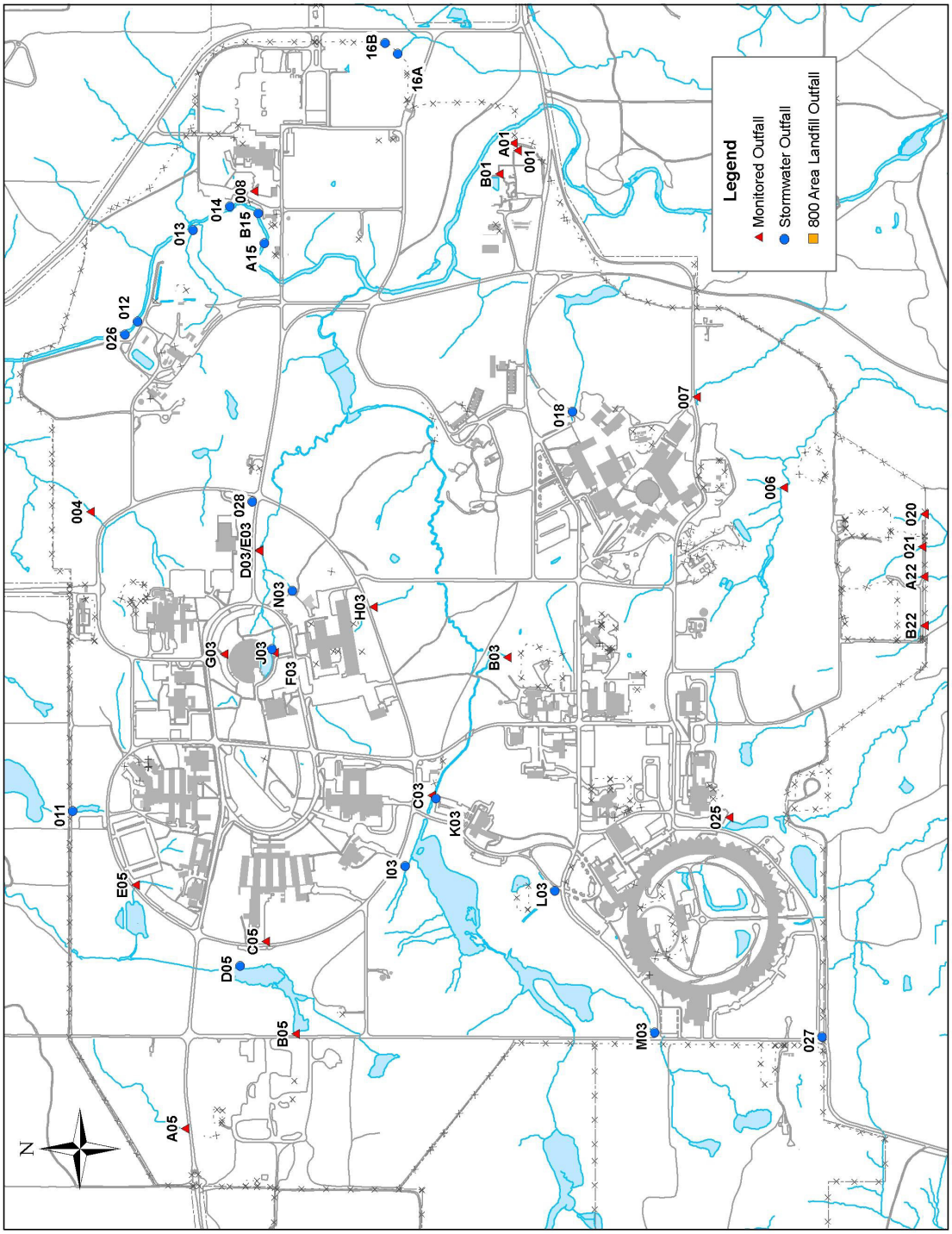

FIGURE 2.2 NPDES Outfall Locations

2.2.1.2. Compliance with NPDES Permit

Wastewater is treated at Argonne 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, some small industrial discharges that cannot be routed to the laboratory sewer, 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, secondary 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 and is pumped to the laboratory wastewater sewer after radiological analysis and release certification. Treatment in the Laboratory Wastewater Treatment Plant (LWTP) consists of aeration, solids-contactor clarification, and pH adjustment. Additional steps can be added, including powdered-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 2007 averaged 1.13 million L/day (0.30 million gal/day) for the sanitary wastewater and 1.89 million L/day (0.50 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 2007, there were 23 exceedances of NPDES permit limits out of approximately 1,700 measurements.

There were five exceedances of the TDS limit at Outfall J03 and two exceedances of the TDS limit at Outfall H03. These exceedances resulted from a continuation of the issues that caused Argonne to receive a Notice of Violation letter from the IEPA in May 2006. Argonne responded to the IEPA with a Compliance Commitment Agreement (CCA) in June 2006 which committed Argonne to actions to bring the discharges into compliance with the NPDES permit limits. The following activities were completed as proposed in the CCA:

- The cooling tower discharges originating from Building 212 that were contributing to high TDS at Outfall H03 were rerouted.
- Faulty equipment contributing to the Building 213 high TDS cooling tower overflow to Outfall J03 was repaired.
- Monitoring methodology was amended.
- The Building 212 sump discharging high TDS was rerouted, which solved the low flow TDS issue at Outfall H03.

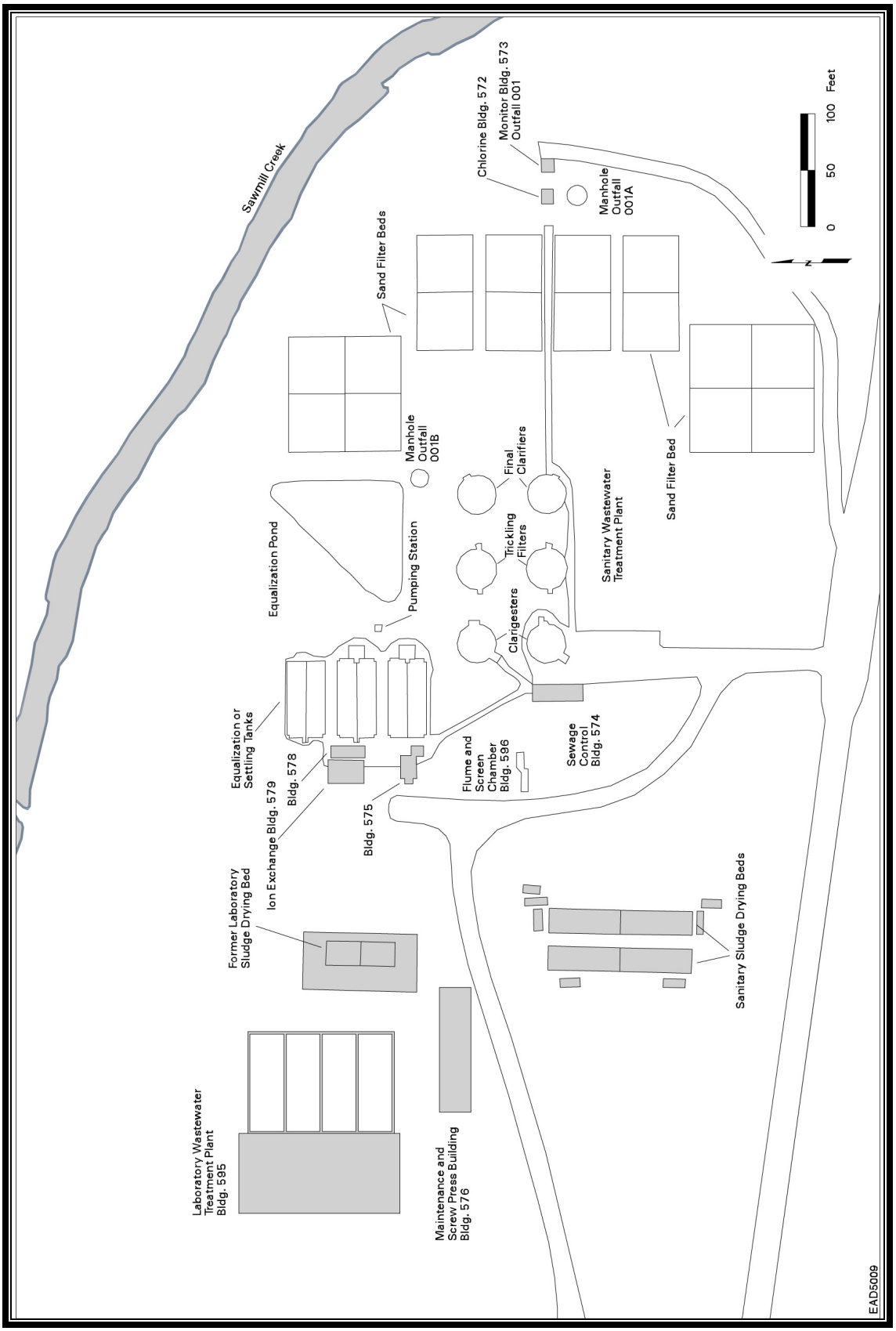

FIGURE 2.3 Argonne Wastewater Treatment Plant

- Extensive soil/water investigation was performed in the Outfall J03 watershed to identify contributing sources.

- Snow management practice was modified, including:

  – Increased use of pretreated salts, which reduced the amount of raw salt applied;

  – Increased snow management personnel training;

  – Initiation of the use of liquid deicing agents as a presnow event strategy, which resulted in decreased raw salt usage;

  – Implementation of a process to track salt usage, which established the baseline during the 2006–2007 season for future tracking and trending;

  – Improved weather tracking and notification systems; and

  – Upgrading of equipment to include two small pick-up trucks with mounted salt spreaders used to plow and salt small lots, docks, and pull-offs, thus reducing salt usage resulting from larger truck overspray.

- Confirmation of no additional contributions to high TDS sources at Outfalls H03 and J03 was obtained.

In May 2007, Argonne completed its investigation and proposed a revision to the CCA to include the following actions:

- Installation of a permanent pipe to reroute the high-TDS Outfall H03 discharges to the laboratory sewer;

- Submittal of a NPDES permit request to reclassify Outfalls H03 and J03 for stormwater and footing tile drainage discharges only — no industrial discharges; and

- Modification of snow management practices to minimize the impact of salt loading on the soil.

Five exceedances of the TDS limit were noted for Outfall 001; one occurred in February, two in March, and two in December. Four exceedances of the chloride limit also occurred at Outfall 001 that coincided with the TDS exceedances. The TDS and chloride exceedances were attributed to road salt associated with snowmelt.

Two exceedances of the TRC limit were noted in 2007, one at Outfall E05 and one at Outfall 025. In order to remove the offending discharge(s) from the outfall, Argonne organized

an investigation for the sources, and shortly after the exceedances, the sources were discovered and stopped. Since these, there have been no exceedances of the TRC limit at this outfall.

There were two exceedances of the TSS limit during June, one at Outfall H03 and one at Outfall 004. These were attributed to algae growth during low flow conditions. There were two exceedances of the TSS limit at Outfall B01 in August, one load limit and one concentration limit, that were attributed to a process upset at the LWTP. There was also one exceedance of the TSS load limit at Outfall B01 in December attributed to a process upset at the laboratory wastewater treatment plant caused by high flows.

Figure 2.4 presents the data for the total number of permit limit exceedances each year over the past 12 years. The increases in the number of exceedances in 2006 and 2007, compared with previous years, reflects the more restrictive discharge limits in the renewed permit issued in September 2005.

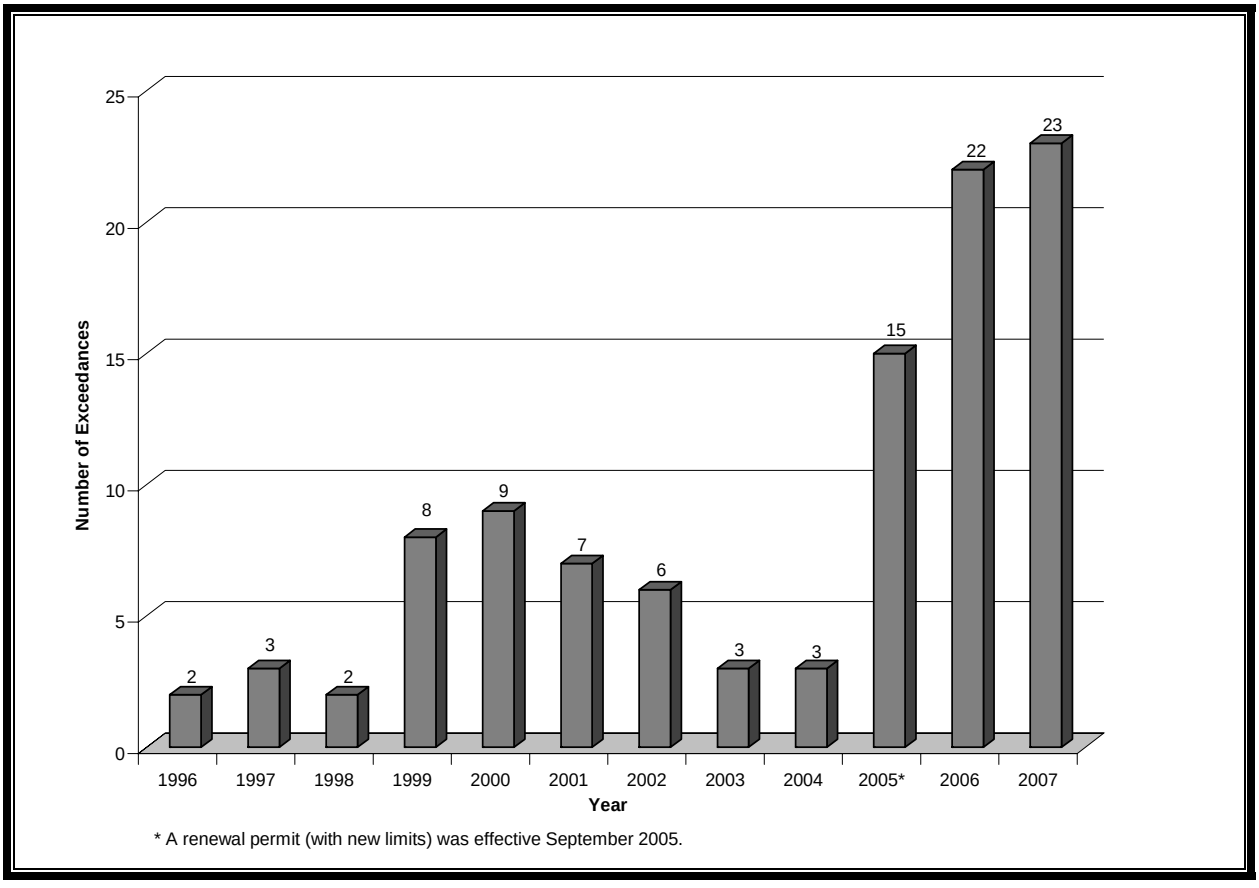

FIGURE 2.4 Total Number of NPDES Exceedances, 1996 to 2007

2.2.1.3. Priority Pollutant Analysis and Biological Toxicity Testing

The NPDES permit requires semiannual testing of Outfall B01 (the LWTP outfall) and annually at Outfall 021 for all the priority pollutants — 124 metals and organic compounds identified by the IEPA as being of particular concern. During 2007, the Outfall B01 sampling was conducted in June and December. Results were similar to past years. Organic compound concentrations were very low. Chloroform was detected at 2 µg/L in both samples and dichlorobromomethane at 2 µg/L in the June sample and at 1 µg/L in the December sample. Dibromochloromethane was detected at 2 µg/L in both samples. Bromoform was detected at 1 µg/L in December. It is suspected that the chloroform, dibromochloromethane, and bromodichloromethane come from chlorination by-products in the potable water or result from the contact of chlorinated water with organic chemicals and residues from cooling tower biocide treatment chemicals. Phenol (as total phenols) was detected at 0.0076 mg/L in June. All semivolatile organic, polychlorinated biphenyl (PCB), and pesticide concentrations were below the detection limits. Normal levels of copper (0.042 mg/L) were also found in the June sample; however, there are no effluent limits for this metal at this outfall. These findings are discussed further in Chapter 5.

Outfall 021 is sampled annually and analyzed for the priority pollutant list of constituents. The 2007 sample was collected on March 1, 2007. Only one compound of the 124 compounds measured by this test was detected above the analytical detection limits. 1,1,1-Trichloroethane (TCA) was found at 1.0 µg/L. The concentration of TCA found is well below the standard of 200 µg/L for this chemical in drinking water.

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 18 through June 22, 2007. 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 Argonne effluent can be correlated with a beneficial effect on aquatic life in the receiving streams.

2.2.1.4. Stormwater Regulations

In November 1990, the EPA promulgated regulations governing the permitting and discharge of stormwater from industrial sites. The Argonne 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 stormwater characterization and permitting program was initiated in 1991 and continues as required in the present NPDES permit; Argonne's NPDES permit includes both industrial and stormwater discharges to surface water.

The NPDES permit was reissued on April 24, 2007. As a portion of the effective permit, there are special conditions that include a number of requirements that Argonne must fulfill, including monitoring, reporting, and investigations. One of these requirements, Special Condition 9, requires Argonne to maintain its existing Stormwater Pollution Prevention Plan (SWPPP), as well as to modify it as necessary to continue compliance with all provisions of the

regulations regarding stormwater. The SWPPP was revised and published in October 2007, and the revision was communicated to affected personnel. Special Condition 9 continues to require Argonne to inspect and report annually on the effectiveness of the sitewide SWPPP. For 2007, the annual inspection was competed, and a report was submitted to the IEPA in December 2007.

2.2.2. Spill Prevention Control and Countermeasures Plan

Argonne 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 recordkeeping requirements mandated by the regulations. Regular training is conducted on implementation of this plan. No reportable spills occurred in 2007 that required activation of the SPCC Plan.

The SPCC Plan was revised to address new EPA requirements and was certified in December 2004. Among the new regulatory requirements are secondary containment for all oil storage containers 55 gallons or greater, tank integrity testing, and additional training. In December 2007, the EPA proposed extending the deadline for amending and implementing the revised SPCC Plan to July 1, 2009.

2.2.3. General Effluent and Stream Quality Standards

In addition to specific NPDES permit conditions, Argonne discharges are monitored to determine if they comply with general effluent limits contained in 35 IAC Part 304. Also, samples are collected to determine if 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.

2.3. Resource Conservation and Recovery Act

The Resource Conservation and Recovery Act (RCRA) and its implementing regulations are intended to ensure that facilities that generate, 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 also includes regulations governing the 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 Argonne and DOE on September 30, 1997. The permit became effective on November 4, 1997. The permit has been modified eight times. Argonne submitted an application to renew the permit in October 2007. The IEPA is currently reviewing the application.

The Argonne remediation program 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. This program was completed on September 30, 2003. However, seven SWMUs could not be remediated to No Further Action (NFA) status. The long-term monitoring of these inactive waste sites has been incorporated into the Argonne Long-Term Stewardship (LTS) Program. Quarterly reports are transmitted to the IEPA for these inactive sites. The LTS Program is described in greater detail in Chapter 6.

Also, one new SWMU and one new Area of Concern (AOC) have been identified since the remediation was completed. Argonne sent a notice about SWMU No. 746 (Building 300 Floor Drains) to DOE in July 2004. The IEPA added this SWMU to the Argonne corrective action program in March 2005. Argonne sent a notice about AOC-J (lead in soil near water towers) to DOE in November 2004. The IEPA added this AOC to the Argonne corrective action program in February 2005. The new SWMU and AOC are being investigated by Argonne's Facilities Management and Services (FMS) Division.

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

The nature of the research activities conducted at Argonne 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. Argonne has 18 Hazardous Waste Management Units: 12 container storage units (the IEPA approved closure of Building 374A in August 2007), 1 tank storage unit, 3 miscellaneous treatment units, and 2 tank chemical treatment units. Table 2.5 provides descriptions of these units. Figure 2.5 shows the locations of the major active hazardous waste treatment, storage, and disposal areas at Argonne.

Argonne 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 2007 was submitted to the IEPA. The RCRA-permitted storage facilities, designed and operated in compliance with RCRA requirements, allow for accumulation and storage of waste pending off-site disposal. Argonne's on-site permitted treatment facilities address a small number of hazardous wastes generated by Argonne operations. Off-site treatment and disposal take place at approved hazardous waste treatment and disposal facilities. Hazardous wastes that were generated, treated, disposed of, or recycled during 2007 are described in Table 2.6.

TABLE 2.5

Permitted Hazardous Waste Treatment and Storage Facilities, 2007

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 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.
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).
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. (Not included in the October 2007 application.)

TABLE 2.5 (Cont.)

Description	Location	Purpose
Treatment (Cont.)		
Chemical/Photooxidation Unit[a]	Building 306	Treatment of ignitable liquid MW containing organic contaminants.
Metal 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.

[a] Not in use.

2.3.2. Hazardous Waste Treatability Studies

The IEPA requires that Argonne 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. No treatability studies were conducted during 2007.

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

The hazardous component of mixed waste is governed by RCRA regulations, while the radioactive component is subject to regulation under the 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. Argonne generates several types of mixed waste, including acids, solvents, and debris contaminated with radionuclides. The RCRA Part B permit provides for on-site treatment in four mixed waste treatment systems. These systems include neutralization of low-level radioactive waste (LLW) and the stabilization of sludge and soil. In addition, during 2007, some of the mixed waste was sent off-site to Energy Solutions and Perma-fix, out-of-state commercial treatment and disposal facilities. Mixed wastes that were generated and disposed of during 2007 are described in Table 2.7.

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 Argonne was submitted to the IEPA and the Illinois Department of Nuclear Safety (IDNS) in March 1995. Argonne's RCRA Part B permit provides for on-site treatment of certain mixed waste as required by the

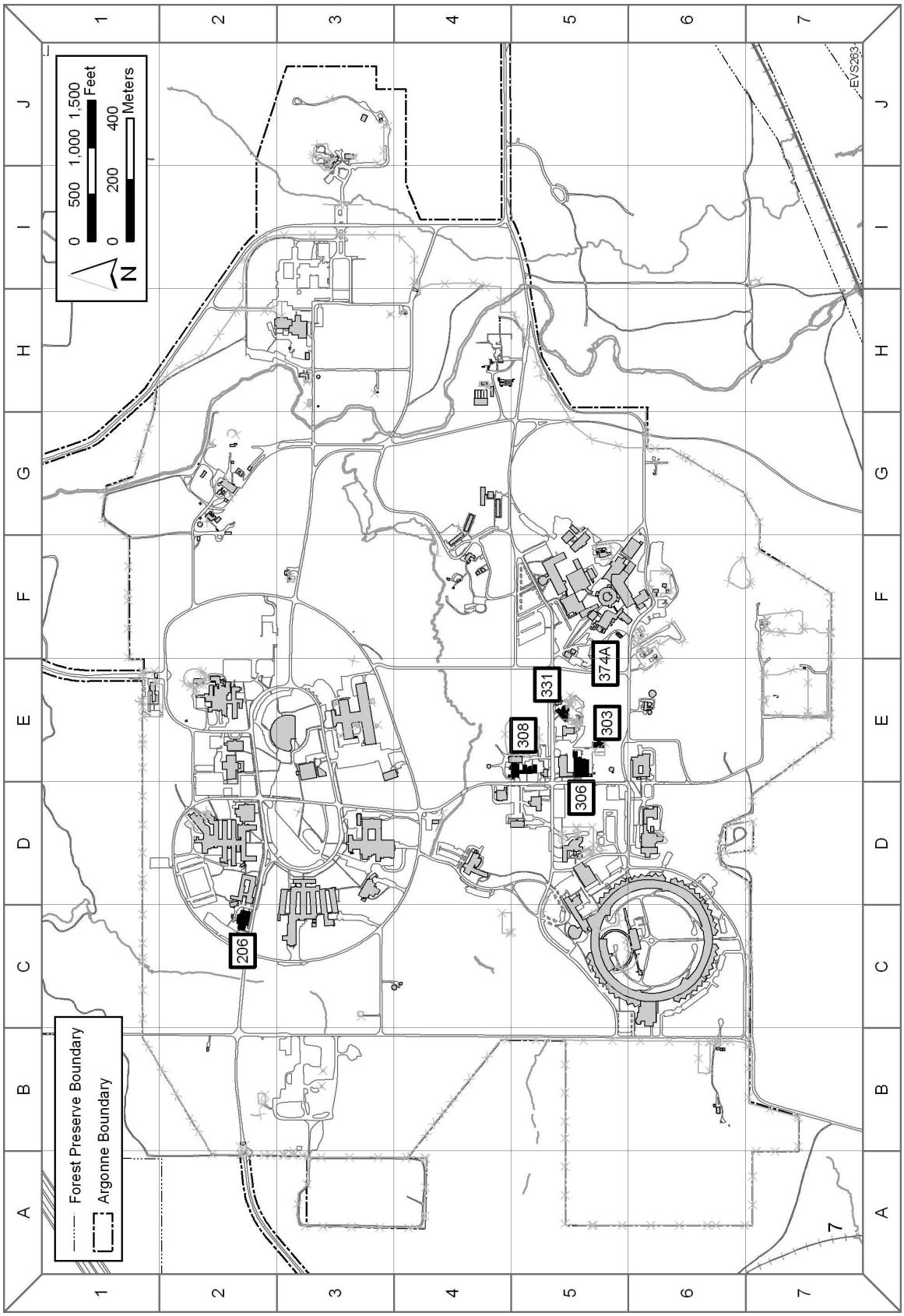

FIGURE 2.5 Major Treatment, Storage, and/or Disposal Areas at Argonne

TABLE 2.6

Waste Generation, Treatment, Disposal, or Recycle, 2007[a]

Waste (amount generated and shipped for disposal)	Weight (lb)
Nonhazardous Special Waste	
Used oil[b]	11,377
Nonhazardous cylinders	97
Nonhazardous solid chemicals	7,666
Nonhazardous liquid chemicals	24,633
Potentially infections medical waste	255
Nonhazardous Nonspecial Waste	
Nonspecial Laboratory sewage sludge	30,000
Fly ash (boiler house)	257,536
TSCA Special Waste	
Asbestos	110,000
PCBs	62,650
Universal Hazardous Waste	
Mercury-containing lamps[b]	14,806
Lead scrap/lead acid batteries[b]	10,556
Other batteries[b]	2,244
Hazardous Waste	
Hazardous liquids	18,890
Hazardous solids	4,963
Hazardous cylinders	445

[a] Abbreviations: PCB = polychlorinated biphenyl; TSCA = Toxic Substances Control Act.

[b] Amount generated and shipped for recycling.

PSTP. During 2007, Argonne met the established treatment target dates. An update to the PSTP was provided to DOE with the treatment target dates for the remaining mixed waste storage. The schedule shows mixed waste governed by the plan, all of which will be treated by the end of 2009.

2.3.5. Underground Storage Tanks

The Argonne site currently contains 13 USTs. Seven of the existing tanks are being used to store fuel oil for emergency generators. The on-site maintenance facility (Building 46) uses underground tanks to store diesel, gasoline, used oil, antifreeze, and an ethanol/gasoline blend.

TABLE 2.7

Mixed Waste Generation and Disposal, 2007[a]

Waste	Volume (ft^3)
Radioactive Mixed Waste Generated	
RMW combustible solids with organics	0.67
RMW corrosive liquids without metals	3.0
RMW corrosive liquids with metals	0.67
RMW general MW debris	98.0
MLLW wastewater with organics	0.07
TRU corrosives	5.2
RMW inorganic solids with cadmium	102.0
RMW piping material with lead	0.004
RMW PPE with lead	1.0
Radioactive Mixed Waste Shipped	
RMW debris	237.96
RMW wastewater with metals	0.02
RMW retention tank sludges	7.41
RMW soil with metals	0.932
RMW lead shielding	35.35
RMW inorganic nitrates	12.0

[a] Abbreviations: PPE = personal protective equipment; MLLW = mixed low-level radioactive waste; RMW = radioactive mixed waste; TRU = transuranic waste.

On August 28, 2006, the Illinois State Fire Marshal certified that the USTs at Argonne are in compliance with the regulations. Argonne compliance staff conducted compliance assessments in February, July, August, and November of 2007.

2.4. Solid Waste Disposal

In September 1992, Argonne 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 Argonne's RCRA Part B permit.

Groundwater Quality Standards of some routine indicator parameters have been consistently exceeded, such as TDS, iron, and manganese. Exceedances occur primarily in shallow, perched pockets of groundwater in the glacial drift that are not in direct communication with the deeper dolomite bedrock aquifer. Hydrogen-3 has been measured in several wells at the

800 Area Landfill at concentrations ranging from <100 pCi/L to 409 pCi/L. The 800 Area Landfill groundwater monitoring program is discussed in detail in Section 6.3.

Argonne generates a large volume and variety of nonhazardous special wastes. Some special waste, such as sanitary sewage sludge, is certified by the IEPA as "nonspecial waste" pursuant to IEPA regulations. Table 2.6 gives the nonhazardous special and nonspecial wastes generated, disposed of, or recycled during 2007. All nonhazardous special and nonspecial wastes generated at Argonne in 2007 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 PCB wastes shipped out of state.

2.5. National Environmental Policy Act

The National Environmental Policy Act of 1969 (NEPA) established a national environmental policy that promotes consideration of environmental impacts 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 at 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 2007. An EA was prepared for the decontamination and demolition (D&D) of Building 301 and was approved on March 27, 2007.

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 set forth requirements to protect human health (primary standards) and provide aesthetically acceptable water (secondary standards).

2.6.1. Applicability to Argonne

In January 1997, Argonne incorporated Lake Michigan water as its domestic source water, thereby replacing the dolomite groundwater that formerly constituted its source of drinking water. Because the Lake Michigan water is purchased from the DuPage County Water Commission, Argonne is now a customer, rather than a supplier of water. Consequently, on January 23, 1997, the DuPage County Health Department notified DOE that the federal and state

monitoring requirements applicable to a "non-transient, non-community" public water supply were no longer applicable. Nevertheless, Argonne voluntarily provides to on-site personnel the Consumer Confidence Report on drinking water quality that Argonne receives as a customer of the DuPage County Water Commission. The annual report indicates that all measured contaminants meet the drinking water standards.

2.6.2. Water Supply Monitoring

During 2007, Argonne continued an informational monitoring program at the previously used dolomite domestic wells; quarterly samples were analyzed for radionuclides and VOCs. No radionuclides or VOCs above drinking water standards were detected.

2.7. Federal Insecticide, Fungicide, and Rodenticide Act

During 2007, all restricted-use pesticides and herbicides at Argonne were applied by a licensed contractor who provides the chemicals used and removes any unused portions. Argonne coordinates the contractor's activities and ensures that the chemicals are EPA-approved, that they are used properly, and that any unused chemicals are 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-licensed contractors under the direction of FMS-Custodial Services or on-site contractors, depending on the building involved. The indoor applications involve EPA "Restricted Use" products.

In 2007, approximately 43,434 L (11,430 gal) of commercial-grade herbicide was applied throughout the Argonne site. Fertilizer with weed control is included in the quantity of herbicide.

2.8. Comprehensive Environmental Response, Compensation, and Liability Act

The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (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 report, followed by a Site Screening Investigation. 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 Argonne sites are included in the NPL.

2.8.1. 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 freestanding 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 for responses to emergency situations involving hazardous materials. Under EPCRA, Argonne submitted reports pursuant to Sections 302, 304, 311, 312, and 313, which are discussed in the following paragraphs. Table 2.8 gives Argonne'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 Argonne, including laboratory usage, that exceed any EHS threshold planning quantity. The Section 302 information for 2007 was transmitted to the LEPC and SERC during June, October, and December of 2007.

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 Argonne Emergency Management Plan Implementing Procedures. There were no incidents requiring notification during 2007.

Under SARA Title III, Section 311, Material Data Safety Sheet (MSDS)/Chemical Inventory, Argonne is required to provide applicable emergency response agencies with MSDSs, or a list of MSDSs, for each hazardous chemical stored on-site. The 2007 information was transmitted to the LEPC and SERC during June, October, and December of 2007.

TABLE 2.8

Status of EPCRA Reporting, 2007

EPCRA Section	Description of Reporting	Status
Section 302	Planning notification	Required
Section 304	Extremely hazardous substance release notification	Not required in 2007
Section 311–312	Material Safety Data Sheet chemical inventory	Required
Section 313	Toxic Release Inventory reporting	Required

Pursuant to EPCRA Section 312, Argonne is required to report certain information regarding inventories and the locations of hazardous chemicals to state and local emergency authorities upon request. 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 2007 was provided to DOE during February 2007. Table 2.9 lists the hazardous chemicals reported.

Section 313 of SARA Title III, Toxic Release Inventory (TRI) Reporting, requires certain facilities to prepare an annual report entitled "Toxic Chemical Release Inventory, Form R," if annual usage of listed toxic chemicals exceeds certain thresholds. Argonne is not within the range of Standard Industrial Codes specified in the statute. Argonne reports this information, however, because DOE, which is subject to EO 13148, "Greening the Government through Leadership in Environmental Management" (April 21, 2000), directs Argonne to do so. No reports were filed from 1997 to 2000, because no listed chemicals were used in amounts that 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, Argonne filed one report under Section 313 in 2007 for activities in 2006 for lead and lead compounds. Use of lead included machining of various types of lead articles in excess of the 45-kg (100-lb) reporting threshold. Lead compounds were included due to conversion of lead in coal to lead oxide. Under TRI, the lead oxide is categorized as having been "manufactured," and it was reported since it exceeded the 100-lb 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,

TABLE 2.9

SARA, Title III, Section 312, Chemical List, 2007

	Physical Hazard			Health Hazard	
Compound	Fire	Pressure	Reactivity	Acute	Chronic
Zinc bromide	–[a]	–	X	X	–
Sulfuric acid	–	–	X	X	–
Hydrofluoric acid	–	–	X	X	–
Chromic chloride	–	–	–	X	–
Nitric acid	–	–	X	X	–

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

processing, and distribution in commerce of designated chemicals. The principal impact of these regulations at the Argonne site concerns the handling of asbestos and PCBs. Suspect PCB-containing items that are subject to this act are identified through the Argonne PCB Item Inventory Program. Argonne has developed procedures to deal with the import/export of TSCA materials by relying on U.S. Customs Service processes.

2.9.1. PCBs in Use at Argonne

PCB items in use or in storage for reuse are tracked by the Argonne 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 Argonne 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 Argonne. The Annual PCB Report for 2007 was completed on April 11, 2008. The PCBs in use at Argonne 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 Argonne 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, the combination of which is known as TSCA mixed waste. Table 2.6 contains the amount of PCBs and PCB-contaminated materials and TSCA mixed waste in storage and shipped by Argonne during 2007.

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 human activities. To comply with the ESA, federal agencies are required to assess the area affected by a proposed project to determine whether it contains any threatened or endangered species, or critical habitat of such species.

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

The Hine's emerald dragonfly (*Somatochlora hineana*), federally 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 federally and state listed as endangered, indicates that this species may occur in the area. The federally listed threatened and state-listed endangered lakeside daisy (*Tetraneuris herbacea*) has a planted population in Waterfall Glen Forest Preserve.

Although state-listed species that occur in the area are not covered by the ESA, the following state-listed species can be found on the Argonne site or within the vicinity of Argonne:

- Endangered
  - Black-crowned night heron (*Nycticorax nycticorax)*
  - Eastern massasauga (*Sistrurus catenatus catenatus*)
  - Great chickweed (*Stellaria pubera*)
  - Prairie bush clover (*Lespedeza leptostachya*)
  - Quillwort (*Isoetes butleri*)
  - Spotted turtle (*Clemmys guttata*)
  - Tennessee milkvetch (*Astragalus tennesseensis*)
  - Tuckerman's sedge (*Carex tuckermanii*)
  - Yellow-crowned night heron (*Nyctanassa violacea*)

- Threatened
  - Blanding's turtle (*Emydoidea blandingii*)
  - Buffalo clover (*Trifolium reflexum*)
  - Common moorhen (*Gallinula chloropus*)
  - Henslow's sparrow (*Ammodramus henslowii*)
  - Kirtland's snake (*Clonophis kirtlandi*)
  - Least bittern (*Ixobrychus exilis*)
  - Marsh speedwell (*Veronica scutellata*)
  - Shadbush (*Amelanchier interior*)
  - Slender sandwort (*Minuartia patula*)
  - White lady's slipper (*Cypripedium candidum*)

Of these, the black-crowned night heron and the Kirtland's snake have been observed on Argonne property. Impacts on these species also would be assessed during the NEPA process.

2.11. National Historic Preservation Act

The National Historic Preservation Act of 1966 (NHPA), as amended, requires federal agencies to assess the impact of proposed projects on historic or culturally important sites, structures, or objects within the area of potential effect for a proposed project. 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 for Historic Preservation (ACHP), as appropriate, when determining if proposed actions would adversely affect properties that are eligible for listing on the NRHP.

The NHPA is implemented at Argonne through the NEPA review process, as well as through the Argonne digging permit process. All proposed actions must consider the potential impact on historic or culturally important properties or artifacts and document this consideration on the Environmental Review Form. Prior to disturbing the soil, an Argonne digging permit must be obtained from the FMS 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 NRHP-eligible (significant) cultural resources would be affected. If the proposed site has not been surveyed for the presence of cultural resources, a cultural resources survey is conducted by qualified personnel, and any artifacts found are documented and carefully removed. At Argonne, DOE consults with the Illinois SHPO through the Illinois Historic Preservation Agency (IHPA) and the ACHP, as appropriate, if proposed actions would adversely affect properties eligible for listing on the NRHP.

Argonne's compliance procedures for satisfying the NHPA and DOE requirements are outlined in a Cultural Resources Management Plan (CRMP), which was approved by the IHPA and ACHP in October 2006. The CRMP replaces a Programmatic Agreement (PA) signed in fiscal year (FY) 2002 among Argonne, the ACHP, and the IHPA, which defined Argonne's procedures for management of cultural resources. The acceptance of the CRMP nullifies the PA as the guiding document for the management of cultural resources at Argonne. The PA has been incorporated into the CRMP. The 5-year update of the CRMP is scheduled for FY 2011.

Cultural resources include both archaeological sites and historic structures. Roughly 191 ha (473 acres) of the Argonne site have been examined through Phase I Archaeological surveys for the presence of cultural resources. It was previously determined that the roughly 63 ha (155 acres) immediately surrounding the buildings in the 200 Area are not expected to contain intact resources as a result of past earthmoving activities. There are approximately 348 ha (861 acres) that require examination for the presence of cultural resources on the Argonne site. Past surveys have identified 46 archaeological sites on Argonne-managed property. Three of the sites have been determined eligible for listing on the NRHP. Twenty-two sites have been determined ineligible for listing on the NRHP. The remaining 21 sites have yet to be evaluated for listing.

In 2001, Argonne completed an evaluation of all structures built prior to 1989 for potential listing on the NRHP. The survey identified the Building 200 M-Wing Caves and

Buildings 203, 205, 212, 315/316, and 350 as individually eligible for listing on the NRHP. The evaluation also identified two historic districts — the Main Campus District (Buildings 200, 202, 203, 205, 208, and 211) and the Freund Estate District (Buildings 600 and 604 and properties 603 [pool], 606 [pavilion], and 616 [tennis courts]). Separate NHPA evaluations generally conducted as part of D&D efforts have also found the Chicago Pile-5 Reactor (CP-5); the Argonne Thermal Source Reactor, Building 301; the Physics and Metallurgy Hot Laboratory; the High Voltage Electron Microscopy Facility; the Alpha-Gamma Hot Cell Facility; and Zero Power Reactors (ZPR) VI and IX eligible for listing on the NRHP.

Compliance activities associated with the NHPA have resulted in the documentation of several properties prior to removal. Building 301, CP-5, ZPRs VI and IX, and the Argonne Thermal Source Reactor have all been documented to the Illinois Historic American Engineering Record standards. The documentation reports are on file with the Illinois State Archives. Archaeological excavations of several farmsteads and prehistoric sites occurred prior to the construction of the APS during the early 1990s. In 2003, site 11-DU-201, a mid-nineteenth century farmstead, was partially excavated, which resulted in the site being determined ineligible for listing on the NRHP.

As stated above, all cultural resource reviews and mitigation work are performed in consultation with the IHPA and the ACHP as required in the Argonne CRMP. The primary FY 2007 compliance activity at Argonne was the final acceptance of Argonne's CRMP. In addition, archaeological field surveys were conducted prior to the installation of an underground communication line and prior to installation of new power lines for the TCS Building. No new cultural resources were identified during these investigations.

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 EO. The EO 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 Argonne 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 of the site near Sawmill Creek, Freund Brook, Wards Creek, and other small streams and associated wetlands and low-lying areas. These areas are delineated in Argonne's site development plan and are contained within areas designated as conservation use, not intended for development. No significant structures are located in these areas, although an existing pumping station for securing canal water as a cooling tower feedstock is situated in the floodplain of the Des Plaines River south of the site. 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 on 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 on 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 restored wetland or 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.

Argonne completed a sitewide wetland delineation in 1993. All wetlands present on-site were identified and mapped following the 1987 *Corps of Engineers Wetlands Delineation Manual*.[3] The delineation map shows the areal extent of all wetlands present at Argonne down to 500 m^2 (1/8th acre). Thirty-five individual wetland areas were identified; their total area is approximately 20 ha (50 acres). The larger wetlands are illustrated in Figure 1.4.

In February 1989, the COE issued a permit to DOE under Section 404 of the CWA, addressing the construction of the APS facility at Argonne. 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 on 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, Argonne 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, 2000, 2001, 2002, and 2005. Planting, the application of herbicides, and monitoring of the wetland continued in 2007.

Argonne's wetland management strategy as described in a September 2001 DOE EA included creating advanced compensatory mitigation as approved by the COE. The advanced compensatory mitigation is similar to a wetland "bank" and is to be used to offset wetland losses at Argonne.

Argonne restored several acres of high-quality wetland in the 400 Area by disabling a drainage tile network installed when the land had been farmed. One of the restored wetlands acres will replace a small wetland lost after construction of the APS and resolve a COE enforcement order. Once the vegetation quality is acceptable to the COE, the remaining restored wetland acreage will be available to offset loses of small wetlands in other portions of the Argonne site, many of which are so small and of such poor quality that they have little ecological value. Monitoring data for the past 2 years show improving vegetation quality on several acres of restored wetland. A proposed upgrade to the APS indicates an expansion north through the wetlands. This proposed expansion project will have to be evaluated regarding its impact on the wetlands.

2.14. Land Management and Habitat Restoration

Land management and habitat restoration has been an area of interest. The retention of scarce habitat types and their need for preservation and husbandry from encroachment by development as well as protection from invasive species is now increasingly prevalent in the Chicago region. After several years of *ad hoc* management initiatives funded through operating budgets, Argonne formalized an advisory committee in 2003 to more systematically address emerging management issues related to habitat and to review and propose, as appropriate, innovations in management of undeveloped areas of the site. The committee was also charged with reviewing policy and implementation of actions being carried out by in-house personnel and contractors to address on-site opportunities for improving environmental conditions or mitigating emerging problems.

As documented in the 2007 *Ten Year Site Plan*, the land use plan for undeveloped areas is based on the tailored need for mitigation, environmental restoration, and diversification of landscape forms and materials through the increased presence of cost-saving native species and reduction or elimination of non-native or potentially invasive plant species. Numerous initiatives have been established to return selected localities within Argonne's boundaries to more viable and self-sustaining habitat types, such as prairie and savannah, that formerly existed in this region, as well as to combat invasive species in remaining areas of high-quality habitat. Additional efforts have sought to increase floristic diversity and use of native plant materials within the developed areas of the site while reducing traditional costs for landscaping maintenance.

Projects have been coordinated with environmental compliance activities related to wetlands mitigation, which complement the committee's efforts to date. Major issues include the control of invasive species and the management of areas that have not been addressed adequately in past practices. Argonne expects that DOE will continue its high level of interest, as evidenced in performance contract measures.

Significant achievements in FY 2007 include establishing a transition plan for grounds maintenance and eventual management of the native habitats and planting in proximity to the newly commissioned Center for Nanoscale Materials, and an evaluation and management plan for reinvigorating the stands of mature bur and white oaks that characterize the savannah setting throughout several areas of the site.

2.15. 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 Argonne and the surrounding Waterfall Glen Forest Preserve.

2.15.1. 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. No white-tailed deer were removed in 2006, but 15 were removed in early 2007.

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.

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 2005 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.

2.15.2. 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 from 2000 through 2005 indicate limited success in recovery of deer-sensitive herbaceous species. Oak seedlings were identified for the first time in Spring 2004 and again in Spring 2005.

2.16. Current Issues and Actions

The purpose of this section is to summarize the most important issues related to environmental protection encountered during 2007. Table 2.10 lists all water effluent exceedances reported during 2007. 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.

2.16.1. Clean Water Act — NPDES

As in previous years, Argonne exceeded NPDES permit limits in 2007 (see Table 2.10). In past years, the TDS concentration was the most persistent exceedance of the NPDES permit limits. The limit for TDS was exceeded 12 times during 2007; 5 times at the Wastewater Treatment Plant (WTP) discharge point Outfall 001, 2 times at Outfall H03, and 5 times at Outfall J03. Road salt runoff associated with snowmelt appears to be the main contributor to high TDS concentrations. The limit for TRC was exceeded 2 times, once at Outfall E05 and once at Outfall 025, due to the discharge of potable water. Investigations regarding cause and corrective actions were completed, as listed in Table 2.10.

Argonne has had occasional positive toxicity test results at several outfalls. These appear to be due to residual chlorine from the 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. No toxicity has been found during the last 2 years of testing.

TABLE 2.10

Summary of 2007 Water Effluent Exceedances

Date	Outfall	Parameter	Assessment
January 25	J03	TDS	Road salt associated with melting snow
February 19	E05	TRC	Discharge of potable water
February 27	001	TDS	Road salt associated with melting snow
February 27	001	Chloride	Road salt associated with melting snow
March 6	001	TDS	Road salt associated with melting snow
March 6		Chloride	Road salt associated with melting snow
March 13	001	TDS	Road salt associated with melting snow
March 13	001	Chloride	Road salt associated with melting snow
March 27	J03	TDS	Road salt associated with melting snow
April 17	J03	TDS	Road salt leached from soil
May 14	H03	TDS	Road salt leached from soil
May 14	J03	TDS	Road salt leached from soil
June 12	H03	TSS	Algae growth due to low water flow
June 12	004	TSS	Algae growth due to low water flow
June 12	H03	TDS	Road salt leached from soil
June 12	J03	TDS	Road salt leached from soil
August 14	B01	TSS	Resulted from plant maintenance activities
August 14	B01	TSS mass[a]	
September 17	025	TRC	Failure of sump pump – corrected
December 11	B01	TSS mass	Process upset caused by high flows
December 18	001	TDS	Road salt associated with melting snow
December 26	001	TDS	Road salt associated with melting snow
December 26	001	Chloride	Road salt associated with melting snow

[a] NPDES limit for total mass of TSS discharged per day was exceeded.

2.16.2. 800 Area Groundwater Monitoring

The IEPA-approved 800 Area Landfill groundwater monitoring program continues to indicate that the Ground Water Quality Standards of some inorganic parameters, such as TDS, iron, and manganese, consistently are being exceeded in several wells. Additional information about the source and extent of these exceedances is needed before a plan of action to resolve the issue can be formulated. The groundwater monitoring program is discussed in detail in Section 6.5.

2.16.3. Long-Term Stewardship Activities

Remediation of waste management units was completed in 2003. During 2004, the long-term operation, maintenance, and monitoring of these sites, recognized as Argonne's LTS

Program, were incorporated, in their entirety, into Argonne's environmental monitoring and surveillance program. Ongoing activities during 2007 are summarized in Chapter 6.

2.16.4. CP-5 Monitoring

Elevated levels of hydrogen-3 in CP-5 Monitoring Well 330031R (up to 45,000 pCi/L) were measured in quarterly groundwater samples after the original well was removed and the well replaced with a new well screened at a lower depth. Although the hydrogen-3 concentrations are decreasing, expanded monitoring activities in this area determined that the hydrogen-3 distribution was localized.

2.17. Environmental Permits

Table 2.11 lists all the environmental permits in effect at the end of 2007. Other portions of this chapter discuss special requirements of these permits and compliance with those requirements.

2.18. IEPA/DOE Inspections/Appraisals

Various inspections and appraisals were conducted during 2007. A short description of each is included in Table 2.12.

2.19. Outstanding Compliance Issues/Actions/Agreements

The initial Compliance Agreement regarding TDS originated in 2006. On May 4, 2007, Argonne submitted a final investigation report into the causes of the TDS at two outfalls, H03 and J03. This report included a revised Compliance Agreement and was submitted to the Compliance Assurance Section of the IEPA. Within this report were data demonstrating that all industrial discharges had been removed from the two outfalls, rendering them outfalls with only stormwater discharge. The revised Compliance Agreement included a description of future actions to be taken, including a proposal that Argonne would submit an application for a NPDES Permit Modification to the IEPA that would include a request for changing the status of the outfalls from industrial wastewater discharge to stormwater only discharge outfalls. This was accomplished by the submittal of the NPDES permit modification application on August 13, 2007. Acceptance of the NPDES permit modification by the IEPA will demonstrate closure of this Compliance Agreement.

TABLE 2.11

Environmental Permits in Effect, 2007

Permit Name	Permit ID	Status	Start Date	End Date
B-203 CARIBU Project Construction Permit	05120055	Effective	3/20/2006	–[a]
CAAPP Title V Permit	95090195	Effective	10/17/2006	10/17/2011
Federal Fish and Wildlife Permit	MB100283-1 Amend	Effective	10/6/2006	2/14/2008
NPDES Wastewater Discharge Permit	IL0034592	Effective	9/1/2005	8/31/2010
Open Burn Permit – Fire Training	B0701142	Effective	1/30/2007	1/29/2008
Open Burn Permit – Vegetative Control	B0610022	Effective	4/19/2007	4/18/2008
RCRA Part B Permit	B-75-M-12/13	Effective	9/30/1997	–[b]
USDA Soil Permit	S-64308	Effective	12/31/1998	12/31/2008
Wastewater Discharge Permit to DuPage County	18965	Effective	7/29/1991	–
Wastewater Treatment Plant Land Application Permit	2004-SC-1419	Effective	8/12/2004	7/31/2009
Nuisance Wildlife Control Permit	Argonne/Group Class C Permit	Effective	1/26/2007	1/31/2008
Boiler #5 Stoker Replacement Project	07040001	Effective (construction)	7/12/2007	–
Howard T. Ricketts Laboratory Construction Project	2006-EN-6007	Effective (construction)	1/12/2006	–

[a] A dash indicates that permit continues to be in effect until it is revised.

[b] Renewal application submitted October 2007; permit is extended until IEPA acts on renewal application.

TABLE 2.12

IEPA/DOE Environmental Compliance Inspections/Appraisals, 2007[a]

Agency	Type	Dates	Results/Issues
IEPA	CWA/NPDES Inspection	November 8, 2007	No issues identified.
IEPA	RCRA Inspection	June 26, 2007	No identified issues.
DOE-ASO	Hazardous and Mixed Waste Functional Area Review	March 5–20, 2007	8 noncompliances, 3 opportunities for improvement, and 3 strengths.
COE	Wetland Inspection Status Certification	October 16, 2007	No identified issues.
DOE-ASO	EMS Implementation	June 11–21, 2007	5 noncompliances, 3 opportunities for improvement, and 1 strength.
DOE-ASO	UMC Review	November 13–16, 2007	2 noncompliances, 9 opportunities for improvement, and 6 strengths.

[a] Abbreviations: DOE-ASO = DOE-Argonne Site Office; EMS = environmental management system; UMC = unneeded materials and chemicals.

3. ENVIRONMENTAL MANAGEMENT SYSTEM

3. ENVIRONMENTAL MANAGEMENT SYSTEM

The Environmental Management System (EMS) is a management tool that describes how Argonne consistently monitors and manages the effects its operations or processes may have on the environment and continually improves its environmental stewardship performance. The EMS is required by DOE Order 450.1, which has been incorporated into the UChicago Argonne, LLC, prime contract for the operation of Argonne.

The UChicago Argonne, LLC, Board of Governors, the Laboratory Directorate, and the Laboratory Management Council are committed to ensuring that ESH considerations are integrated into the performance of all work. Implicit in this commitment is support to continually improve and maintain an EMS in compliance with DOE Order 450.1. The Argonne overall policy for ESH is documented in Chapter 7 of the Argonne Policy Manual. As part of this policy, Argonne has established a detailed environmental policy, Section 7.3, Environmental Protection Policy, of the Argonne Policy Manual.

A supporting document to the Environmental Protection Policy is the EMS Description Document. The EMS document is structured to mirror the organizational structure of the Argonne Integrated Safety Management System (ISMS) in order to demonstrate integration between the two documents. The DOE Argonne Site Office (DOE-ASO) approved the Argonne EMS on December 22, 2005. Other EMS supporting documents are the Environment, Safety, and Health (ESH) Manual and division-specific policies, procedures, and other activity-specific documents.

3.1. EMS Components

3.1.1. Environmental Aspects and Impacts

Argonne evaluates its operations, identifies aspects of its operations that can impact the environment, and determines which of those impacts are significant. When operations have an environmental aspect, Argonne implements the EMS to minimize or eliminate any potential adverse impact.

The environmental aspects addressed in the EMS are air emissions, water effluents, drinking water, waste management, waste minimization/pollution prevention, floodplain/wetlands, pesticide management, cultural resources management, PCB management, TSCA chemical management, UST management, EPCRA reporting, and long-term stewardship. Regulatory responsibilities as well as organizational roles and responsibilities are delineated in the EMS description document to address the management of the aspects and impacts.

3.1.2. Performance Measures

Argonne establishes performance measures to drive improvements and ultimately, environmental performance. Focus is on the environmental aspects that can have a significant

impact, address stakeholder concerns, and align the commitments made in the environmental policy. Performance measures are developed each fiscal year.

3.1.3. Objectives and Targets

Another mechanism to improve environmental performance is the annual establishment of EMS Objectives and Targets. Objectives describe Argonne's goals for environmental performance. The objectives are a set of measurable or qualitative goals concerning how Argonne will address each environmental aspect. Targets are specific and measureable interim steps taken to obtain objectives. Targets are documentable actions with due dates. All organizations are encouraged to establish and implement environmental targets where applicable to individual programs.

Objectives and targets are established as part of the annual management review of the EMS document. Each year, typically in July, the EMS is reviewed. The objectives are evaluated for relevance while targets are revised to reflect the next step in continuous improvement in that area. A Subject Matter Expert (SME) is assigned to each environmental aspect. Each SME is responsible for the creation and maintenance of the objectives and targets in that area. A listing of objectives and targets can be found in the Argonne EMS Description Document.

In 2007, Argonne's EMS objectives included:

1. Reducing the amount of potable water used,

2. Optimizing the use of laboratory hoods,

3. Reducing lead and mercury inventories, and

4. Conducting Pollution Prevention Opportunity Assessments.

For 2007, Argonne established 25 targets. In addition to several core activities, a set of targets was established to encourage line management to increase its participation in the process.

3.1.4. Incorporation of New Environmental Requirements

The Argonne Policy Manual, Chapter 6.18, DOE Directives Processing Policy, defines the procedure for processing environmental draft and final DOE orders or other directives and incorporating them into the documentation hierarchy. SMEs prepare changes to environmental requirements or procedures in manuals such as the ESH Manual, and then broad-based committees of SMEs and representatives of organizational units affected by the changes perform reviews. Argonne personnel with compliance responsibilities also monitor the *Federal Register* and other sources for changes that could impact Argonne.

In addition to new or revised DOE orders and regulations that prescribe requirements, Argonne uses other sources to identify opportunities for environmental improvement. These include lessons-learned reports, interaction with other DOE sites, participation in forums, Occurrence Reporting Processing System reports, assessments by stakeholders, monitoring changes in environmental regulations, and feedback from public interest groups and others.

3.2. Environmental Organization Structure and Roles

The roles and responsibilities in implementing EMS flow from the DOE to UChicago Argonne, LLC, to the Argonne Laboratory Director, the Laboratory Directorate and Management Council, to the individual Associate Laboratory Directors (ALDs), to the Division Directors, and to the Argonne workers along the line management structure.

The line organization appoints a number of individuals with environmental responsibilities to provide advice and guidance to them. Each ALD is supported by an ESH/Quality Assurance (QA) representative. The environmental responsibilities of the ESH/QA representative include most or all of the following: interfaces with division ESH/QA coordinators on environmental issues; interfaces with Environment, Safety, and Health/Quality Assurance (EQO) on environmental issues; serves as a participant and point of contact for assessments; and maintains cognizance of ALD activities in order to ensure environmental protection support when needed. Each ALD also appoints a NEPA owner to oversee and implement the NEPA program in his/her area of responsibility. Division/department environmental compliance representatives (ECRs) are also appointed. The ECRs report to the organization management and serve as the primary point of contact on matters related to environmental protection. Other division staff also assist the line in maintaining a safe environment, such as the ESH coordinators, health physicists, health physics technicians, and QA representatives.

3.3. EMS Support

3.3.1. Environmental Planning and Compliance

The Environmental Planning and Compliance (EPC) group serves as the primary support organization dealing with the implementation of environmental regulations. The staff is knowledgeable in federal, state, and local regulations and DOE orders. The EPC responsibilities include providing expert assistance, supported by the Argonne Legal Department, in the planning, designing, implementing, and permitting of operations to ensure that the environmental requirements are met; providing prompt reporting to management and regulators of any noncompliances; developing and administering the Argonne NEPA program; administering, reviewing, and consulting on the permitting process; functioning as a technical resource on environmental issues/regulations; conducting environmental reviews of projects; conducting

compliance assessments for major program areas; maintaining an environmental compliance Web site; and supporting oversight activities by participating in audits.

3.3.2. Environmental Monitoring and Surveillance

The Environmental Monitoring and Surveillance group is responsible for monitoring the effects, if any, of Argonne activities on the public and the environment. Environmental monitoring consists of two major activities: effluent monitoring and environmental surveillance. Effluent monitoring includes collecting and analyzing samples or measuring liquid and gaseous releases for the purpose of characterizing and quantifying contaminants, assessing radiation exposure to the public, providing information used to control effluent releases, and demonstrating compliance with applicable standards and permit conditions. Environmental surveillance includes collecting and analyzing samples or directly measuring contamination in air, surface water, groundwater, and sediment from the Argonne site and its environs and assessing radiation exposure of members of the public and assessing the effects, if any, on the local environment. The information generated by the monitoring program is the basis for reports to various federal and state agencies to satisfy permit and regulatory requirement.

3.3.3. Analytical Support

The Analytical Services group is responsible for providing radiological and chemical analysis to support the environmental monitoring, bioassay, industrial hygiene, and health physics programs. This dedicated on-site laboratory provides quality analytical data needed by programs to satisfy their regulatory and internal needs. The analytical program is supported by a rigorous QA program, including participation in environmental quality control (QC) programs. The analytical program is accredited by the Department of Energy Laboratory Accreditation Program and the American Industrial Hygiene Association.

3.3.4. Training

The Training group is responsible for developing training modules, conducting training, and administrating the Training Management System, which is used to determine the training needs of each worker based on the worker's responsibilities/activities and the hazards each employee may encounter in the workplace. Argonne has developed a comprehensive environmental training program to train staff, visitors, and contractors to ensure that they are competent to carry out their environmental responsibilities. The environmental training program includes general environmental awareness, regulatory compliance training, and specific courses for managers, internal assessors, and operations personnel.

3.3.5. Waste Management Operations

The WMO Department is responsible for the safe collection, treatment, storage, and disposal of all regulated waste generated at Argonne. This includes hazardous waste, special waste, LLW, mixed waste (MW), and transuranic waste (TRU). Argonne activities do not generate or involve the use of any high-level radioactive waste. WMO is also responsible for compliance with the RCRA Part B permit, the DOE requirements for radioactive waste management, and all other applicable regulations.

3.3.6. Waste Minimization and Pollution Prevention

Argonne implements a sitewide Pollution Prevention/Waste Minimization (P2/WM) Program in accordance with DOE Order 450.1, and site-specific P2 performance measures. The P2 program tracks the generation of waste and recyclable material at Argonne and monitors the progress with regard to performance measures.

Argonne management fosters a work environment that promotes the development and implementation of P2 activities. Argonne management has established a P2 policy statement and constituted a requirement that all new project reviews include the use of a P2 review checklist. In addition, Argonne uses the ISMSs to promote and institutionalize P2 strategies across the Argonne site.

Historically, those involved in the Argonne P2 program have identified, developed, and performed Pollution Prevention Opportunity Assessments (PPOAs). PPOAs are reviews of programs, projects, and activities to determine what changes can be made to reduce or eliminate pollution. During 2007, the following were performed:

- Gate Pass Recycling: This assessment involved investigating the possibility of recycling temporary site access badges.

- Aerosol Can Recyling: This assessment involved the review of the use of an Aerosol Can Puncture Unit.

- Chemistry Division (CHM) Plastic Material Recycling: This assessment was conducted by the CHM Division to reduce plastic material entering the waste stream.

- Building 200 Solvent Recycler: This assessment involved evaluating the use of a Solvent Recycler in Building 200.

- Dosimeter Badge Recycling: This assessment involved evaluating the potential to recycle obsolete dosimeter badges that contain several metal filters.

- Energy-Efficient Fluorescent Lighting in the Technical Services Division (TSD) Central Shops Evaluation: This assessment evaluated the feasibility and benefits of increasing the use of energy-efficient fluorescent lighting in TSD Central Shops.

- Environmental Science Division (EVS) Evaluation and Energy, Lead, and Mercury Usage: This assessment was conducted by the EVS Division and examined current practices, equipment, and supplies to identify ways to reduce the use and storage of lead and mercury.

- Evaluation of the Potential for Recycling the Building 212 10-ton Crane: This assessment evaluated the potential for recycling a 10-ton crane that was scheduled for demolition.

Argonne's comprehensive solid waste recycling program effectively recycles/reduces a wide range of materials. Table 3.1 presents a summary of the results for 2007.

Many of the recycling activities result in significant savings for Argonne. For example, Argonne received approximately $50,000 for the mixed office paper and scrap metal. The other material that is recycled represents a cost avoidance for Argonne, that is, Argonne does not pay for disposal of the material.

TABLE 3.1

Recycled Materials (tons)

Material	Amount Recycled (tons)
Mixed office paper	391.27
Aluminum (70%), steel (19%), glass (10%), plastic (5%), Styrofoam (5%)	68.38
Asphalt, concrete, construction debris	190.32
Scrap metal	405.53
Computer components (PCs)	16.84
Computer monitors	27.04
Toner cartridges	1.11
Batteries	1.12
Engine lubricating oils	4.44
Fluorescent lightbulbs	4.36
Nonhazardous washer fluid	2.22
Lead/acid batteries	5.23
Transparencies	0.22
Athletic shoes	0.11

Argonne continues to utilize programs, such as the Argonne Property Excess System (APES), which allows employees and contractors to minimize waste and reuse available materials. The APES program was developed to assist Argonne employees in recycling and reusing surplus equipment, supplies, and materials by promoting the availability or need for items via the Argonne e-mail system. Also, the Argonne Chemical Exchange System is being revised so that surplus chemicals can be used.

3.3.7. Fire Department

The Fire Department provides primary support in the handling of environmental emergencies such as response to hazardous material spills and specialized training in spill prevention and cleanup.

3.3.8. Emergency Management

The Emergency Management group is responsible for maintaining the requirements of the Comprehensive Emergency Management Plan (CEMP). The CEMP identifies potential environmental concerns and impacts of issues resulting in or contributing to operational emergencies as defined in DOE Order 151.1A.

3.3.9. Committees

Identification, implementation, and conformance with environmental regulations/requirements are also assisted through Argonne-wide and division-level committees. The members of committees come from various Argonne organizations, and the representation allows for development of processes and procedures that are appropriate for Argonne environmental concerns and can be applied across the diverse Argonne organizations. Examples of such committees are the Environment, Safety, Security and Health (ESS&H) Committee; the Waste Minimization and Pollution Prevention (WM&P2) Advisory Committee; the As Low As Reasonably Achievable (ALARA) Committee; the Land Management and Habitat Restoration Committee; and the Stormwater Pollution Prevention Committee.

3.4. Strengthening Federal Environmental, Energy, and Transportation Management (EO 13423)

On January 24, 2007, the President signed EO 13423 entitled, “Strengthening Federal Environmental, Energy, and Transportation Management.” This new EO consolidates and replaces five previous EOs and two Memoranda of Understanding (MOU). It establishes new and updated goals, practices, and reporting requirements for environmental, energy, and transportation performance and accountability. This EO lists requirements to implement certain sustainable practices and to meet specific goals in specific areas, such as increasing alternative

fuel usage, increasing renewable power usage, increasing sustainability strategies for building performance and construction, increasing electronic product management, expanding affirmative procurements, reducing petroleum consumption, reducing energy intensity, reducing greenhouse gas emissions, decreasing water usage, and decreasing the use of chemical and toxic materials. Examples of the EO 13423 goals and Argonne's usage follow.

***Water Usage*:** Beginning in FY 2008, the EO 13423 goal is to reduce water consumption intensity by 2% annually through the end of FY 2015 or by 16% by the end of FY 2015 relative to the baseline water consumption established in FY 2007. Argonne receives water from two sources (Lake Michigan and the Canal Plant). Figure 3.1 shows Argonne's annual water usage from 2000 to present. The EO 13423 goal is indicated as a dashed line within the figure.

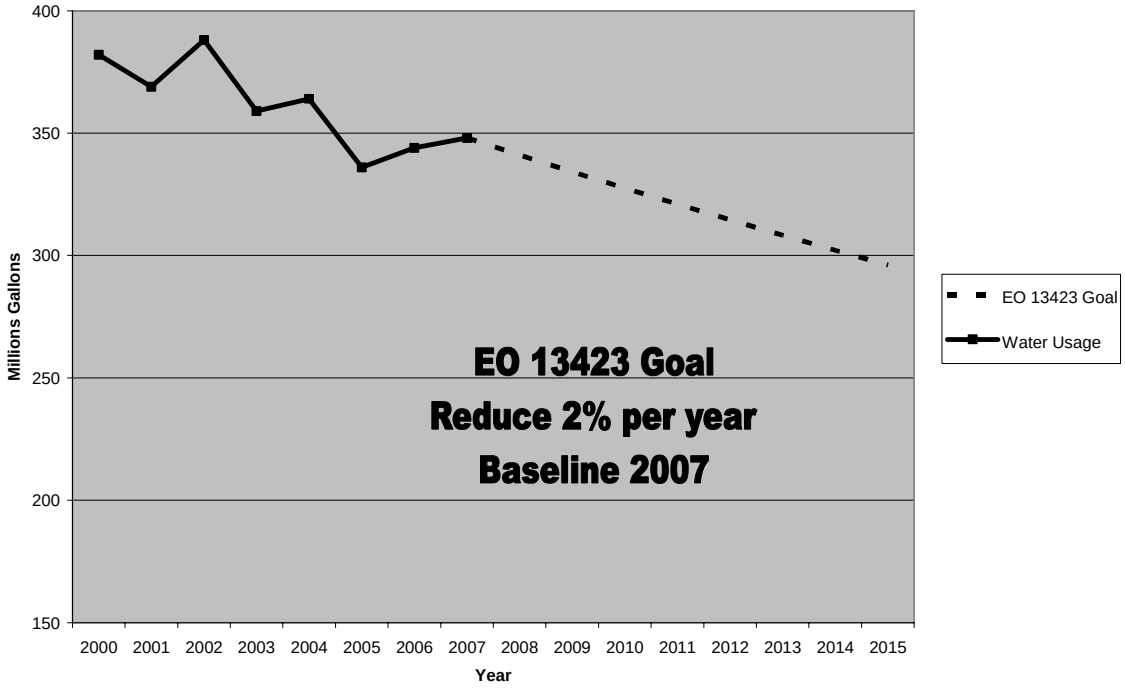

FIGURE 3.1 Water Usage

Electrical Usage: The EO 13423 goal is to improve energy efficiency and reduce greenhouse gas emissions through the reduction of energy intensity by 3% per year through the end of FY 2015 or by 30% by the end of FY 2015, relative to the baseline of energy usage in FY 2003. Figure 3.2 shows Argonne's electrical usage from 2000 to present. The EO 13423 goal is indicated by the dashed line within the figure.

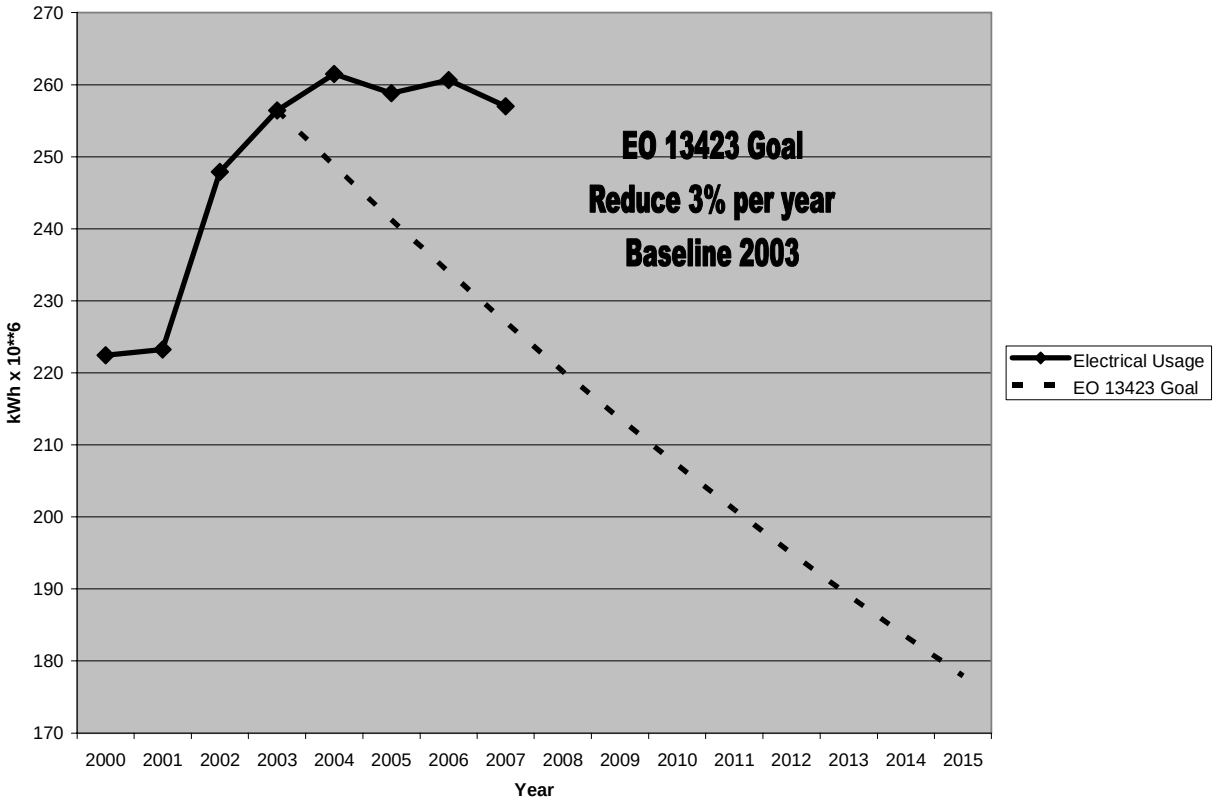

FIGURE 3.2 Electrical Usage

Motor Vehicle Fuel Usage: The EO 13423 goal is to reduce consumption of petroleum products by 2% per year through the end of FY 2015, to increase the total fuel consumption that is nonpetroleum-based by 10% annually, and to use plug-in hybrid vehicles when commercially available at a cost reasonably comparable to non-plug-in hybrid vehicles. Figure 3.3 shows Argonne's petroleum fuel usage from 2000 to the present. Figure 3.4 shows Argonne's E85 (an example of an alternative fuel) usage from 2000 to the present. The EO 13423 goals are depicted by a dashed line within each figure based on 2005 usage.

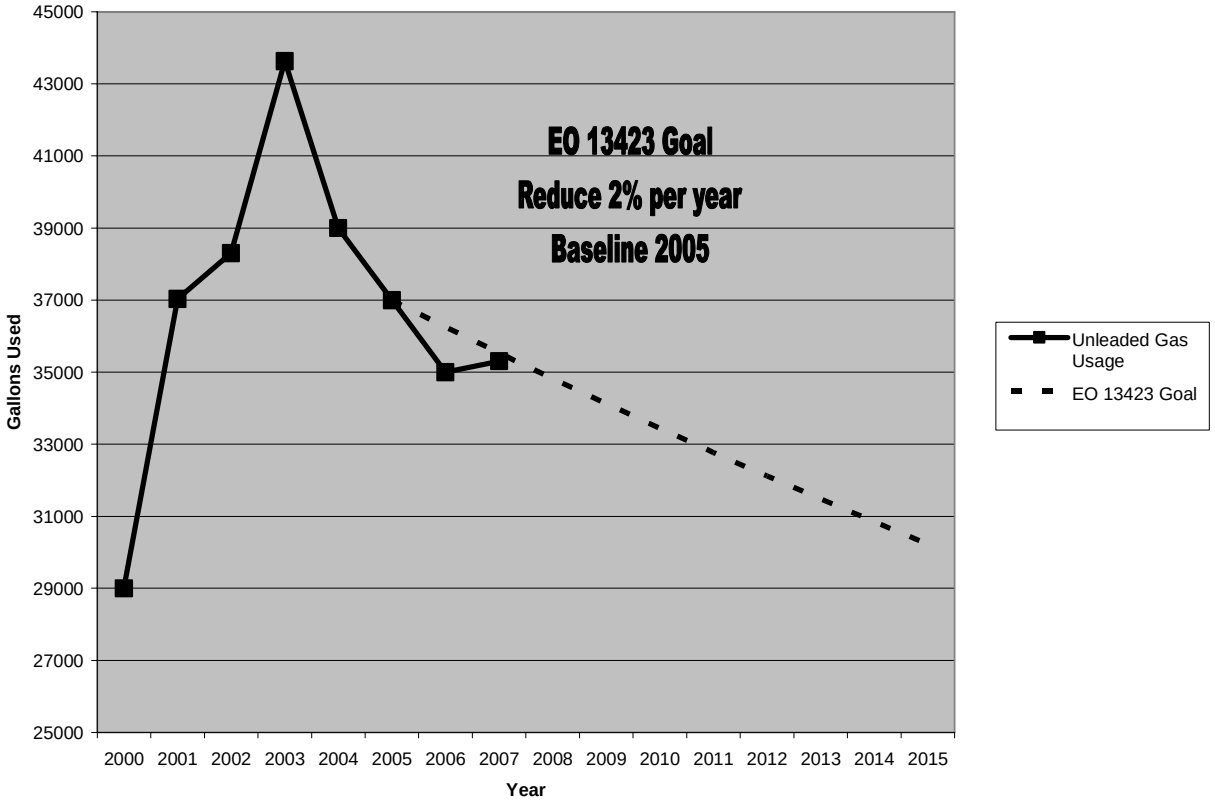

FIGURE 3.3 Unleaded Gasoline Usage

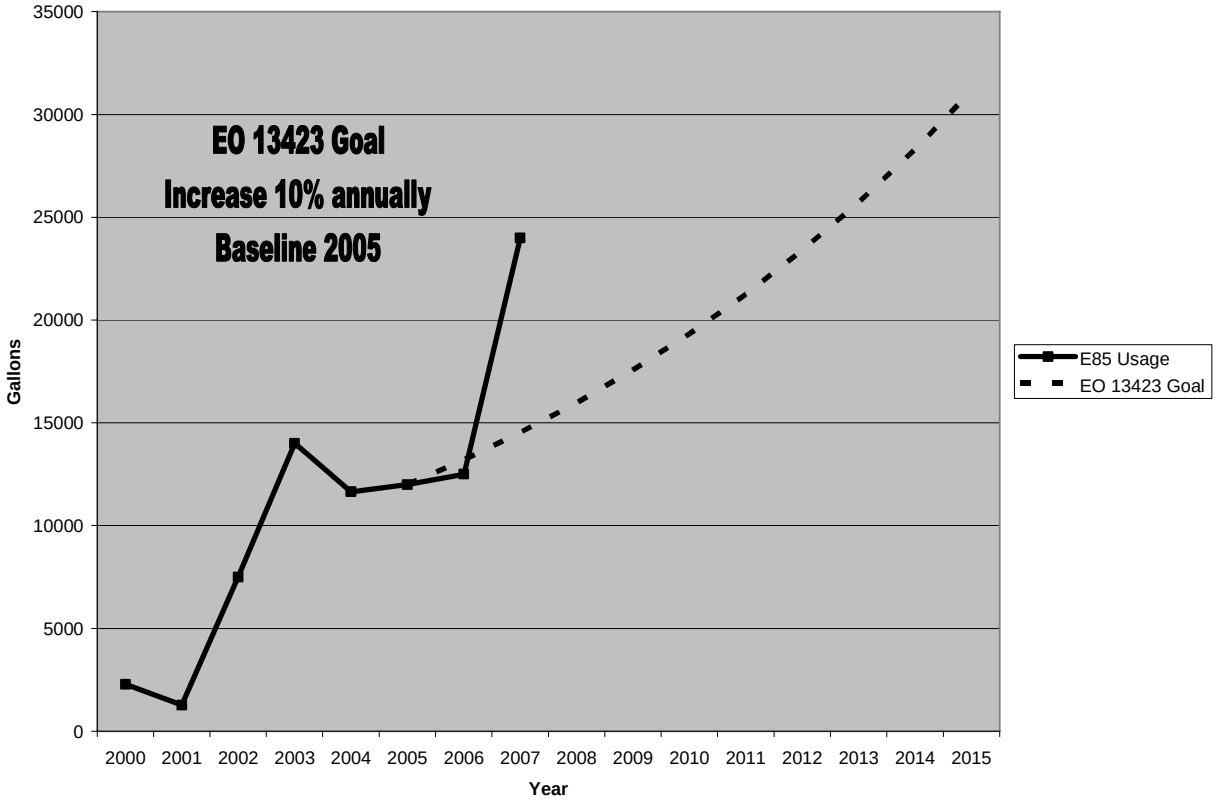

FIGURE 3.4 E85 Fuel Usage

4. ENVIRONMENTAL RADIOLOGICAL PROGRAM INFORMATION

4. ENVIRONMENTAL RADIOLOGICAL PROGRAM INFORMATION

4.1. Description of Monitoring Program

The radioactivity of the environment around Argonne in 2007 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.[4] The results of radioactivity measurements are expressed in terms of pCi/L for water, fCi/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[5] for effective dose equivalent calculations for members of the public based on International Commission on Radiological Protection (ICRP) Publications 26 and 30.[6,7] 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. To ensure that at least 90% of the total CEDE is accounted for, the DOE guidance requires that sufficient data on exposure to radionuclide sources be available. For 2007, approximately 93% of the samples that were scheduled were collected. Dry wells, dry surface water locations, or equipment failures accounted for the samples that could not be collected. 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 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[8] and were compared with the annual dose limits for uncontrolled areas. The CEDEs were calculated from the DOE Derived Concentration Guides (DCGs)[5] 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 4.24). 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. Argonne 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 12 locations around the Argonne perimeter and at 4 off-site locations approximately 8 km (5 mi) from Argonne, to determine the ambient or background concentrations. 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 Argonne, 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.

Airborne particle samples for measurement of total alpha, total beta, and gamma-ray emitters are collected continuously at 12 perimeter locations and at 4 off-site locations on glass fiber filter media. One air sampler was removed on October 1, 2007, to allow for construction of a new building (location 14H in Figure 1.1). Average flow rates on the air samplers are about 70 m^3/h (2,472 ft^3/h). Filters are changed weekly. Argonne staff change the filters on perimeter samplers, and the filters on off-site samplers are changed and mailed to Argonne by cooperating local agencies. 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 Argonne, where this information is transferred to the Environmental Protection Data Management System.

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 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 analyzed to determine alpha and beta activity. The remainder of the filter is saved.

Stack monitoring is conducted continuously at four locations (see Section 4.8.1), at 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)[9] atmospheric dispersion computer code and dose conversion method.

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 in 2007. 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 remained in place for 2 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 5 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 values 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 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 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.[10]

TABLE 4.1

Total Alpha and Beta Activities in Air Filter Samples, 2007
(concentrations in fCi/m^3)

			Alpha Activity			Beta Activity		
Month	Location	No. of Samples	Avg.	Min.	Max.	Avg.	Min.	Max.
January	Perimeter	59	0.97	< 0.1	2.77	15.60	0.1	32.2
	Off-Site	15	1.61	1.0	2.84	23.54	12.2	38.3
February	Perimeter	48	1.13	0.3	2.12	14.17	3.7	28.3
	Off-Site	12	1.82	< 0.1	5.16	17.71	< 0.1	27.5
March	Perimeter	48	1.02	0.2	2.19	13.12	4.0	21.5
	Off-Site	11	1.45	1.0	1.86	16.65	10.7	24.3
April	Perimeter	48	1.27	0.3	3.23	12.05	2.4	20.5
	Off-Site	11	1.48	0.2	2.32	12.19	1.1	17.4
May	Perimeter	60	1.39	0.5	2.53	13.69	4.0	23.6
	Off-Site	13	1.55	0.8	2.38	14.27	10.4	18.7
June	Perimeter	47	1.25	0.2	2.71	14.43	2.4	26.5
	Off-Site	11	1.57	0.7	2.33	17.57	10.3	23.4
July	Perimeter	46	1.04	< 0.1	2.04	15.44	0.7	27.4
	Off-Site	11	1.39	0.8	2.98	16.97	9.7	42.9
August	Perimeter	56	1.25	0.1	2.38	18.71	8.2	32.9
	Off-Site	20	1.84	< 0.1	4.06	23.53	1.4	48.7
September	Perimeter	47	1.22	0.3	2.42	20.69	6.3	40.1
	Off-Site	16	1.94	0.8	3.31	29.21	14.8	46.1
October	Perimeter	55	1.84	0.5	3.33	25.01	8.8	38.6
	Off-Site	19	2.30	0.4	3.85	27.70	13.7	40.4
November	Perimeter	44	2.06	1.1	3.91	28.64	17.3	51.4
	Off-Site	15	2.24	0.8	4.31	29.79	21.9	41.4
December	Perimeter	42	2.32	0.6	4.59	36.15	10.1	63.3
	Off-Site	14	3.60	1.3	8.51	42.72	21.3	65.2
Annual	Perimeter	600	1.38 ± 0.3	< 0.1	4.59	18.58 ± 0.7	0.1	63.3
Summary	Off-Site	168	1.94 ± 0.4	< 0.1	8.51	23.60 ± 0.9	< 0.1	65.2

TABLE 4.2

Gamma-Ray Activity in Air Filter Samples, 2007
(concentrations in fCi/m^3)

Month	Location	Beryllium-7	Lead-210
January	Perimeter	55	17
	Off-Site	63	19
February	Perimeter	65	14
	Off-Site	76	17
March	Perimeter	102	12
	Off-Site	92	10
April	Perimeter	115	10
	Off-Site	86	7
May	Perimeter	136	12
	Off-Site	98	8
June	Perimeter	122	12
	Off-Site	109	10
July	Perimeter	110	12
	Off-Site	86	9
August	Perimeter	111	12
	Off-Site	103	15
September	Perimeter	108	18
	Off-Site	108	19
October	Perimeter	124	21
	Off-Site	99	19
November	Perimeter	112	27
	Off-Site	83	23
December	Perimeter	105	35
	Off-Site	98	34
Annual	Perimeter	105	17
Summary	Off-Site	92	16
Dose (mrem)	Perimeter	(0.00026)	(1.94)
	Off-Site	(0.00023)	(1.82)

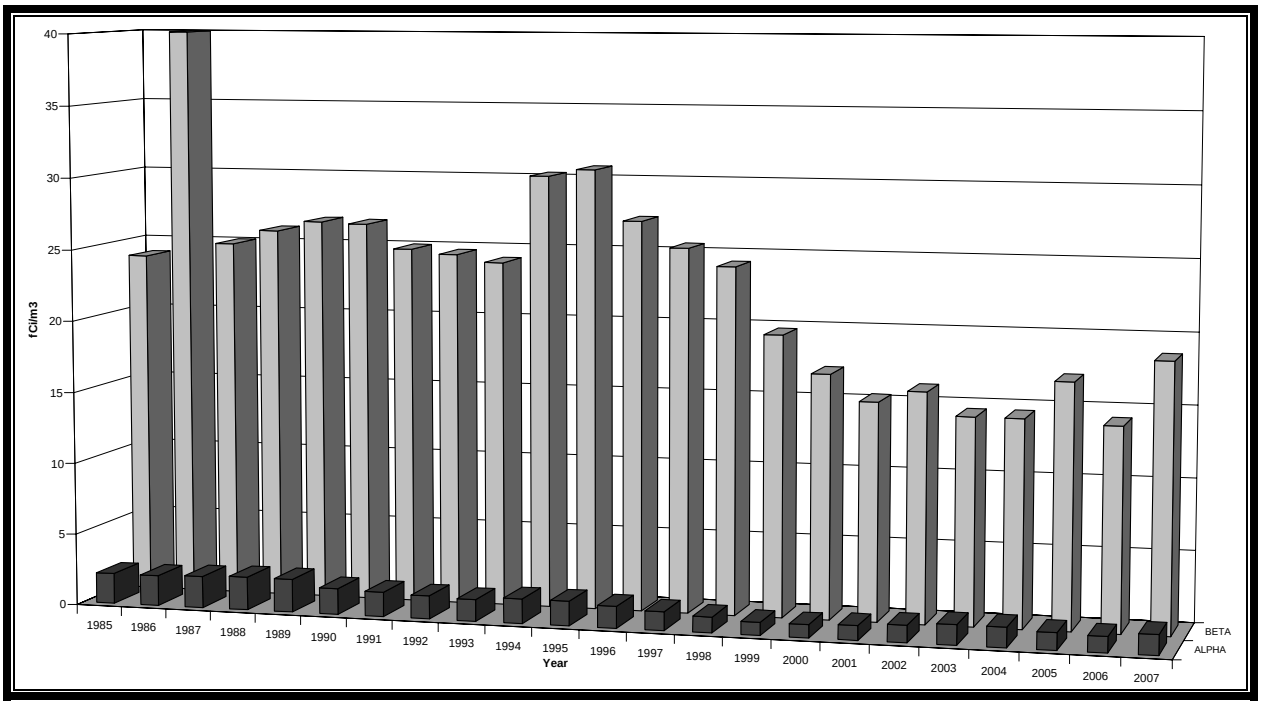

FIGURE 4.1 Comparison of Total Alpha and Beta Activities in Air Filter Samples, 1985 to 2007

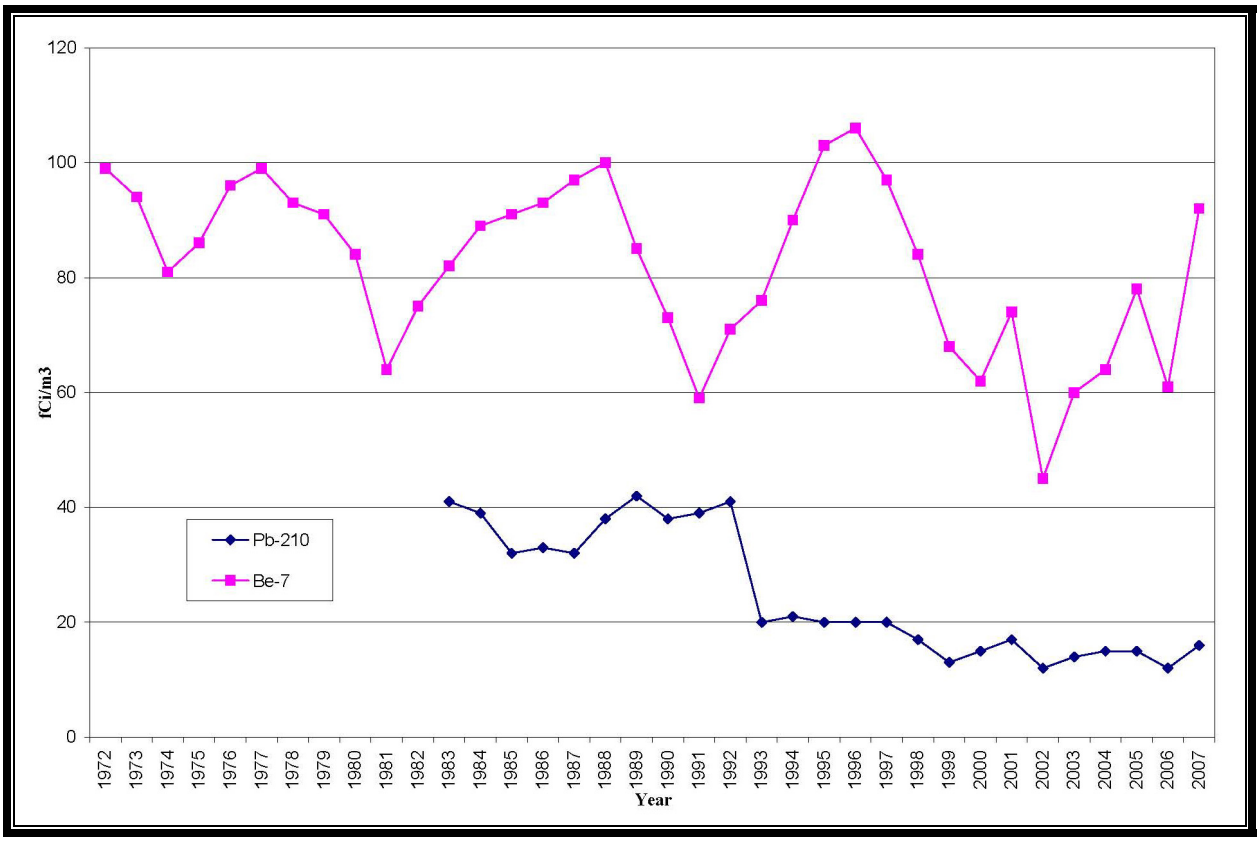

FIGURE 4.2 Comparison of Gamma-Ray Activity in Air Filter Samples, 1972 to 2007

The major airborne effluents released at Argonne during 2007 are listed by location in Table 4.3. 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 compared with previous years. The hydrogen-3 emitted from Building 212 is from hydrogen-3 recovery studies, while short-lived neutron activation products were emitted from the IPNS and APS (the operation of IPNS was terminated at the end of 2007). In addition to the radionuclides listed in Table 4.3, several other fission products also were released in millicurie or smaller amounts. The quantities listed in Table 4.3 were measured by on-line stack monitors in the exhaust systems of the buildings, except those for Buildings 350 and 411.

Phytoremediation is being performed in 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 shallow-rooted willow and special deep-rooted poplar trees. Approximately 800 poplar trees were planted in the fall of 1999. In 2003, approximately 200 willow trees were planted to expand the system near the French drains.

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

TABLE 4.3

Summary of Airborne Radioactive Emissions from Argonne Facilities, 2007

Building	Nuclide	Half-Life	Amount Released (Ci)	Amount Released (Bq)
200	Radon-220	56 s	30	1.1×10^{12}
212 (Alpha-Gamma Hot Cell Facility)	Hydrogen-3 (tritiated water vapor [HTO])	12.3 yr	5.0	2.0×10^{11}
	Hydrogen-3 (tritiated hydrogen gas [HT])	12.3 yr	19.0	7.0×10^{11}
	Krypton-85	10.7 yr	0.3	1.1×10^{10}
	Radon-220	56 s	0.12	4.4×10^{9}
350 (NBL)	Uranium-234	2.4×10^{5} yr	3.4×10^{-7}	1.2×10^{2}
	Uranium-238	4.5×10^{9} yr	3.4×10^{-7}	1.2×10^{2}
375 (IPNS)	Carbon-11	20 min	1090.0	4.0×10^{13}
	Argon-41	1.8 h	31.0	1.1×10^{11}
411/415 (APS)	Carbon-11	20 min	1.3	4.8×10^{10}
	Nitrogen-13	10 min	59.0	2.2×10^{12}
	Oxygen-15	122 s	6.3	2.3×10^{11}

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.

Quarterly monitoring is conducted at the 18 wells that are within the phytoremediation plantation. The average hydrogen-3 concentration for 2007 for all the wells was 458 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 2007, the total hydrogen-3 released was 0.008 Ci. Applying the CAP-88 code,[9] an estimate of the annual dose to the maximally exposed individual was 0.0000001 mrem. This estimated dose is extremely small compared with the 10-mrem annual dose limit of NESHAP.

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 (0.3 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-232 or 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 as radioactive waste. 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. If the radioactivity is below the release limits, the wastewater is conveyed to the LWTP in dedicated pipes to waste storage tanks. At the influent to the LWTP, all effluent wastewater is screened for gamma-ray radioactivity. 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.[5]

Another component of the radiological effluent monitoring program 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 5.9). 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 4.4 gives the results for 2007. The results show that the radionuclides hydrogen-3 and possibly strontium-90 detected in the effluent water can be attributed to Argonne operations. However, analysis of the Argonne domestic water, which is obtained from Lake Michigan, indicates the presence of strontium-90 at about 0.4 pCi/L. This was confirmed by

TABLE 4.4

Radionuclides in Effluents from the Argonne Wastewater Treatment Plant, 2007

		Concentrations in pCi/L			Dose (mrem)		
Activity	No. of Samples	Avg.	Min.	Max.	Avg.	Min.	Max.
Alpha	52	0.79	< 0.1	3.73	–[a]	–	–
Beta	52	12.60	7.44	24.31	–	–	–
Hydrogen-3	52	< 100	< 100	375	< 0.0046	< 0.0046	0.0173
Strontium-90	52	0.35	0.27	0.46	0.034	0.026	0.044
Cesium-137	52	< 2.0	< 2.0	< 2.0	< 0.07	< 0.07	< 0.07
Uranium-234	52	0.30	0.06	0.74	0.057	0.011	0.141
Uranium-238	52	0.26	0.03	0.69	0.043	0.005	0.114
Neptunium-237	52	< 0.0010	< 0.0010	0.0012	< 0.0028	< 0.0028	0.0034
Plutonium-238	52	< 0.0010	< 0.0010	0.0017	< 0.0028	< 0.0028	0.0048
Plutonium-239	52	< 0.0010	< 0.0010	0.0014	< 0.0031	< 0.0031	0.0043
Americium-241	52	< 0.0010	< 0.0010	0.0074	< 0.0033	< 0.0033	0.0244
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.

the direct analysis of Lake Michigan water. The concentrations are well below the DOE limits. These findings confirmed Argonne 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 (1.10×10^9 L) is computed. These results are given in Table 4.5.

TABLE 4.5

Total Radioactivity Released, 2007

Radionuclide	WTP Outfall (Ci)
Hydrogen-3	0.10
Strontium-90	0.0004
Uranium-234	0.0003
Uranium-238	0.0003
Plutonium-239	<0.0001
Other transuranics	<0.0001
Total	0.10

Treated Argonne wastewater is discharged into Sawmill Creek (Location 7M in Figure 1.1). The creek runs through the Argonne 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 Argonne wastewater outfall. Sawmill Creek was sampled upstream from the Argonne site and downstream from the wastewater discharge point to determine whether radioactivity was added to the stream by Argonne 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 analyzed for the same radionuclides measured in the below-outfall samples.

Table 4.6 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 Argonne 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, downstream of the Argonne outfall, the annual average concentrations of most measured radionuclides were similar to recent annual averages. All annual averages were well below the applicable DOE standards.

On the basis of the results of the Stormwater Characterization Study, two perimeter surface water locations that contained measurable levels of radionuclides were identified. 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 at Location 7J and hydrogen-3 at Location 11D. The results are presented in Table 4.7.

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. The final cap was installed in 1999. Since the construction and operation of the leachate collection system and cap, 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

TABLE 4.6

Radionuclides in Sawmill Creek Water, 2007

Activity	Location[a]	No. of Samples	Concentrations (pCi/L) Avg.	Min.	Max.	Dose (mrem) Avg.	Min.	Max.
Alpha	16K	12	2.6	0.43	18.95	–[b]	–	–
(nonvolatile)	7M	52	0.9	< 0.10	5.08	–	–	–
Beta	16K	12	5.2	3.62	6.84	–	–	–
(nonvolatile)	7M	52	10.6	4.37	18.86	–	–	–
Hydrogen-3	16K	12	< 100	< 100	131	< 0.0046	< 0.0046	0.0060
	7M	52	< 100	< 100	401	< 0.0046	< 0.0046	0.0184
Strontium-90	16K	12	< 0.25	< 0.25	< 0.25	< 0.024	< 0.024	< 0.024
	7M	51	0.30	< 0.25	0.43	0.029	< 0.024	0.041
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	0.777	0.153	1.407	0.148	0.029	0.269
	7M	52	0.376	0.052	1.314	0.072	0.010	0.251
Uranium-238	16K	12	0.696	0.143	1.297	0.116	0.024	0.215
	7M	52	0.335	0.046	0.958	0.056	0.008	0.159
Neptunium-237	16K	12	< 0.0010	< 0.0010	< 0.0010	< 0.0028	< 0.0028	< 0.0028
	7M	52	< 0.0010	< 0.0010	< 0.0010	< 0.0028	< 0.0028	< 0.0028
Plutonium-238	16K	12	< 0.0010	< 0.0010	0.0024	< 0.0028	< 0.0028	0.0067
	7M	52	< 0.0010	< 0.0010	0.0014	< 0.0028	< 0.0028	0.0039
Plutonium-239	16K	12	< 0.0010	< 0.0010	< 0.0010	< 0.0031	< 0.0031	< 0.0031
	7M	52	< 0.0010	< 0.0010	0.0030	< 0.0031	< 0.0031	0.0093
Americium-241	16K	12	< 0.0010	< 0.0010	< 0.0010	< 0.0033	< 0.0033	< 0.0033
	7M	52	< 0.0010	< 0.0010	0.0043	< 0.0033	< 0.0033	0.0141
Curium-242 and/or	16K	12	< 0.0010	< 0.0010	< 0.0010	< 0.0007	< 0.0007	< 0.0007
Californium-252	7M	52	< 0.0010	< 0.0010	< 0.0010	< 0.0007	< 0.0007	< 0.0007
Curium-244 and/or	16K	12	< 0.0010	< 0.0010	< 0.0010	< 0.0034	< 0.0034	< 0.0034
Californium-249	7M	52	< 0.0010	< 0.0010	< 0.0010	< 0.0034	< 0.0034	< 0.0034

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

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

TABLE 4.7

Radionuclides in Stormwater Outfalls, 2007
(concentrations in pCi/L)

Date Collected	Location 7J			Location 11D
	Hydrogen-3	Strontium-90	Cesium-137	Hydrogen-3
January 5	<100	0.53	<2	Dry
April 12	<100	0.50	<2	Dry
August 20	<100	0.48	<2	<100
December 12	<100	0.34	<2	Dry

from earlier years is due to the completion of the clay cap on the 800 Area Landfill in the fall of 1993.

One of the Argonne waste management locations is within the 398A Area 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 stormwater flow through the 398A Area, quarterly sampling is conducted from the 398A Area 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 detected no radionuclides associated with Argonne 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 Argonne wastewater to environmental radioactivity. The Des Plaines River was sampled twice a month downstream and once a month upstream of the mouth of Sawmill Creek to determine whether the radioactivity in the creek had any effect on the radioactivity in the river. Table 4.8 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. Average 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 the drying, grinding, and mixing of portions of each of the bottom sediment samples, the samples were analyzed by the methods described in prior reports[11] 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 (110ºC [230ºF]) weight.

TABLE 4.8

Radionuclides in Des Plaines River Water, 2007

Activity	Location[a]	No. of Samples	Concentrations (pCi/L) Avg.	Min.	Max.	Dose (mrem) Avg.	Min.	Max.
Alpha	A	12	1.1 ± 0.5	< 0.1	2.3	–[b]	–	–
(nonvolatile)	B	24	1.2 ± 0.5	< 0.1	5.3	–	–	–
Beta	A	12	10.9 ± 0.3	6.76	15.97	–	–	–
(nonvolatile)	B	24	11.8 ± 0.4	7.00	17.28	–	–	–
Hydrogen-3	A	12	< 100	< 100	116	< 0.0046	< 0.0046	0.0053
	B	24	< 100	< 100	184	< 0.0046	< 0.0046	0.0085
Strontium-90	A	12	< 0.25	< 0.25	0.26	< 0.024	< 0.024	0.025
	B	24	< 0.25	< 0.25	0.27	< 0.024	< 0.024	0.026
Uranium-234	A	12	0.485 ± 0.055	0.261	0.747	0.093	0.050	0.143
	B	24	0.474 ± 0.055	0.138	0.824	0.090	0.026	0.157
Uranium-238	A	12	0.426 ± 0.050	0.251	0.697	0.071	0.042	0.116
	B	24	0.408 ± 0.047	0.115	0.703	0.068	0.019	0.117
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	< 0.0010	< 0.0028	< 0.0028	< 0.0028
	B	12	< 0.0010	< 0.0010	< 0.0010	< 0.0028	< 0.0028	< 0.0028
Plutonium-239	A	12	< 0.0010	< 0.0010	0.0015	< 0.0031	< 0.0031	0.0047
	B	12	< 0.0010	< 0.0010	0.0012	< 0.0031	< 0.0031	0.0037
Americium-241	A	12	< 0.0010	< 0.0010	< 0.0010	< 0.0033	< 0.0033	< 0.0033
	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.

TABLE 4.9

Radionuclides in Bottom Sediment, 2007

Sawmill Creek Location	Concentration (pCi/g)					Concentration (fCi/g)		
	Potassium-40	Cesium-137	Radium-226	Thorium-228	Thorium-232	Plutonium-238	Plutonium-239	Americium-241
25 m above outfall	11.74 ± 0.53	0.02 ± 0.01	0.60 ± 0.04	0.38 ± 0.03	0.39 ± 0.06	0.14 ± 0.26	0.32 ± 0.44	0.70 ± 0.21
At outfall	12.42 ± 0.54	0.06 ± 0.02	0.80 ± 0.05	0.41 ± 0.03	0.43 ± 0.06	0.09 ± 0.18	0.36 ± 0.35	5.75 ± 1.63
50 m below outfall	17.20 ± 0.63	< 0.1	0.77 ± 0.05	0.58 ± 0.03	0.52 ± 0.07	0.05 ± 0.18	0.50 ± 0.35	0.02 ± 0.24
100 m below outfall	13.80 ± 0.57	0.07 ± 0.02	0.67 ± 0.05	0.46 ± 0.03	0.43 ± 0.06	0.45 ± 0.35	9.63 ± 1.59	2.89 ± 1.11
At Des Plaines River	20.20 ± 0.68	0.15 ± 0.02	1.12 ± 0.06	0.80 ± 0.03	0.86 ± 0.08	0.27 ± 0.26	13.60 ± 1.94	4.28 ± 1.36

A set of sediment samples was collected on October 24, 2007, from the Sawmill Creek bed, above, at the outfall, and at several locations below the point at which Argonne discharges its treated wastewater (Location 7M in Figure 1.1). The results, as listed in Table 4.9, 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.[11] The plutonium, americium, and cesium-137 concentrations are elevated below the outfall, which indicates that their origin is in Argonne wastewater. Plutonium results varied widely among locations and were strongly dependent on the retentiveness of the sediment 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 Argonne site were measured with aluminum oxide thermoluminescent dosimeter (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.

The results are summarized in Tables 4.10 and 4.11, and the site boundary and on-site readings are shown in Figure 4.3. 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 102 ± 13 mrem/yr and were similar to last year's off-site average of 101 ± 6 mrem/yr.[12] 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 102 ± 18 mrem/yr may be considered to be the average natural background with a 95% probability. Only three locations had radiation levels above the off-site results. None of these were at the site perimeter.

TABLE 4.10

Environmental Penetrating Radiation at Off-Site Locations, 2007

	Period of Measurement (Dose Rate [mrem/yr])				
Location	Jan. 2–April 3	April 3–July 2	July 2–Oct. 1	Oct. 1–Jan. 3	Average
Lemont	95	103	99	95	98 ± 4
Oak Brook	111	108	92	93	101 ± 10
Orland Park	112	120	122	141	124 ± 12
Willow Springs	71	100	96	79	87 ± 14
Woodridge	96	104	103	101	101 ± 4
Average	97 ± 16	107 ± 8	102 ± 12	102 ± 23	102 ± 13

TABLE 4.11

Environmental Penetrating Radiation at Argonne, 2007

Location[a]	Period of Measurement (Dose Rate [mrem/yr]) Jan. 2–April 3	April 3–July 2	July 2–Oct. 1	Oct. 1–Jan. 3	Average
14G – Boundary	103	120	114	101	110 ± 9
14I – Boundary	–[b]	107	101	88	104 ± 10
14L – Boundary	101	101	95	97	99 ± 3
6I – 200 m N of Quarry Road	85	110	98	95	97 ± 10
7I – Center, Waste Storage Area Facility 317	95	100	112	95	101 ± 8
7I – Boundary	92	102	109	–	101 ± 9
8H – Boundary	94	105	112	94	101 ± 9
8H – 65 m S of Building 316	96	101	118	88	101 ± 13
8H – 200 m NW of Waste Storage Area (Heliport)	90	102	123	116	108 ± 15
8H – Boundary, Center, St. Patrick Cemetery	105	110	124	97	109 ± 11
9H – 50 m SE of CP-5	95	72	122	92	100 ± 15
9H/I – 50 m E of Building 331	396	479	422	142	320 ± 149
9/10I – E of D306	267	498	436	270	368 ± 117
9/10I – 65 m NE of Building 350 230 m NE of Building 316	85	99	107	87	95 ± 10
9/10E/F – Boundary	97	118	127	105	112 ± 13
9J – 50 m W of 398A Area	516	756	732	718	681 ± 111
10/11K – Lodging Facilities	109	97	105	92	103 ± 8

[a] See Figure 1.1.

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

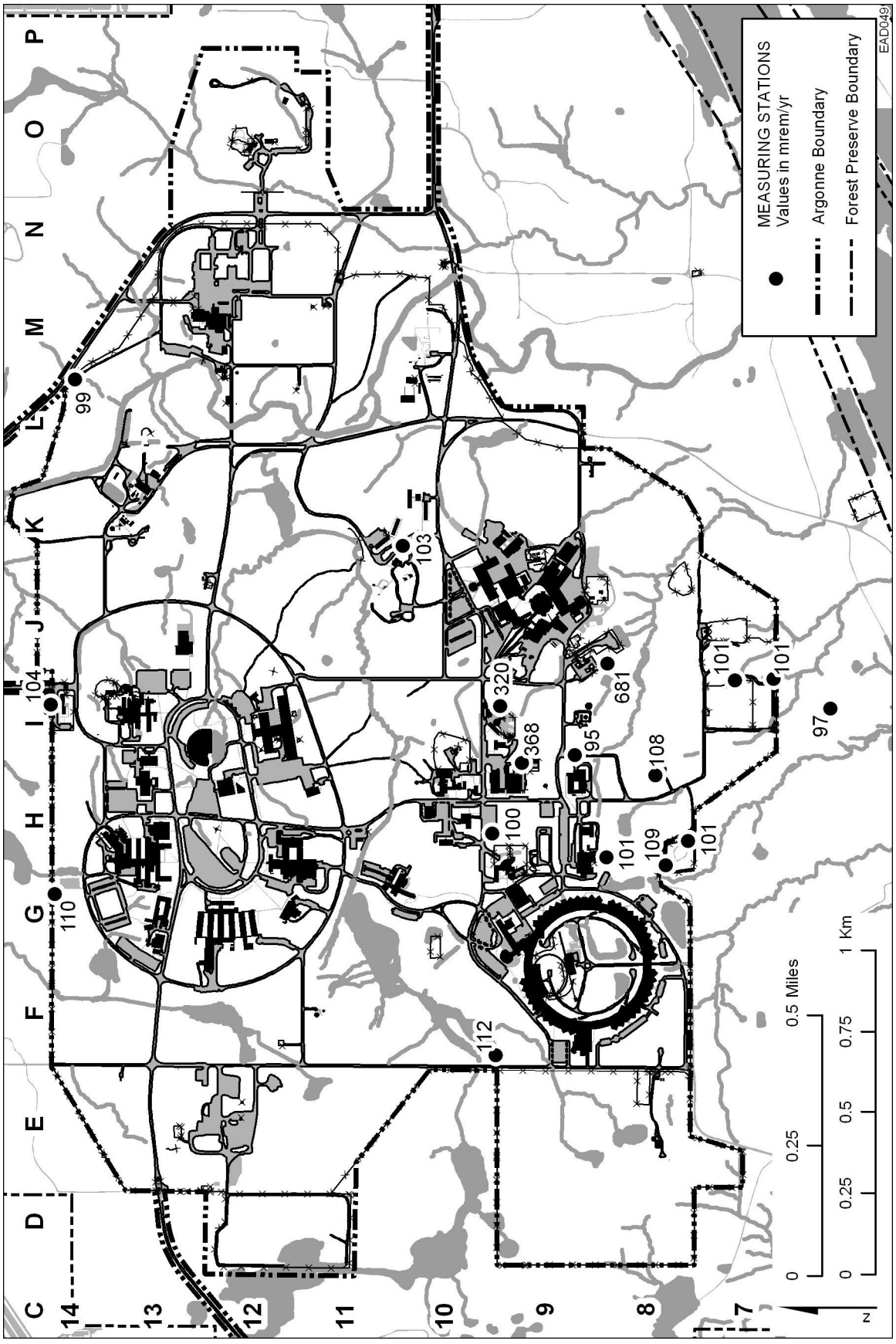

FIGURE 4.3 Penetrating Radiation Measurements at the Argonne Site, 2007

The site boundary at Location 7I had past dose rates above the average background. This was the result of radiation from Argonne'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 2007, the dose at this perimeter fence location was 101 ± 9 mrem/yr. Approximately 300 m (960 ft) south of the fence in grid 6I, the measured dose is 97 ± 10 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 100 mrem/yr in 2007.

Three locations were added to monitor radioactive waste facilities and areas. Significant movement of radioactive waste took place, principally waste from the D&D activities and the relocation of radioactive waste from the 317 Area to the 398A Area. Some waste is repacked in Building 306 (Location 9/10I). 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 9H/I) is being used as a staging area to load trucks for shipment off-site. A number of radioactive waste shipments were made during 2007, 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 the IPNS. Although Argonne 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 in 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 4.8.1.

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 unaffected by Argonne operations. The neutron dosimeters were changed quarterly. The results are given in Table 4.12 and shown in Figure 4.4.

TABLE 4.12

Fast Neutron Dose at Argonne, 2007

Location	Period of Measurement (dose equivalent for measurement period in mrem)				
	Jan. 2–April 3	April 3–July 2	July 2–Oct. 2	Oct 2.–Jan. 3	Total
On-Site					
60 m NE of Bldg. 375	30	< 1	< 1	–[a]	30
30 m NW of Bldg. 375	< 1	< 1	< 1	< 1	< 1
45 m SW of Bldg. 375	< 1	< 1	< 1	–	< 1
60 m S of Bldg. 375	< 1	< 1	< 1	–	< 1
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	20	< 1	< 1	20
120 m WNW of ATLAS	< 1	< 1	< 1	–	< 1
Off-Site					
Woodridge	< 1	< 1	< 1	< 1	< 1

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

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 the IPNS did not operate continuously, there were time periods of up to a month when the system was not generating neutrons. The monitored locations are outside but near the facility. Although these areas are not continuously occupied, measurements in 2007 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. Operations at the IPNS facility were terminated at the end of 2007.

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.

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 4.12. No fast neutron dose was measurable at most of the ATLAS dosimeter locations.

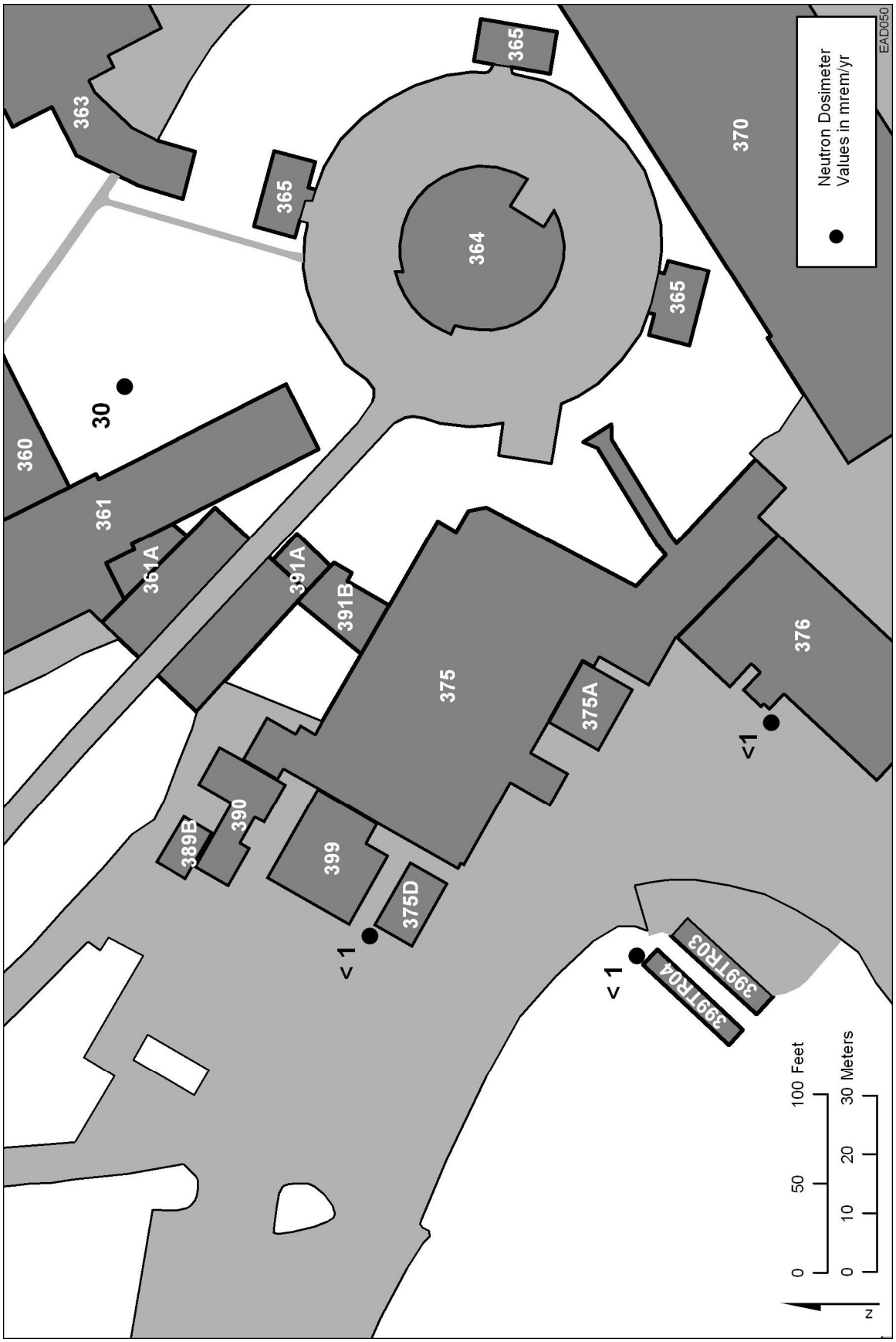

FIGURE 4.4 Neutron Dose Measurements, 2007

4.7. Compliance with DOE Order 435.1

DOE Order 435.1, "Radioactive Waste Management," requires that an environmental monitoring and surveillance program be conducted to determine any releases or migration from low-level radioactive waste treatment, storage, or disposal sites. Compliance with these requirements is an integral part of the Argonne sitewide monitoring and surveillance program. Waste management operations in general are covered by relying on the perimeter air monitoring network and monitoring of the liquid effluent streams and Sawmill Creek.

Of particular interest is monitoring of the waste management activities conducted in the 317 Area. These include air particulate monitoring for total alpha, total beta, and gamma-ray emitters; direct radiation measurements with TLDs; surface water discharges for hydrogen-3 and gamma-ray emitters; and subsurface water samples at all 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 here and in Chapters 5 and 6 of this report.

During 2007, Argonne did not release any property containing residual radioactive material for recycle or reuse. All property that contained residual radioactivity, based on the criteria in DOE Order 5400.5, was disposed of in an off-site low-level radioactive disposal facility.

4.8. 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.

4.8.1. Airborne Pathway

DOE facilities with airborne releases of radioactive materials are subject to 40 CFR Part 61, Subpart H,[13] which requires the use of the EPA's CAP-88 code[9] to calculate the dose for radionuclides released to the air and to demonstrate compliance with the regulation. The dose limit applicable for 2007 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 2007, 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 4.3. Separate calculations were performed for each of the five 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 Argonne. 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 4.3) 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 Building 200 (Tables 4.13 and 4.14), Building 212 (Tables 4.15 and 4.16), Building 350 (Tables 4.17 and 4.18), Building 375 (Tables 4.19 and 4.20), and Building 411/415 (APS) (Tables 4.21 and 4.22). The doses given in these tables are the committed whole body effective dose equivalents.

TABLE 4.13

Radiological Airborne Releases from Building 200, 2007

Direction	Distance to Perimeter (m)	Dose[a] (mrem/yr)	Distance to Nearest Resident (m)	Dose[a] (mrem/yr)
N	500	2.5×10^{-2}	1,000	8.6×10^{-3}
NNE	600	2.8×10^{-2}	1,100	1.1×10^{-2}
NE	750	1.9×10^{-2}	2,600	2.5×10^{-3}
ENE	1,700	4.5×10^{-3}	3,100	1.7×10^{-3}
E	2,400	2.8×10^{-3}	3,500	1.3×10^{-3}
ESE	2,200	2.8×10^{-2}	3,600	1.3×10^{-3}
SE	2,100	2.7×10^{-3}	4,000	9.5×10^{-4}
SSE	2,000	2.4×10^{-3}	4,000	8.2×10^{-4}
S	1,500	5.1×10^{-3}	4,000	1.4×10^{-3}
SSW	1,000	3.0×10^{-3}	2,500	7.9×10^{-4}
SW	800	1.4×10^{-2}	2,200	2.7×10^{-3}
WSW	1,100	1.2×10^{-2}	1,500	8.4×10^{-3}
W	750	1.5×10^{-2}	1,500	5.2×10^{-3}
WNW	800	1.1×10^{-2}	1,300	5.3×10^{-3}
NW	600	1.6×10^{-2}	1,100	6.0×10^{-3}
NNW	600	1.5×10^{-2}	800	1.0×10^{-2}

[a] Source term: radon-220 = 30 Ci (plus daughters).

TABLE 4.14

Maximum Perimeter and Individual Doses
from Building 200 Air Emissions, 2007
(dose in mrem/yr)

Pathway	Perimeter (600 m NNE)	Individual (1,100 m NNE)
Ingestion	4.0×10^{-17}	1.2×10^{-17}
Inhalation	2.8×10^{-2}	1.1×10^{-2}
Air immersion	3.0×10^{-5}	1.1×10^{-5}
Ground surface	2.3×10^{-6}	9.4×10^{-6}
Total	2.8×10^{-2}	1.1×10^{-2}
Radionuclide		
Thallium-208	4.0×10^{-5}	1.6×10^{-5}
Bismuth-212	2.5×10^{-3}	9.5×10^{-4}
Lead-212	2.6×10^{-2}	9.9×10^{-3}
Radon-220	7.0×10^{-9}	2.7×10^{-9}
Total	2.8×10^{-2}	1.1×10^{-2}

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 30 Ci, because of the termination of the nuclear medical program that separates radium-224 from the thorium-228 parent and the continued D&D of other cells.

The doses from each of the CAP-88 dose assessments were combined on the basis of the assumption that the IPNS is the central emission point for the site. The 16 compass directions from the IPNS were established for each perimeter and actual resident location. The five individual building assessments were then overlayed on the IPNS grid, and the estimated dose was summed according to which values fell within the IPNS 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.

The highest perimeter dose was in the east direction, with a maximum value of 0.22 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 lower than 2006 due to reduced carbon-11 emissions from the IPNS.

The full-time resident who would receive the largest annual dose (0.045 mrem/yr), if he or she were outdoors during the entire year, is located approximately 2.7 km (1.7 mi)

TABLE 4.15

Radiological Airborne Releases from Building 212, 2007

Direction	Distance to Perimeter (m)	Dose[a] (mrem/yr)	Distance to Nearest Resident (m)	Dose[a] (mrem/yr)
N	800	6.5×10^{-4}	2,000	1.6×10^{-4}
NNE	1,000	6.7×10^{-4}	2,500	1.6×10^{-4}
NE	1,300	4.2×10^{-4}	2,000	2.1×10^{-4}
ENE	1,500	3.0×10^{-4}	2,500	1.3×10^{-4}
E	1,600	2.6×10^{-4}	2,800	1.0×10^{-4}
ESE	1,200	4.0×10^{-4}	2,500	1.3×10^{-4}
SE	1,400	2.8×10^{-4}	3,500	6.5×10^{-5}
SSE	1,400	2.3×10^{-4}	4,500	3.9×10^{-5}
S	1,500	2.6×10^{-4}	5,000	5.6×10^{-5}
SSW	1,600	8.3×10^{-5}	5,000	1.6×10^{-5}
SW	1,400	3.1×10^{-4}	2,400	1.3×10^{-4}
WSW	1,300	5.2×10^{-4}	2,300	2.6×10^{-4}
W	1,700	2.3×10^{-4}	2,200	1.5×10^{-4}
WNW	1,500	2.3×10^{-4}	2,000	1.5×10^{-4}
NW	1,300	2.5×10^{-4}	2,000	1.3×10^{-4}
NNW	1,000	3.8×10^{-4}	2,000	1.4×10^{-4}

[a] Source terms: hydrogen-3 = 19.0 Ci (HT = gaseous tritium)
hydrogen-3 = 5.0 Ci (HTO = tritiated water vapor)
krypton-85 = 0.3 Ci
antimony-125 = 5.0×10^{-7} Ci
iodine-125 = 1.0×10^{-8} Ci
iodine-129 = 4.0×10^{-7} Ci
radon-220 = 0.12 Ci

west-southwest (WSW) of the IPNS facility. The major contributor to the whole body dose is the air immersion dose from carbon-11 (0.039 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 NESHAP reportable dose to the maximally exposed individual would also be 0.045 mrem/yr.

The individual doses to the maximally exposed member of the public and the maximum fence line dose are shown in Figure 4.5. 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 2004 is principally due to increased emissions from the IPNS as a result of increased operating time.

TABLE 4.16

Maximum Perimeter and Individual Doses
from Building 212 Air Emissions, 2007
(dose in mrem/yr)

Pathway	Perimeter (1,000 m NNE)	Individual (2,300 m WSW)
Ingestion	1.4×10^{-4}	5.5×10^{-5}
Inhalation	5.3×10^{-4}	2.0×10^{-4}
Air immersion	2.2×10^{-7}	8.6×10^{-8}
Ground surface	3.6×10^{-8}	1.4×10^{-8}
Total	6.7×10^{-4}	2.6×10^{-4}
Radionuclide		
Hydrogen-3	6.5×10^{-4}	2.5×10^{-4}
Krypton-85	2.2×10^{-7}	8.4×10^{-8}
Antimony-125	1.2×10^{-8}	4.6×10^{-9}
Iodine-125	3.4×10^{-11}	8.1×10^{-12}
Iodine-129	3.6×10^{-7}	8.6×10^{-8}
Radon-220	1.2×10^{-11}	4.7×10^{-12}
Total	6.7×10^{-4}	2.6×10^{-4}

The population data in Table 1.1 were used to calculate the cumulative population dose from airborne radioactive effluents from Argonne operations. The results are given in Table 4.23, 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.[14] It is assumed that this dose is representative of the entire area within an 80-km (50-mi) radius. The population dose resulting from Argonne operations since 1987 is shown in Figure 4.6.

The significant increase in population dose in 2006 and 2007 compared with earlier years is due to a change in the dispersion calculation in Version 3.0 of CAP-88. In the past, Version 1.0 of CAP-88 was used. The change to Version 3.0 involved the replacement of the dispersion section used in Version 1.0 with the methodology from the ICRP.[6,7] Although technically more correct, the effect is to increase the apparent population dose, which is accentuated by a combination of short half-life gases coupled with a large receptor population. This appears to be the case for Argonne.

The potential radiation exposures by the inhalation pathways also were calculated by the methodology specified in DOE Order 5400.5.[5] 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.[15] This annual intake is then multiplied by the CEDE conversion factor for the appropriate lung retention class.[5] The CEDE conversion factors

TABLE 4.17

Radiological Airborne Releases from Building 350, 2007

Direction	Distance to Perimeter (m)	Dose[a] (mrem/yr)	Distance to Nearest Resident (m)	Dose[a] (mrem/yr)
N	1,700	3.8×10^{-7}	2,200	2.7×10^{-7}
NNE	1,800	5.2×10^{-7}	3,200	2.3×10^{-7}
NE	2,200	3.7×10^{-7}	3,100	2.2×10^{-7}
ENE	2,000	3.8×10^{-7}	3,100	2.0×10^{-7}
E	1,700	4.7×10^{-7}	2,500	2.0×10^{-7}
ESE	900	9.3×10^{-7}	3,000	1.9×10^{-7}
SE	900	8.7×10^{-7}	3,000	2.0×10^{-7}
SSE	700	8.0×10^{-7}	2,700	1.6×10^{-7}
S	600	6.2×10^{-7}	2,700	1.9×10^{-7}
SSW	400	3.4×10^{-7}	2,500	7.2×10^{-8}
SW	600	1.3×10^{-6}	2,700	2.2×10^{-7}
WSW	800	1.3×10^{-6}	2,100	4.3×10^{-7}
W	900	8.9×10^{-7}	2,200	2.9×10^{-7}
WNW	1,000	7.0×10^{-7}	2,100	2.7×10^{-7}
NW	1,900	2.7×10^{-7}	2,400	1.9×10^{-7}
NNW	1,900	2.5×10^{-7}	2,200	2.1×10^{-7}

[a] Source terms: uranium-234 = 3.4×10^{-7} Ci
uranium-238 = 3.4×10^{-7} Ci

TABLE 4.18

Maximum Perimeter and Individual Doses
from Building 350 Air Emissions, 2007
(dose in mrem/yr)

Pathway	Perimeter (600 m SW)	Individual (2,100 m WSW)
Ingestion	–[a]	–
Inhalation	1.3×10^{-6}	4.3×10^{-7}
Air immersion	7.0×10^{-15}	2.3×10^{-15}
Ground surface	–	–
Total	1.3×10^{-6}	4.3×10^{-7}
Radionuclide		
Uranium-234	7.2×10^{-7}	2.4×10^{-7}
Uranium-238	5.9×10^{-7}	2.0×10^{-7}
Total	1.3×10^{-6}	4.3×10^{-7}

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

TABLE 4.19

Radiological Airborne Releases from Building 375 (IPNS), 2007

Direction	Distance to Perimeter (m)	Dose[a] (mrem/yr)	Distance to Nearest Resident (m)	Dose[a] (mrem/yr)
N	1,600	4.0×10^{-2}	3,200	1.3×10^{-2}
NNE	1,700	5.8×10^{-2}	3,100	2.0×10^{-2}
NE	1,700	5.4×10^{-2}	2,700	2.3×10^{-2}
ENE	1,500	5.5×10^{-2}	2,500	2.4×10^{-2}
E	600	2.2×10^{-1}	2,500	2.4×10^{-2}
ESE	600	2.0×10^{-1}	2,500	2.3×10^{-2}
SE	600	1.8×10^{-1}	2,500	2.0×10^{-2}
SSE	600	1.4×10^{-1}	3,000	1.3×10^{-2}
S	800	1.1×10^{-1}	3,000	1.9×10^{-2}
SSW	800	3.8×10^{-2}	3,500	4.8×10^{-3}
SW	800	1.3×10^{-1}	4,000	1.1×10^{-2}
WSW	1,500	8.0×10^{-2}	2,700	4.1×10^{-2}
W	2,200	3.0×10^{-2}	2,700	2.0×10^{-2}
WNW	1,500	4.1×10^{-2}	2,600	1.7×10^{-2}
NW	2,200	1.9×10^{-2}	2,500	1.6×10^{-2}
NNW	1,800	3.0×10^{-2}	2,200	2.2×10^{-2}

[a] Source terms: carbon-11 = 1,090.0 Ci
argon-41 = 31.0 Ci

are in units of rem/μCi, and this calculation gives the 50-year CEDE. Table 4.24 lists the applicable CEDE factors.

An evaluation was conducted of potential sensitive receptors of Argonne airborne releases, including children at the Argonne Child Development Center (Location 120 in Figure 1.1). The airborne dose from Argonne 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 present at this location only 6 hours per day, 5 days per week, and for 35 weeks a year, the actual dose is closer to 0.001 mrem/yr.

4.8.2. Water Pathway

Following the methodology outlined in DOE Order 5400.5,[5] the annual intake of radionuclides (in μCi) ingested with water is obtained by multiplying the concentration of

TABLE 4.20

Maximum Perimeter and Individual Doses from Building 375 (IPNS) Air Emissions, 2007 (dose in mrem/yr)

Pathway	Perimeter (600 m E)	Individual (2,700 m WSW)
Ingestion	–[a]	–
Inhalation	2.8×10^{-3}	4.6×10^{-4}
Air immersion	2.2×10^{-1}	4.0×10^{-2}
Ground surface	–	–
Total	2.2×10^{-1}	4.1×10^{-2}
Radionuclide		
Carbon-11	2.1×10^{-1}	3.9×10^{-2}
Argon-41	1.0×10^{-2}	1.9×10^{-3}
Total	2.2×10^{-1}	4.1×10^{-2}

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

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 CEDE conversion factor for ingestion (Table 4.24) 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 Argonne operations could be found in off-site water was Sawmill Creek below the wastewater outfall (see Table 4.6). 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 Argonne wastewater, their net average 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 4.25. 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 4.7 is a plot (1986–2007) showing the estimated dose a hypothetical individual would receive if ingesting Sawmill Creek water.

As indicated in Table 4.6, occasional Sawmill Creek samples (fewer than 10%) contained traces of cesium-137, plutonium-238, curium-242 and 244, or californium-249 and 252; however, the averages were only slightly greater than the detection limit. The annual dose to an

TABLE 4.21

Radiological Airborne Releases from Building 411/415 (APS), 2007

Direction	Distance to Perimeter (m)	Dose[a] (mrem/yr)	Distance to Nearest Resident (m)	Dose[a] (mrem/yr)
N	1,500	1.7×10^{-3}	2,000	1.1×10^{-3}
NNE	1,600	2.3×10^{-3}	2,100	1.5×10^{-3}
NE	2,200	1.3×10^{-3}	3,100	7.2×10^{-4}
ENE	2,500	9.4×10^{-4}	3,300	6.0×10^{-4}
E	1,600	1.8×10^{-3}	3,400	5.3×10^{-4}
ESE	1,500	2.0×10^{-3}	3,500	5.3×10^{-4}
SE	400	1.2×10^{-2}	3,000	5.8×10^{-4}
SSE	400	8.8×10^{-3}	3,000	5.0×10^{-4}
S	350	7.9×10^{-3}	2,500	9.5×10^{-4}
SSW	400	2.8×10^{-2}	2,800	2.6×10^{-4}
SW	550	8.9×10^{-3}	3,000	6.4×10^{-4}
WSW	800	7.1×10^{-3}	1,400	3.3×10^{-3}
W	800	5.0×10^{-3}	1,500	2.0×10^{-3}
WNW	500	8.2×10^{-3}	1,400	1.8×10^{-3}
NW	350	1.1×10^{-2}	1,600	1.3×10^{-3}
NNW	1,500	1.5×10^{-3}	2,000	9.9×10^{-4}

[a] Source terms: carbon-11 = 1.3 Ci
nitrogen-13 = 59.0 Ci
oxygen-15 = 6.3 Ci

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.

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 Argonne is about 25 m^3/s (900 ft^3/s). Applying this ratio to the concentration of radionuclides in Sawmill Creek listed in Table 4.25, 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 farther 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 4.22

Maximum Perimeter and Individual Doses
from Building 411/415 (APS) Air Emissions, 2007
(dose in mrem/yr)

Pathway	Perimeter (400 m SSW)	Individual (1,400 m WSW)
Ingestion	–[a]	–
Inhalation	4.1×10^{-6}	1.1×10^{-6}
Air immersion	1.2×10^{-2}	3.3×10^{-3}
Ground surface	–	–
Total	1.2×10^{-2}	3.3×10^{-3}
Radionuclide		
Carbon-11	3.4×10^{-4}	9.5×10^{-5}
Nitrogen-13	1.2×10^{-2}	3.2×10^{-3}
Oxygen-15	1.3×10^{-4}	3.6×10^{-5}
Total	1.2×10^{-2}	3.3×10^{-3}

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

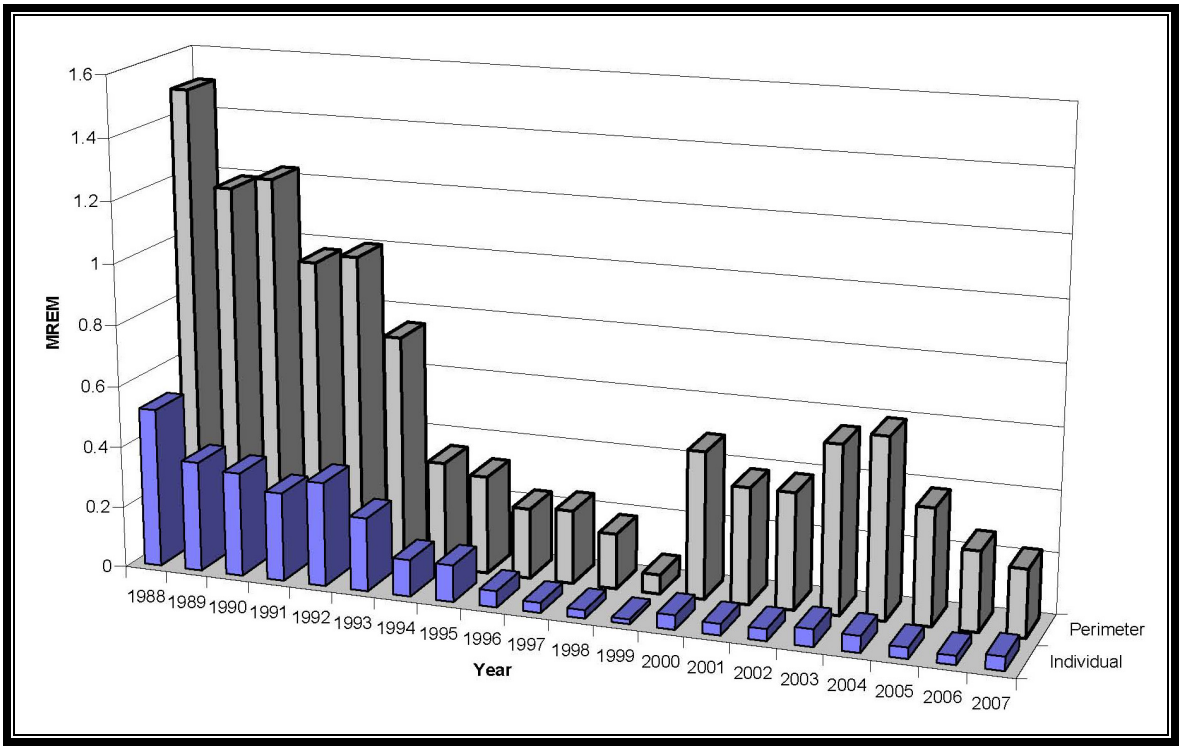

FIGURE 4.5 Individual and Perimeter Doses from Airborne Radioactive Emissions

TABLE 4.23

Population Dose within 80 km (50 mi), 2007

Radionuclide	Person-rem
Hydrogen-3	<0.01
Carbon-11	6.86
Nitrogen-13	0.27
Oxygen-15	<0.01
Argon-41	0.33
Krypton-85	<0.01
Antimony-125	<0.01
Iodine-125	<0.01
Iodine-129	<0.01
Radon-220	<0.01
Uranium-234	<0.01
Uranium-238	<0.01
Total	7.78
Natural	2.7×10^6

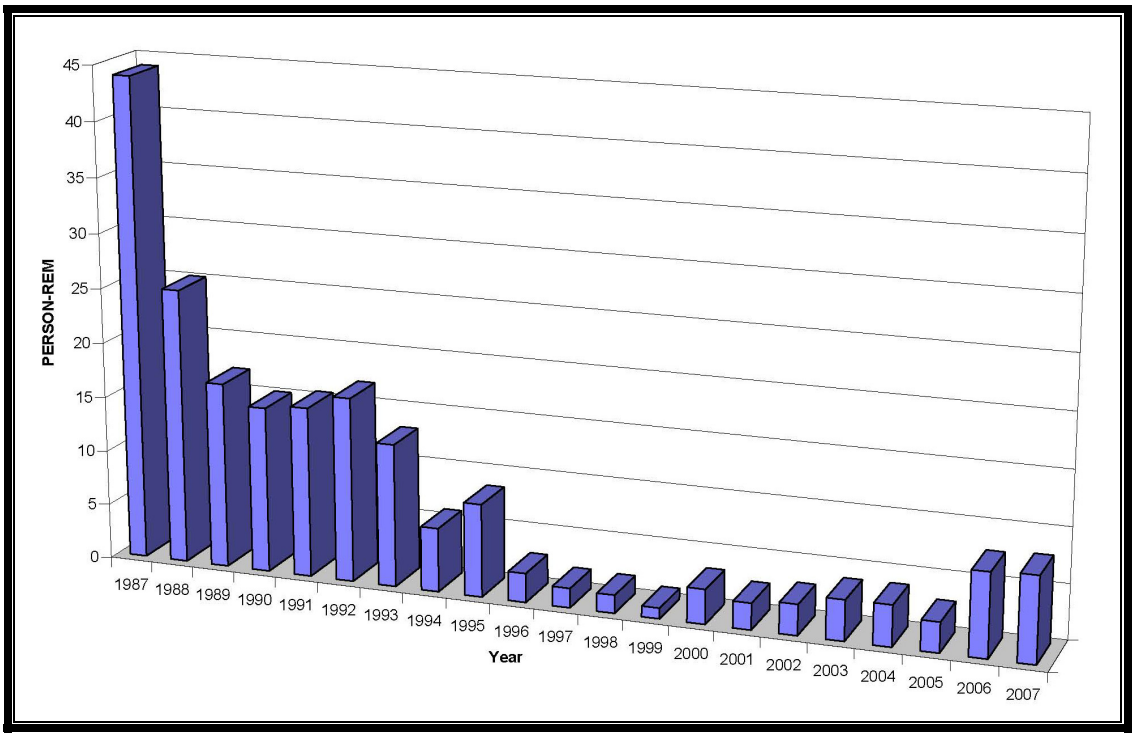

FIGURE 4.6 Population Dose from Airborne Radioactive Emissions

TABLE 4.24

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	–	1,100
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.

4.8.3. Biota Dose Assessment

DOE Order 5400.5[5] 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 Argonne 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 by using the DOE Technical Standard, *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota*.[16] 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, plutonium-239, and americium-241 were obtained from Table 4.6, while maximum sediment concentrations for cesium-137, plutonium-239, and americium-241 were obtained from Table 4.9. Summing the ratios of their respective BCGs for each radionuclide resulted in a ratio of 0.0015 to aquatic biota. This is well below a ratio of one and demonstrates compliance with the limit in DOE Order 5400.5.

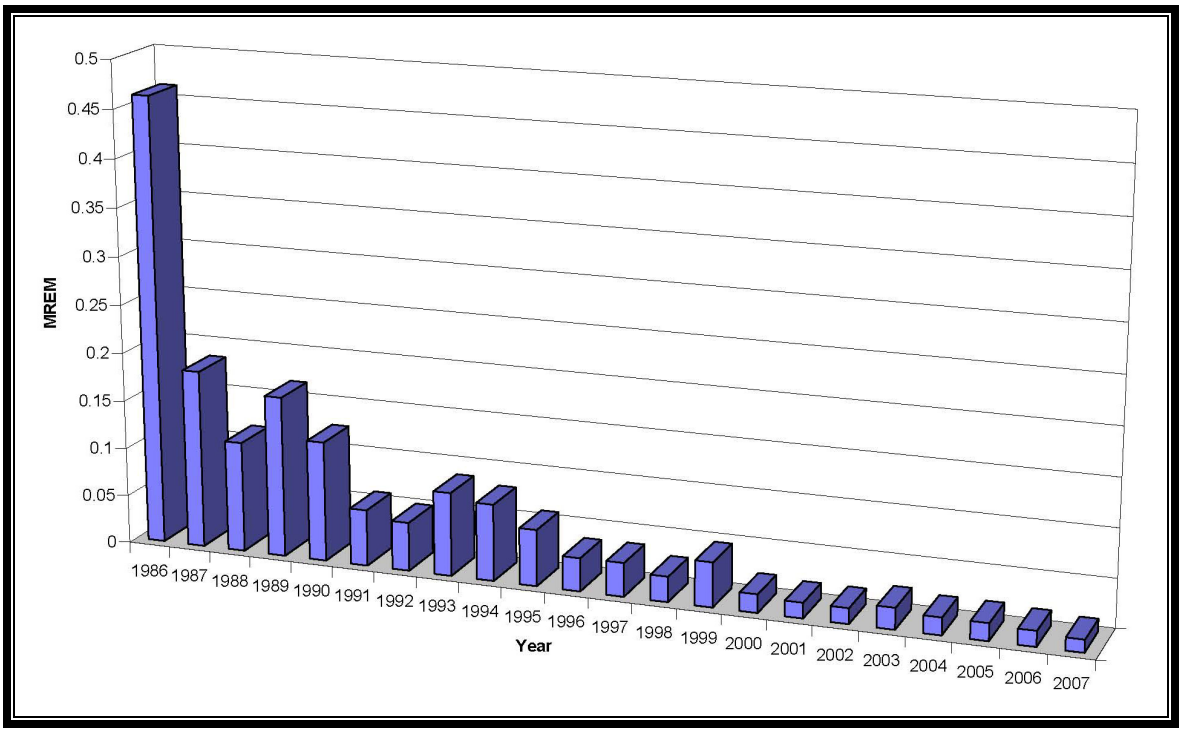

FIGURE 4.7 Comparison of Dose Estimate from Ingestion of Sawmill Creek Water

TABLE 4.25

Radionuclide Concentrations and Dose Estimates
for Sawmill Creek Water, 2007

Radionuclide	Total Released (Ci)	Net Avg. Concentration (pCi/L)	Dose (mrem)
Hydrogen-3	0.1	17	0.0008
Strontium-90	0.0004	0.12	0.011
Plutonium-239	<0.0001	0.0003	0.0009
Americium-241	<0.0001	0.0001	0.00003
Total	0.1		0.013

4.8.4. External Direct Radiation Pathway

The TLD measurements given in Section 4.5 were used to calculate the radiation dose from external sources. At Location 7I, the fence-line dose from Argonne was 101 ± 9 mrem/yr. Approximately 300 m (960 ft) south of the fence line (grid 6I), the measured dose was 97 ± 10 mrem/yr, essentially the same as the off-site average (102 ± 13 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 in the past, 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 Argonne that could result in exposure to radiation from this site. Examples of these activities are 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 Argonne operations.

4.8.5. Dose Summary

The total effective dose equivalent received by off-site residents during 2007 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 0.045 mrem/yr to individuals living west southwest 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 7.78 person-rem. The dose pathways are presented in Table 4.26 and are compared with the applicable standards.

To receive the hypothetical maximum public dose, an individual would need to live at the point of maximum air and direct radiation exposure and use only water from Sawmill Creek below the Argonne wastewater discharge. This is a very conservative and unlikely situation. To put the hypothetical maximum individual dose from all pathways of 0.059 mrem/yr attributable to Argonne 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 4.27. These site-related doses are in addition to the background doses. The magnitude of the doses received from Argonne operations is insignificant compared with these sources. Therefore, the monitoring program results establish that the radioactive emissions from Argonne are very low and do not endanger the health or safety of those living in the vicinity of the site.

TABLE 4.26

Summary of the Estimated Dose to a Hypothetical Individual, 2007 (mrem/yr)

Pathway	Argonne Estimate	Applicable Standard
Air total	0.045	10 (EPA)
Water	0.013	4 (EPA)[a]
Direct radiation	0.001	25 (NRC)[b]
Maximum dose	0.059	100 (DOE)

[a] The 4-mrem/yr EPA value is not an applicable standard, since it applies to community water systems.[17] It is used here for illustrative purposes.

[b] NRC = National Research Council.

TABLE 4.27

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/dental	
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.[14]

5. ENVIRONMENTAL NONRADIOLOGICAL PROGRAM INFORMATION

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5.1. Introduction

In addition to monitoring for the release of radioactive materials, Argonne monitors for the release of hazardous chemicals to the environment. The nonradiological monitoring program involves monitoring of point-source air discharges for certain chemicals and particulates and the collection and analysis of surface water and groundwater samples from numerous locations throughout the site. Argonne's extensive groundwater monitoring program is discussed separately in Chapter 6. This chapter discusses the monitoring of releases to the air and surface water.

5.1.1. Chapter Highlights

Air Releases. Monitoring of releases of nonradiological contaminants to the air from Argonne operations is limited to compliance monitoring of combustion products from the on-site coal-fired boiler. During 2007, there were no exceedances of the air permit limits for this facility during 3,033 hours of operation.

Surface Water. Wastewater from Argonne operations is discharged to the environment through a series of wastewater outfalls permitted under the NPDES program administered by the IEPA. These outfalls are sampled on schedules that range from weekly to semiannual. During 2007, approximately 99% of all NPDES analyses were in compliance with their applicable permit limits. At the end of 2007, the only significant ongoing issue was the exceedance of the TDS limit at Outfall 001, the combined wastewater discharge point into Sawmill Creek, resulting from the use of road salt during the winter. There were eight exceedances of TDS and chloride limits at Outfall 001 during 2007. No toxicity was observed in Outfall 001, which was tested for aquatic toxicity. Samples of treated effluent and water in Sawmill Creek downstream of Argonne were collected and analyzed for a variety of metals. Samples from the combined wastewater discharge and Sawmill Creek were found to meet the IEPA's criteria for effluent quality and general use water quality. Thus, it appears that, with the exception of the elevated levels of TDS and chloride from road salt, the Argonne site is in compliance with permit limits and surface water quality criteria.

5.2. Monitoring Air Discharges

Argonne operations and research activities utilize a number of nonradioactive volatile chemicals and fuels that have the potential to adversely impact the environment if released to the air in sufficient quantities. However, because of the nature of the research conducted at Argonne, most chemicals are used in small quantities within laboratories, and the potential for a significant release to the outside air is very small. These potential discharges are not monitored. Only one exhaust point has the potential for significant releases, and this discharge is monitored. Argonne does not conduct ambient air quality monitoring for conventional air pollutants due to the lack of significant air emission sources.

The most significant conventional air pollutants at Argonne are combustion products discharged from the five on-site steam boilers, particularly Boiler No. 5, which is equipped to burn coal as well as natural gas. Most of the time, all of the boilers burn natural gas, which emits relatively small amounts of regulated pollutants, and do not require stack monitoring. In Boiler No. 5, coal is used during the peak heating demand periods in the winter. It is equipped with dedicated stack monitoring equipment for sulfur dioxide and opacity to be used while burning coal. No exceedances were noted during 2007 over a period of 3,033 hours of coal-burning operation (see Section 2.1.2). The lack of exceedances for 2007 indicates that the boiler house is operating within its allowable discharge constraints. Other significant sources of air discharges include a number of backup power generators that are operated periodically for maintenance reasons and a transportation research facility that evaluates internal combustion engines. Chapter 2 (Table 2.3) contains a summary of estimated air discharges (estimated based on run time and typical emission factors for each type of equipment) from the major air point-source discharges at Argonne. The major pollutants discharged from these sources were carbon monoxide, nitrous oxides, and sulfur dioxide, nearly all of which were discharged from the boilers. In addition to conventional regulated pollutants, a total of 51,000 tons of carbon dioxide was released from these facilities.

Another nonradioactive air pollutant that is monitored is methane gas generated by the decomposition of solid waste in the 800 Area Landfill. The primary purpose of this monitoring is to determine if a potential safety concern exists due to gas migration into structures around landfills. Gas composition is measured quarterly at 4 wells located in the waste mound, at 10 gas monitoring wells adjacent to the landfill but outside of the buried waste, and in two nearby structures. Monitoring in 2007 indicated that the gas within the landfill waste mound contained up to 70% methane, but no methane was found in the gas monitoring wells surrounding the landfill except for single readings of 0.1% methane in two gas wells, G-2 and G-11, well below the action level of 2.5% methane. The quantity of gas generated is not measured, but observations during sampling indicated that the flow is very small.

Small amounts of research-related volatile chemicals are released to the air as laboratory wastewater is treated in the LWTP. The amount of volatile organic materials (VOM) and hazardous air pollutants (HAP) in the LWTP wastewater is calculated each month on the basis of an analysis of a single sample of wastewater flowing into the plant and the flow rate of wastewater through the plant. The amount potentially released to the air is estimated by using the EPA's WATER9 model, designed for determining emissions from such facilities. Section 5.3 discusses the results of the wastewater analysis. During 2007, the estimated amount of VOM and HAP released from the LWPT was approximately 59 kg (130 lb), much lower than in previous years.

5.3. Monitoring Wastewater Treatment Plant Influent

Untreated wastewater entering the LWTP is sampled once per month and analyzed for VOCs. In addition to satisfying the requirements of Argonne's Title V air permit, this

information allows Argonne to track the success of its efforts to reduce the discharge of hazardous chemicals to the sewer system.

Table 5.1 summarizes the results of the monthly analysis of laboratory wastewater influent in 2007. The 2007 results are similar to those from previous years except for ethanol. The maximum concentration of ethanol found in 2007 was 726 μg/L. In previous years, ethanol was found to be present above 10,000 μg/L on several occasions.

Low concentrations of bromoform, bromodichloromethane, chloroform, and dibromochloromethane were found in nearly all of the samples. These compounds are halogenated organic chemicals that are produced when chlorine is added to the water supply during treatment by the Chicago Water Department, which provides the water that Argonne purchases from the DuPage Water Commission. The chlorine interacts with naturally occurring organic chemicals in the water and produces low concentrations of a number of chlorinated or brominated chemicals collectively known as trihalomethanes (THMs). Some of these materials remain in the wastewater and are detected in the influent samples. The chloroform concentrations since 1992 are shown in Figure 5.1. The decrease in chloroform observed in 1997 is likely the result of the switch from Argonne well water to Lake Michigan water, which occurred in 1997. The drinking water limit for the sum of all of the THM compounds is 80 μg/L. The concentrations detected are all well below this limit.

In addition to the THMs, thirteen other chemicals were detected in at least one sample. The chemicals consistently detected in the highest concentrations were acetone, acetaldehyde, and ethanol. Acetone was found in 11 of 12 samples and is likely the result of equipment cleaning. Acetaldehyde was found in 5 samples and ethanol was detected in 4 samples. Figure 5.2 shows acetone concentrations since 1992. A significant drop in acetone concentration occurred from 1994 to 2000, and it has remained essentially steady since. The precise source of these chemicals is not known, but research activities at Argonne utilize a wide variety of chemicals for many purposes and discharge small amounts of such chemicals into the sewer from time to time. As discussed later in this chapter, only the THMs were detected in the effluent from the treatment plant.

As part of its ongoing pollution prevention efforts, Argonne conducts a waste generator education program in which proper handling and disposal of chemicals are explained. The decrease in influent concentrations of acetone since the late 1990s can, in part, be attributed to educational efforts related to waste disposal and pollution prevention.

In addition to laboratory activities, VOCs are discharged into the laboratory sewer from the 317/319 Area lift station, which pumps contaminated groundwater generated by Argonne's groundwater extraction systems in this area. The chemicals in the groundwater discharged to the treatment plant are organic solvents, including acetone, 1,1-dichloroethane, trichloroethene, 1,4-dioxane, and chloroform. Of these, only chloroform was detected in influent samples during 2007, and its presence was likely due to disinfection of potable water with chlorine rather than contaminated groundwater.

TABLE 5.1

Laboratory Influent Wastewater, 2007
(concentrations in µg/L)

Compound	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Avg.[b]
Chlorination By-Products													
Bromodichloromethane	3	1	2	2	3	3	3	4	2	2	5	2	3
Bromoform	–[a]	–	–	2	4	2	5	7	30	16	14	–	10
Chloroform	3	2	4	4	3	3	3	3	2	2	3	2	3
Dibromochloromethane	2	1	1	1	4	3	5	6	6	5	10	1	4
Chemicals Discharged													
1-Propanol	–	–	–	–	–	413	–	–	–	–	–	–	413
2-Propanol	–	–	–	–	–	50	44	–	–	–	–	–	47
2-Butanone	–	–	–	0.9	1	–	1	1	1	0.6	2	2	1
4-Methyl-2-pentanone	–	4	–	–	–	–	0.7	–	–	–	–	–	2
Acetaldehyde	–	35	–	–	–	79	22	–	19	–	–	51	41
Acetone	–	10	61	209	20	29	198	22	32	65	26	218	81
Chlorodifluoromethane	–	–	1	–	–	–	–	–	–	–	–	–	1
Ethanol	–	–	–	–	–	726	71	–	25	–	–	523	336
Ethyl acetate	–	–	5	–	–	–	–	–	–	–	–	–	5
Ethyl ether	–	–	11	5	–	178	–	–	–	–	–	–	65
Methylene chloride	–	–	20	3	–	–	–	–	–	–	–	10	11
n-Dodecane	–	–	–	–	–	17	6	–	–	–	–	–	12
Tetrahydrofuran	–	7	13	–	–	–	–	–	–	–	–	–	10

[a] A dash indicates that the concentration was less than the detection limit.

[b] Average calculated from values above the detection limits only.

5.4. Monitoring Discharges to Surface Water

The release of nonradioactive pollutants to surface water is monitored in several different ways. Samples of wastewater discharged to on-site streams and Sawmill Creek are routinely collected from 16 NPDES-permitted outfalls. Sampling frequency and analyses conducted on the samples from the NPDES outfalls vary, depending on their permit-mandated monitoring requirements. 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 a DMR.[18] Stormwater is sampled at several locations across the site, and the overall effects of the Argonne site on Sawmill Creek are monitored by sampling the creek downstream of the site. The wastewater sampling program is discussed in this section.

5.4.1. Wastewater Discharge Monitoring

The main treated wastewater outfalls include the treated SWTP discharge, Outfall A01, and the treated water from the LWTP, Outfall B01. These outfalls are internal monitoring points since their flows combine before they discharge to Sawmill Creek. The combined discharge is

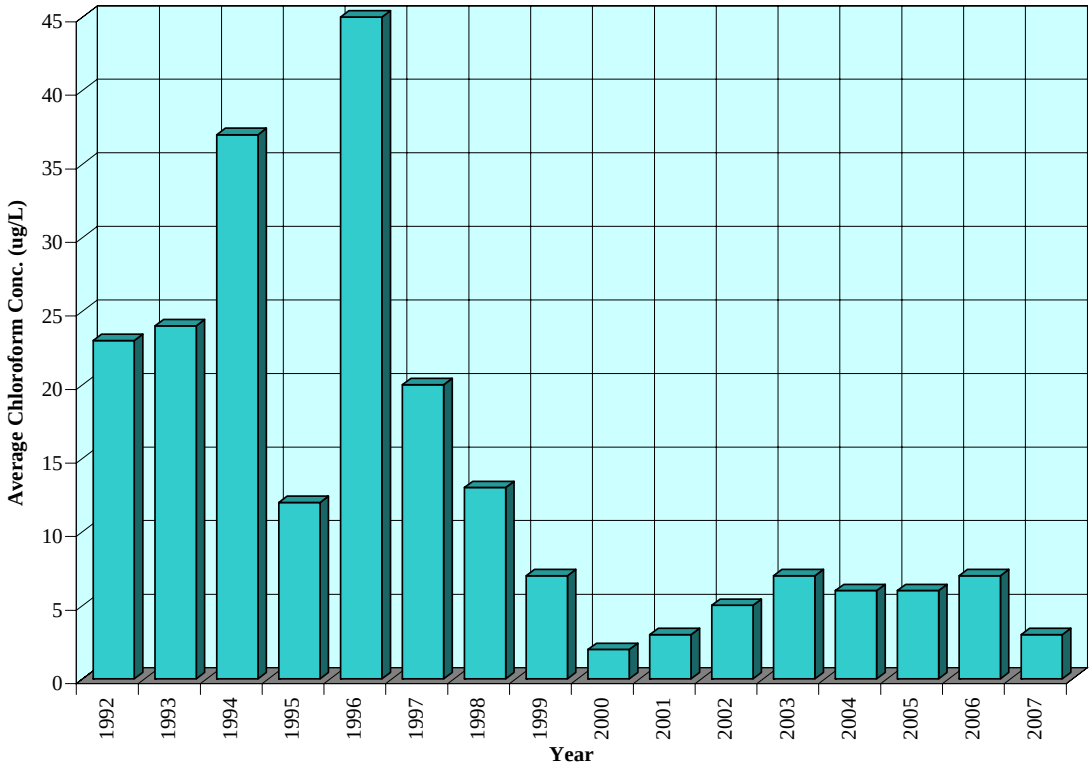


FIGURE 5.1 Average Chloroform Levels in Laboratory Influent Wastewater, 1992 to 2007

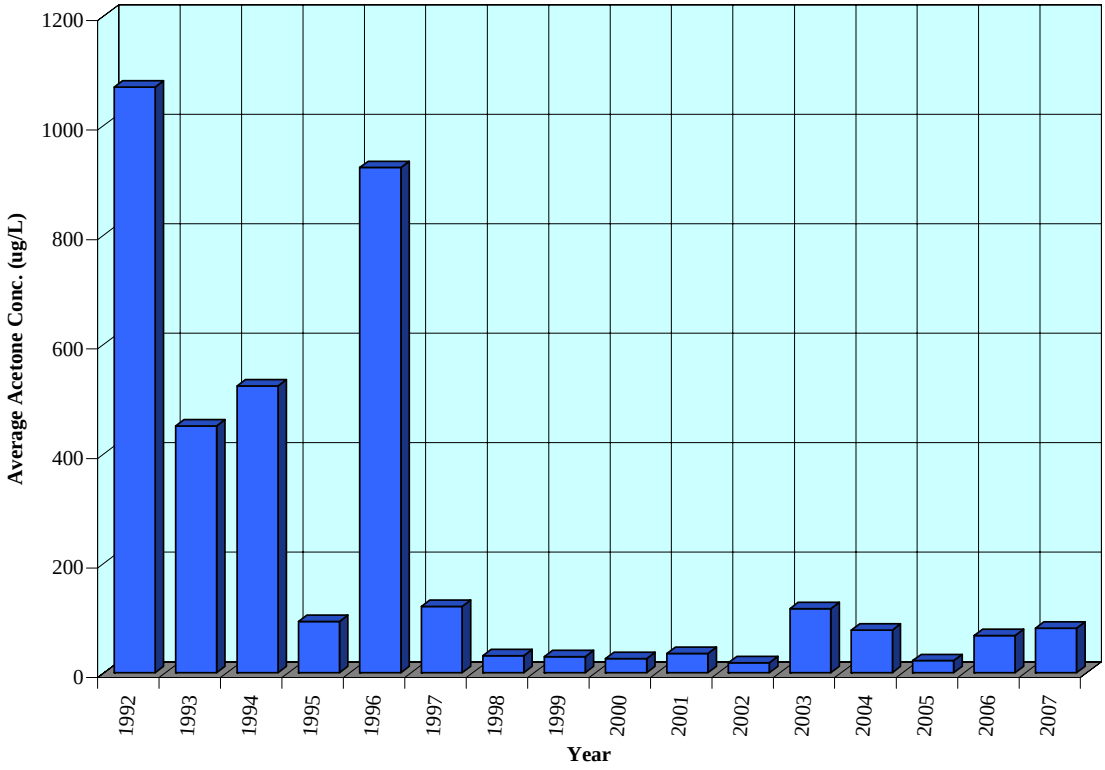


FIGURE 5.2 Average Acetone Levels in Laboratory Influent Wastewater, 1992 to 2007

known as Outfall 001, which is also located at the WTP. The combined wastewater stream flows through an outfall pipe that discharges into Sawmill Creek approximately 1,100 m (3,500 ft) south of the WTP, at the location designated as 7M in Figure 1.1.

Thirteen direct discharge outfalls are also monitored when flow is present. These outfalls contain small amounts of process wastewater as well as rainwater runoff after a storm. The wastewater in these outfalls comes from sources that do not contribute contamination, such as cooling towers, once-through cooling water, condensate, and footing drain water, and therefore it is not treated prior to its discharge from the outfalls. For these 13 outfalls, only the dry weather process discharges are subject to discharge limits and monitoring requirements in the permit. In recent years, many of the cooling tower blowdown, condensate, and cooling water discharges have been rerouted to the Argonne sewer system, resulting in a reduction or elimination of dry weather flow in the number of outfalls of this type.

5.4.1.1. Sample Collection and Analysis

Effluent samples are collected from Argonne outfalls as specified by the NPDES permit. Sampling intervals range from weekly sampling of the main treated wastewater to semiannual sampling of certain stormwater outfalls. This section summarizes the monitoring requirements and discusses the results of the monitoring.

All samples are collected in specially cleaned and labeled sample bottles with appropriate preservatives added. Custody seals and chain-of-custody sheets also are used as needed. Samples are submitted to the appropriate laboratory for analysis, so that testing can be completed within the required holding time.

Sample collection, preservation, holding times, and analytical methods are specified by the EPA as codified in 40 CFR Part 136, Tables 1B and 2,[19] as well as Standard Methods.[20] Table 5.2 provides a summary of the analytical methods used for the NPDES monitoring programs. These analyses are conducted by the Argonne EQO Analytical Services (EQO-AS) laboratory as well as commercial laboratories. Commercial laboratories are used for a select set of analyses that the Argonne laboratory does not perform.

NPDES sample analyses conducted by Argonne are performed in accordance with standard operating procedures (SOPs) that are issued and updated periodically 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 Water Act"[19] and Standard Methods.[20] Commercial laboratories utilize their own SOPs based on the same protocols.

5.4.2. Outfall Monitoring Requirements and Results

This section discusses the monitoring requirements and summarizes the results of monitoring at the outfalls covered by the NPDES permit.

TABLE 5.2

Analytical Procedures

Analyte	Description	Analytical Lab
Wastewater Properties		
pH	Electrochemical pH electrode method	Field
Temperature	Electronic probe method	Field
Inorganic Constituents		
Ammonia nitrogen	Ion-selective electrode measurement	Commercial
Chloride	Turbidimetric method	Argonne
Hexavalent/trivalent chromium	Inductively coupled plasma (ICP) emission spectroscopy	Argonne
Iron/dissolved iron	ICP emission spectroscopy	Argonne
Low-level mercury	Cold-vapor atomic fluorescence spectrometry	Commercial
Nitrate-nitrite	Colorimetric method	Commercial
Sulfate	Ultraviolet/visible absorption spectrometry	Argonne
Total dissolved solids (TDS)	Drying and gravimetric method	Argonne
Total residual chlorine (TRC)	*n*, *n*-Diethyl-p-phenylene diamine (DPD) colorimetric method	Field
Total suspended solids (TSS)	Filtering and drying gravimetric method	Argonne
Organic Constituents		
Oil and grease	Solvent partition-gravimetric method	Argonne
Biological oxygen demand (BOD_5)	Fermentation and dissolved oxygen depletion method (5-day)	Commercial
Chemical oxygen demand (COD)	Closed reflux, colorimetric method	Argonne
Carbon tetrachloride	Purge and trap gas chromatograph and mass spectrometer (GC/MS) method	Argonne
Total organic halogen (TOX)	Carbon adsorption with a microcoulometric titration detector	Commercial
Total organic carbon (TOC)	Oxidation and off-gas carbon measurement	Commercial
Phenols	Distillation followed by colorimetric measurement	Commercial
Tetrachloroethene	Purge and trap capillary-column GC/MS method	Argonne
Priority Pollutant List Analyses		
Cyanide (total)	Distillation and colorimetric method	Commercial
Herbicides/pesticides	Liquid/liquid extraction followed by GC/MS	Commercial
PCBs	Liquid/liquid extraction followed by GC/MS	Argonne
Semivolatile organics	Liquid/liquid extraction followed by GC/MS	Argonne
Volatile organics	Purge and trap capillary-column GC/MS method	Argonne
Metals (except mercury) antimony, arsenic, beryllium, cadmium, chromium, copper, lead, nickel, selenium, silver, thallium, zinc	ICP/atomic emission spectrometry	Argonne
Mercury	Cold vapor atomic absorption spectrometry	Argonne

5.4.2.1. Wastewater Treatment Facility Outfalls

Outfall A01. This outfall consists of sanitary wastewater treated in the SWTP. The effectiveness of the wastewater treatment system is evaluated by monitoring the constituents shown in Table 5.3 at the frequency shown. The results are then compared with the concentration limits shown in this table. Two sets of limits are listed; one is a maximum limit for any single sample (Daily Maximum Limit), and the other is for the average of all weekly samples collected during the month (30-Day Average Limit). Table 5.3 also contains a summary of the monitoring results from 2007. No limits were exceeded at this outfall during 2007.

The current NPDES permit requires that Argonne conduct a study to determine the effects of stormwater infiltration into the sanitary sewer system. Because of the age of the sewers at Argonne, rainwater and shallow groundwater can enter the sewer system through cracks and gaps in the pipe and significantly increase the flow into the treatment plant after a major rain event. To determine if this increased flow adversely impacts the operation of the plant, the permit required the collection of samples immediately after 12 significant rain storms (greater than 0.3 cm [0.1 in.] of precipitation). Both a grab sample, collected within the first 30 minutes of storm-flow out of the plant, and a flow-weighted composite were collected and analyzed for the same parameters as the normal monitoring. During 2006, 6 of these 12 samples were collected, and during 2007 the remaining 6 samples were collected. The results of these samples were submitted to the IEPA on the DMR forms. These results are included in the results summarized in Table 5.3. None of these special samples exceeded the permit limits, so they confirm that the plant operation is not hindered by stormwater infiltration.

Outfall B01. This outfall consists of treated wastewater from the LWTP. Table 5.4 gives the monitoring requirements and effluent limits and summarizes the monitoring results for this outfall. This outfall is subject to both concentration limits and mass discharge limits. The mass discharge limit represents the maximum weight of material that can be discharged per day. The mass discharge amount that is compared with the limit is calculated by using the constituent concentration and the flow rate measured the day that the sample was collected. In August, both the TSS concentration and TSS mass limits were exceeded on the same day. In December, the mass limit was exceeded but the concentration limit was not. An investigation determined that the unusually high TSS values resulted from a temporary process upset that released more suspended matter than normal.

Iron and chemical oxygen demand (COD) are included in the permit as monitor-only constituents. The COD results provide a rough indication of the oxygen-consuming potential of this effluent on the receiving stream. None of the samples in 2007 had COD concentrations above the analytical detection limits of 20 mg/L. Only one sample contained iron above the detection limit of 0.5 mg/L.

Outfall B01 is also monitored semiannually (June and December) for priority pollutant compounds. Priority pollutants are 124 organic and inorganic constituents that the EPA has determined deserve special attention in monitoring programs. The June sample is to be collected at the same time that aquatic toxicity testing of Outfall 001 is conducted. Samples were collected

TABLE 5.3

Outfall A01 Effluent Limits and Monitoring Results, 2007
(concentrations mg/L except where noted)

	NPDES Permit Requirements			Monitoring Results			
Constituent	Monitoring Frequency	30-Day Average Limit	Maximum Daily Limit	Minimum	Average	Maximum	Exceedances in 2007
Flow (MGD)[a]	Weekly	NA[b]	NA	0.144	0.299	1.411	NA
pH (pH units)	Weekly	NA	6.0–9.0	6.0	7.1	8.1	0
BOD_5	Weekly	10.0	20.0	1	3	13	0
TSS	Weekly	12.0	24.0	<0.4[c]	2.4	8.0	0
Copper	Weekly	0.5	1	<0.025	<0.025	0.036	0
Iron	Weekly	2	4	<0.5	<0.5	<0.5	0
Manganese	Weekly	1	2	<0.075	<0.075	<0.075	0
Zinc	Weekly	1	2	<0.5	<0.5	<0.5	0

[a] MGD = million gallons per day.

[b] NA indicates that there is no limit or value of the type shown.

[c] A value shown with a "less than" (<) sign indicates that the constituent was not present above the detection limits of the analytical method. The value shown is the method detection limit.

on June 19, 2007, and December 11, 2007, and analyzed within the required holding times. Table 5.5 gives the results for those constituents that were found above the analytical detection limits. The results for most of the metals and VOCs, and all of the semivolatile organic compounds (SVOCs), PCBs, pesticides, and cyanide were less than the detection limits of 1 to 10 µg/L. Low levels of copper (0.042 mg/L) were noted in the December sample, but copper was not detected in the June sample. The samples contained very low concentrations of several THMs, which result from the chlorination of drinking water and were also found in the influent to the LWTP. In general, these results indicate that the treated wastewater is free of most of the toxic chemicals on this list, and the few that were detected are only occasionally present at extremely low concentrations or are not the result of Argonne activities.

Outfall 001. This outfall represents the combined wastewater from both treatment plants. The combined effluent flows through a 1,100-m (3,500-ft) outfall pipe where it is eventually discharged into Sawmill Creek at the main outfall south of the Argonne site (Location 7M).

Composite and grab samples of the combined effluent are collected weekly or monthly, as required by the permit. Table 5.6 lists the monitoring requirements and limits, summarizes the results, and lists the number of exceedances of the limits during 2007.

TABLE 5.4

Outfall B01 Effluent Limits and Monitoring Results, 2007
(concentrations in mg/L except where noted)

	NPDES Permit Requirements			Monitoring Results			
Constituent	Monitoring Frequency	30-Day Average Limit	Maximum Daily Limit	Minimum	Average	Maximum	2007 Exceedances
Flow (MGD)	Weekly	NA[a]	NA	0.398	0.498	1.028	NA
pH (pH units)	Weekly	NA	6.0–9.0	6.8	7.5	8.5	0
BOD_5 concentration	Weekly	10	20	1	2	12	0
BOD_5 mass (lb/day)	Weekly	41.9	83.7	5	9	63	0
TSS concentration	Weekly	12	24	1	5	25	1
TSS mass (lb/day)	Weekly	50.2	100.5	10	20	131	2
Zinc concentration	Weekly	1	2	<0.5[b]	<0.5	<0.5	0
Zinc mass (lb/day)	Weekly	4.19	8.37	<1.6[c]	<2.1	<3.2	0
Mercury concentration	Weekly	0.003	0.006	<0.0002[b]	<0.0002	<0.0002	0
Mercury mass (lb/day)	Weekly	0.0126	0.0251	<0.00064[c]	<0.00084	<0.00130	0
Oil and grease concentration	Weekly	15	30	<5	<5	6	0
Oil and grease mass (lb/day)	Weekly	62.8	125.6	<16	<21	<32	0
Iron[d]	Weekly	NA	NA	<0.5	<0.5	0.63	NA
COD[e]	Weekly	NA	NA	<20	<20	<20	NA
Priority pollutants[e]	Semiannual	NA	NA	–[f]	–	–	NA

[a] NA indicates that there is no limit or value of the type shown.

[b] A concentration value shown with a "less than" (<) sign indicates that the constituent was not present above the detection limits of the analytical method. The value shown is the method detection limit.

[c] A mass value shown with a "less than" (<) sign indicates that one or more of the concentration values used to calculate the mass was less than the detection limits of the analytical method; thus, the mass amount is shown as a "less than" quantity.

[d] Monitor only parameter.

[e] Priority pollutant results are presented in Table 5.5.

[f] A dash indicates that the concentration was less than the detection limit.

TABLE 5.5

Outfall B01 Effluent Priority Pollutant Monitoring Results, 2007

Compound[a]	Concentration in June Sample	Concentration in December Sample
Copper (mg/L)	<0.025[b]	0.042
Bromodichloromethane (µg/L)	2	2
Bromoform (µg/L)	<1	1
Chloroform (µg/L)	2	2
Dibromochloromethane (µg/L)	2	1
Phenol (total) (mg/L)	0.0076	<0.005

[a] All 124 priority pollutants were analyzed. Only those found above the analytical detection limits are shown in this table.

[b] A "<" sign indicates that the element or compound was not detected above analytical detection limits. The value shown is the detection limit.

Nine permit exceedances occurred at Outfall 001 in 2007. The TDS limit was exceeded once in February, twice in March, and twice in December during periods of heavy snowmelt. Four chloride exceedances occurred during these time periods. The TDS and chloride exceedances are believed to be related to the introduction of salt-laden snowmelt into the sewer system. The snowmelt appears to be introduced to the sewer system through infiltration of salty surface water into the sewer systems though cracks and gaps in the pipe, the intentional collection and discharge to the laboratory sewer of runoff from salted roadways and parking lots near the boiler house, and elevated levels of salt in the Chicago Sanitary and Ship Canal (the source of water for the Argonne Canal Water Treatment Plant), which provides approximately 50% of the total water used on site. The role of road salt in the TDS exceedances was confirmed by comparing the TDS and chloride concentrations for the same time period. Figure 5.3 shows the results of TDS and chloride analyses for 2000 through 2007. This figure shows the seasonal nature of TDS levels in the outfall, corresponding with the seasonal use of road salt, and the close correlation between TDS and chloride. High chloride levels and a close correlation between TDS and chloride indicate that the source is probably salt (sodium chloride).

The December 8, 2005, IEPA-approved biomonitoring plan called for acute toxicity testing of the effluent from Outfall 001. Prior to 2007, toxicity testing had also been required at Outfalls H03, I03, J03, 004, 006, and 025. However, past testing confirmed that there was no longer any toxicity associated with these outfalls and no more testing was needed. Only Outfall 001 was tested in 2007.

The toxicity testing of Outfall 001 was performed during June. The testing is performed by creating samples with various ratios of Argonne effluent and dilution water, into which two types of organisms are introduced, water fleas (*Ceriodaphnia dubia*) and fathead minnows (*Pimephales promelas*). Survival is measured over 2 to 4 days, and statistically significant

TABLE 5.6

Outfall 001 Monitoring Results and Effluent Limits, 2007
(concentrations in mg/L except where noted)

	NPDES Permit Requirements			Monitoring Results			
Constituent	Monitoring Frequency	30-day Average Limit	Maximum Daily Limit	Minimum	Average	Maximum	2007 Exceedances
Flow (MGD)	Daily	NA[a]	NA	0.541	0.740	2.32	NA
pH (pH units)	Weekly grab	NA	6.0–9.0	6.38	–[b]	8.45	0
TDS	Weekly composite	NA	1,000	476	668	1,379	5
Chloride	Weekly composite	NA	500	150	241	590	4
Sulfate	Weekly composite	NA	500	72	110	177	0
Dissolved iron	Weekly composite	NA	1	<0.5	<0.5	<0.5	0
Ammonia nitrogen (Nov.–March)	Weekly composite	2.4	10.8	<0.05	0.36	1.2	0
Ammonia nitrogen (Apr.–Oct.)	Weekly composite	1.2	3.8	<0.05	0.45	2	0
Copper	Weekly composite	0.031	0.051	<0.025	<0.025	0.027	0
Manganese	Weekly composite	NA	1	<0.075	<0.075	<0.075	0
Zinc	Weekly composite	NA	1	<0.5	<0.5	<0.5	0
Lead	Monthly composite	NA	NA	<0.09	<0.09	<0.09	NA
Hexavalent chromium	Monthly composite	NA	NA	<0.05	<0.05	<0.05	NA
Trivalent chromium	Monthly composite	NA	NA	<0.05	<0.05	<0.05	NA
Phosphorus	Monthly composite	NA	NA	0.68	0.86	1.35	NA
Beta radioactivity	Monthly grab	NA	NA	3.06	4.49	6.08	NA
Low-level mercury[c]	Monthly grab	NA	NA	0.0000033	0.0000111	0.0000198	NA

[a] NA = not applicable.

[b] Since pH is a log function of hydrogen ion concentrations, average values are not mathematically correct. Only minimum and maximum values are listed.

[c] Effective April 2007, low-level mercury is sampled once per month as a monitor-only parameter.

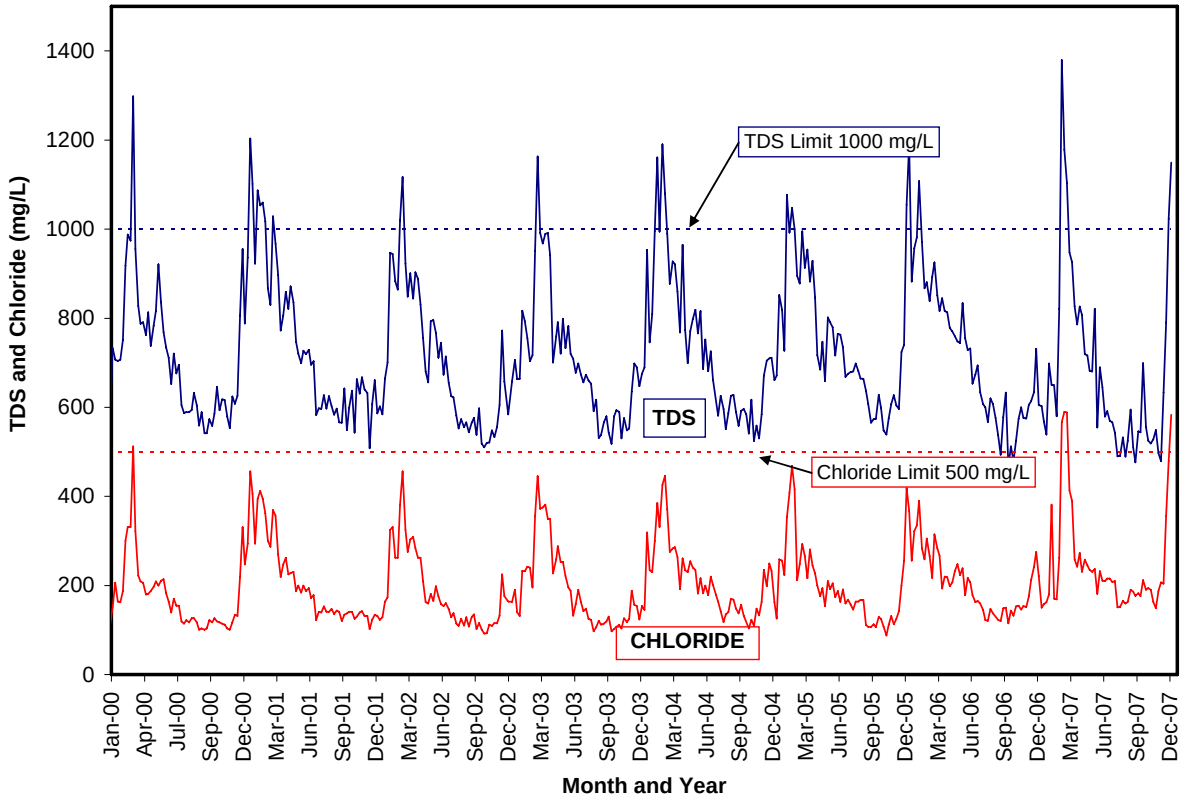


FIGURE 5.3 Total Dissolved Solids and Chloride in Outfall 001 Water, 2000 to 2007

mortality is reported as a function of effluent concentration. An off-site contract laboratory performed the sample collection and analyses. Samples were collected June 18 to 22. Table 5.7 summarizes the results of the toxicity tests from 2001 to 2007. No toxicity was observed to the fathead minnow or to the water flea in the 2007 samples. This table shows the concentration of wastewater that produces 50% mortality in the test population (i.e., the median lethal concentration [LC_{50}]). A value of >100 shown in this table means that even the undiluted effluent is not toxic to these species.

5.4.2.2. Direct Discharge Outfalls

In addition to the three outfalls at the wastewater treatment facilities, 17 other outfalls were sampled in 2007. Thirteen of these outfalls currently discharge, or have discharged at some time in the past, process wastewater that does not require treatment prior to release, as well as stormwater. Four outfalls discharge only stormwater. Four additional stormwater-only outfalls were sampled in 2007 to complete a one-time study of stormwater quality. The sampling requirements and effluent limits for these outfalls are described in Table 5.8.

Five of the direct discharge outfalls monitored in 2007 experienced permit exceedances. Outfalls H03 and J03 had repeated exceedance of the TDS limit of 1,000 mg/L. Investigations

TABLE 5.7

Toxicity Testing Results, 2001 to 2007
(% of effluent producing toxicity)

NPDES Outfall	2001		2002		2003		2004		2005		2006		2007
	June/July[a]	August	June/July	August	June/July	August	June/July	August	June/July	August	June/July	August	June/July
Water Flea, 48-Hour Acute Toxicity Results													
001	>100[b]	NA[c]	>100	NA	>100	NA	>100	NA	>100	NA	>100	NA	>100
H03	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100	–
I03	71	>100	>100	**88**[d]	>100	**82**	>100	>100	>100	>100	–[e]	–	–
J03	**<20**	>100	**<20**	**<20**	>100	>100	>100	>100	>100	>100	>100	>100	–
004	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100	–	–	–
006	**40**	**60**	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100	–
025	**64**	>100	>100	>100	**57**	>100	**34**	**20**	**62**	**47**	>100	>100	–
Fathead Minnow, 96-Hour Acute Toxicity Results													
001	>100	NA	>100	NA	>100	NA	>100	NA	>100	NA	>100	NA	>100
H03	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100	–
I03	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100	–	–	–
J03	**<20**	>100	**30**	**45**	>100	>100	>100	>100	>100	>100	>100	>100	–
004	>100	>100	>100	>100	>100	>100	>100	>100	**88**	>100	–	–	–
006	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100	–
025	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100	–

[a] Outfall 001 was sampled in June; the other outfalls were sampled in July and August.

[b] A value of >100 indicates that the undiluted wastewater was not toxic to the test species.

[c] NA = no samples required.

[d] Bold type indicates that acute toxicity was detected.

[e] A dash indicates that toxicity testing is no longer required for these outfalls.

TABLE 5.8

Summary of Monitored Direct Discharge NPDES Outfalls, 2007

			Sample Results		
Outfall	Constituent	Permit Limit	Average for 2007	No. of Samples	2007 Exceedances
B03	Flow (MGD)	None	0.011	12	NA[a]
	pH	6–9	7.7	12	0
	Temperature	<2.8°C rise	14.4	12	0
	TSS	Monitor only	<1	12	NA
C03	Flow (MGD)	None	0.017	12	NA
	pH	6–9	7.9	12	0
D03	Flow (MGD)	None	0.015	12	NA
	pH	6–9	7.6	12	0
	Temperature	<2.8°C rise	23.6	12	0
	TSS	Monitor only	<1	12	NA
E03	Flow (MGD)	None	No Flow	0	NA
	pH	6–9	No Flow	0	NA
	Temperature	<2.8°C rise	No Flow	0	NA
	TSS	Monitor only	No Flow	0	NA
G03	Flow (MGD)	None	0.015	12	NA
	pH	6–9	7.6	12	0
	Temperature	<2.8°C rise	21.8	12	0
H03	Flow (MGD)	None	0.015	6	NA
	pH	6–9	6.9	6	0
	Temperature	<2.8°C rise	9.1	6	0
	TDS	1,000	1460	6	2
	TSS	15 Avg.; 30 Max.	4.0	6	1
	TRC[b]	0.011 Avg.; 0.019 Max.	<0.05	26	0
J03	Flow (MGD)	None	0.005	6	NA
	pH	6–9	8.01	6	0
	Temperature	<2.8°C rise	11.9	6	0
	TDS	1,000	3666	6	5
	TRC[b]	0.011 Avg.; 0.019 Max.	<0.05	23	0
004	Flow (MGD)	None	0.051	12	NA
	pH	6–9	7.8	12	0
	TSS	15 Avg.; 30 Max. 30 Max.	3	12	1
	TRC[b]	0.011 Avg.; 0.019 Max.	<0.05	50	0
A05[c,d]	Flow (MGD)	None	0.279	2	NA
	Iron (total)	Monitor only	63.2	2	NA
	Iron (dissolved)	Monitor only	0.93	2	NA

TABLE 5.8 (Cont.)

Outfall	Constituent	Permit Limit	Sample Results: Average for 2007	Sample Results: No. of Samples	Sample Results: 2007 Exceedances
B05[c,d]	Flow (MGD)	None	0.502	2	NA
	Iron (total)	Monitor only	6.1	2	NA
	Iron (dissolved)	Monitor only	0.60	2	NA
	Oil and grease	Monitor only	1.0	2	NA
C05	Flow (MGD)	None	0.022	12	NA
	pH	6–9	7.9	12	0
	Temperature	<2.8°C rise	14.7	12	0
E05	Flow (MGD)	None	0.003	10	NA
	pH	6–9	7.2	10	0
	Temperature	<2.8°C rise	12.8	10	0
	TRC	0.011 Avg.; 0.019 Max.	<0.05	39	1
006	Flow (MGD)	None	0.077	12	NA
	pH	6–9	8.2	12	0
	Temperature	<2.8°C rise	12.6	12	0
	TSS	15 Avg.; 30 Max.	2	12	0
	TDS	1,000	655	12	0
	TRC	0.011 Avg.; 0.019 Max.	<0.05	48	0
	Phenols	0.01	<0.005	4	0
007	Flow (MGD)	None	0.022	11	NA
	pH	6–9	8.1	11	0
	Temperature	<2.8°C rise	14.1	11	0
008[c]	Flow (MGD)	None	0.688	3	NA
	pH	6–9	7.5	3	0
	Tetrachloroethene	Monitor only	<0.001	3	NA
	Carbon tetrachloride	Monitor only	<0.001	3	NA
	bis(2-ethylhexyl) phthalate	Monitor only	<0.01	3	NA
020[c,d]	Flow (MGD)	None	0.045	6	NA
	COD	Monitor only	44	6	NA
021[d]	Flow (MGD)	None	0.045	6	NA
	Hydrogen-3	Monitor only	<100	6	NA
	Iron	Monitor only	0.79	6	NA
	Priority pollutants	Monitor only	–[e]	1	NA
A22[d]	Flow (MGD)	None	0.003	1	NA
	Hydrogen-3	Monitor only	125	1	NA

TABLE 5.8 (Cont.)

Outfall	Constituent	Permit Limit	Sample Results: Average for 2007	Sample Results: No. of Samples	Sample Results: 2007 Exceedances
B22[d]	Flow (MGD)	None	0.010	2	NA
	Hydrogen-3	Monitor only	119	2	NA
023[d]	Flow (MGD)	None	0.124	5	NA
	Hydrogen-3	Monitor only	120	5	NA
	Copper	Monitor only	<0.025	5	NA
025	Flow (MGD)	None	0.002	12	NA
	pH	6–9	7.8	12	0
	Temperature	<2.8°C rise	14.1	12	0
	TDS	1,000	347	12	0
	TRC[b]	0.011 Avg.; 0.019 Max.	<0.05	51	1

[a] NA = not applicable; the parameter is a monitor-only constituent and limit exceedance is not applicable.

[b] Analytical detection limit it 0.05 mg/L. Values less than 0.05 mg/L are considered in compliance with the discharge limits.

[c] A one time study of stormwater runoff quality at this outfall was required. Monitoring of outfall required immediately after a rain storm, six events total.

[d] Stormwater-only outfall.

[e] A dash indicates that priority pollutant results are presented in Section 5.4.2.1.

conducted in 2006 and early 2007 demonstrated that the elevated levels of TDS were the result of salt used to melt snow in the winter. Some of this salt moves into the soil and gravel immediately below the parking lots where it finds its way into the storm drains running under the parking lot, resulting in elevated TDS concentrations. The TDS limits at these two outfalls apply to process wastewater only. In recent years, all process discharges that had been piped to these storm drains were repiped to discharge to the laboratory or sanitary sewer system; therefore, there is no longer any process wastewater in these outfalls. In mid 2007, the IEPA confirmed that sampling of these outfalls was no longer necessary since there was no longer any process wastewater flow. Thus, sampling was discontinued in July of 2007.

Outfalls H03 and 004 experienced one exceedance each of the TSS limits in June, during a period of low flow. The elevated TSS concentrations were thought to result from algae growing in the slow-moving water in the ditch upstream of the outfalls. Outfall E05 and 025 experienced one exceedance each of the total residual chlorine limits of 0.05 mg/L. The source in each instance was found to be wastewater piping problems that permitted the discharge of small amounts of chlorinated potable water directly to the stormwater outfalls. The piping problems were corrected soon after discovery, and the discharges were stopped.

Outfall 021 is sampled once per year and analyzed for the priority pollutant constituents. Because of ongoing remedial actions in the 317 and 319 Areas, the potential for release of toxic organic chemicals into stormwater runoff exists. The 2007 sample was collected on March 1, 2007. Only one compound of the 124 compounds measured was detected above the analytical detection limits. 1,1,1-trichloroethane was found at 1 μg/L. This compound is present in the soil and groundwater in the 317 Area. Such low levels of this chemical do not represent a hazard to potential users of this water. The concentration of 1,1,1-trichloroethane found is well below the standard of 200 μg/L for this chemical in drinking water.

5.5. Additional Surface Water Monitoring

To supplement the permit-required monitoring, other analyses are voluntarily conducted on samples collected from the combined treatment plant effluent (Outfall 001) and Sawmill Creek downstream of the site. These samples are analyzed for a number of inorganic constituents and radiological parameters. The results of the radiological analyses are discussed in Chapter 4. The results of the inorganic analyses are presented in this chapter. The inorganic results are compared with the IEPA's General Effluent Standards and Stream Quality Standards listed in IAC, Title 35, Subtitle C, Chapter I.[21] While Argonne is not required to meet these standards in the effluent or Sawmill Creek, they provide a useful frame of reference against which the effluent quality and stream quality downstream of Argonne can be compared.

Surface water discharges from the closed 800 Area and the 319 Area Landfills are sampled quarterly, when flow is present, to monitor for potential leachate seepage from the waste mounds. This sampling is required by the postclosure care plans for these landfills.

5.5.1. Sample Collection and Analysis

Outfall 001. Samples for analysis of inorganic constituents were collected daily from Outfall 001 with 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 for the constituents shown in Table 5.9 by using the analytical procedures previously discussed. The pH was within the acceptable range, and none of the results exceeded the General Effluent Limits.[22] Only two metals were present above analytical detection limits in any of the 52 weekly samples collected. Three samples contained copper above analytical detection limits. All 52 samples contained low but detectable levels of fluoride.

Sawmill Creek. Sawmill Creek is a small natural stream that is fed primarily by stormwater runoff. During extended periods of low precipitation, the creek upstream of Argonne has a very low flow. At these times, a major portion of the water in Sawmill Creek south of the site consists of Argonne wastewater. To determine the impact that Argonne wastewaters have on Sawmill Creek, samples of the creek downstream of all Argonne discharge points were collected

TABLE 5.9

Chemical Constituents in Effluents from the Argonne Wastewater Treatment Plant, 2007

Constituent	No. of Samples	Concentration (mg/L)			
		Average	Minimum	Maximum	IEPA Limit
Arsenic	52			< 0.025[a]	0.25
Barium	52			< 0.5	2.0
Beryllium	52			< 0.0025	–[b]
Cadmium	52			< 0.0025	0.15
Chromium	52			< 0.05	1.0
Cobalt	52			< 0.25	-
Copper	52	< 0.025	< 0.025	0.0307	0.5
Fluoride	52	0.896	0.592	1.19	15.0
Iron	52			< 0.5	2.0
Lead	52			< 0.09	0.2
Manganese	52			< 0.075	1.0
Mercury	52			< 0.0002	0.0005
Nickel	52			< 0.05	1.0
Silver	52			< 0.0025	0.1
Thallium	52			< 0.002	–
Vanadium	52			< 0.075	–
Zinc	52			< 0.5	1.0
pH	52	NA[c]	6.74	7.84	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; pH values are not averaged since they are log functions.

and analyzed. The results were then compared with IEPA General Use Water Quality Standards found in 35 IAC, Subtitle C, Part 302.[23]

A time-proportional sampler was used to collect a daily sample at a point well downstream of the combined wastewater discharge point to allow mixing of the Argonne effluent with Sawmill Creek. After the pH was measured, the daily samples were acidified and then combined into equal-volume weekly composites and analyzed for the inorganic constituents in Table 5.10. The results obtained for 2007 are shown in Table 5.10. The pH was in the appropriate range throughout the year, and none of the metals results exceeded General Use Water Quality Standards.[23] Only fluoride was present in high enough concentrations to be detected in any of the samples.

TABLE 5.10

Chemical Constituents in Sawmill Creek, Location 7M,[a] 2007

		Concentration (mg/L)			
Constituent	No. of Samples	Average	Minimum	Maximum	IEPA Limit
Arsenic	52			< 0.025[b]	0.36[c]
Barium	52			< 0.5	5.0
Beryllium	52			< 0.0025	–[d]
Cadmium	52			< 0.0025	0.03
Chromium	52			< 0.05	3.6
Cobalt	52			< 0.25	–
Copper	52			< 0.025	0.041[c]
Fluoride	52	0.722	0.175	1.16	1.4
Iron	52			< 0.5	1.0
Lead	52			< 0.09	0.3[c]
Manganese	52			< 0.075	1.0
Mercury	52			< 0.0002	0.0026[c]
Nickel	52			< 0.05	1.0
Silver	52			< 0.0025	0.005
Thallium	52			< 0.002	–
Vanadium	52			< 0.075	–
Zinc	52			< 0.5	1.0
pH	52	NA[e]	7.18	8.13	6.5–9.0

[a] Location 7M is 15 m (50 ft) downstream from the Argonne 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.

5.5.2. 800 Area Stormwater Sampling

The Post Closure Care Plan[24] for the 800 Area Landfill requires the quarterly sampling of stormwater discharges from the landfill site. Stormwater flows from the landfill area through two outfalls, 023 and 114. Outfall 023 (old Outfall 113) is also included in the NPDES program. These two outfalls are monitored for TDS, TSS, and pH. No limits are included in the plan. The average monitoring results for 2007 are shown in Table 5.11. Comparing these values with other NPDES discharges in 2007 suggests that there is no indication of stormwater contamination from landfill operations.

TABLE 5.11

Average Monitoring Results for 800 Area Landfill Stormwater, 2007

Outfall Number	Total Dissolved Solids (mg/L)	Total Suspended Solids (mg/L)	pH range
023 (113)	202	1.3	7.4 -7.8
114	228	2.3	7.5 -7.8

5.5.3. 319 Area Stormwater Sampling

Because of the characteristics of the drainage area that generates the stormwater runoff flowing past the 319 Area, flow is present only immediately after a storm event with a large amount of precipitation. Four attempts to collect stormwater were made in 2007, but only one sample was obtained, on March 1, 2007. The sample was analyzed for VOCs and hydrogen-3. Only one compound, 1,1,1 trichloroethane, was detected at the detection limits, of 1 μg/L. Hydrogen-3 was not present above the analytical detection limit of 100 pCi/L.

6. GROUNDWATER PROTECTION

6. GROUNDWATER PROTECTION

Groundwater is present beneath the Argonne site in several different geologic units. Above the bedrock is glacial drift, which is a mixture of clay, silt, sand, and gravel deposited during past glacial retreat periods. Layers of drift with high proportions of sand and gravel may contain groundwater. Some of these layers are interconnected and provide a path for groundwater migration, while others are isolated and have limited potential for movement. Dolomite bedrock underlies the glacial drift throughout the site. The dolomite contains numerous cracks, fissures, and solution cavities that allow groundwater to migrate through the stone. This zone contains the uppermost aquifer used near Argonne as a source of drinking water for low-capacity wells. Several hundred feet below the dolomite is a layer of porous sandstone that contains the most commonly used aquifer in this region. The sandstone is isolated from overlying soil and groundwater by a thick layer of shale. Argonne monitors the quality of groundwater in the glacial drift and the dolomite. The sandstone aquifer is too deep to be affected by Argonne operations.

The groundwater below the Argonne site is monitored through the collection and analysis of samples obtained from the formerly used on-site water supply wells, from a series of groundwater monitoring wells located in areas that have the potential for affecting groundwater, and from other monitoring wells on and off the Argonne site. Regulatory requirements intended to protect groundwater resources are contained in IEPA Groundwater Quality Standards (GQSs), 35 IAC, Subtitle F, Part 620.[25] Argonne groundwater is considered Class I (highest quality) groundwater under these regulations. In addition, DOE Order 450.1 contains groundwater protection requirements for DOE sites, including the need for sitewide characterization studies and monitoring well networks. This chapter documents Argonne's compliance with these requirements.

In addition to general groundwater quality protection standards, Argonne is subject to specific groundwater monitoring requirements at several former waste management units. Various permits discussed in Chapter 2 require groundwater monitoring programs for the former 800 Area Landfill, the 317/319 Area remedial action site, and the East-Northeast (ENE) former landfill. Argonne is also voluntarily conducting groundwater monitoring near the former CP-5 reactor. This section summarizes the results from these monitoring programs.

6.1. Monitoring of the Former Potable Water Well System

6.1.1. Overview

Starting in the early years of the laboratory, domestic water was supplied by four potable water supply wells (described in Table 6.1). The well locations are shown in Figure 1.1. Use of these wells was discontinued in 1997 when Argonne's water supply was changed to Lake Michigan water, obtained from DuPage County. Lake Michigan water was selected over well water because of its higher quality, lower levels of TDS, and lower corrosivity. Lake Michigan water is treated by the City of Chicago and distributed by DuPage County. Three of the four former potable water wells are maintained as a backup water supply in the case of a loss of

TABLE 6.1

Argonne 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 no longer operational.

Lake Michigan water. Well 2 is no longer operational. The three remaining wells are all constructed in the dolomite bedrock aquifer.

6.1.2. Former Supply Well Monitoring Program and Results

Samples were collected quarterly at the wellheads of the three active wells. The existing pumps were used to purge the wells of stagnant water after which samples of the pump discharge were collected. The samples were analyzed for total alpha radioactivity, total beta radioactivity, hydrogen-3, strontium-90, and VOCs. Samples also were analyzed annually for isotopic uranium and radium. Table 6.2 describes the analytical methods used for the radiological analyses. VOCs were determined by using the analytical method listed in Table 5.2.

TABLE 6.2

Radiological Analytical Procedures

Analyte	Description	Analytical Lab
Alpha and beta radioactivity	Gas-flow proportional counting technique	Argonne
Hydrogen-3	Distillation followed by a beta liquid scintillation counting	Argonne
Strontium-90	Ion-exchange and chromatographic separations followed by proportional counting.	Argonne
Uranium	Chromatographic separation followed by alpha spectrometry.	Argonne
Radium	Resin separation followed by gamma spectrometry to measure radium-226 and radium-228.	Argonne

The results are summarized in Table 6.3. All radiological results were similar to previous years' results. None of the samples from these wells contained hydrogen-3 above the detection limit of 100 pCi/L. All results are consistent with normal background levels. No VOCs were detected in any of the samples; for clarity, these VOC results are not shown. The detection limits for VOCs were 1 to 10 μg/L.

TABLE 6.3

Radioactivity in Argonne Former Water Supply Wells, 2007
(concentrations in pCi/L)

Type of Activity	Location	No. of Samples	Average	Minimum	Maximum
Alpha	Well 1	4	6.9	1.0	19.9
	Well 3	4	1.8	1.4	2.2
	Well 4	4	3.3	2.2	4.3
Beta	Well 1	4	7.4	6.8	7.0
	Well 3	4	9.5	8.2	10.3
	Well 4	4	10.6	9.6	14.5
Hydrogen-3	Well 1	4	–[a]	–	< 100
	Well 3	4	–	–	< 100
	Well 4	4	–	–	< 100
Strontium-90	Well 1	4	–	–	< 0.25
	Well 3	4	–	–	< 0.25
	Well 4	4	–	–	< 0.25
Uranium-234	Well 1	1	–	–	0.36[b]
	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	–	–	0.26
	Well 3	1	–	–	0.11
	Well 4	1	–	–	0.07

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

[b] When all four samples were less than the detection limit, the detection limit is shown in the maximum column.

6.2. Dolomite Aquifer Monitoring

Groundwater in the dolomite aquifer is monitored at several locations across the site. Most of the monitoring is conducted to satisfy permit requirements for waste management units, and those results are discussed elsewhere in this chapter. However, in the East Area of the Argonne site, a set of dolomite wells has been monitored since 1998 to track the amount of hydrogen-3 present in the dolomite aquifer in that part of the site. Analytical data from the late 1990s identified the presence of low levels of hydrogen-3 (less than 300 pCi/L) in the former domestic supply Well 1. Natural background levels of tritium are less than 100 pCi/L. Hydrogen-3 was not found in this well in 2007; however, in recent years low levels of hydrogen-3 were occasionally found in this well. It was speculated at the time hydrogen-3 was first detected that, during the 1950s, hydrogen-3–contaminated wastewater stored in an unlined earthen holding basin at the wastewater treatment area (located northwest of the existing equalization pond shown in Figure 1.1) could have migrated to the dolomite bedrock. To determine if such a release had occurred, groundwater monitoring in this area was begun. A monitoring well network was established throughout the eastern end of the site. The network consists of three wells on Argonne property and seven wells in the Waterfall Glen Forest Preserve. The well locations are shown in Figure 6.l. Well 570091D is located immediately adjacent to the former holding basin. During 2007, samples were collected quarterly and analyzed for hydrogen-3. Table 6.4 shows the 2007 results. Hydrogen-3 was noted at very low levels in only three samples from any of the wells, including Well 570091D (122 pCi/L) and the well at the Ranger House (129 and 109 pCi/L). Two of the four control blank samples (samples of hydrogen-3 free water were used to verify the analytical detection limits) were reported to contain hydrogen-3 at levels higher than the well samples. Since the blank samples yielded reported values higher than the field samples, it is possible that the positive results are due to artifacts of the analytical process rather than hydrogen-3 actually being present in groundwater. These results are similar to past results, though the concentrations detected in 2007 were significantly lower than those during the first few years of monitoring. It appears that dilution and radioactive decay have essentially eliminated the hydrogen-3 in this part of the dolomite aquifer. In any case, the highest concentration is far below the drinking water limit of 20,000 pCi/L.

6.3. Groundwater Monitoring at Former Waste Management Areas

Argonne has occupied its current site since 1948. Over the years of operation, various wastes generated by Argonne were placed in a number of on-site disposal units. These ranged from pits and ditches filled with construction and demolition debris created in the 1950s to a former sanitary landfill used for nonhazardous solid waste disposal, which operated until September 1992. No radioactive waste was knowingly placed in any of these units for disposal; however, radiologically contaminated equipment and debris were disposed of. Several contained significant amounts of chemically hazardous materials and, therefore, represented a potential threat to the environment. Extensive site characterization and remediation of these units occurred under the Argonne remediation program that was completed in September 2003. Most of the

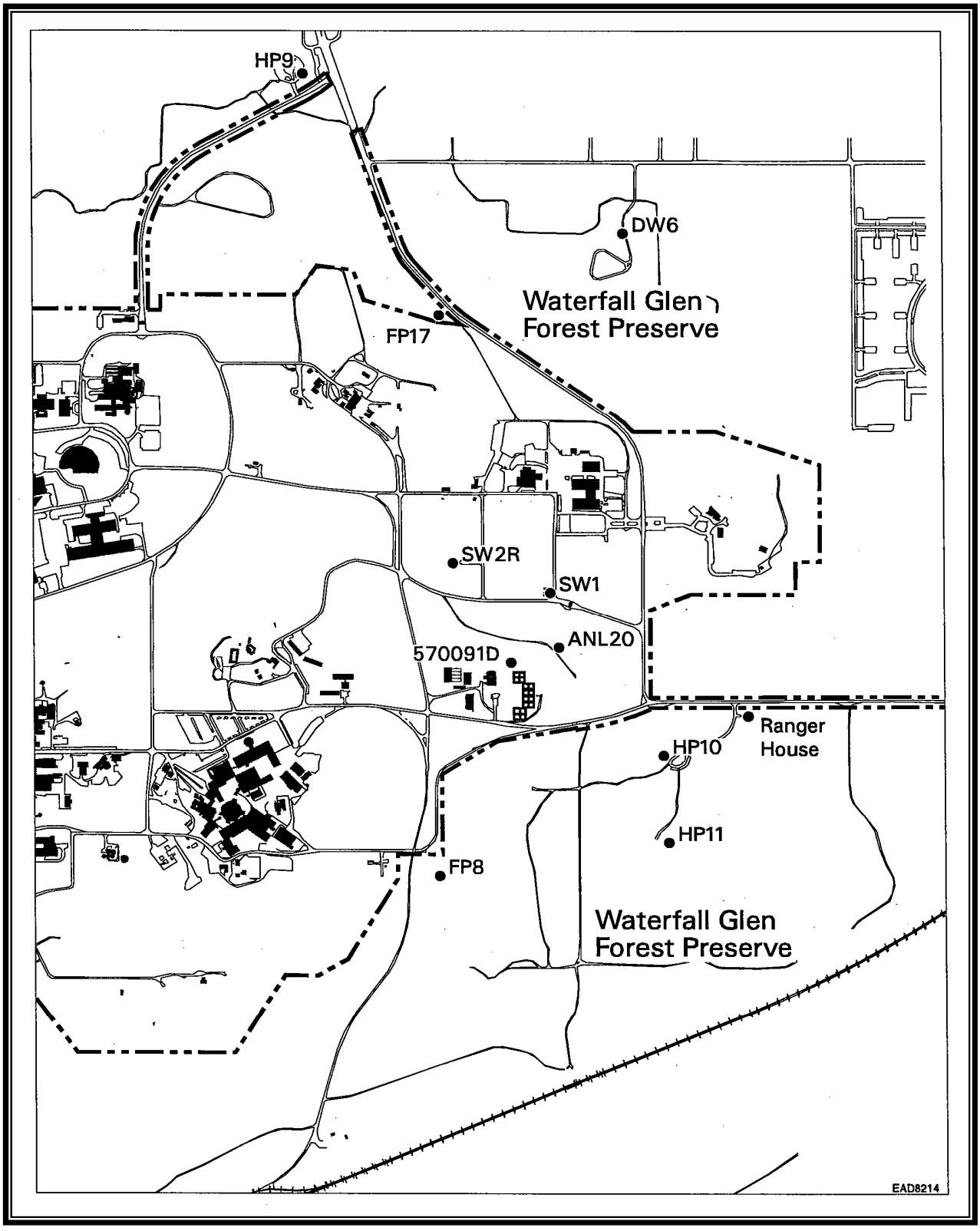


FIGURE 6.1 East Area/Forest Preserve Monitoring Wells

TABLE 6.4

Hydrogen-3 in Dolomite Wells, 2007
(concentrations in pCi/L)

	Month Collected			
Well	Jan.	Apr.	Jul.	Oct.
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	129	<100	109
Argonne				
570091D	<100	<100	<100	122
ANL-20	<100	<100	<100	<100
SW2R	<100	<100	<100	<100
Control blank	<100	135	<100	128

sites were closed by the removal of buried waste and contaminated soil, and no further action was required. However, several waste units could not be remediated by complete removal of the waste and continue to be maintained and monitored as part of the LTS Program. LTS areas that require ongoing remedial actions, including routine monitoring of groundwater, include the 317 and 319 Areas, the 800 and ENE Landfill Areas, and three off-site groundwater seeps. Groundwater below the sites with waste in place is monitored routinely to determine if hazardous materials have migrated from the units. Where contaminants have already been released to the environment, the monitoring is carried out to assess the effectiveness of the remedial actions underway and to monitor for changes in the nature and extent of contamination. The LTS Program and related groundwater monitoring have been integrated with the Argonne Environmental Monitoring and Surveillance Program.

6.3.1. 317/319 Area

The 317/319 Area contains seven separate active or former units that have been used for handling or disposal of various types of waste. The 317 Area currently contains an active radioactive waste container storage area that includes an aboveground storage area as well as the North Vault, an in-ground radioactive material container storage vault that was refurbished in 2003 but is currently empty. Five similar waste storage vaults in this area were cleaned and demolished in place during remedial actions. A small aboveground waste processing building, the Baler Building, was also demolished. Low levels of hydrogen-3 are present in the groundwater below this area as a result of past radioactive waste management practices.

In the past, the 317 Area was used for the 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. The wastes were primarily VOCs, including cleaning solvents. This unit operated during the late 1950s. Because of these past disposal practices, there is a region of contaminated soil in the northern half of the 317 Area. The most highly contaminated sections of the French Drain area were treated by using a deep soil mixing and metallic iron treatment technique during 1998. However, areas of untreated soil, and groundwater below and downgradient of this area, still contain significant amounts of these chemicals. General features of the 317 and 319 Areas are shown in Figure 6.2.

The 319 Area contains an inactive landfill that was used for disposal of a variety of solid wastes generated on-site prior to 1969. It was not intended for disposal of radioactive waste; however, a small amount of radioactive material, most notably hydrogen-3, was detected in soil and leachate during site characterization activities completed in the 1990s. The 319 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 contained a French drain that was used for several years after the French drain in the 317 Area was closed. The levels of chemical contamination in the 319 Area are far lower than the levels in the 317 Area.

Groundwater below the 317/319 Area is present in several shallow sand and gravel units, up to 6 m (20 ft) thick, within the glacial drift as well as in the upper portion of the dolomite bedrock. The presence of liquid chemical wastes from the 317 and 319 French drains, as well as the presence of hydrogen-3 in the 319 Area Landfill, have resulted in the generation of a plume of contaminated groundwater extending to the south about 200 m (600 ft). Most of the contamination is present in a porous zone 6 to 10 m (20 to 30 ft) deep in the glacial drift; however, low levels of contamination have been found in the dolomite aquifer. Two separate plumes from the 317 Area and the 319 Area Landfill mingle and together come to the surface approximately 360 m (1200 ft) south of the mound, in a series of small groundwater seeps located at the base of a ravine directly south of the waste mound, in the Waterfall Glen Forest Preserve. Since their discovery, these seeps have been monitored on a regular basis (see Section 6.4.4). The seeps contain low levels of several VOCs. During the first few years of monitoring, the seeps also contained hydrogen-3 at concentrations below all applicable standards; in recent years, the levels of hydrogen-3 have decreased to less than the detection limits. There are no known consumers of groundwater downgradient of the Argonne site.

Cleanup of the 317/319 Area has been under way since the late 1980s. The cleanup has been carried out in a series of interrelated actions designed to remove or contain the waste and chemical contaminants so that they will not migrate away from the waste disposal units. To prevent migration of contaminated groundwater from the 317 French Drain area, an underground footing drain pipe around the vaults was sealed and a groundwater collection system was installed in the southern end of the 317 Area. This system consists of 15 groundwater extraction wells with screens located in the porous zone where contaminated groundwater was found during site characterization activities. This system removes contaminated groundwater and discharges it to the on-site wastewater treatment plant.

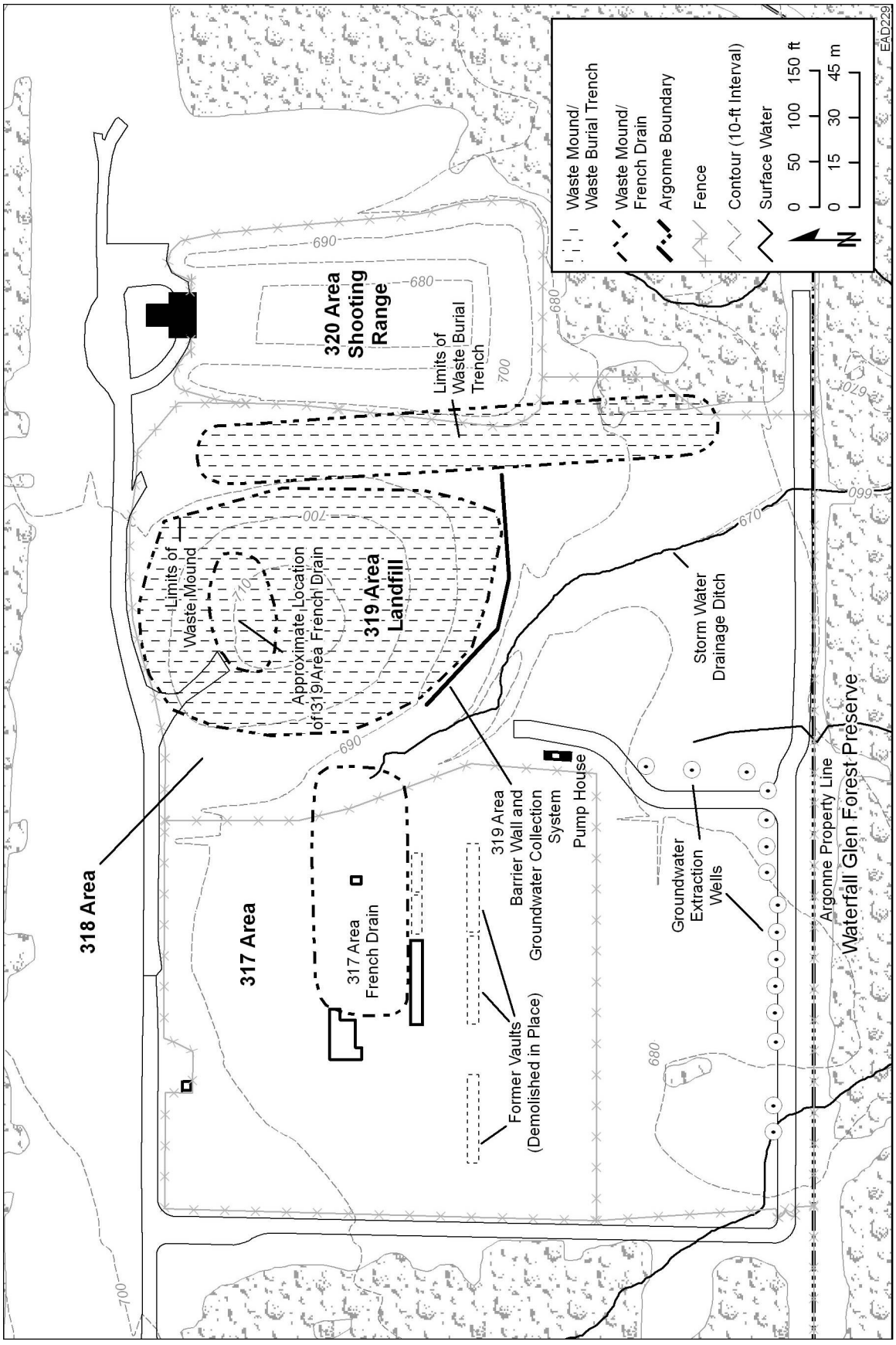


FIGURE 6.2 Locations of Components within the 317/319/ENE Area

In the 319 Area, remedial actions included constructing a subsurface clay barrier wall to prevent migration of leachate, installing a leachate and groundwater collection system to remove accumulated leachate and contaminated groundwater from under the waste mound, and installing a multilayered impermeable cap over the landfill mound and a clay cap over the burial trench.

To address the comingled groundwater plumes south of the 317 and 319 Areas, a phytoremediation system was installed in 1999. Phytoremediation involves the use of green plants to remove contaminated groundwater by evapotranspiration. The plants also facilitate the biodegradation of contaminants in soil and groundwater. The Argonne system consists of 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 Area and the former 319 Area Landfill. Approximately 950 poplar and willow trees were planted. Most of the poplar trees were installed in special lined boreholes designed to force the tree roots to grow toward the contaminated zones. This system is monitored to document its ability to control groundwater flow and remove contaminants.

The landfill caps, leachate and groundwater extraction systems, and phytoremediation system require ongoing operation and maintenance, which is conducted as part of the LTS Program. Sampling and analysis of groundwater and surface water are conducted as part of the LTS Program as well as the routine Environmental Monitoring and Surveillance Program.

The results of the IEPA-required LTS monitoring are transmitted to the IEPA on a quarterly basis through the submittal of Quarterly Progress Reports. The data from these monitoring activities are too voluminous to include in this report; however, the results are summarized and general conclusions are discussed below (see Section 6.4).

In addition to the permit-required monitoring, Argonne has voluntarily conducted groundwater sampling from a network of wells installed starting in 1986. This groundwater surveillance network was established during the early years of the site remediation program and has provided valuable insight into changes in the contaminant levels as remedial actions have progressed in the area. Section 6.3.2 discusses the results of the voluntary surveillance program.

6.3.2. Voluntary Groundwater Surveillance at the 317/319 Area

Groundwater sampling in the 317/319 Area was begun by the sitewide monitoring and surveillance program in 1986, prior to any remedial actions. The original wells were installed during a series of campaigns from 1986 through 1989. As time progressed, some wells were added, replaced, or removed. The surveillance system currently consists of the 10 wells shown in Figure 6.3 and described in Table 6.5. Eight of the wells are completed in various porous glacial drift layers less than 13 m (41 ft) deep. Wells 317121D and 319131D are completed in the dolomite aquifer about 20 m (64 ft) deep. In this area, groundwater in both the glacial drift and the dolomite flows southeast, toward the Des Plaines River. Wells 317101 and 317111 are upgradient of the 317 Area, and Well 319011 is upgradient of the 319 Area Landfill. These serve as reference wells for the downgradient wells 317021, 317052, 317061, 319031, and 319032. These wells are independent of wells installed as part of remedial actions and are not LTS wells

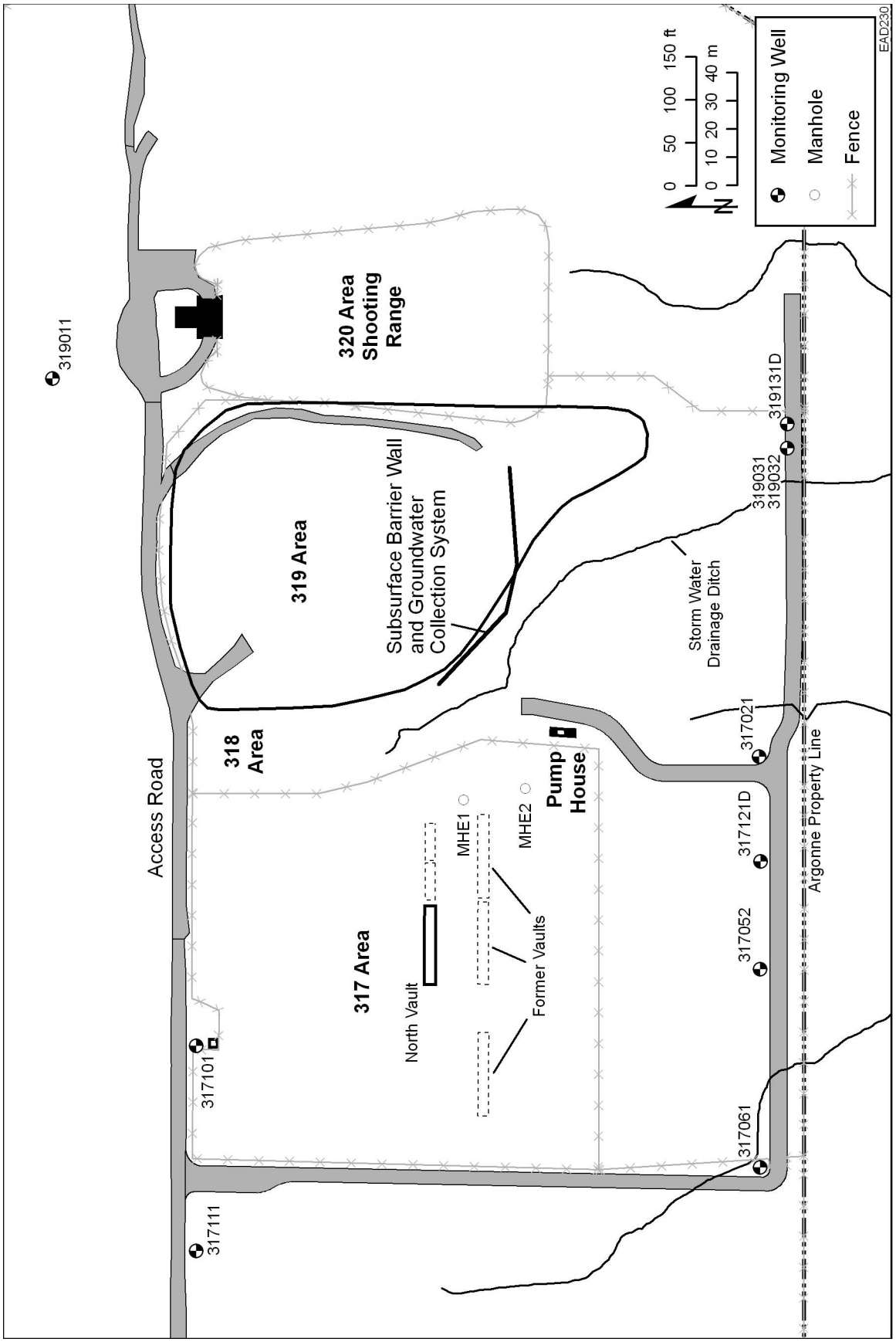


FIGURE 6.3 Groundwater Surveillance Wells in the 317/319 Area, 2006

TABLE 6.5

Groundwater Monitoring Wells: 317/319 Area

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	9/1986
317021	12.19	209.2	198.5–197.0	0.05/PVC	9/1986
319031	12.50	204.3	194.8–191.8	0.05/PVC	9/1986
319032	7.62	204.3	198.2–196.7	0.05/PVC	6/1989
317052	4.27	208.3	207.1–204.0	0.05/PVC	6/1989
317061[b]	10.36	207.6	197.3–199.7	0.05/PVC	5/2000
317101	11.89	211.0	202.2–199.1	0.05/PVC	9/1988
317111	11.89	210.3	201.4–198.4	0.05/PVC	9/1988
317121D[c]	24.08	207.6	185.0–183.5	0.15/CS	11/1989
319131D	21.03	203.5	184.0–182.5	0.15/CS	11/1989

[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.

used to directly monitor the progress of the remediation systems, but are used for general groundwater surveillance for the 317 and 319 Areas as a whole. In general, they are not located in the main contaminated groundwater plume associated with the 317 and 319 Areas.

6.3.2.1. Sample Collection

The monitoring wells are sampled according to EPA protocols described in the *RCRA Ground-Water Monitoring Technical Enforcement Guidance Document*.[26] Prior to collecting any samples, stagnant water is removed from the well. The volume of water to remove from the casing is calculated after measuring the water depth in the well. For those wells that recharge rapidly, at least three well volumes are purged by using dedicated submersible pumps or bailers. During well purging, the field parameters (pH, specific conductivity, redox potential, and temperature) are measured. Sampling is conducted after three well volumes are removed and field parameters have stabilized. For wells in the glacial drift that recharge slowly, the well is emptied completely and allowed to refill. For these wells, field parameters were measured only once. After the well refills, samples are collected using a dedicated Teflon® bailer for the shallow wells or an electronic pump for the dolomite wells. Samples for VOCs, SVOCs, PCBs and pesticides, metals, nonmetals, and radionuclide analysis are collected in that order. The samples are placed in precleaned bottles, labeled, and preserved in accordance with EPA guidance.

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. The field blank consists of a sample bottle filled with ultra-pure

water in the laboratory that is submitted for the same analysis as the field samples. This is done to verify the cleanliness of the sample bottles.

6.3.2.2. Sample Analyses — 317/319 Area Surveillance

Groundwater samples from these wells are analyzed quarterly for hydrogen-3, strontium-90, gamma-emitting radionuclides, soluble (filtered) metals, chloride, and VOCs. Once per year each well is also analyzed for semivolatile organics and PCBs and pesticides. Analyses are conducted using the methods outlined in Tables 5.2 and 6.2.

6.3.2.3. Results of Analyses

To determine if groundwater quality on the perimeter of the 317/319 Area has been impacted, the analysis results were compared with the appropriate GQSs found in 35 IAC, Section 620.410. Standards for the most conservative groundwater classification, Class I, Potable Resource Groundwater, were used. The groundwater under this site has not been formally designated by the IEPA; however, it fits the technical criteria for Class I groundwater, even though it is not used as a potable water supply. The current standards for inorganic and radioactive constituents are shown in Table 6.6. When used to officially document compliance with state standards, these standards are to be compared with analysis results from unfiltered groundwater samples. However, for environmental surveillance purposes, filtered samples were used. This was done to reduce the interference from suspended soil particles in the samples caused by the use of a bailer to collect water samples. The introduction of soil solids into a sample causes significantly higher metals results that do not reflect the true character of the in-situ groundwater. The standards for organic compounds are presented in Table 6.7. Results that exceed these standards are shown in bold in the following data tables.

The results of field parameter measurement and the results of chemical and radiological analyses of samples from the surveillance wells in the 317/319 Area are contained in Tables 6.8 through 6.17. All field parameter measurements, and radiological and inorganic analytical results are provided in these tables. The analytical methods used for organic compounds could identify and quantify all organic compounds contained in the EPA's Contract Laboratory Program (CLP) Target Compound List if present above the detection limits, typically 1 to 10 µg/L. However, only a few of these compounds were detected in the samples. The results for compounds present above the analytical detection limits are listed toward the bottom of the data tables. Compounds that were not detected above the detection limit are not included.

Field Parameters. The field parameter results listed in the tables are the final readings obtained at the time of sampling. The only parameter with a GQS is pH. The only pH values that were outside of the acceptable pH range were found in dolomite Well 317121D, which exceeded the range all four quarters. This well has a history of high pH, which may be related to the construction materials used to install this well. As in past years, the conductivity in background wells 317101 and 317111 was higher than the other wells. Chloride levels in these two wells

TABLE 6.6

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

Constituent	Standard
Antimony	0.006
Arsenic	0.05
Barium	2.0
Beryllium	0.004
Boron	2.0
Cadmium	0.005
Chloride	200.0
Chromium	0.1
Cobalt	1.0
Copper	0.65
Cyanide	0.2
Fluoride	4.0
Hydrogen-3	20,000 pCi/L
Iron	5.0
Lead	0.0075
Manganese	0.15
Mercury	0.002
Nickel	0.1
Nitrate, as N	10.0
pH	6.5–9.0
Radium-226	20 pCi/L
Radium-228	20 pCi/L
Selenium	0.05
Silver	0.05
Strontium-90	8.0 pCi/L
Sulfate	400
TDS	1,200
Thallium	0.002
Zinc	5.0

are also elevated, in most cases above the GQS. It is likely that the elevated conductivity and chloride are related to the fact that both wells are located near a road that is salted during the winter.

Inorganic Parameters. IEPA-approved background values for this area have not yet been developed; however, Wells 317111, 317101, and 319011 are upgradient of the 317/319 Area and represent background conditions. In these wells only one sample (and a duplicate sample collected from the same well) contained any metals above the detection limits. Manganese was found in Well 317111 at a concentration below the GQS. Manganese was also found in two of the four shallow downgradient wells. Well 317052 exceeded the GQS for manganese all four quarters. Iron was also detected in Well 317052 at levels below the GQS. In Well 317061, manganese was detected twice. One result exceeded the GQS. The presence of manganese in one of the upgradient wells indicates that manganese is naturally present in the 317/319 Area groundwater. Many other wells discussed in this chapter exhibit elevated manganese and iron concentrations, indicating that they are naturally present at levels that exceed GQS. The two dolomite wells did not contain any metals above detection limits.

Organic Parameters. Low levels of several VOCs were noted in four of the five downgradient wells. Well 317021 contained very low levels of TCA, 1,1-dichloroethane (DCA), and trichloroethene (TCE), as it has for years. DCA is often found along with TCA since it is a biodegradation product of TCA. Low levels of TCA were also noted each quarter in Wells 319031 and 319032. 1,4-Dioxane was found in three wells, including the dolomite well 319121D. This is a highly soluble chemical that moves easily in groundwater but is difficult to analyze. Bromoform, trichlorofluoromethane, and dibromochloromethane were detected in one sample each from Wells 319031 and 319032. No organics were found in the three background wells. Only one sample contained organics above the GQSs: TCE exceeded the GQS of 5 μg/L in Well 319031.

TABLE 6.7

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

Constituent	Standard	Constituent	Standard
Alachlor	2	Ethylene dibromide	0.05
Aldicarb	3	Heptachlor	0.4
Atrazine	3	Heptachlor epoxide	0.2
Benzene	5	Hexachlorocyclopentadiene	50
Benzo(a)pyrene	0.2	Lindane	0.2
Carbofuran	40	Methoxychlor	40
Carbon tetrachloride	5	Monochlorobenzene	100
Chlordane	2	PCBs (decachlorobiphenyl)	0.5
2,4-D	70	Pentachlorophenol	1
Dalapon	200	Phenols	100
1,2-Dibromo-3-chloropropane	0.2	Picloram	500
o-Dichlorobenzene	600	2,4,5-TP (Silvex)	50
p-Dichlorobenzene	75	Simazine	4
1,2-Dichloroethane	5	Styrene	100
Dichloromethane	5	Tetrachloroethylene	5
1,1-Dichloroethene	7	Toluene	1,000
cis-1,2-Dichloroethylene	70	Toxaphene	3
trans-1,2-Dichloroethylene	100	1,1,1-Trichloroethane	200
1,2-Dichloropropane	5	1,1,2-Trichloroethane	0.5
Di(2-ethyhexyl)phthalate	6	1,2,4-Trichlorobenzene	70
Dinoseb	7	Trichloroethylene	5
Endothall	100	Vinyl chloride	2
Endrin	2	Xylenes	10,000
Ethylbenzene	700		

TABLE 6.8

Groundwater Surveillance Results, 300 Area Well 317021, 2007

Parameter	Unit	Date of Sampling 2/20/2007	5/31/2007	9/18/2007	12/17/2007
Field Parameters					
Water elevation[a]	m	203.09	201.84	199.61	198.87
Temperature	ºC	10.6	12.7	12.0	8.1
pH	pH	7.18	7.23	7.01	7.07
Redox	mV	-12	-8	2	5
Conductivity	µS/cm	891	775	688	688
Filtered Samples					
Chloride	mg/L	26	22	59	61
Arsenic	mg/L	< 0.025	< 0.025	< 0.025	< 0.025
Barium	mg/L	< 0.5	< 0.5	< 0.5	< 0.5
Beryllium	mg/L	< 0.0025	< 0.0025	< 0.0025	< 0.0025
Cadmium	mg/L	< 0.0025	< 0.0025	< 0.0025	< 0.0025
Chromium	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Cobalt	mg/L	< 0.25	< 0.25	< 0.25	< 0.25
Copper	mg/L	< 0.025	< 0.025	< 0.025	< 0.025
Iron	mg/L	< 0.5	< 0.5	< 0.5	< 0.5
Lead	mg/L	< 0.004	< 0.004	< 0.004	< 0.004
Manganese	mg/L	< 0.075	< 0.075	< 0.075	< 0.075
Mercury	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Nickel	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Silver	mg/L	< 0.0025	< 0.0025	< 0.0025	< 0.0025
Thallium	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium	mg/L	< 0.075	< 0.075	< 0.075	< 0.075
Zinc	mg/L	< 0.5	< 0.5	< 0.5	< 0.5
Radioactive Materials					
Cesium-137	pCi/L	< 2.0	< 2.0	< 2.0	< 2.0
Hydrogen-3	pCi/L	< 100	125	< 100	< 100
Strontium-90	pCi/L	< 0.25	< 0.25	< 0.25	< 0.25
VOCs Found above Quantitation Limits[b]					
1,1,1-Trichloroethane	µg/L	8	3	13	5
1,1-Dichloroethane[c]	µg/L	2	< 1	3	1
Trichloroethene	µg/L	< 1	< 1	1	< 1

[a] Well point elevation = 197.44 m (MSL); ground surface elevation = 209.16 m (MSL); casing material = PVC.

[b] Only VOCs detected in at least one sample above detection limits are shown.

[c] No GQS exists for 1,1-dichloroethane.

TABLE 6.9

Groundwater Monitoring Results, 300 Area Well 317052, 2007

Parameter	Unit	Date of Sampling 2/19/2007	5/8/2007	9/18/2007	12/17/2007
Field Parameters					
Water elevation[a]	m	205.33	206.13	205.07	204.70
Temperature	ºC	8.8	10.0	15.0	10.3
pH	pH	7.06	7.04	7.01	6.98
Redox	mV	-5	2	4	8
Conductivity	µS/cm	940	1,066	798	826
Filtered Samples					
Chloride	mg/L	19	39	25	46
Arsenic	mg/L	< 0.025	< 0.025	< 0.025	< 0.025
Barium	mg/L	< 0.5	< 0.5	< 0.5	< 0.5
Beryllium	mg/L	< 0.0025	< 0.0025	< 0.0025	< 0.0025
Cadmium	mg/L	< 0.0025	< 0.0025	< 0.0025	< 0.0025
Chromium	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Cobalt	mg/L	< 0.25	< 0.25	< 0.25	< 0.25
Copper	mg/L	< 0.025	< 0.025	< 0.025	< 0.025
Iron	mg/L	< 0.5	1.5	< 0.5	1.6
Lead	mg/L	< 0.004	< 0.004	< 0.004	< 0.004
Manganese	mg/L	**0.15**[b]	**0.44**	**0.22**	**0.54**
Mercury	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Nickel	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Silver	mg/L	< 0.0025	< 0.0025	< 0.0025	< 0.0025
Thallium	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium	mg/L	< 0.075	< 0.075	< 0.075	< 0.075
Zinc	mg/L	< 0.5	< 0.5	< 0.5	< 0.5
Radioactive Materials					
Cesium-137	pCi/L	< 2.0	< 2.0	< 2.0	< 2.0
Hydrogen-3	pCi/L	< 100	138	< 100	< 100
Strontium-90	pCi/L	< 0.25	< 0.25	< 0.25	< 0.25
VOCs Found above Quantitation Limits[c]					
1,1-Dichloroethane[d]	µg/L	< 1	< 1	2	< 1

[a] Well point elevation = 204.53 m (MSL); ground surface elevation = 208.18 m (MSL); casing material = PVC.

[b] Bold type indicates value exceeded its GQS.

[c] Only VOCs detected in at least one sample above detection limits are shown.

[d] No GQS exists for 1,1-dichloroethane.

TABLE 6.10

Groundwater Monitoring Results, 300 Area Well 317061R, 2007

Parameter[a]	Unit	Date of Sampling			
		2/19/2007	5/9/2007	9/19/2007	12/18/2007
Field Parameters					
Water elevation[b]	m	200.15	201.06	198.63	198.34
Temperature	ºC	10.7	13.5	12.2	10.2
pH	pH	7.06	7.06	7.07	6.99
Redox	mV	-7	1	0	7
Conductivity	µS/cm	1,207	1,223	909	969
Filtered Samples					
Chloride	mg/L	131	165	162	194
Arsenic	mg/L	< 0.025	< 0.025	< 0.025	< 0.025
Barium	mg/L	< 0.5	< 0.5	< 0.5	< 0.5
Beryllium	mg/L	< 0.0025	< 0.0025	< 0.0025	< 0.0025
Cadmium	mg/L	< 0.0025	< 0.0025	< 0.0025	< 0.0025
Chromium	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Cobalt	mg/L	< 0.25	< 0.25	< 0.25	< 0.25
Copper	mg/L	< 0.025	< 0.025	< 0.025	< 0.025
Iron	mg/L	< 0.5	< 0.5	< 0.5	< 0.5
Lead	mg/L	< 0.004	< 0.004	< 0.004	< 0.004
Manganese	mg/L	< 0.075	< 0.075	< 0.075	< 0.075
Mercury	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Nickel	mg/L	< 0.05	< 0.05	0.086	**0.22**[c]
Silver	mg/L	< 0.0025	< 0.0025	< 0.0025	< 0.0025
Thallium	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium	mg/L	< 0.075	< 0.075	< 0.075	< 0.075
Zinc	mg/L	< 0.5	< 0.5	< 0.5	< 0.5
Radioactive Materials					
Cesium-137	pCi/L	< 2.0	< 2.0	< 2.0	< 2.0
Hydrogen-3	pCi/L	623	954	774	1,012
Strontium-90	pCi/L	< 0.25	< 0.25	< 0.25	< 0.25

[a] No VOCs above analytical detection limits were found in this well.

[b] Well point elevation = 197.68 m (MSL); ground elevation = 207.57 m (MSL); casing material = PVC.

[c] Bold type indicates value exceeded its GQS.

TABLE 6.11

Groundwater Monitoring Results, 300 Area Well 317101, 2007

Parameter[a]	Unit	Date of Sampling 2/12/2007	5/7/2007	5/7/2007 (Duplicate)	9/17/2007	12/17/2007
Field Parameters						
Water elevation[b]	m	203.89	205.53	205.53	203.01	202.38
Temperature	ºC	11.3	13.0	13.0	12.9	11.1
pH	pH	6.87	6.99	6.99	7.06	6.94
Redox	mV	4	6	6	5	11
Conductivity	µS/cm	2,540	2,460	2,460	1,748	2,240
Filtered Samples						
Chloride	mg/L	**630[c]**	**578**	**612**	**578**	**979**
Arsenic	mg/L	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025
Barium	mg/L	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Beryllium	mg/L	< 0.0025	< 0.0025	< 0.0025	< 0.0025	< 0.0025
Cadmium	mg/L	< 0.0025	< 0.0025	< 0.0025	< 0.0025	< 0.0025
Chromium	mg/L	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Cobalt	mg/L	< 0.25	< 0.25	< 0.25	< 0.25	< 0.25
Copper	mg/L	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025
Iron	mg/L	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Lead	mg/L	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004
Manganese	mg/L	< 0.075	< 0.075	< 0.075	< 0.075	< 0.075
Mercury	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Nickel	mg/L	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Silver	mg/L	< 0.0025	< 0.0025	< 0.0025	< 0.0025	< 0.0025
Thallium	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium	mg/L	< 0.075	< 0.075	< 0.075	< 0.075	< 0.075
Zinc	mg/L	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Radioactive Materials						
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] No VOCs above analytical detection limits were found in this well.

[b] Well point elevation = 198.66 m (MSL); ground surface elevation = 211.01 m (MSL); casing material = PVC.

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

TABLE 6.12

Groundwater Monitoring Results, 300 Area Well 317111, 2007

Parameter[a]	Unit	Date of Sampling 2/12/2007	5/7/2007	9/18/2007	12/17/2007	12/17/2007 (Duplicate)
Field Parameters						
Water elevation[b]	m	204.13	206.14	203.19	202.45	202.45
Temperature	°C	11.0	12.0	12.8	9.9	9.9
pH	pH	7.00	7.05	7.04	7.04	7.04
Redox	mV	-1	4	1	4	4
Conductivity	µS/cm	1,285	1,278	940	1,152	1,152
Filtered Samples						
Chloride	mg/L	162	**220[c]**	**215**	**335**	**333**
Arsenic	mg/L	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025
Barium	mg/L	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Beryllium	mg/L	< 0.0025	< 0.0025	< 0.0025	< 0.0025	< 0.0025
Cadmium	mg/L	< 0.0025	< 0.0025	< 0.0025	< 0.0025	< 0.0025
Chromium	mg/L	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Cobalt	mg/L	< 0.25	< 0.25	< 0.25	< 0.25	< 0.25
Copper	mg/L	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025
Iron	mg/L	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Lead	mg/L	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004
Manganese	mg/L	< 0.075	< 0.075	< 0.075	0.082	0.084
Mercury	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Nickel	mg/L	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Silver	mg/L	< 0.0025	< 0.0025	< 0.0025	< 0.0025	< 0.0025
Thallium	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium	mg/L	< 0.075	< 0.075	< 0.075	< 0.075	< 0.075
Zinc	mg/L	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Radioactive Materials						
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] No VOCs above analytical detection limits were found in this well

[b] Well point elevation = 198.37 m (MSL); ground surface elevation = 210.25 m (MSL); casing material = PVC.

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

TABLE 6.13

Groundwater Monitoring Results, 300 Area Well 317121D, 2007

Parameter	Unit	Date of Sampling 2/21/2007	5/31/2007	9/19/2007	12/19/2007
Field Parameters					
Water elevation[a]	m	186.82	186.80	186.60	186.59
Temperature	ºC	11.3	14.3	12.0	10.5
pH	pH	**11.49[b]**	**9.48**	**9.34**	**9.04**
Redox	mV	-251	-132	-125	-105
Conductivity	µS/cm	738	600	416	461
Filtered Samples					
Chloride	mg/L	75	70	143	161
Arsenic	mg/L	< 0.025	< 0.025	< 0.025	< 0.025
Barium	mg/L	< 0.5	< 0.5	< 0.5	< 0.5
Beryllium	mg/L	< 0.0025	< 0.0025	< 0.0025	< 0.0025
Cadmium	mg/L	< 0.0025	< 0.0025	< 0.0025	< 0.0025
Chromium	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Cobalt	mg/L	< 0.25	< 0.25	< 0.25	< 0.25
Copper	mg/L	< 0.025	< 0.025	< 0.025	< 0.025
Iron	mg/L	< 0.5	< 0.5	< 0.5	< 0.5
Lead	mg/L	< 0.004	< 0.004	< 0.004	< 0.004
Manganese	mg/L	< 0.075	< 0.075	< 0.075	< 0.075
Mercury	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Nickel	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Silver	mg/L	< 0.0025	< 0.0025	< 0.0025	< 0.0025
Thallium	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium	mg/L	< 0.075	< 0.075	< 0.075	< 0.075
Zinc	mg/L	< 0.5	< 0.5	< 0.5	< 0.5
Radioactive Materials					
Cesium-137	pCi/L	< 2.0	< 2.0	< 2.0	< 2.0
Hydrogen-3	pCi/L	221	304	142	141
Strontium-90	pCi/L	< 0.25	< 0.25	< 0.25	< 0.25
VOCs Found above Quantitation Limits[c]					
1,4-Dioxane[d]	µg/L	<1	15	<1	<1

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

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

[c] Only VOCs detected in at least one sample above detection limits are shown.

[d] No GQS exists for 1,4-dioxane.

TABLE 6.14

Groundwater Monitoring Results, 300 Area Well 319011, 2007

Parameter[a]	Unit	Date of Sampling			
		2/20/2007	5/9/2007	9/17/2007	12/17/2007
Field Parameters					
Water elevation[b]	m	203.51	205.25	202.95	202.20
Temperature	ºC	10.8	12.5	11.0	9.9
pH	pH	7.21	7.00	7.32	7.00
Redox	mV	-13	4	-9	5
Conductivity	µS/cm	958	941	727	724
Filtered Samples					
Chloride	mg/L	56	60	56	54
Arsenic	mg/L	< 0.025	< 0.025	< 0.025	< 0.025
Barium	mg/L	< 0.5	< 0.5	< 0.5	< 0.5
Beryllium	mg/L	< 0.0025	< 0.0025	< 0.0025	< 0.0025
Cadmium	mg/L	< 0.0025	< 0.0025	< 0.0025	< 0.0025
Chromium	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Cobalt	mg/L	< 0.25	< 0.25	< 0.25	< 0.25
Copper	mg/L	< 0.025	< 0.025	< 0.025	< 0.025
Iron	mg/L	< 0.5	< 0.5	< 0.5	< 0.5
Lead	mg/L	< 0.004	< 0.004	< 0.004	< 0.004
Manganese	mg/L	< 0.075	< 0.075	< 0.075	< 0.075
Mercury	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Nickel	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Silver	mg/L	< 0.0025	< 0.0025	< 0.0025	< 0.0025
Thallium	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium	mg/L	< 0.075	< 0.075	< 0.075	< 0.075
Zinc	mg/L	< 0.5	< 0.5	< 0.5	< 0.5
Radioactive Materials					
Cesium-137	pCi/L	< 2.0	< 2.0	< 2.0	< 2.0
Hydrogen-3	pCi/L	< 100	< 100	< 100	195
Strontium-90	pCi/L	< 0.25	< 0.25	< 0.25	< 0.25

[a] No VOCs above analytical detection limits were found in this well.

[b] Well point elevation = 197.51 m (MSL); ground elevation = 209.80 m (MSL); casing material = PVC.

TABLE 6.15

Groundwater Monitoring Results, 300 Area Well 319031, 2007

Parameter	Unit	Date of Sampling 2/20/2007	5/30/2007	September	December
Field Parameters					
Water elevation[a]	m	193.19	193.20	Dry	Dry
Temperature	ºC	10.5	12.0	Dry	Dry
pH	pH	7.10	7.17	Dry	Dry
Redox	mV	-8	-3	Dry	Dry
Conductivity	µS/cm	935	918	Dry	Dry
Filtered Samples					
Chloride	mg/L	27	28	Dry	Dry
Arsenic	mg/L	< 0.025	< 0.025	Dry	Dry
Barium	mg/L	< 0.5	< 0.5	Dry	Dry
Beryllium	mg/L	< 0.0025	< 0.0025	Dry	Dry
Cadmium	mg/L	< 0.0025	< 0.0025	Dry	Dry
Chromium	mg/L	< 0.05	< 0.05	Dry	Dry
Cobalt	mg/L	< 0.25	< 0.25	Dry	Dry
Copper	mg/L	< 0.025	< 0.025	Dry	Dry
Iron	mg/L	< 0.5	< 0.5	Dry	Dry
Lead	mg/L	< 0.004	< 0.004	Dry	Dry
Manganese	mg/L	< 0.075	< 0.075	Dry	Dry
Mercury	mg/L	< 0.0002	< 0.0002	Dry	Dry
Nickel	mg/L	< 0.05	< 0.05	Dry	Dry
Silver	mg/L	< 0.0025	< 0.0025	Dry	Dry
Thallium	mg/L	< 0.002	< 0.002	Dry	Dry
Vanadium	mg/L	< 0.075	< 0.075	Dry	Dry
Zinc	mg/L	< 0.5	< 0.5	Dry	Dry
Radioactive Materials					
Cesium-137	pCi/L	< 2.0	< 2.0	Dry	Dry
Hydrogen-3	pCi/L	437	337	Dry	Dry
Strontium-90	pCi/L	< 0.25	0.29	Dry	Dry
VOCs Found above Quantitation limits[b]					
1,1,1-Trichloroethane	µg/L	5	7	Dry	Dry
1,4-Dioxane[c]	µg/L	<1	21	Dry	Dry
Bromoform	µg/L	<1	1	Dry	Dry
Trichloroethene	µg/L	4	**8**[d]	Dry	Dry
Trichlorofluoromethane	µg/L	<1	1	Dry	Dry

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

[b] Only VOCs detected in at least one sample above detection limits are shown.

[c] No GQS exists for 1,4-dioxane, bromoform, or trichlorofluoromethane.

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

TABLE 6.16

Groundwater Monitoring Results, 300 Area Well 319032, 2007

Parameter	Unit	Date of Sampling			
		2/20/2007	5/30/2007	9/18/2007	12/18/2007
Field Parameters					
Water elevation[a]	m	198.17	198.40	197.92	197.41
Temperature	ºC	10.5	11.3	11.3	10.3
pH	pH	7.06	7.20	7.01	7.03
Redox	mV	-6	-5	4	6
Conductivity	µS/cm	1,006	991	775	755
Filtered Samples					
Chloride	mg/L	17	21	21	21
Arsenic	mg/L	< 0.025	< 0.025	< 0.025	< 0.025
Barium	mg/L	< 0.5	< 0.5	< 0.5	< 0.5
Beryllium	mg/L	< 0.0025	< 0.0025	< 0.0025	< 0.0025
Cadmium	mg/L	< 0.0025	< 0.0025	< 0.0025	< 0.0025
Chromium	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Cobalt	mg/L	< 0.25	< 0.25	< 0.25	< 0.25
Copper	mg/L	< 0.025	< 0.025	< 0.025	< 0.025
Iron	mg/L	< 0.5	< 0.5	< 0.5	< 0.5
Lead	mg/L	< 0.004	< 0.004	< 0.004	< 0.004
Manganese	mg/L	< 0.075	< 0.075	< 0.075	< 0.075
Mercury	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Nickel	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Silver	mg/L	< 0.0025	< 0.0025	< 0.0025	< 0.0025
Thallium	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium	mg/L	< 0.075	< 0.075	< 0.075	< 0.075
Zinc	mg/L	< 0.5	< 0.5	< 0.5	< 0.5
Radioactive Materials					
Cesium-137	pCi/L	< 2.0	< 2.0	< 2.0	< 2.0
Hydrogen-3	pCi/L	189	280	276	227
Strontium-90	pCi/L	< 0.25	< 0.25	< 0.25	< 0.25
VOCs Found above Quantitation limits[b]					
1,1,1-Trichloroethane	µg/L	8	5	2	1
1,1-Dichloroethane[c]	µg/L	2	2	1	<1
1,4-Dioxane[c]	µg/L	<1	41	30	29
Bromoform[c]	µg/L	< 1	1	< 1	< 1
Dibromochloromethane[c]	µg/L	< 1	1	< 1	< 1

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

[b] Only VOCs detected in at least one sample above detection limits are shown.

[c] No GQS exists for 1,1-dichloroethane, 1,4-dioxane, bromoform, or dibromochloromethane.

TABLE 6.17

Groundwater Monitoring Results, 300 Area Well 319131D, 2007

Parameter[a]	Unit	Date of Sampling			
		2/21/2007	5/31/2007	9/19/2007	12/19/2007
Field Parameters					
Water elevation[b]	m	184.95	185.03	184.74	184.68
Temperature	ºC	10.9	12.7	12.7	10.5
pH	pH	7.17	7.25	7.21	7.05
Redox	mV	-12	-8	-8	3
Conductivity	µS/cm	961	911	800	786
Filtered Samples					
Chloride	mg/L	71	59	77	79
Arsenic	mg/L	< 0.025	< 0.025	< 0.025	< 0.025
Barium	mg/L	< 0.5	< 0.5	< 0.5	< 0.5
Beryllium	mg/L	< 0.0025	< 0.0025	< 0.0025	< 0.0025
Cadmium	mg/L	< 0.0025	< 0.0025	< 0.0025	< 0.0025
Chromium	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Cobalt	mg/L	< 0.25	< 0.25	< 0.25	< 0.25
Copper	mg/L	< 0.025	< 0.025	< 0.025	< 0.025
Iron	mg/L	< 0.5	< 0.5	< 0.5	< 0.5
Lead	mg/L	< 0.004	< 0.004	< 0.004	< 0.004
Manganese	mg/L	< 0.075	< 0.075	< 0.075	< 0.075
Mercury	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Nickel	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Silver	mg/L	< 0.0025	< 0.0025	< 0.0025	< 0.0025
Thallium	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium	mg/L	< 0.075	< 0.075	< 0.075	< 0.075
Zinc	mg/L	< 0.5	< 0.5	< 0.5	< 0.5
Radioactive Materials					
Cesium-137	pCi/L	< 2.0	< 2.0	< 2.0	< 2.0
Hydrogen-3	pCi/L	806	971	509	633
Strontium-90	pCi/L	< 0.25	< 0.25	< 0.25	< 0.25

[a] No VOCs above analytical detection limits were found in this well.

[b] Well point elevation = 182.77 m (MSL); ground elevation = 203.55 m (MSL); casing material = steel.

Figure 6.4 shows the TCA and DCA concentrations in Well 310021 since 1988, a period that spans all of the remediation activities completed in this area. As shown in the figure, the concentrations of these two compounds roughly parallel each other. The levels were low and relatively consistent until 1991, at which time a trend of increasing concentrations continues until 1995 when a rapid decrease in concentrations begins. This period represents the time when active remediation of the 317 French drain was underway. This well is immediately adjacent to a former footing drain discharge pipe that was known to transport contaminated groundwater to the south. This drain line was sealed in 1997. A groundwater collection system was installed in the vicinity of this well in late 1997, and contaminated soil in the 317 French drain area was treated in 1998. A phytoremediation system was installed in 1999. All of these remedial actions may be responsible for the rapid decrease in VOC concentrations in this well since 1994. Since 1999, only very low residual amounts of VOCs have been present at this well.

Once during the year, the wells were sampled and analyzed for SVOCs, PCBs, pesticides, and herbicides. None of these types of compounds was found in any of the wells during 2007.

The results from these wells imply that only a low level of groundwater contamination exists in the 317/319 Area, outside of the remedial action zones. However, it should be noted that monitoring conducted within the remediation areas as part of the LTS Program, described in

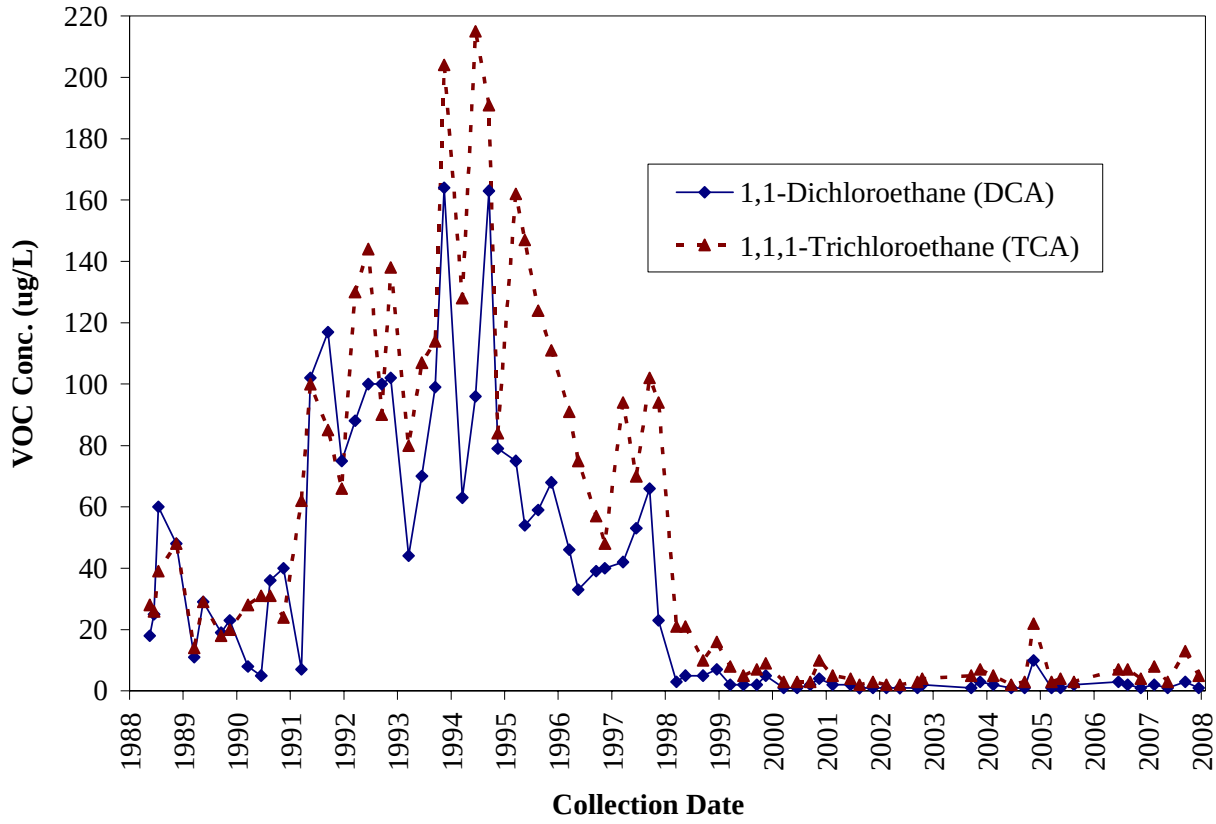


FIGURE 6.4 Concentrations of 1,1-Dichloroethane and 1,1,1-Trichloroethane in Well 317021

Section 6.4, routinely detects orders of magnitude higher concentrations of VOCs than those described above (see Table 6.20); and many results are well in excess of GQSs. These samples are collected closer to the 317 French drain and landfill areas and within shallow saturated soil layers know to be contaminated. Higher concentrations of contaminants at these targeted zones are expected at this point in the remediation process.

Radiological Parameters. Because the 317 and 319 Areas were used to process radioactive materials and contaminated equipment, three isotopes were monitored in these wells — cesium-137, hydrogen-3, and strontium-90. No cesium-137 was detected in any of the samples. Strontium-90 was found in only one sample from Well 319031 at a level only slightly higher than the analytical detection limits. Hydrogen-3 was found in one sample from one background well and in all of the downgradient wells, including the two dolomite wells. The hydrogen-3 levels were all very low, well below the drinking water standard of 20,000 pCi/L. The well with the highest historic hydrogen 3-levels is the dolomite wells south of the 319 Area, Well 319131D. The source of hydrogen-3 is thought to be leachate from the 319 Area Landfill; leachate that had migrated away from the landfill prior to the start of remedial actions. Figure 6.5 shows the annual average hydrogen-3 concentrations since 1995. This figure shows that there is a downward trend, particularly since 2001, compared with relatively stable concentrations prior to 2001. The decrease is related to the construction of the cap over the 319 Area Landfill in 1999 as well as radioactive decay of residual hydrogen-3 in the groundwater.

6.3.3. 317 Area Manhole Sampling

In addition to the wells in this area, two manholes associated with the waste storage vault footing drain sewer system are also monitored on a monthly basis. Figure 6.3 shows the locations of these two manholes. These manholes convey contaminated groundwater from footing drains around the North Vault and several of the now-demolished vaults (the footing drains were left in place after the vaults were demolished) through Manhole E1 and on to Manhole E2. A pump located in Manhole E2 pumps the water to the on-site LWTP. There it is treated and discharged to Sawmill Creek. Since 1997, water collected by the 317 and 319 leachate and groundwater collection systems has also been discharged to Manhole E2 where it is pumped to the treatment plant. Thus, the water in these manholes, particularly Manhole E2, is a mixture of groundwater from vaults in the 317 Area, leachate and groundwater from the 319 Area Landfill system, and groundwater from the 317 Area groundwater collection system. Monitoring contaminant concentrations in these manholes provides information about the progress of remedial actions in the 317 French drain area.

No record of the total volume of water pumped from Manhole E2 is maintained; however, contributions of groundwater into Manhole E2 during 2007 included an average of 1,800 L/day (472 gal/day) from the 319 Area groundwater collection system, and an average of 9,700 L/day (2,561 gal/day) from the 317 Area groundwater collection system, in addition to an unknown amount of groundwater originating in the 317 Area footing drains around the vaults. The relatively low flow from the 319 Area is the result of the impermeable cap installed over the waste mound during the summer of 1999.

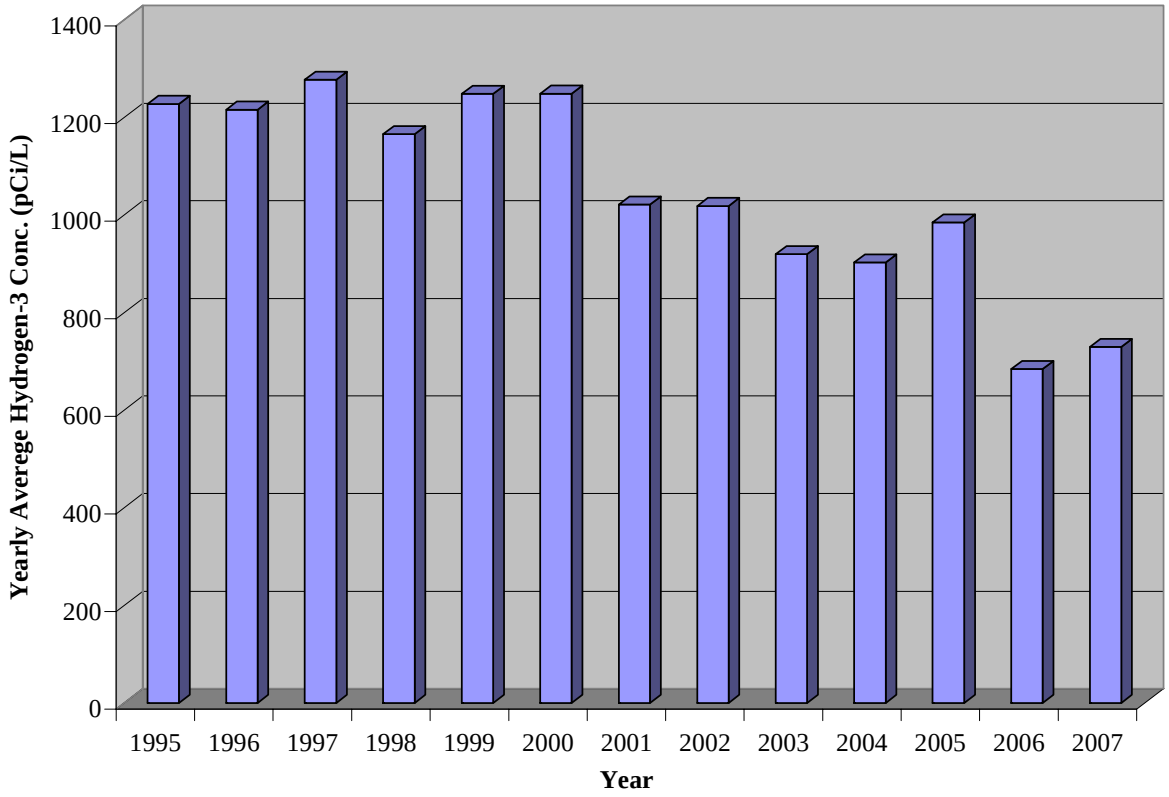


FIGURE 6.5 Hydrogen-3 in Dolomite Well 319131D

Manholes E1 and E2 were sampled monthly and analyzed for VOCs using methods discussed previously. The results are presented in Table 6.18. Figure 6.6 contains a plot of total VOC concentrations (sum of all VOCs detected) since 1994. The results are highly variable but some patterns are apparent. The highest concentrations were often found in the early spring when groundwater elevations are the highest. The high concentrations noted in mid-2005 may be related to the failure of the pump in Manhole E2, which caused the groundwater levels around the vaults to increase, bringing the water into contact with highly contaminated soil. The concentrations in E2 are typically much lower than in E1. The much lower levels of VOCs in Manhole E2 are likely due to the introduction of the discharges from the 317 and 319 Areas, which have less contamination than the groundwater from the footing drain. No significant decreasing trend in VOC concentrations is evident, and there could even be a slight increasing trend in the last 3 years.

Figures 6.7 and 6.8 show the annual average VOC results for four of the most abundant compounds since 1995, with VOC values from both manholes shown on the same vertical scale to highlight the difference in concentration. The introduction of the additional flows in 1997 makes it difficult to interpret the changes in VOC concentrations since the measured values represent an unknown mixture of water from three distinctly different and changing sources. In general, annual average VOC concentrations in Manhole E1 had decreased significantly from initial levels detected in 1995 and 1996 until unusually high levels were noted in 2005. In the

TABLE 6.18

Volatile Organic Compounds in the 317 Area: Manholes E1 and E2, 2007
(concentrations in μg/L)

Month Collected	Chloroform	Tetra-chloroethene	Trichloro-ethene	*cis*-1,2-Dichloro-ethane	1,1-Dichloro-ethane	Carbon Tetra-chloride	1,1,1-Trichloro-ethane	1,4-Dioxane
Manhole E1								
Jan.	301	13	77	17	2	361	3	ND[a]
Feb.	244	19	61	24	3	169	2	ND
March	253	10	111	26	1	153	1	ND
April	373	19	125	17	2	296	3	ND
May	756	37	198	39	5	591	4	20
June	505	77	154	36	5	513	5	31
July	213	14	94	15	1	177	2	ND
Aug.	306	10	78	14	1	261	119	ND
Sept.	313	12	63	22	3	85	3	26
Oct.	113	9	23	6	3	90	4	8
Nov.	84	9	35	8	2	63	2	7
Dec.	134	12	46	23	2	40	2	20
Manhole E2								
Jan.	110	35	26	7	<1	252	1	ND
Feb.	94	40	13	6	<1	175	2	ND
March	34	8	12	3	<1	38	<1	ND
April	48	11	16	3	21	48	26	ND
May	7	4	6	<1	16	12	19	ND
June	88	40	15	8	4	145	4	21
July	4	3	<1	<1	9	5	24	ND
Aug.	3	1	4	<1	5	2	12	ND
Sept.	3	2	3	<1	6	4	13	ND
Oct.	<1[a]	1	1	<1	5	<1	7	ND
Nov.	<1	1	<1	<1	3	1	1	ND
Dec.	159	24	52	24	3	83	3	16

[a] An ND indicates the compound was not detected. No detection limits for this compound were reported by the lab.

[b] Values shown as "<1" were not detected. The value of 1 μg/L shown is the detection limit.

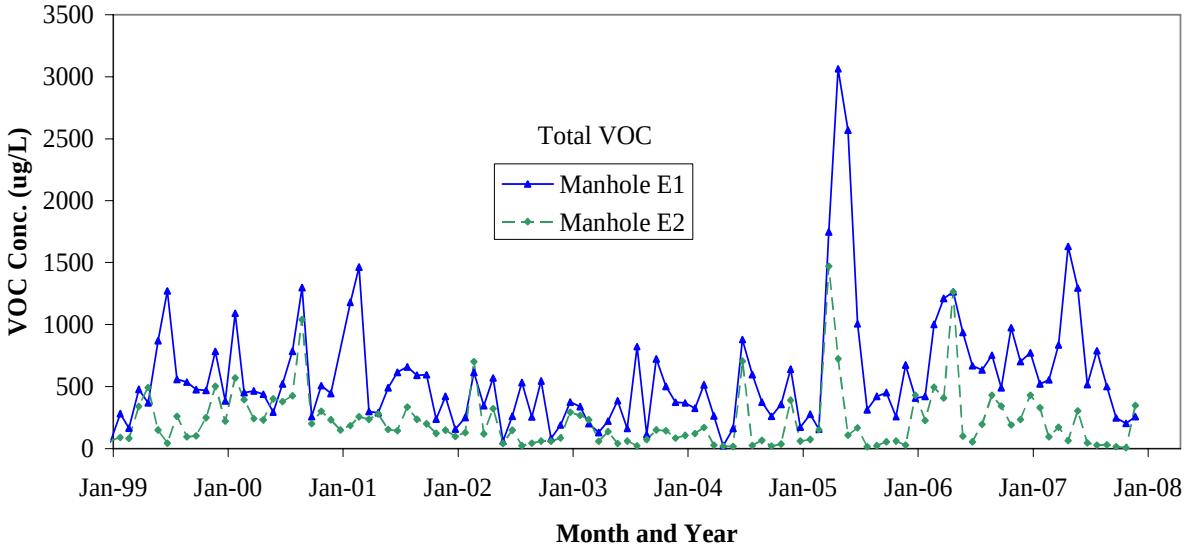


FIGURE 6.6 Total VOCs in Manholes E1 and E2

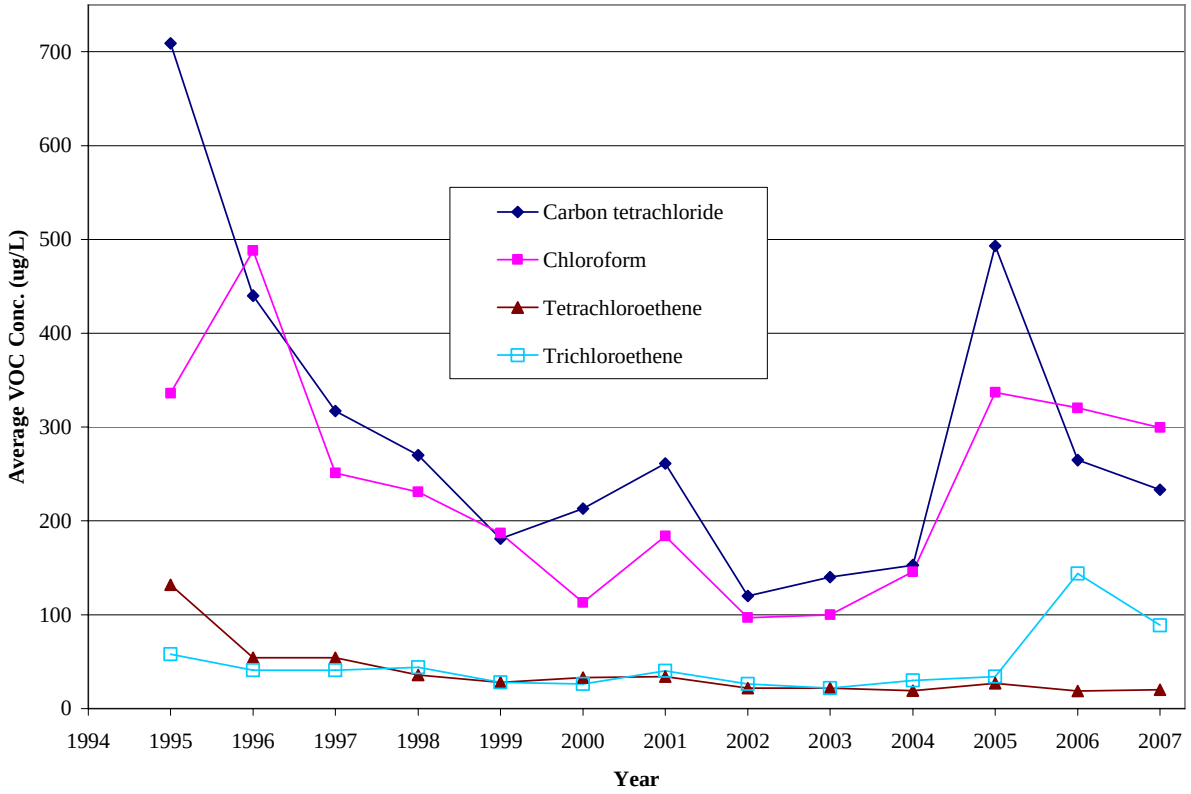


FIGURE 6.7 VOCs in Manhole E1

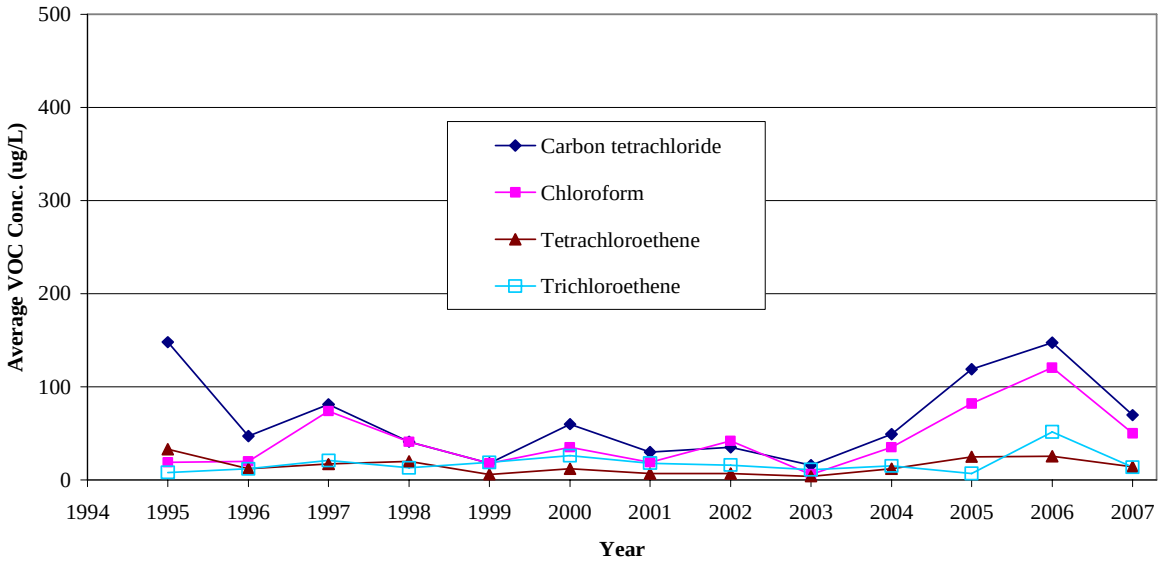


FIGURE 6.8 VOCs in Manhole E2

last 2 years VOC concentrations have slowly decreased and are moving toward levels found before 2005. The concentrations in E2 fluctuated throughout the monitoring period.

In addition to VOCs, the manhole water is analyzed for hydrogen-3 and gamma-ray-emitting radionuclides. Table 6.19 gives the hydrogen-3 results. All values were well below the GQS of 20,000 pCi/L. Unlike the VOCs, Manhole E2 often exhibits higher hydrogen-3 concentrations than Manhole E1. The primary source of the hydrogen-3 is the 319 Area groundwater extraction system that handles groundwater with elevated hydrogen-3 levels up to 10,000 pCi/L. No gamma-ray-emitting radionuclides were detected above the detection limits of 2.0 pCi/L in any samples. Figure 6.9 shows changes in hydrogen-3 concentrations in the manholes since 1998. Since 2000, hydrogen-3 concentrations have been low and relatively steady. The reduction in hydrogen-3 concentration since 1999 may be the result of the cap placed over the 319 Area Landfill, which was completed in 1999.

TABLE 6.19

Hydrogen-3 Concentrations in Manhole Water Samples, 2007
(concentrations in pCi/L)

Month Collected	Manhole E1	Manhole E2
Jan.	757	743
Feb.	1,063	2,480
March	611	216
April	785	381
May	1,004	275
June	1,193	4,217
July	772	262
Aug.	1,017	172
Sept.	1,119	146
Oct.	501	160
Nov.	723	1,081
Dec.	1,466	1,401

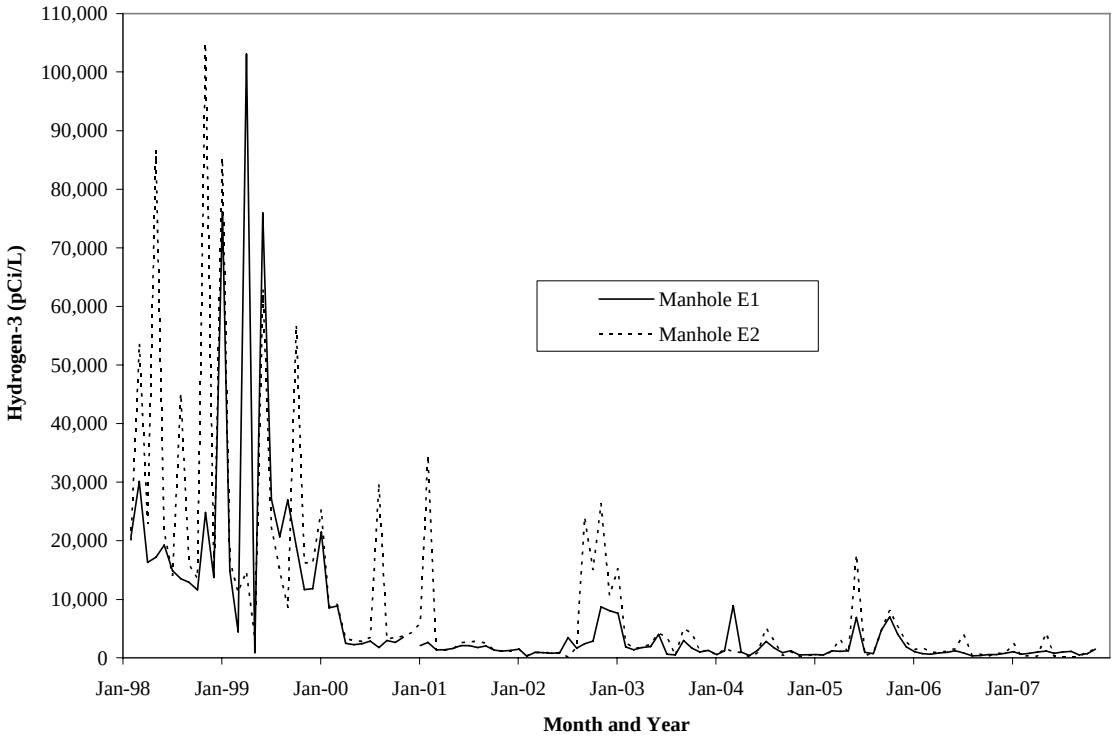


FIGURE 6.9 Hydrogen-3 in the 317 Manholes

6.4. Permit-Required Groundwater Monitoring at the 317/319 Area

The LTS Program includes the collection of groundwater data from an extensive network of monitoring wells and other sampling points located throughout the 317/319 Area. The purpose of this monitoring is to track the movement of contaminated groundwater, to determine the rate at which contaminant levels are decreasing, and to monitor the performance of the various remedial actions constructed in the 317 and 319 Areas. Most samples are collected on a quarterly basis and analyzed for VOCs and hydrogen-3 by using methods discussed elsewhere in this chapter. Once per year, samples of groundwater from several of these wells are also analyzed for metals, SVOCs, PCBs, pesticides, and radionuclides other than hydrogen-3. These data are transmitted to the IEPA quarterly and are summarized in this section.

Because of the number of wells and other sampling points sampled in this area, the volume of analytical data generated is quite large. To simplify the presentation of the data in this report, only a summary of the most significant results is presented. No organics other than VOCs were detected, and no metals other than naturally occurring metals were detected. Only normal background levels of other radionuclides were detected. None of these results are discussed in this chapter.

Overall, the monitoring results generated during 2007 indicate that the two groundwater collection systems south of the 319 Area Landfill and the 317 Area are effectively preventing off-site migration of contaminated groundwater that moves south toward the Des Plaines River. High concentrations of a number of VOCs are still present in groundwater in the immediate

vicinity of the former 317 Area French Drain. However, downgradient (south) of the French drain the levels are much lower than in the French drain area itself, though still in excess of GQSs. Contaminant concentrations at the Argonne fence line are slowly decreasing.

6.4.1. 317 Area Groundwater Monitoring

Remediation in the 317 Area consisted of in-situ soil treatment in the former French Drain area (source area), operation of a groundwater extraction system at the site boundary and installation of the phytoremediation trees. The French drain soil treatment completed in 1998 resulted in the removal of approximately 80% of the subsurface contaminants. The groundwater extraction system has been operational since 1997. The phytoremediation trees were planted in 1999 to accelerate the removal of residual soil and groundwater contamination. Phytoremediation (phyto) is a process that relies on plants to extract pore water and dissolved contaminants from subsurface soils, degrade and/or sequester them, and transpire water vapor and some volatile constituents into the atmosphere. To monitor the effectiveness of these remedial processes, monitoring wells were installed throughout the 317 Area. The wells are shown in Figure 6.10.

Samples are collected quarterly from the wells and analyzed for VOCs and hydrogen-3. Table 6.20 shows the maximum and minimum values from the 2007 quarterly samples from the four most highly contaminated wells in the French drain area. These four wells form two well clusters, with one well in each cluster in the uppermost saturated zone (4 to 5 m [13 to 16 ft] deep) and the other in a deeper saturated zone (9 to 10 m [29 to 33 ft] deep). Organics that were below the quantitation limit in all four wells are not shown in this table. Values that exceed the applicable IEPA-approved Groundwater Remediation Objective (GRO) are indicated in bold type. Comparing maximum and minimum results shows that the concentrations vary a great deal during the year, which is likely to be caused by seasonal changes in groundwater elevation.

The data in Table 6.20 indicate that pockets of elevated VOCs remain in the French drain area. The contaminants present and concentrations in these wells vary tremendously from well to well, and even between the wells in the same cluster. These values are consistent with results found in past sampling events and no consistent trend in concentrations has yet been observed, indicating that the phytoremediation process has not yet resulted in a significant reduction of VOCs in the French drain area.

Table 6.21 contains results for the same constituents listed in Table 6.20 for four downgradient wells south of the French drain. Two wells (317151 and 317351) are approximately mid-way between the French drain and the southern fence line, and two (317232 and 317462) are near the southern fence line. The concentrations found in these wells are much lower than in the French drain area; however, quite a few of the constituents are present above applicable standards. Apparently, the highly contaminated groundwater in the French drain area is not migrating downgradient. The phyto plantation in this part of the 317 Area is intended to accelerate the removal of this part of the groundwater plume.

Figure 6.11 is a map showing the approximate location of the region of contaminated groundwater within the contaminated aquifer below the 317 Area. The core of the plume extends

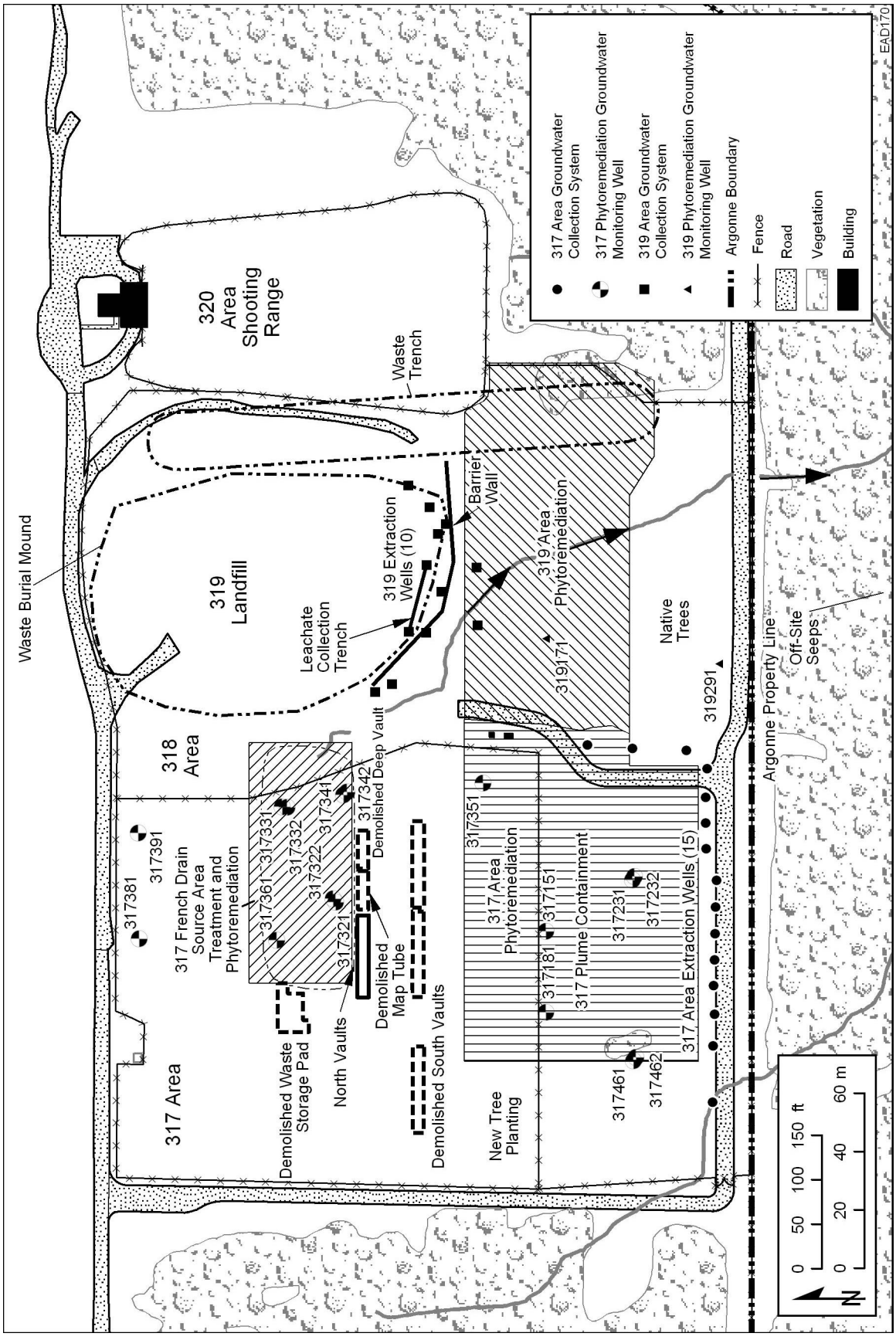


FIGURE 6.10 Phytoremediation Monitoring Wells

TABLE 6.20

Annual Maximum and Minimum Concentrations of French Drain Well Water Constituents, 2007

	Well No.								
	317321		317322		317331		317332		
Parameter	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Remediation Objective
VOC (µg/L)									
Acetone	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1	1,121	6,300
Benzene	**10,922**[a]	**22,107**	**351**	**751**	**318**	**800**	**351**	**751**	5
Carbon tetrachloride	**353,196**	**640,265**	**41**	**1,393**	<1.0	<1.0	**41**	**1,393**	5
Chloroform	**65,509**	**142,394**	**91**	**7,059**	**609**	**1,515**	**91**	**7,059**	0.2
Chloroethane	<5	<5	<5	<5	<5	99	<5	<5	2,800
Chloromethane	<5	<5	<5	125	<5	<5	<5	125	NA[b]
1,1-Dichloroethane	<1.0	<1.0	**905**	**4,294**	**5,669**	**11,722**	**905**	**4,294**	700
1,1-Dichloroethene	<1.0	<1.0	<1.0	<1.0	**1,754**	**4,846**	<1	**55**	7
1,2-Dichloroethane	<1.0	**587**	<1.0	0	**84**	**4,326**	<5	<5	5
cis-1,2-Dichloroethene	<1.0	**828**	**3,312**	**43,201**	**13,714**	**33,320**	**3,312**	**43,201**	70
Dichlorodifluoromethane	<5.0	<5.0	<5.0	<5.0	<1.0	237	<1.0	<1.0	1,400
1,4-Dioxane	<1.0	**7,453**	<1.0	**2,314**	<1.0	**4,276**	<1.0	**2,314**	1
Ethanol	<1.0	293,148	<1.0	0	<1.0	<1.0	<1.0	<1.0	NA[b]
Ethylether	<1.0	823	<1.0	0	<1.0	<1.0	<1.0	<1.0	1,400
4-Methyl-2-Pentanone	53,767	137,645	833	7,150	<1.0	2,439	833	7,150	NA
Methylene chloride	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	**2,963**	5
Nitrobenzene	<1.0	**23,827**	<1.0	**435**	<1.0	<1.0	<1.0	<1.0	3.5
Tetrachloroethene	890	1,550	<1.0	0	<1.0	<1.0	<1.0	**435**	5
Toluene	**1,005**	**2,016**	<1.0	44	<1.0	<1.0	<1.0	44	1,000
trans-1,2-Dichloroethene	<1.0	<1.0	72	<1.0	**913**	**1,837**	72	**398**	100
1,1,1-Trichloroethane	<1.0	<1.0	<1.0	<1.0	**95,103**	**243,857**	<1.0	<1.0	200
Trichloroethene	**22,779**	**53,545**	1	**479**	**34,920**	**67,995**	1	**479**	5
Trichlorofluoromethane	2,079	**5,366**	<1.0	30	<1.0	90	<1.0	30	2,100
Vinyl chloride	<2.0	**244**	**827**	**5,495**	**143**	**424**	**827**	**5,495**	2
Xylene (total)	<1.0	707	< 1.0	< 1.0	< 1.0	< 1.0	<1.0	<1.0	10,000
Total VOCs	513,575	1,325,052	15,341	62,166	159,587	377,056	15,341	62,166	
Hydrogen-3 (pCi/L)	1,350	1,491	505	697	224	320	505	697	20,000

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

[b] NA indicates no standard exists for this compound.

TABLE 6.21

Annual Maximum and Minimum Concentrations of Downgradient French Drain Well Water Constituents, 2007

	Well No.								
	Wells midway to fence				Wells near fence line				
	317151		317351		317232		317462		
Parameter VOC (µg/L)	Min	Max	Min	Max	Min	Max	Min	Max	Remediation Objective
Acetone	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	6,300
Benzene	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	5
Carbontetrachloride	<1.0	<1.0	**31**[a]	**319**	<1.0	<1.0	<1.0	<1.0	5
Chloroform	**13**	**80**	**144**	**861**	<1.0	**1.0**	<1.0	<1.0	0.2
Chloroethane	<5	<5	<5	<5	<5	<5	<5.0	<5.0	2,800
Chloromethane	<5	<5	<5	<5	<5	<5	<5.0	<5.0	NA[b]
1,1-Dichloroethane	313	557	<1.0	<1.0	<1.0	1	**1,829**	**3,455**	700
1,1-Dichloroethene	**18**	**117**	<1.0	<1.0	<1.0	<1.0	**50**	**79**	7
1,2-Dichloroethane	**20**	**166**	<1.0	<1.0	<1.0	<1.0	< 1	**149**	5
cis-1,2-Dichloroethene	15	**406**	10	39	<1.0	<1.0	54	**84**	70
Dichlorodifluoromethane	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	1,400
1,4-Dioxane	< 1.0	< 1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1
Ethanol	< 1.0	< 1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	NA
Ethylether	< 1.0	< 1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1,400
4-Methyl-2-Pentanone	< 1.0	< 1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	NA
Methylenechloride	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	5
Nitrobenzene	< 1.0	< 1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	3.5
Tetrachloroethene	**36**	**920**	**241**	**667**	<1.0	<1.0	<1.0	<1.0	5
Toluene	< 1.0	< 1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1,000
trans-1,2-Dichloroethene	56	56	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	100
1,1,1-Trichloroethane	**1,997**	**4,466**	<1.0	<1.0	<1.0	<1.0	**311**	**690**	200
Trichloroethene	**532**	**1,061**	5	**13**	<1.0	<1.0	**57**	**129**	5
Trichlorofluoromethane	< 1.0	< 1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	2,100
Vinylchloride	<2.0	< 2.1	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	2
Xylene(total)	<1.0	< 1.1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	10,000
Total VOCs	3,040	6,327	611	1,716	3	7	2,429	4,424	
Hydrogen-3	168	273	172	617	339	442	187	358	20,000

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

[b] NA indicates no standard exists for this compound.

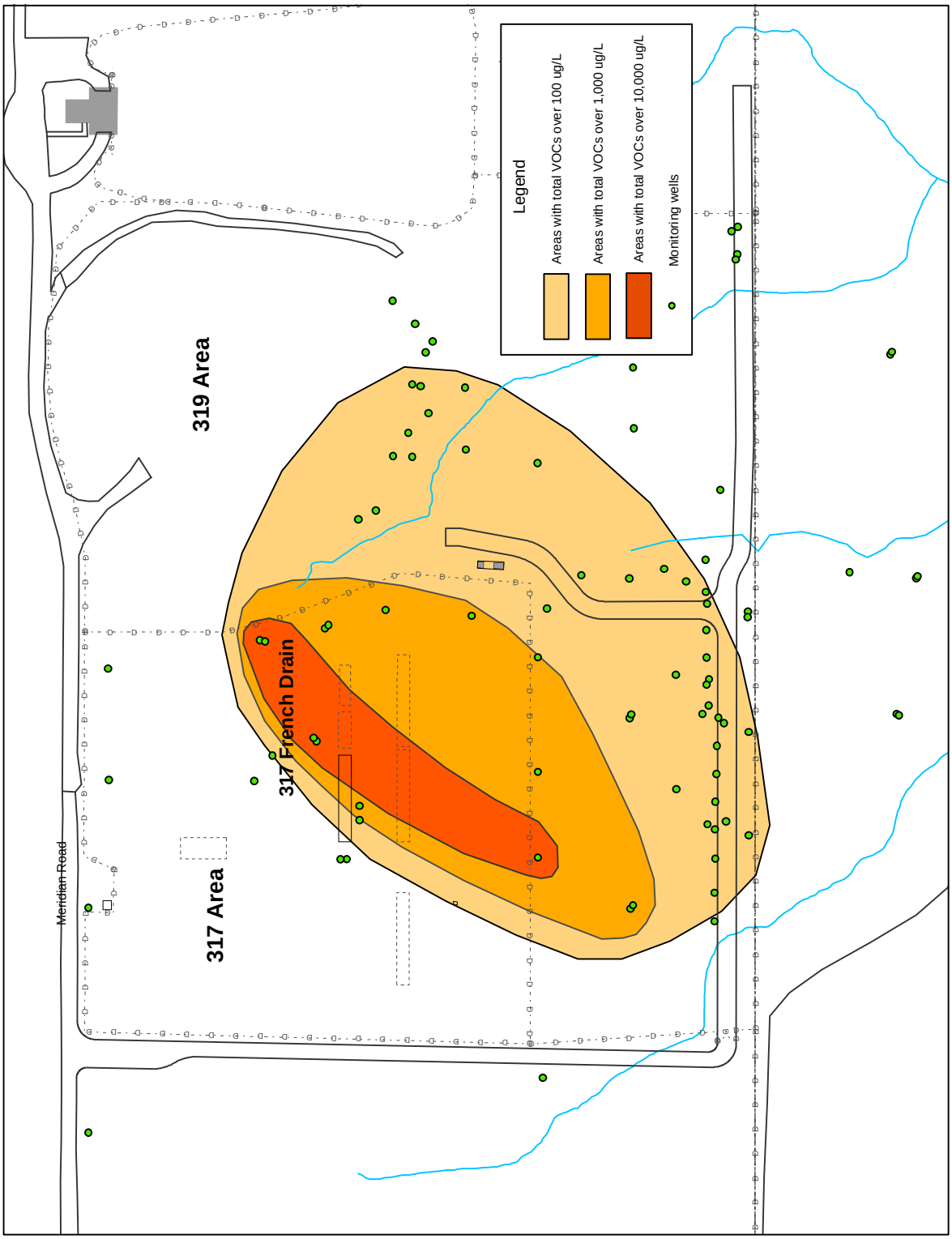


FIGURE 6.11 Region of Contaminated Groundwater in the 317 Area

from the French drain area to the southwest. The plume extends a small distance off-site into Waterfall Glen Forest Preserve.

The phytoremediation plantation encompasses this contaminant plume area. Plant tissue monitoring conducted in the phytoremediation system during the last few years indicates that the trees are indeed taking up the organic contaminants from the soil and transpiring them to the air or degrading them within the plant. Because of the difficulty of estimating sap flow rates and measuring contaminant concentrations in sap and tree tissue, it has not yet been possible to measure the rate at which the trees are removing VOCs or how quickly they will reduce residual contaminant levels. Long-term monitoring of this system will determine its effectiveness at achieving the remediation objectives for this area.

6.4.2. Extraction Well Monitoring

Two groundwater management systems in the 317/319 Area remove contaminated groundwater to prevent further migration. A line of 15 groundwater extraction wells was installed near the 317 Area south fence, and 10 wells (8 groundwater and 2 leachate collection wells) were installed south of the 319 Area Landfill. The groundwater extraction wells were installed at approximately 10-m (30-ft) intervals at a depth of 10 to 15 m (30 to 50 ft) in the porous zones. The discharge from the extraction wells is routed to the lift station in the 317 Area where the combined wastewater is pumped to the LWTP. The locations of the extraction wells are shown in Figure 6.12.

The flow from the 317 Area extraction wells is influenced by the amount of precipitation as well as the uptake of groundwater by the phyto trees during the warm months. The long-term average flow from this system through 2007 was 14,800 L/day (3,912 gal/day), with the flow prior to 2002 often exceeding 30,000 L (8,000 gal) per day. The flow rate decreased significantly starting in late 2002, possibly because of the trees removing groundwater from the shallow aquifers. The average flow rate during 2007 was 9,600 L/day (2,533 gal) per day. The flow rate from the 319 Area collection system is much lower than the 317 Area system because the size of the system is much smaller, and an impermeable clay cap was installed over the 319 Area Landfill, greatly reducing the amount of groundwater generated. Prior to installation of the cap, flows averaged approximately 5,680 L (1,500 gal) per day. During 2007, the average flow was less than 2,300 L (614 gal) per day. Both flow rates were significantly higher than in 2006 due to a return to normal precipitation amounts after an extended drought period in late 2005 that depressed flows throughout most of 2006.

Analysis of groundwater from the extraction wells is conducted annually. During 2007, two 317 Area extraction wells were completely dry, preventing sample collection. Samples are analyzed for VOCs and various radiological parameters. The concentrations of most of the parameters were below laboratory detection limits. Table 6.22 summarizes the range of contaminant concentrations above detection limits in the two extraction well systems. Both systems exceeded GQS in at least one sample during 2007. The highest VOC concentrations in the 317 Area extraction wells are orders of magnitude lower than the highest concentrations in groundwater under the French drain (see Section 6.4.1.). This indicates that the groundwater in

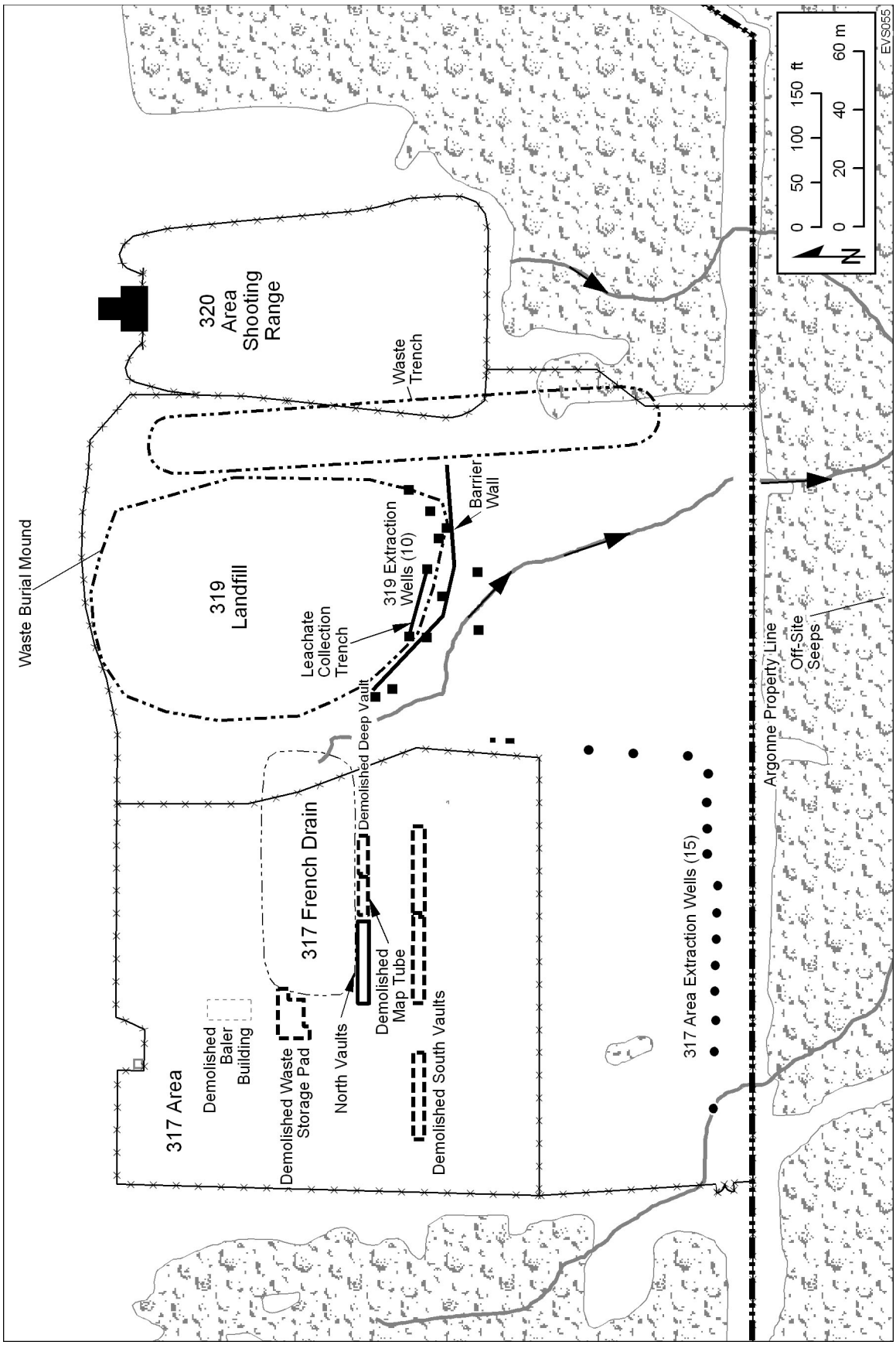


FIGURE 6.12 Extraction Wells

TABLE 6.22

Range of VOC and Hydrogen-3 Concentrations in the 317/319 Extraction Wells, 2007

Parameter	317 System Min.	317 System Max.	319 System Min.	319 System Max.	Remediation Objective
Carbon tetrachloride	<1.0	<1.0	<1.0	<1.0	5
Chloroethane	<1.0	4	<1.0	<1.0	2,800
Chloroform	**3**[a]	**4**	<1.0	<1.0	0.2
Chloromethane	<1.0	<1.0	<1.0	1	NA[b]
1,1-Dichloroethane	3	412	<1.0	9	700
1,2-Dichloroethane	<1.0	**28**	<1.0	<1.0	5
1,1-Dichloroethene	<1.0	2	<1.0	<1.0	7
cis-1,2-Dichloroethene	<1.0	9	<1.0	**130**	70
trans-1,2 Dichloroethene	<1.0	<1.0	1	4	100
Dimethyldisulfide	<1.0	<1.0	<1.0	10	NA
1,4-Dioxane	**11**	**15**	<1.0	**38**	1
Tetrachloroethene	<1.0	3	<1.0	**167**	5
1,1,1-Trichloroethane	3	**273**	<1.0	7	200
Trichloroethene	<1.0	**31**	<1.0	**44**	5
Vinyl chloride	<1.0	<1.0	3	3	2
Total VOC	**5**	**517**	<1	**193**	5
Hydrogen-3 (pCi/L)	<100	223	<100	**81,590**	20,000
Uranium-234	0.52	1.20	0.96	4.64	NA
Uranium-238	0.47	0.89	0.72	5.15	NA

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

[b] NA = not applicable.

the French drain area is not migrating and only a relatively small amount of this contamination had migrated south of this area prior to the start of remediation. The remaining contamination south of the French drain should slowly decrease because of dilution from rainwater, natural biodegradation, and the effects of the phytoremediation plantation.

In addition to VOCs, the extraction well water was also analyzed for cesium-137, isotopic uranium, and hydrogen-3. The results for the detectable amounts are shown in Table 6.22. No cesium-137 was found in any of the samples. Several wells in the 319 Area are removing groundwater or leachate with significant amounts of hydrogen-3, as evidenced by the high hydrogen-3 concentration of 81,590 pCi/L maximum, which was found in well EXT271 near the leachate trench. Only two extraction wells had hydrogen-3 concentrations higher than the 20,000 pCi/L GQS. These values were higher than the values measured in 2006. However, the hydrogen-3 values decreased in three other extraction wells. Leachate from the landfill and

underlying groundwater has been known to contain hydrogen-3 since the site was first characterized. Since the landfill cap was installed, the amount of leachate produced has been very small, and most sampling attempts do not yield a sample. The levels of uranium were somewhat higher in the 319 Area than the 317 Area but both areas are consistent with normal background levels.

Each quarter the groundwater elevations around the extraction wells are analyzed to determine the effectiveness of the extraction systems. On the basis of this analysis and estimations of groundwater flow directions, the extraction wells appear to be effectively preventing migration of contaminated groundwater from the Argonne site.

Each quarter an attempt is made to collect a sample of surface water from the stormwater ditch south of the 317 and 319 Areas. The samples are analyzed for VOCs and hydrogen-3. During 2007, one sample was collected during the first quarter of the year. The only compound detected in this sample was 1,1,1-trichloroethane just above the detection limit of 1 μg/L. From the type of compound detected, and lack of hydrogen-3, it is believed that the contamination noted results from rainwater contacting contaminated soil in the 317 French drain area.

6.4.3. ENE Landfill Groundwater Monitoring

In September 2001, Argonne completed the remediation of a small solid waste disposal area used in the early years of Argonne, known as the ENE Landfill. Waste material was consolidated and a clay cap was constructed over the waste mound. Five monitoring wells were installed 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 installed immediately downgradient of the landfill. Four other wells southeast of the mound (ENE011, ENE012, ENE013D, and ENE021D), which had been installed earlier as part of the 317/319/ENE RCRA Facility Investigation (RFI) in 1996, were incorporated into the sampling network. Figure 6.13 shows the well locations.

In April 2003, the IEPA issued a RCRA corrective action permit covering postclosure care and groundwater monitoring for the ENE Landfill. The purpose of groundwater monitoring at the ENE Landfill is to verify that contaminants found in the landfill contents, including metals (chromium, lead, and selenium) and PCB Aroclor 1254, which were all above their respective Tier 1 soil remediation objectives (as found in 35 IAC Part 742 [i.e., Tiered Approach to Corrective Action Objectives]), as well as hydrogen-3 and other radionuclides, are not of concern with regard to shallow groundwater.[29] The contaminants in the landfill soil were only of concern because of their potential ingestion risk and not their potential to migrate to groundwater. The cap placed over the landfill contents was designed to prevent exposure to future site workers, thus eliminating the ingestion pathway, and not to prevent the generation of contaminated groundwater or leachate. Nonetheless, the groundwater sampling program is in place to monitor for possible future releases of waste constituents from the former landfill. As required by the IEPA, monitoring at the ENE Landfill will be conducted throughout the 15-year postclosure care period, which started in December 2002.

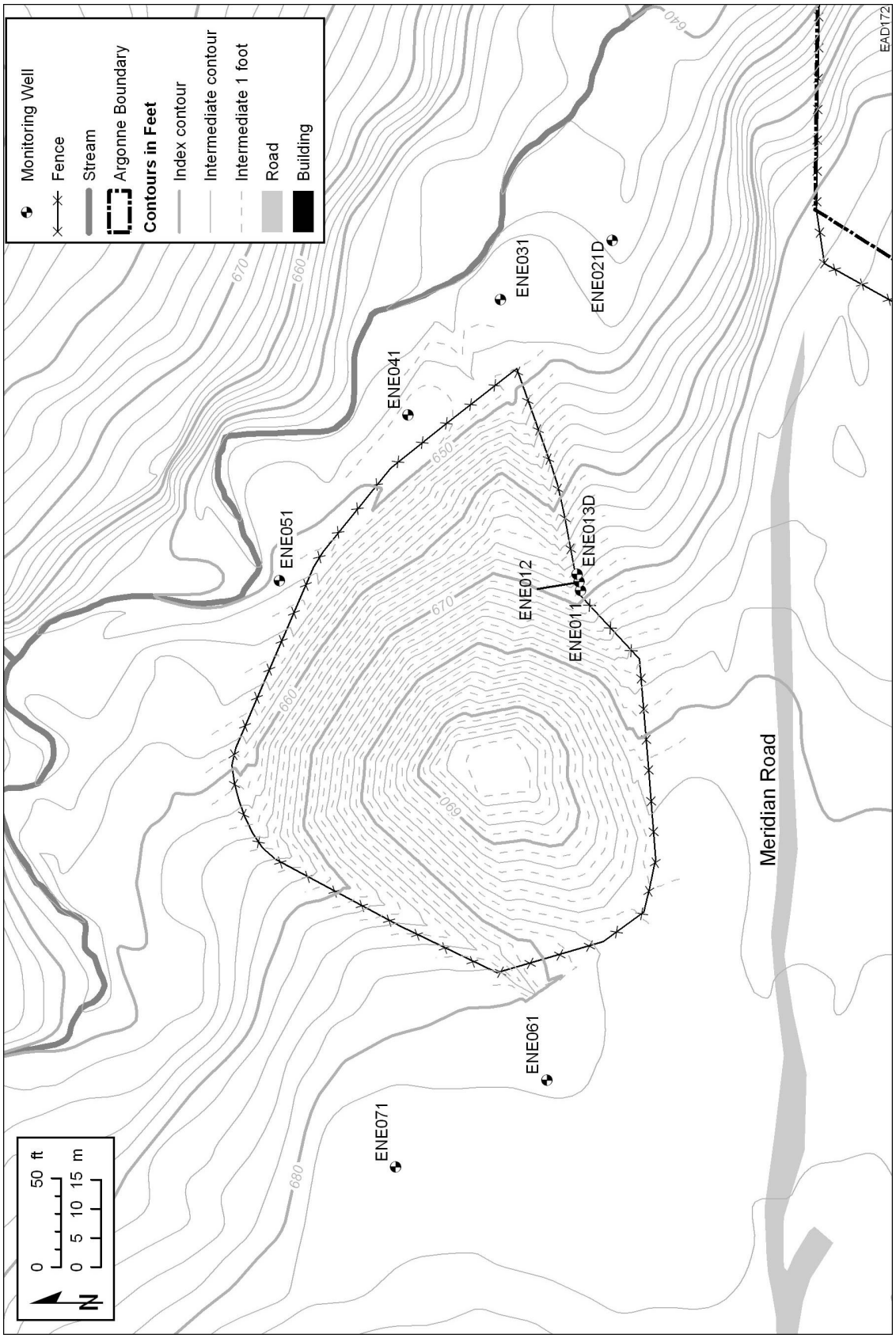


FIGURE 6.13 ENE Area Groundwater Monitoring Wells

All wells shown in Figure 6.13 are included in the quarterly monitoring program. Parameters analyzed on a quarterly basis include total PCBs and filtered and unfiltered arsenic, chromium, lead, manganese, nickel, and selenium. In 2006, some of the wells were equipped with low flow samplers to reduce the impact of suspended sediment in the samples and to produce a more representative groundwater sample. Samples are collected using these samplers whenever possible; however, frequently, groundwater levels are too low to allow this type of sampler to operate. At times, site conditions prevented a vehicle from accessing the wells, which prevented the use of the low flow sampler since the vehicle is needed to operate the pumps. In such a situation, the pump was removed from the well and the sample was collected by hand with a baler.

The 2007 results of this program are summarized in Table 6.23. The averages of quarterly results that were above detection limits from each well are shown (the individual values were submitted to the IEPA with the required quarterly LTS report). As shown in this table, a number of average results exceed the GROs for arsenic, lead, and manganese in seven of the eight wells sampled. One exceedance each for chromium and nickel was also found. The data show that total (unfiltered) metals results were much higher than dissolved (filtered) metals results. Only 2 of the 17 exceedances were from filtered samples, and these 2 were for manganese, which is a relatively soluble and abundant naturally occurring metal. The higher total metals concentration results found in unfiltered samples indicate that soil solids in the sample contributed to the elevated metals. Only 6 of the 32 samples collected in 2007 were collected with the low-flow pump. Some of the samples collected by low flow pumps were found to have all the metals results below detection limits while other samples, including several subsequent samples from the same well, had several metals with high concentrations. Thus, the effects of low-flow sampling were unclear. PCBs were not detected above the analytical detection limit of 0.5 μg/L in any of the eight wells.

Argonne is currently gathering data on normal background levels of naturally occurring groundwater constituents, such as iron, manganese, and nickel. Once a sufficient number of samples are obtained from the two upgradient wells, a statistical analysis of the results will be completed and a set of IEPA-approved background values established. The monitoring results will then be compared with these background values as well as the GROs. It is anticipated that many of the sample results that currently appear elevated will be shown to be consistent with natural background levels. Some of the highest levels of arsenic, lead, manganese, and nickel were found in the two background wells.

6.4.4. Monitoring of the Seeps South of the 300 Area

In 1996, during the RFI 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 southeast of the 317 and 319 Areas. Shallow monitoring wells were placed in three locations where the seeps are visible at the surface. These wells (SP01, SP02, and SP04) are sampled each quarter. They are located about 200 m (600 ft) south of the 319 Area. SP04 is located adjacent to an old hand-dug well. The locations are shown in Figure 6.14. The seeps are located in a pristine, heavily wooded section of the forest preserve. The ravines carry stormwater drainage from the

TABLE 6.23

Annual Average Concentrations of ENE Landfill Well Water Constituents, 2007

	Well No.									
Metal[a]	ENE-011	ENE-012	ENE-013D	ENE-021D	ENE-031	ENE-041	ENE-051	ENE-061[c]	ENE-071[c]	Standard
Arsenic–filtered	<25	<25	<25	<25	<25	29.6	<25	<25	<25	50
Arsenic–unfiltered	<25	<25	**70**[b]	<25	<25	<25	<25	**83**	**61**	50
Chromium–filtered	<50	<50	<50	<50	<50	<50	<50	<50	<50	100
Chromium–unfiltered	<50	<50	92	**183**	98	<50	84	63	90	100
Lead–filtered	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	7.5
Lead–unfiltered	5	**11**	5	4	**18**	7	<4.0	**42**	**45**	7.5
Manganese–filtered	<75	<75	<75	85	**307**	<75	<75	<75	**634**	150
Manganese–unfiltered	**178**	**313**	<75	**405**	**1,651**	**567**	**3,813**	**1,833**	**1,739**	150
Nickel–filtered	<50	<50	<50	69.7	<50	<50	<50	<50	<50	100
Nickel–unfiltered	<50	<50	<50	93	<50	<50	93	89	**102**	100
Selenium–filtered	<10	<10	<10	<10	<10	<10	<10	<10	<10	50
Selenium–unfiltered	<10	<10	<10	<10	<10	<10	<10	<10	<10	50
PCB–total	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	1.0

[a] Concentrations in µg/L.

[b] Bold type indicates that the value exceeds the GRO.

[c] Wells ENE-061 and ENE-071 are upgradient, background wells

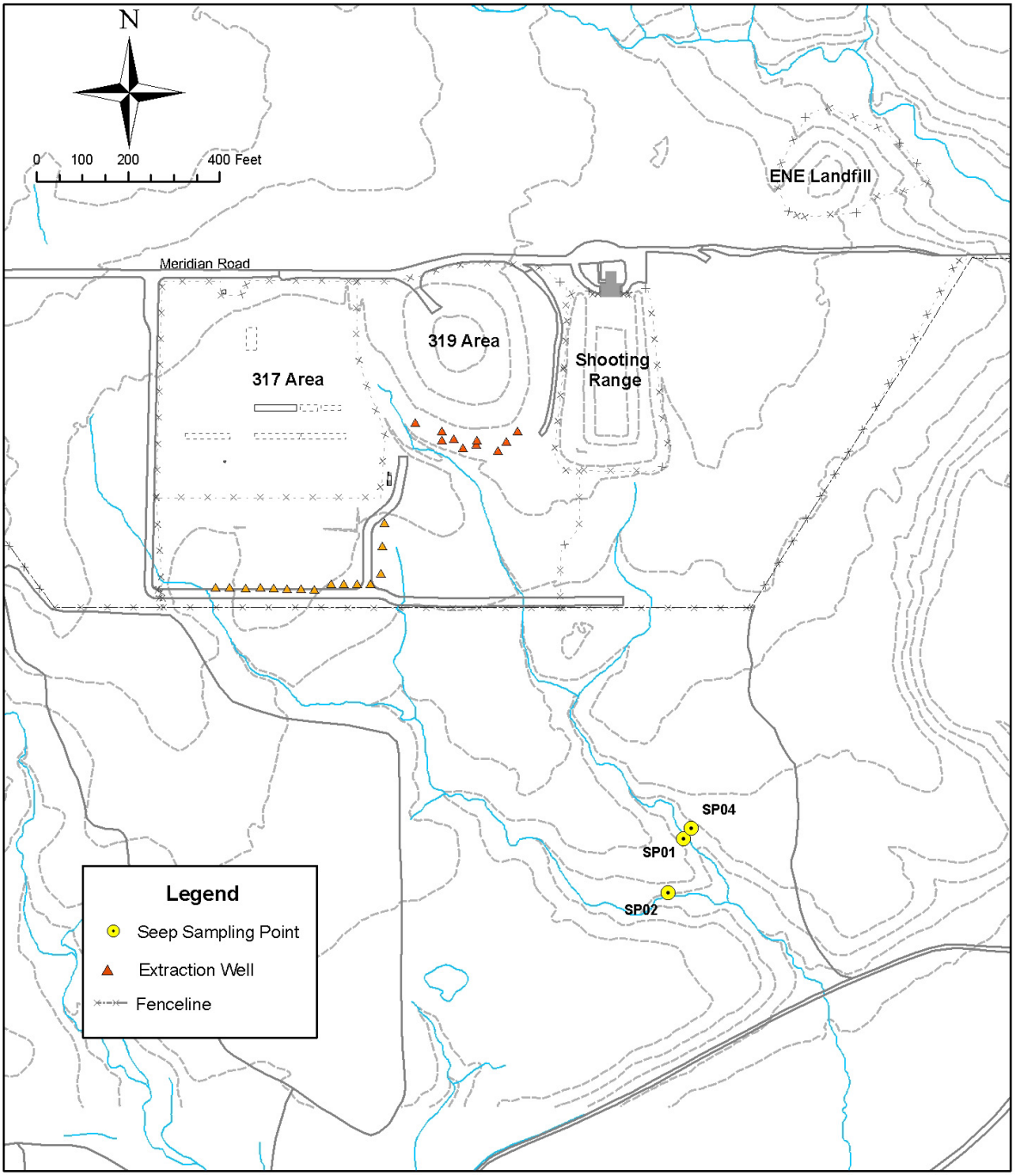


FIGURE 6.14 Seep Locations South of the 317/319 Area

317 and 319 Areas and intersect a thin shallow sandy layer containing small amounts of 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 water from the seeps is usually no longer visible because it drains back into the soil in the bed of the ravine or evaporates. During extended dry-weather conditions, the seeps disappear completely.

All three seeps have been monitored on a regular basis since discovery. Only hydrogen-3 and three VOCs (carbon tetrachloride, chloroform, and tetrachloroethene) have been consistently found. During 2007, the seeps were sampled quarterly for VOCs and hydrogen-3. Table 6.24 contains the results for 2007. VOCs were noted in all three seeps but hydrogen-3 was found only once in one seep. The levels of VOCs in SP01 and SP02 were very low. Seep SP04 showed the highest levels of all three VOCs. Figure 6.15 contains a series of charts showing annual average VOC concentrations in the three seeps since 1996. As seen in this figure, the VOC concentrations vary significantly from year to year. The VOCs in seeps SP01 and SP04 may be exhibiting a slow downward trend; however, because of the variability in results, it is difficult to discern a clear pattern. The VOCs in SP02 appear to have increased for several years after monitoring began but have been slowly decreasing since 2002. The VOC concentrations in SP04 are several orders of magnitude higher than the other seeps. The concentrations appear to be strongly influenced by precipitation, as shown in Figure 6.16. This figure shows how the concentrations of carbon tetrachloride and chloroform vary in SP04. In three instances during extended dry periods, SP04 was completely dry. Immediately after such dry periods, the carbon tetrachloride and chloroform concentrations were found to have decreased significantly. They then increased to relatively high levels, which in turn slowly decreased once normal precipitation patterns returned. These fluctuations may indicate that a decreasing groundwater elevation caused the groundwater to flow through relatively clean portions of the saturated zone, where it picked up little contamination. During periods when groundwater is normal or higher than normal, the groundwater flows through more contaminated soil, resulting in higher VOC concentrations.

The hydrogen-3 results for the seeps show a clear decline in hydrogen-3 concentrations since monitoring began. Figure 6.17 shows the hydrogen-3 results in all three seeps since 1997. The decline in hydrogen-3 since 1999 could be related to the installation of the cap over the 319 Area Landfill, which is the likely source of the hydrogen-3 at the seeps. The decline in hydrogen-3 is much more rapid than radioactive decay alone would account for. In recent years, most of the hydrogen-3 results have been at or below the analytical detection limits.

Monitoring for hydrogen-3 was also conducted quarterly in the forest preserve at an artesian well located about 2,000 m (6,000 ft) southwest of the 317 Area (grid location 3E in Figure 1.1). All hydrogen-3 concentrations were below the detection limit of 100 pCi/L. This finding suggests that any subsurface hydrogen-3 contamination does not extend to this location.

TABLE 6.24

Contaminant Concentrations in Seep Water, 2007

Sample Date	Carbon Tetrachloride (µg/L)	Chloroform (µg/L)	Tetrachloroethene (µg/L)	Hydrogen-3 (pCi/L)
SP01				
1/19/2007	5	1	<1	<100
5/1/2007	5	1	<1	<100
8/1/2007	3	1	<1	<100
10/16/2007	5	<1	<1	<100
SP02				
1/19/2007	3	<1	<1	120
5/1/2007	2	<1	<1	<100
8/1/2007	1	<1	<1	<100
10/16/2007	1	<1	<1	<100
SP04				
1/19/2007	253	20	5	<100
5/1/2007	152	24	6	<100
8/1/2007	179	29	7	<100
10/16/2007	135	23	6	<100

6.4.5. Groundwater Monitoring at the Groundwater Monitoring Zone (GMZ) Area

Remedial investigations and remedial actions have been underway in the 317/319 Area since 1994. Many of these actions have been discussed elsewhere in this chapter. These actions were focused on identifying, removing, or containing sources of contamination. The final such action was the installation of the phytoremediation system in 1999. Because of the nature, extent, and depth of contamination, it was not feasible to remove all contaminated soil or groundwater during the active remediation phase. The phytoremediation system, as well as the groundwater extraction systems, was intended to contain residual contamination and slowly reduce contaminant levels until the GRO levels are attained. The regulatory tool the IEPA utilizes to oversee such a remedial process is a GMZ. 35 IAC Part 620.250 allows for the establishment of a GMZ as a three-dimensional region containing groundwater being actively remediated to clean up contamination caused by past releases. For a GMZ to be sustained, the groundwater within the proposed GMZ must be managed to ensure that cleanup of the contaminants continues until GRO levels are achieved. Because of the proximity of the 317 and 319 Areas and the fact that the groundwater plumes have intermingled and emerged to the surface in the seeps, the entire area encompassing the 317 Area, 319 Area, and the area extending down to the seeps was included within the GMZ. The GMZ measures approximately 8.9 ha (22 acres) in extent. The GMZ was approved by the IEPA on November 22, 2000.

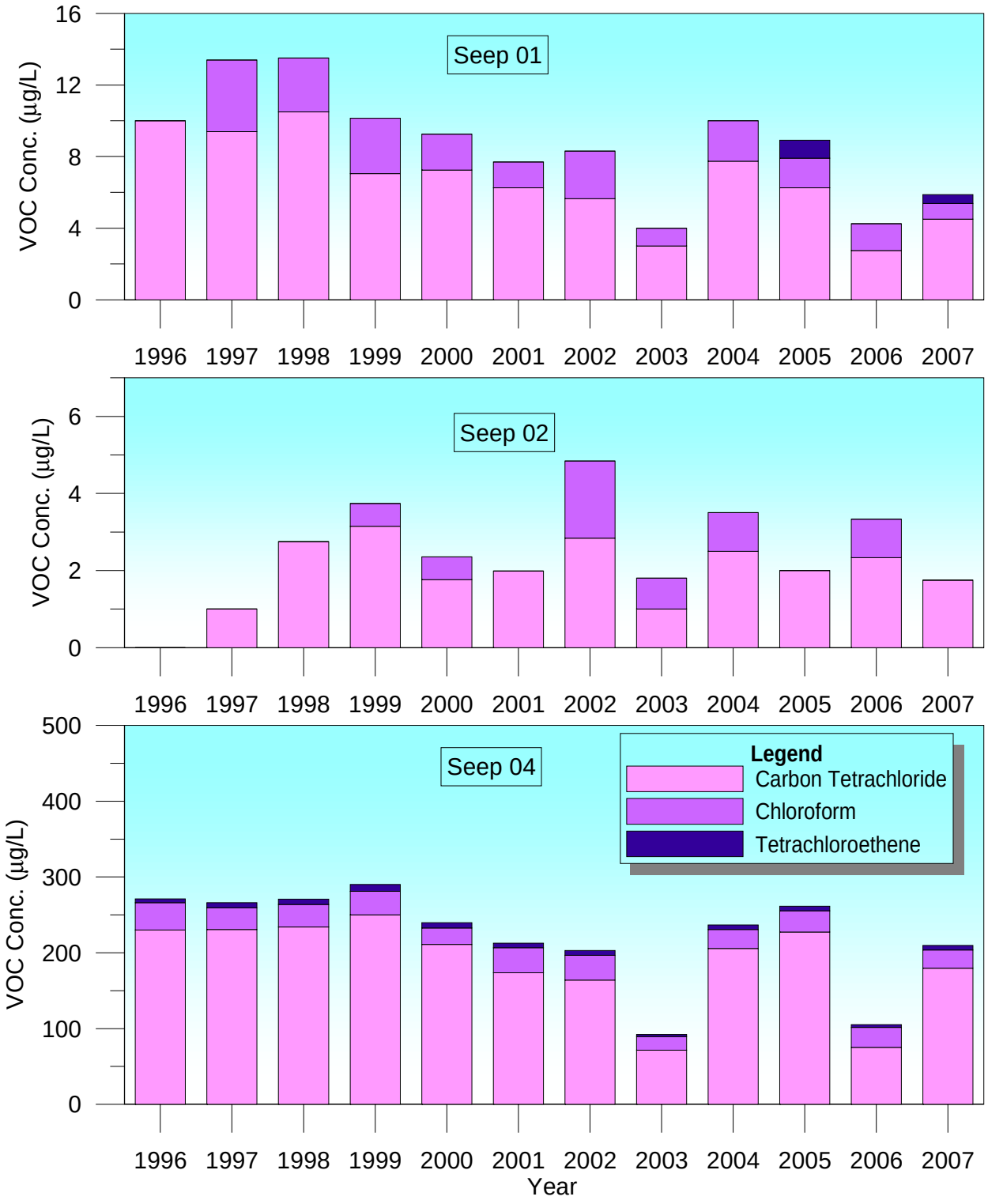


FIGURE 6.15 Groundwater Seeps Annual Average VOC Concentrations since 1996

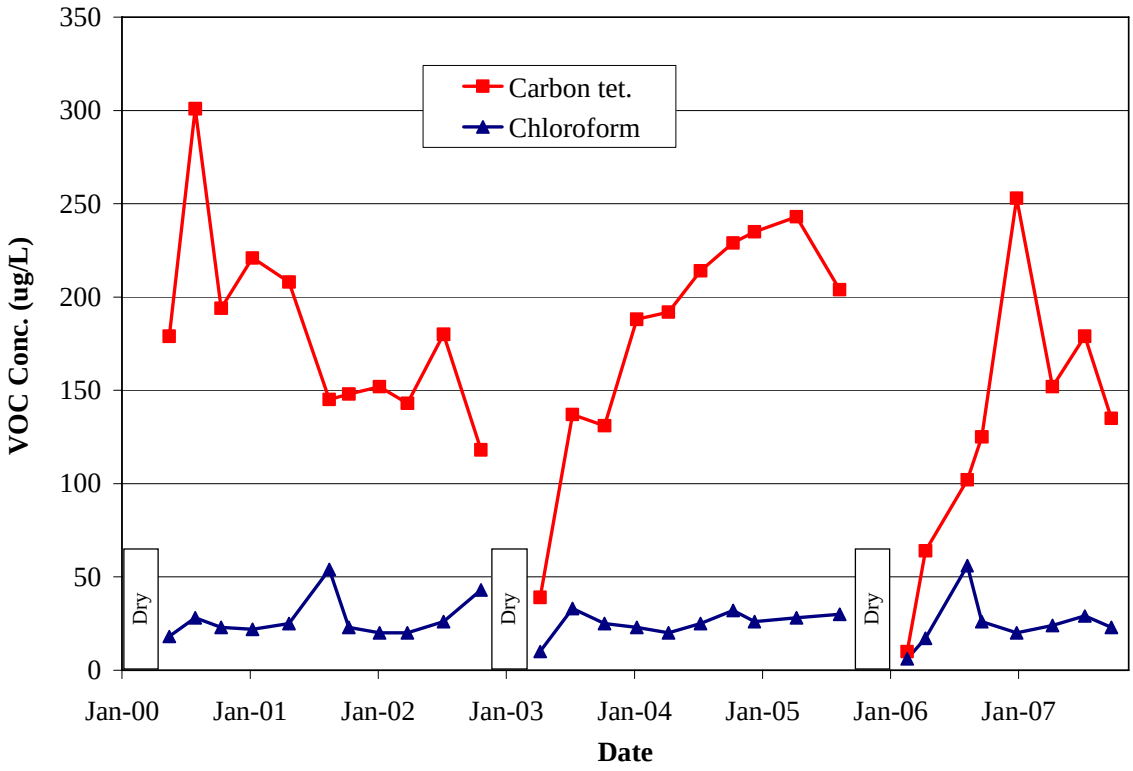


FIGURE 6.16 Carbon Tetrachloride and Chloroform in Seep 04, 2000 to 2007

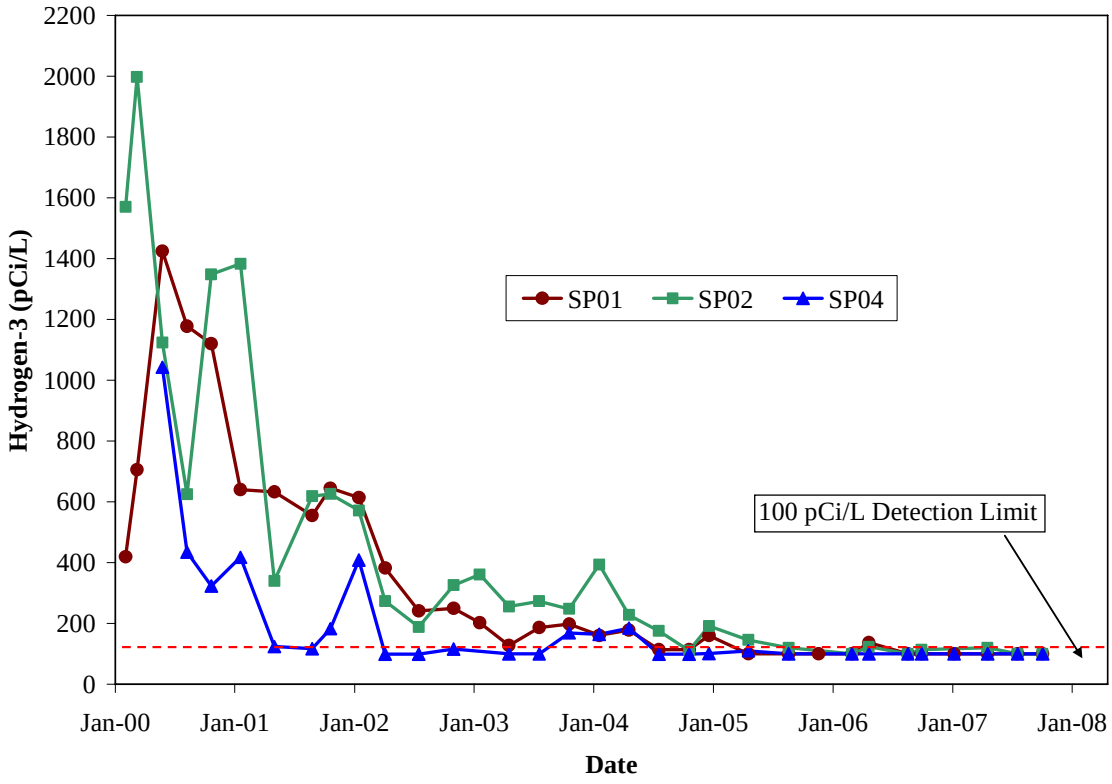


FIGURE 6.17 Hydrogen-3 Concentrations in Seep Water, 2000 to 2007

The boundaries of the GMZ are delineated by a set of monitoring wells that are located on the outer boundary of the region of contaminated groundwater, both laterally and vertically. These wells are intended to be in clean groundwater unaffected by past releases. Figure 6.18 shows the locations of these boundary wells. Four of these wells are screened in the glacial drift (Wells 317971, 317941, 319781, and 319801), and four are in the upper dolomite bedrock (Wells 317012D, 317951D, 319961D, and 319013D). They include three mini-monitoring wells (MMW06D, MMW013, and MMW011) installed in the shallow glacial drift in the forest preserve between the Argonne site and the seeps. Because of the inaccessibility of this area, a different well installation technique was used that required the installation of small diameter wells, termed mini-monitoring wells. Well 317941 has shown contamination above GROs for several years and was replaced by Well 317971 in 2002. Well 317941 continues to be sampled but is no longer considered a perimeter GMZ well. Wells 317951D and 319961D were installed in 2002 to replace existing dolomite wells 317121D and 319131D, which were installed in 1988 by using techniques that are no longer used to install groundwater monitoring wells. Both the original and replacement wells will be sampled for several years to compare results. If similar results are found, the older wells will be closed.

Samples from the GMZ wells are collected semiannually. The samples are analyzed for the list of Contaminants of Concern for the 317 and 319 Areas, which includes a number of VOCs, two semivolatile organics *(bis*(2-ethylhexyl)phthalate and nitrobenzene), one pesticide (alpha-BHC), and hydrogen-3. The purpose of this monitoring is to determine if contamination has migrated beyond the perimeter of the approved GMZ. The averages of the two semiannual samples collected in 2007 are shown in Table 6.25. Well 319781 was dry the first quarter of 2007 so only one sample was collected. The individual results were transmitted to the IEPA in the quarterly LTS report.

Monitoring results from 2007 indicate that 1,4-dioxane contamination above GROs was found in one of two samples from mini-well MMW013. All other values for the wells on the perimeter of the GMZ were below GRO. Results from Well 317941 do exceed the GROs; however, this well does not represent the western boundary of the GMZ. 1,4-Dioxane is present above the GRO in two adjacent bedrock monitoring wells (317121D and 317951D) and in the other older dolomite well, 319131D. The replacement dolomite well at this location had detectable amounts of 1,4-dioxane, but below the GRO. The fact that both the original and replacement wells contained 1,4-dioxane tends to indicate that its presence is likely the result of migration through the glacial till overlying the bedrock, and not the result of outdated or deteriorating well construction, as previously believed.

The presence of 1,4-dioxane in the deepest of the GMZ wells indicates that the vertical extent of the contaminated region may not yet be defined. If subsequent monitoring of the replacement well continues to confirm the presence of contamination above GROs, it may be necessary to install a deeper well to better delineate the bottom of the contaminated region. The one detection of 1,4-dioxane in the mini-well needs to be confirmed by additional monitoring before a conclusion can be reached.

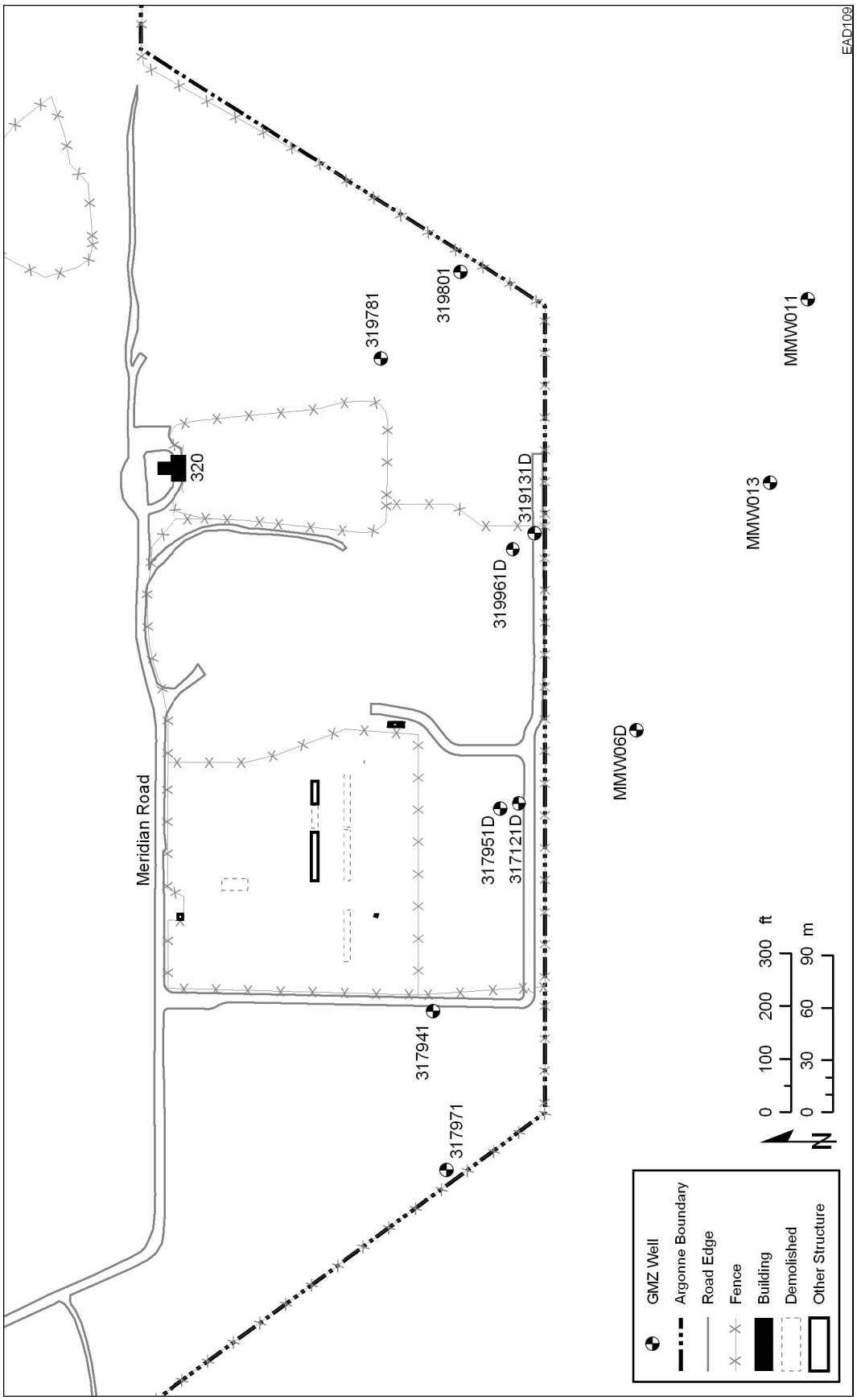


FIGURE 6.18 Locations of Monitoring Wells in the GMZ within the 317/319 Area and Adjacent Forest Preserve Property

TABLE 6.25

Annual Average Results from the GMZ Monitoring Wells, 2007
(concentrations in µg/L, except hydrogen-3)

	Monitoring Well No.						
Parameter	319781	317951D	319961D	317121D	319131D	319801	GRO
Alpha-BHC	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0.03
Benzene	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	5.0
Carbon tetrachloride	<1.0	<1.0	<1.0	<1.0	1	<1.0	5.0
Chloroform	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.2
1,1-Dichloroethane	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	700
1,2-Dichloroethane	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	5.0
1,1-Dichloroethene	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	7.0
cis-1,2-Dichloroethene	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	70
1,4-Dioxane	<1.0	**16**[a]	0.8	**4.0**	**2.0**	<1.0	1.0
bis(2-ethylhexyl)phthalate	<6.0	<6.0	<6.0	<6.0	<6.0	<6.0	6.0
Hydrogen-3 (pCi/L)	119	294	948	160.5	1,043	<100	20,000
Methylene chloride	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	5.0
Nitrobenzene	<3.5	<3.5	<3.5	<3.5	<3.5	<3.5	3.5
Tetrachloroethene	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	5.0
1,1,1-Trichloroethane	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	200
1,1,2-Trichloroethane	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.5
Trichloroethene	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	5.0
Vinyl chloride	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	2.0

	Monitoring Well No.					
Parameter	317941	317971	MMW06	MMW011	MMW013	GRO
Alpha-BHC	<0.03	<0.03	DRY[b]	DRY[b]	DRY[b]	0.03
Benzene	<1.0	<1.0	<1.0	<1.0	<1.0	5.0
Carbon tetrachloride	<1.0	<1.0	<1.0	<1.0	<1.0	5.0
Chloroform	<0.2	<0.2	<0.2	<0.2	<0.2	0.2
1,1-Dichloroethane	<1.0	<1.0	<1.0	<1.0	<1.0	700
1,2-Dichloroethane	<1.0	<1.0	<1.0	<1.0	<1.0	5.0
1,1-Dichloroethene	<1.0	<1.0	<1.0	<1.0	<1.0	7.0
cis-1,2-Dichloroethene	12	<1.0	<1.0	<1.0	<1.0	70
1,4-Dioxane	1.0	<1.0	<1.0	<1.0	**1.5**	1.0
bis(2-ethylhexyl)phthalate	<6.0	<6.0	DRY[b]	DRY[b]	DRY[b]	6.0
Hydrogen-3 (pCi/L)	1,060	<100	172	<100	<100	20,000
Methylene chloride	<1.0	<1.0	<1.0	<1.0	<1.0	5.0
Nitrobenzene	<3.5	<3.5	DRY[b]	DRY[b]	DRY[b]	3.5
Tetrachloroethene	<1.0	<1.0	<1.0	<1.0	<1.0	5.0
1,1,1-Trichloroethane	<1.0	<1.0	<1.0	<1.0	<1.0	200
1,1,2-Trichloroethane	<1.0	<1.0	<1.0	<1.0	<1.0	0.5
Trichloroethene	<1.0	<1.0	<1.0	<1.0	<1.0	5.0
Vinyl chloride	**26.5**	<2.0	<2.0	<2.0	<2.0	2.0

[a] Bold type indicates that the value exceeds the GRO.

[b] The three mini-wells did not yield enough water to perform all the analyses. Only VOC and hydrogen-3 analyses were conducted for these wells.

6.5. Sanitary Landfill

The former Argonne sanitary landfill is located in the 800 Area on the western edge of the site (see Figure 1.1). The 8.8-ha (21.8-acre) former landfill received miscellaneous solid waste from 1966 until September 1992 and was operated under IEPA Permit No. 1981-29-OP, which was issued in 1981. The landfill received general refuse, construction debris, boiler house ash, and other nonradioactive solid waste. The landfill was also used for the disposal of liquid wastes from 1969 to 1978. The wastes were placed into the landfill through a French drain, which consisted of a pipe inserted into the waste mound. The liquid waste was poured into the pipe and allowed to absorb into the waste. Historic documentation indicates that 109,000 L (29,000 gal) of liquid waste was placed in this drain. Most of this material was used oil or used machining coolant (an oil-water emulsion), though small quantities of toxic wastes were also placed in the landfill.

The landfill was closed in 1992 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. Closure of the landfill and associated areas was also subject to the RCRA Corrective Action process since the landfill area included SWMUs No. 4 (landfill mound), No. 20 (the French drain), No. 744 (a small area of buried waste adjacent to the main waste mound), AOC-B (wetlands immediately adjacent to the landfill), and AOC-C (leachate seeps from the waste mound). Closure included the installation of a 0.6-m (2-ft) thick compacted clay cap over the waste mounds. An RFI was required under the RCRA Corrective Action program. This RFI was conducted to determine if any hazardous materials had migrated from the landfill. It consisted of an extensive characterization program that was completed in 1997. Measurable amounts of several hazardous materials were identified in leachate in the waste mound itself and a small amount in the adjacent wetlands, but none were found in groundwater near the landfill. The study determined that no further remedial actions were required. An NFA determination was received from the IEPA on March 25, 2003, in a RCRA Part B permit modification. This letter specified that postclosure care and future groundwater monitoring activities at the 800 Area Landfill would be carried out under the corrective action provisions (Section V) of Argonne's RCRA Part B permit.

The 15-year postclosure care period for the landfill began in 1999. The primary requirements during postclosure are groundwater monitoring and maintenance and inspection of the landfill cap. This section discusses the groundwater monitoring results for 2007.

On October 25, 2005, the IEPA modified the RCRA corrective action permit for the 800 Area Landfill to include a set of background values for groundwater constituents upgradient of the landfill. The background values were developed from five years of monitoring results from two upgradient monitoring wells, one in the shallow glacial drift and one in the dolomite bedrock. These background levels, along with IEPA groundwater quality standards for unfiltered samples, are compared with the analytical results from landfill perimeter wells to determine if a release has occurred from the landfill. The background values are discussed in Section 6.5.1.3.

6.5.1. Sanitary Landfill Groundwater Monitoring

The current groundwater monitoring well network is shown in Figure 6.19. Table 6.26 contains a description of each active well. All wells are specially designed groundwater monitoring wells consisting of 0.05-m (2-in.) diameter stainless-steel casings and screens installed in boreholes sealed with bentonite grout, a concrete cap, and locking steel protective cover. The network consists of three groups of wells. Fifteen shallow wells are screened in shallow glacial till between 4 and 14 m (13 and 46 ft) deep. These wells have well screens situated in a series of thin porous sandy zones within the glacial drift under the 800 Area. They provide samples of the uppermost layers of groundwater under and adjacent to the landfill. Five deep wells are screened in the top of the dolomite limestone bedrock underlying the glacial till. The upper part of the dolomite bedrock represents the uppermost true aquifer under the landfill that has the potential for off-site migration of groundwater. These five wells are situated near five of the shallow wells, forming five well clusters. Two background wells (800271 and 800273D) are located in a cluster approximately 670 m (2,200 ft) to the northeast of the landfill mound. These wells are located out of the influence of the landfill and provide information on the normal background level of groundwater constituents.

Prior to 2005, the network also included four intermediate wells (800382, 800192, 800202, and 800272) that were part of three-well clusters with shallow and deep dolomite wells. These wells were usually dry and were not situated at a depth that yielded meaningful results for the monitoring program. They were removed from the network by the October 2005 RCRA Part B permit modification. Thus, these wells are no longer included in the program, and no data from them are included in this report.

The wells were installed in stages, and a number of wells have been installed, monitored, and removed from the network over the last 20 years. Only the currently active wells are described in this report. The oldest set of active wells was installed in 1992 as part of the closure process. Additional wells were installed in 1999 to enhance the effectiveness of the network. Well 800191R, installed in 2005, is a replacement for the original 800191 well, which was removed because its sampling pump failed and could not be removed from the well.

6.5.1.1. Sample Collection

Each well is sampled quarterly in accordance with the RCRA Part B permit. During the first, third, and fourth quarters, only the List 1 (field parameters, including groundwater depth, pH, specific conductivity, and temperature) and List 2 (filtered metals, sulfate, chloride, TDS, cyanide, phenols, total organic carbon [TOC], and total organic halogen [TOX]) parameters and constituents are measured. During the second quarter, additional samples are collected and analyzed for List 3 and 3A parameters (unfiltered metals, VOCs, SVOCs, PCBs, pesticides, and herbicides). In addition to the required annual analyses, VOCs and hydrogen-3 are also monitored by Argonne during all quarters to provide better documentation of conditions under the landfill.

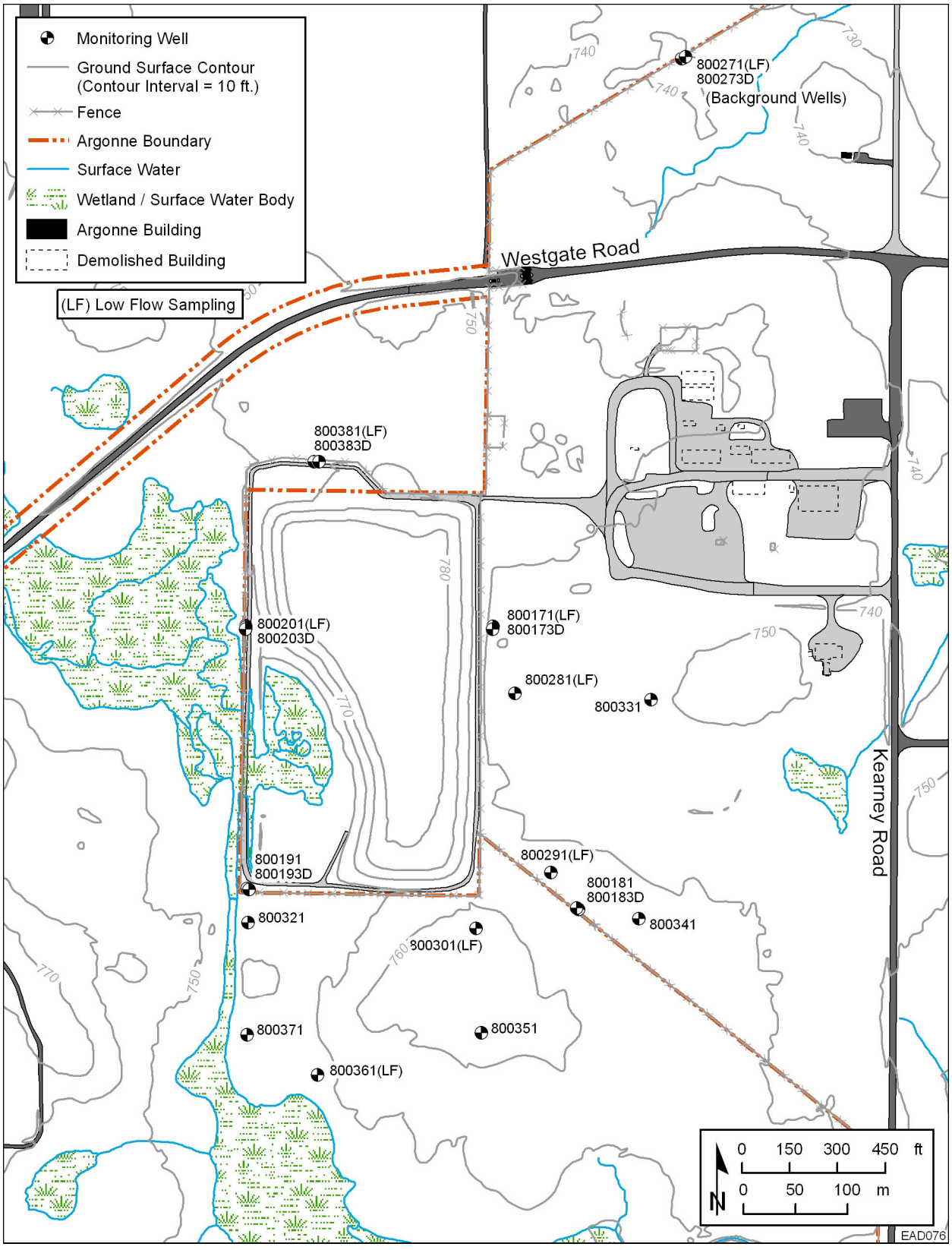


FIGURE 6.19 800 Area Landfill Monitoring Wells

TABLE 6.26

Groundwater Monitoring Wells: 800 Area Landfill

Argonne ID Number	IEPA Well Number	Well Depth (m bgs)	Ground Elevation (m AMSL)	Monitoring Zone (m AMSL)	Date Drilled	Sampling Device
Background Wells						
800271	G16S	4.57	225.62	223.18–221.65	Aug. 1999	Low flow pump
800273D[a]	D16D	37.49	225.61	191.78–188.12	Aug. 1999	Submersible pump
Shallow Monitoring Wells						
800171	G06S	7.62	228.42	222.32–220.80	Oct. 1992	Low flow pump
800181	G08S	10.67	230.52	221.37–219.85	Oct. 1992	Bailer
800191R[b]	G11S	4.63	227.38	224.43–222.90	Sept. 2005	Bailer
800201	G14S	10.67	227.93	218.78–217.26	Oct. 1992	Low flow pump
800281	G17S	3.96	227.66	225.52–224.00	Sept. 1999	Low flow pump
800291	G18S	7.01	230.49	225.00–223.48	Sept. 1999	Low flow pump
800301	G19S	7.62	232.53	226.51–224.91	Sept. 1999	Low flow pump
800321	G21S	4.27	227.93	225.26–223.66	Sept. 1999	Bailer
800331	G22S	5.18	227.93	224.27–222.75	Sept. 1999	Bailer
800341	G23S	3.96	229.97	227.53–226.01	Sept. 1999	Bailer
800351	G24S	11.89	232.75	223.91–220.86	Sept. 1999	Bailer
800361	G25S	7.01	227.24	222.12–220.52	Sept. 1999	Low flow pump (Bailed in Oct.)
800371	G26S	9.75	227.50	219.27–217.44	Sept. 1999	Bailer
800381[c]	G03S	7.31	231.11	227.44–224.40	June 1999	Low flow pump
Dolomite Bedrock Monitoring Wells						
800173D	G06D	39.62	228.40	192.13–189.09	Oct. 2001	Submersible pump
800183D	G08D	49.99	230.37	183.43–180.38	Oct. 2001	Submersible pump
800193D	G11D	46.02	227.34	184.40–181.35	Oct. 2001	Submersible pump
800203D	G14D	38.40	227.92	192.63–189.47	Sept. 2001	Submersible pump
800383D[c]	G03D	44.50	231.24	190.39–187.35	June 2001	Submersible pump

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

[b] Replacement for original Well 800191.

[c] Replacement wells used after July 1, 1999.

During the early years of monitoring the landfill, it was noted that high levels of unfiltered metals were detected in samples with high levels of turbidity. The turbidity resulted from the resuspension of soil solids in the sample during the collection of samples using a baler. The baler agitates the water in the well as it is lowered into the well. It was thought that many of the high metals concentrations in shallow wells were artifacts of this type of sampling and not a result of landfill operations. To reduce this source of interference, low flow sampling was implemented. Starting in 2003, IEPA-approved low flow sampling devices were installed in Wells 800171, 800201, 800281, 800291, 800301, 800361, and 800381 and the shallow background well 800271. This low flow sampling system allows samples to be collected at a steady, low flow rate that does not disturb the sediment in the well. The remaining wells are sampled using a baler. The wells with low flow samplers in Figure 6.19 have "(LF)" next to the well number.

Samples from the deeper dolomite wells are collected by using an electronic submersible pump. These wells are screened in fractured rock that does not produce as much sediment as the glacial drift does. Thus low flow samplers are not required in these wells.

Wells that are equipped with a bailer or submersible pumps are sampled after stagnant water is purged from the well by removing 3 to 5 well volumes of water out of the well. The temperature, pH, conductivity, and redox potential are measured periodically as the purging process progresses. Samples are collected after the water quality parameters have stabilized.

Wells equipped with low flow samplers are sampled once water quality parameters stabilize and turbidity has reached its target level regardless of the amount of water removed. The low flow sampling system pumping rate is controlled by monitoring the field parameters while pumping at a rate low enough to prevent significant drawdown of water in the well. Turbidity of the groundwater is also monitored during this process. For these wells, samples are collected after the field parameters have stabilized and turbidity has reached its target level. Field parameter values reported are those measured after purging is complete.

6.5.1.2. Sample Analyses — 800 Area

The analysis of 800 Area groundwater samples is conducted by EQO Analytical Services (EQO-AS) as well as several commercial laboratories. The 800 Area sample analyses were performed using EPA-approved analytical procedures discussed in Chapter 5, Table 5.2, and radiological analyses procedures shown in Table 6.2.

6.5.1.3. Basis for Evaluation of Analytical Results

The monitoring results are evaluated by comparing the results with either the IEPA-approved background values or the GQS for each constituent, where such limits exist. For routine indicator parameters (Lists 1 and 2), the permit requires the comparison of the individual results with background results. For unfiltered metals and organic analyses, the results are compared with the GQSs for Class I Potable Resource Groundwater (35 IAC Part 620.410),

where such standards exist. Otherwise, they are compared with the practical quantitation limit (PQL) for that compound. Table 6.27 lists all of the applicable permit limits for the 800 Area landfill. Footnotes to this table explain the source of the individual groundwater quality limits. A number of filtered metals results do not have permit limits. These results are collected for informational purposes only and are not reported to the IEPA. In the data tables that follow, values that exceed these background values or permit limits are shown in bold print.

6.5.1.4. Results of Analyses

For each well monitored, field parameters measured during sample collection, and the results of chemical and radiological analysis of the two background wells are presented in Tables 6.28 and 6.29; the shallow landfill wells are presented in Tables 6.30 through 6.43; and the dolomite wells in Tables 6.44 through 6.48. The results for all inorganic species measured are shown in these tables. In addition to the inorganics, each well was analyzed quarterly for VOCs and annually for SVOCs, PCBs, and pesticides. The analytical method used for these compounds is able to identify and quantify all of the compounds contained in the CLP Target Compound List to concentrations of less than 1 to 10 μg/L. However, none were detected above the detection limits in any of the wells. These constituents are not shown in the following tables for clarity.

6.5.2. Discussion of Results — Shallow Wells

The shallow wells produce groundwater samples from the uppermost saturated zones underlying the landfill. As such, they would be the first to show evidence of migration of hazardous materials from the landfill if such migration was occurring. The soil in these saturated zones is a highly heterogenous mix of clay, silt, sand, and gravel, with somewhat different geochemistry in each saturated region. As a result, the concentrations of naturally occurring constituents will vary considerably from zone to zone.

The RFI of the 800 Landfill identified several potential contaminants of concern in the leachate from the waste. The most significant contaminants were low levels of PCBs and pesticides (Aroclor 1260, DDE, and DDT), several VOCs (toluene, acetone, and methylene chloride), and SVOCs (several phthalates). Many of these were thought to be artifacts caused by inadvertent contamination of the samples in the laboratory and were not actually present in the landfill. Several metals were detected above background in soil, but these were attributed to natural variation in soil composition. Thus, if VOCs or SVOCs were detected in groundwater it may indicate that waste products from the landfill are being released. As the data tables demonstrate, there were no detections of these materials in any of the groundwater samples collected in 2007. Thus, there is no indication of a release of hazardous materials from the landfill. However, the data are useful in understanding the hydrogeology and geochemistry of the area surrounding the landfill.

A discussion of groundwater flow direction and all analytical results for 2007 are summarized in the 2007 Annual Summary Assessment of the groundwater monitoring program for the 800 Area Landfill, which was sent to the IEPA in July 2008.

TABLE 6.27

Permits Limits for 800 Area Groundwater

Parameter	Unit	Permit Limit – Shallow Wells	Source[a]	Permit Limit – Deep Wells	Source[a]
Field Parameters					
Conductivity	µS/cm	703	4	1,306	1
Oxid./red. potential	mV	NA[b]	–[c]	NA	–
pH	pH	6.57–7.88	1	6.48–7.74	1
Temperature	ºC	NA	–	NA	–
Water elevation	m	NA	–	NA	–
Filtered Samples					
Ammonia nitrogen	mg/L	0.90	4	1.0	4
Chloride	mg/L	20	4	137	1
Sulfate	mg/L	58.54	1	152	1
TDS	mg/L	428.45	1	880	1
Arsenic	mg/L	0.010	2	0.0048	4
Barium	mg/L	NA	–	NA	–
Boron	mg/L	NA	–	NA	–
Cadmium	mg/L	0.001	2	0.001	2
Chromium	mg/L	NA	–	NA	–
Cobalt	mg/L	NA	–	NA	–
Copper	mg/L	NA	–	NA	–
Iron	mg/L	0.099	4	1.60	1
Lead	mg/L	0.01	2	0.01	2
Manganese	mg/L	0.097	4	0.021	4
Mercury	mg/L	0.002	2	0.002	2
Nickel	mg/L	NA	–	NA	–
Selenium	mg/L	NA	–	NA	–
Silver	mg/L	NA	–	NA	–
Zinc	mg/L	NA	–	NA	–
Unfiltered Samples					
Chloride	mg/L	200	3	200	3
Cyanide (total)	mg/L	0.011	4	0.04	2
Fluoride	mg/L	4.0	3	4.0	3
Hydrogen-3	pCi/L	NA	–	NA	–
Nitrate	mg/L	10.0	3	10.0	3
Phenols	mg/L	0.033	4	0.033	4
Sulfate	mg/L	400	3	400	3
TOC	mg/L	2.71	5	5.3	4
TOX	mg/L	0.086	4	0.041	4
Arsenic	mg/L	0.05	3	0.05	3
Barium	mg/L	2.0	3	2.00	3
Boron	mg/L	2.0	3	2.00	3
Cadmium	mg/L	0.005	3	0.005	3
Chromium	mg/L	0.10	3	0.10	3
Cobalt	mg/L	1.0	3	1.00	3
Copper	mg/L	0.65	3	0.65	3
Iron	mg/L	5.0	3	5.00	3

TABLE 6.27 (Cont.)

Parameter	Unit	Permit Limit – Shallow Wells	Source[a]	Permit Limit – Deep Wells	Source[a]
Unfiltered Samples (Cont.)					
Lead	mg/L	0.008	3	0.008	3
Manganese	mg/L	0.15	3	0.15	3
Mercury	mg/L	0.002	3	0.002	3
Nickel	mg/L	0.10	3	0.10	3
Selenium	mg/L	0.05	3	0.05	3
Silver	mg/L	0.05	3	0.05	3
Zinc	mg/L	5.0	3	5.0	3

[a] The various permit limits were generated in the following manner:
1 = Calculated from 95% upper confidence interval of the data set. Calculation uses one-half the detection limits for values less than the detection limits.
2 = Background values equal the PQL for that constituent. All measured values in background wells were below PQLs.
3 = IEPA's Class 1 Groundwater Quality Standard.
4 = Background value based on nonparametric statistical methods for data sets with more than 15% but less than 100% of measured values below detection limits.
5 = Calculated from 95% upper confidence interval for data set that was first transformed by calculating the natural log of the measured values.

[b] NA indicates that no permit limit exists for this constituent. The data are collected for informational purposes only.

[c] A dash indicates that no limit exists, and thus listing a source is not necessary.

6.5.2.1. Field Parameters

Field parameters include well and water depth information, pH, specific conductivity, oxidation/reduction potential, and water temperature. pH is the only parameter with approved background values. Only one pH value in 2007 was outside of the range of background values. Well 800281 had one sample with a pH of 6.4 compared with the background lower limit of 6.57. The specific conductivity results are discussed in the next section. In general, the results are consistent from quarter to quarter and are similar to results obtained in previous years.

6.5.2.2 Filtered Inorganic Constituents

Several inorganic constituents were detected above their respective limits. The most common exceedances were TDS, specific conductivity, sulfate, and chloride, iron, and manganese, which are measures of the amount of dissolved ionic material in the groundwater. Almost all of the downgradient wells sampled exhibited TDS, conductivity, sulfate, and chloride results above the background values in at least one sample. Half of the wells had iron and manganese above background levels. The wells with the highest TDS and conductivity values also exhibited the highest sulfate concentrations. The highest concentrations were found in the

TABLE 6.28

Groundwater Monitoring Results, Sanitary Landfill Background Well 800271, 2007

		Date of Sampling				
Parameter	Unit	1/29/2007	1/29/2007 (Duplicate)	5/7/2007	7/25/2007	10/23/2007
Field Parameters						
Conductivity	µS/cm	569	569	554	658	511
Oxid./red. potential	mV	-17	-17	-9	-6	0
pH	pH	7.26	7.26	7.25	7.17	7.06
Temperature	ºC	7.0	7.0	14.4	15.4	12.6
Water elevation[a]	m	225.11	225.11	224.98	223.59	223.43
Filtered Samples						
Ammonia nitrogen	mg/L	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Chloride	mg/L	4	4	6	4	4
Sulfate	mg/L	29	27	26	47	47
TDS	mg/L	229	236	254	319	332
Arsenic	mg/L	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
Barium	mg/L	0.015	0.015	0.016	0.018	0.019
Boron	mg/L	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Cadmium	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium	mg/L	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Cobalt	mg/L	< 0.25	< 0.25	< 0.25	< 0.25	< 0.25
Copper	mg/L	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025
Iron	mg/L	< 0.021	< 0.021	< 0.021	< 0.021	< 0.021
Lead	mg/L	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004
Manganese	mg/L	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Mercury	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Nickel	mg/L	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Selenium	mg/L	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
Silver	mg/L	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Zinc	mg/L	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Unfiltered Samples						
Chloride	mg/L	–[b]	–	5.4	–	–
Cyanide (Total)	mg/L	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Fluoride	mg/L	–	–	< 0.1	–	–
Hydrogen-3	pCi/L	< 100	< 100	< 100	< 100	< 100
Nitrate	mg/L	–	–	4.4	–	–
Phenols	mg/L	< 0.005	< 0.005	0.0075	< 0.005	< 0.005
Sulfate	mg/L	–	–	26	–	–
TOCs (max. of 4 samples)	mg/L	1.6	1.5	1.6	1.5	1.2
TOXs (max. of 2 samples)	mg/L	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Arsenic	mg/L	–	–	< 0.015	–	–
Barium	mg/L	–	–	0.015	–	–
Boron	mg/L	–	–	< 0.08	–	–
Cadmium	mg/L	–	–	< 0.0002	–	–
Chromium	mg/L	–	–	< 0.05	–	–
Cobalt	mg/L	–	–	< 0.25	–	–
Copper	mg/L	–	–	< 0.025	–	–
Iron	mg/L	–	–	< 0.021	–	–
Lead	mg/L	–	–	< 0.004	–	–
Manganese	mg/L	–	–	< 0.01	–	–
Mercury	mg/L	–	–	< 0.0002	–	–
Nickel	mg/L	–	–	< 0.05	–	–
Selenium	mg/L	–	–	< 0.003	–	–
Silver	mg/L	–	–	< 0.001	–	–
Zinc	mg/L	–	–	< 0.02	–	–

[a] Well point elevation = 221.65 m (MSL); ground surface elevation = 225.62 m (MSL); casing material = stainless steel.

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

TABLE 6.29

Groundwater Monitoring Results, Sanitary Landfill Well 800273D, 2007

Parameter	Unit	Date of Sampling 1/29/2007	5/7/2007	7/25/2007	10/23/2007
Field Parameters					
Conductivity	µS/cm	1099	1063	1000	810
Oxid./red. potential	mV	-12	-3	-4	-7
pH	pH	7.16	7.13	7.14	7.19
Temperature	ºC	10.1	11.9	12.6	10.8
Water elevation[a]	m	193.12	193.13	192.64	192.92
Filtered Samples					
Ammonia nitrogen	mg/L	0.73	0.69	0.72	0.74
Chloride	mg/L	110	**141**[b]	**142**	**144**
Sulfate	mg/L	133	111	102	110
TDS	mg/L	570	624	609	675
Arsenic	mg/L	0.004	0.004	**0.005**	0.003
Barium	mg/L	0.049	0.048	0.047	0.047
Boron	mg/L	0.14	0.162	0.163	0.160
Cadmium	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Cobalt	mg/L	< 0.25	< 0.25	< 0.25	< 0.25
Copper	mg/L	< 0.025	< 0.025	< 0.025	< 0.025
Iron	mg/L	1.16	1.12	1.18	1.30
Lead	mg/L	< 0.004	< 0.004	< 0.004	< 0.004
Manganese	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Mercury	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Nickel	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Selenium	mg/L	< 0.003	< 0.003	< 0.003	< 0.003
Silver	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Zinc	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Unfiltered Samples					
Chloride	mg/L	–[c]	125	–	–
Cyanide (Total)	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Fluoride	mg/L	–	0.437	–	–
Hydrogen-3	pCi/L	< 100	< 100	< 100	< 100
Nitrate	mg/L	–	< 0.1	–	–
Phenols	mg/L	< 0.005	0.014	< 0.005	< 0.005
Sulfate	mg/L	–	106	–	–
TOCs (max. of 4 samples)	mg/L	1.4	1.4	1.3	1.3
TOXs (max. of 2 samples)	mg/L	0.022	< 0.02	< 0.02	< 0.02
Arsenic	mg/L	–	0.015	–	–
Barium	mg/L	–	0.049	–	–
Boron	mg/L	–	0.179	–	–
Cadmium	mg/L	–	< 0.0002	–	–
Chromium	mg/L	–	< 0.05	–	–
Cobalt	mg/L	–	< 0.25	–	–
Copper	mg/L	–	< 0.025	–	–
Iron	mg/L	–	1.573	–	–
Lead	mg/L	–	< 0.004	–	–
Manganese	mg/L	–	0.012	–	–
Mercury	mg/L	–	< 0.0002	–	–
Nickel	mg/L	–	< 0.05	–	–
Selenium	mg/L	–	< 0.003	–	–
Silver	mg/L	–	< 0.001	–	–
Zinc	mg/L	–	< 0.02	–	–

[a] Well point elevation = 188.12 m (MSL); ground surface elevation = 225.61 m (MSL); casing material = stainless steel.

[b] Bold type indicates that the value exceeds the applicable limits shown in Table 6.27.

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

TABLE 6.30

Groundwater Monitoring Results, Sanitary Landfill Well 800171, 2007

Parameter	Unit	Date of Sampling 1/17/2007	4/16/2007	7/16/2007	10/10/2007
Field Parameters					
Conductivity	µS/cm	**924**[a]	**825**	**1,077**	**828**
Oxid./red. potential	mV	3	14	16	10
pH	pH	6.72	6.87	6.77	6.87
Temperature	ºC	10.3	11.6	17.0	12.5
Water elevation[b]	m	227.44	227.57	224.96	224.98
Filtered Samples					
Ammonia nitrogen	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Chloride	mg/L	**69**	**45**	**79**	**69**
Sulfate	mg/L	50	39	**94**	**74**
TDS	mg/L	**453**	**439**	**793**	**603**
Arsenic	mg/L	< 0.003	< 0.003	< 0.003	< 0.003
Barium	mg/L	0.049	0.048	0.058	0.060
Boron	mg/L	0.140	0.166	0.131	0.160
Cadmium	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Cobalt	mg/L	< 0.25	< 0.25	< 0.25	< 0.25
Copper	mg/L	< 0.025	< 0.025	< 0.025	< 0.025
Iron	mg/L	< 0.021	< 0.021	< 0.021	< 0.021
Lead	mg/L	< 0.004	< 0.004	< 0.004	< 0.004
Manganese	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Mercury	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Nickel	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Selenium	mg/L	< 0.003	< 0.003	< 0.015	< 0.003
Silver	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Zinc	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Unfiltered Samples					
Chloride	mg/L	–[c]	40	86	–
Cyanide (Total)	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Fluoride	mg/L	–	< 0.1	–	–
Hydrogen-3	pCi/L	< 100	< 100	< 100	< 100
Nitrate	mg/L	–	2.1	–	–
Phenols	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Sulfate	mg/L	–	38	85	
TOCs (max of 4 samples)	mg/L	**3.2**	**3.8**	2.6	2.1
TOXs (max of 2 samples)	mg/L	0.02	0.039	< 0.020	< 0.020
Arsenic	mg/L	–	< 0.003	–	–
Barium	mg/L	–	0.049	–	–
Boron	mg/L	–	0.185	–	–
Cadmium	mg/L	–	< 0.0002	–	–
Chromium	mg/L	–	< 0.05	–	–
Cobalt	mg/L	–	< 0.25	–	–
Copper	mg/L	–	< 0.025	–	–
Iron	mg/L	–	0.054	–	–
Lead	mg/L	–	< 0.004	–	–
Manganese	mg/L	–	< 0.01	–	–
Mercury	mg/L	–	< 0.0002	–	–
Nickel	mg/L	–	< 0.05	–	–
Selenium	mg/L	–	< 0.003	–	–
Silver	mg/L	–	< 0.001	–	–
Zinc	mg/L	–	< 0.02	–	–

[a] Bold type indicates that the value exceeds the applicable limits shown in Table 6.27.

[b] Well point elevation = 220.80 m (MSL); ground surface elevation = 228.42 m (MSL); casing material = stainless steel.

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

TABLE 6.31

Groundwater Monitoring Results, Sanitary Landfill Well 800181, 2007

Parameter	Unit	Date of Sampling			
		1/11/2007	4/25/2007	7/18/2007	10/9/2007
Field Parameters					
Conductivity	µS/cm	**761**[a]	684	**1,003**	**906**
Oxid./red. potential	mV	-32	-30	-25	-29
pH	pH	7.35	7.69	7.55	7.61
Temperature	ºC	10.4	9.5	15.5	11.0
Water elevation[b]	m	228.51	228.84	225.11	224.17
Filtered Samples					
Ammonia nitrogen	mg/L	0.08	0.07	< 0.05	0.09
Chloride	mg/L	6	6	9	13
Sulfate	mg/L	**81**	56	**171**	**106**
TDS	mg/L	375	337	**918**	**682**
Arsenic	mg/L	< 0.003	< 0.003	0.005	0.007
Barium	mg/L	0.029	0.026	0.046	0.039
Boron	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
Cadmium	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Cobalt	mg/L	< 0.25	< 0.25	< 0.25	< 0.25
Copper	mg/L	< 0.025	< 0.025	< 0.025	< 0.025
Iron	mg/L	< 0.021	< 0.021	< 0.021	< 0.021
Lead	mg/L	< 0.004	< 0.004	< 0.004	< 0.004
Manganese	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Mercury	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Nickel	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Selenium	mg/L	< 0.003	< 0.003	< 0.015	< 0.003
Silver	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Zinc	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Unfiltered Samples					
Chloride	mg/L	–[c]	7.7	–	–
Cyanide (Total)	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Fluoride	mg/L	–	0.481	–	–
Hydrogen-3	pCi/L	< 100	< 100	< 100	< 100
Nitrate	mg/L	–	0.12	–	–
Phenols	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Sulfate	mg/L	–	54	–	–
TOCs (max. of 4 numbers)	mg/L	2.5	**2.9**	**3.7**	2.2
TOXs (max. of 2 numbers)	mg/L	< 0.02	0.031	< 0.020	< 0.02
Arsenic	mg/L	–	< 0.003	–	–
Barium	mg/L	–	0.041	–	–
Boron	mg/L	–	< 0.1	–	–
Cadmium	mg/L	–	< 0.0002	–	–
Chromium	mg/L	–	< 0.05	–	–
Cobalt	mg/L	–	< 0.25	–	–
Copper	mg/L	–	< 0.025	–	–
Iron	mg/L	–	1.49	–	–
Lead	mg/L	–	0.005	–	–
Manganese	mg/L	–	0.057	–	–
Mercury	mg/L	–	< 0.0002	–	–
Nickel	mg/L	–	< 0.05	–	–
Selenium	mg/L	–	< 0.003	–	–
Silver	mg/L	–	< 0.001	–	–
Zinc	mg/L	–	< 0.02	–	–

[a] Bold type indicates that the value exceeds the applicable limits shown in Table 6.27.

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

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

TABLE 6.32

Groundwater Monitoring Results, Sanitary Landfill Well 800191R, 2007

Parameter	Unit	Date of Sampling 1/9//2007	4/9/2007	7/11/2007	10/2/2007
Field Parameters					
Conductivity	µS/cm	**1,964**[a]	**2,000**	**1,992**	**1,541**
Oxid./red. potential	mV	7	21	24	25
pH	pH	6.69	6.81	6.64	6.64
Temperature	°C	7.4	8.0	11.7	14.9
Water elevation[b]	m	225.93	225.84	225.52	225.52
Filtered Samples					
Ammonia nitrogen	mg/L	**0.97**	**1.30**	< 0.05	0.41
Chloride	mg/L	**87**	**128**	**151**	**163**
Sulfate	mg/L	**564**	**624**	**665**	**643**
TDS	mg/L	**1,561**	**1,203**	**1,686**	**1,622**
Arsenic	mg/L	< 0.003	< 0.003	< 0.003	< 0.003
Barium	mg/L	0.028	0.033	0.030	0.027
Boron	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
Cadmium	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Cobalt	mg/L	< 0.25	< 0.25	< 0.25	< 0.25
Copper	mg/L	< 0.025	< 0.025	< 0.025	< 0.025
Iron	mg/L	**0.296**	**2.030**	**0.476**	**0.176**
Lead	mg/L	< 0.004	< 0.004	< 0.004	< 0.004
Manganese	mg/L	**1.02**	**1.52**	**0.78**	**0.50**
Mercury	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Nickel	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Selenium	mg/L	< 0.015	< 0.015	< 0.003	< 0.009
Silver	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Zinc	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Unfiltered Samples					
Chloride	mg/L	–[c]	126	–	–
Cyanide (Total)	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Fluoride	mg/L	–	0.546	–	–
Hydrogen-3	pCi/L	173	409	121	< 100
Nitrate	mg/L	–	< 0.1	–	–
Phenols	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Sulfate	mg/L	**–**	**663**	**–**	**–**
TOCs (max. of 4 samples)	mg/L	**5.5**	**5.5**	**4.9**	**4.5**
TOXs (max. of 2 samples)	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Arsenic	mg/L	–	< 0.005	–	–
Barium	mg/L	–	0.064	–	–
Boron	mg/L	–	< 0.1	–	–
Cadmium	mg/L	–	< 0.0002	–	–
Chromium	mg/L	–	< 0.05	–	–
Cobalt	mg/L	–	< 0.25	–	–
Copper	mg/L	–	< 0.025	–	–
Iron	mg/L	–	**8.16**	–	–
Lead	mg/L	–	0.004	–	–
Manganese	mg/L	–	**1.65**	**–**	–
Mercury	mg/L	–	< 0.0002	–	–
Nickel	mg/L	–	< 0.05	–	–
Selenium	mg/L	–	< 0.015	–	–
Silver	mg/L	–	< 0.001	–	–
Zinc	mg/L	–	< 0.02	–	–

[a] Bold type indicates that the value exceeds the applicable limits shown in Table 6.27.

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

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

TABLE 6.33

Groundwater Monitoring Results, Sanitary Landfill Well 800201, 2007

Parameter	Unit	Date of Sampling 1/23/2007	4/23/2007	7/24/2007	10/16/2007
Field Parameters					
Conductivity	µS/cm	**1,077**[a]	**1,080**	**1,033**	**825**
Oxid./red. potential	mV	5	15	12	9
pH	pH	6.86	6.85	6.85	6.91
Temperature	ºC	8.5	13.3	14.1	12.7
Water elevation[b]	m	225.40	225.40	224.34	224.21
Filtered Samples					
Ammonia nitrogen	mg/L	**3.8**	**3.9**	**3.8**	**3.4**
Chloride	mg/L	17	19	**27**	**26**
Sulfate	mg/L	**76**	**77**	**74**	**72**
TDS	mg/L	**637**	**653**	**646**	**654**
Arsenic	mg/L	0.007	0.009	0.005	0.009
Barium	mg/L	0.286	0.294	0.255	0.255
Boron	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
Cadmium	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Cobalt	mg/L	< 0.25	< 0.25	< 0.25	< 0.25
Copper	mg/L	< 0.025	< 0.025	< 0.025	< 0.025
Iron	mg/L	**3.98**	**4.78**	**2.09**	**2.44**
Lead	mg/L	< 0.004	< 0.004	< 0.004	< 0.004
Manganese	mg/L	**0.22**	**0.205**	**0.127**	**0.193**
Mercury	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Nickel	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Selenium	mg/L	< 0.003	< 0.003	< 0.003	< 0.003
Silver	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Zinc	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Unfiltered Samples					
Chloride	mg/L	–[c]	22	–	–
Cyanide (Total)	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Fluoride	mg/L	–	0.351	–	–
Hydrogen-3	pCi/L	< 100	< 100	< 100	< 100
Nitrate	mg/L	–	0.28	–	–
Phenols	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Sulfate	mg/L	–	76	–	–
TOCs (max. of 4 samples)	mg/L	**35**	**34**	**31**	**35**
TOXs (max. of 2 samples)	mg/L	< 0.02	0.029	< 0.02	< 0.02
Arsenic	mg/L	–	0.011	–	–
Barium	mg/L	–	0.317	–	–
Boron	mg/L	–	0.101	–	–
Cadmium	mg/L	–	< 0.0002	–	–
Chromium	mg/L	–	< 0.05	–	–
Cobalt	mg/L	–	< 0.25	–	–
Copper	mg/L	–	< 0.025	–	–
Iron	mg/L	–	**6.38**	–	–
Lead	mg/L	–	0.005	–	–
Manganese	mg/L	–	**0.228**	–	–
Mercury	mg/L	–	< 0.0002	–	–
Nickel	mg/L	–	< 0.05	–	–
Selenium	mg/L	–	< 0.003	–	–
Silver	mg/L	–	< 0.001	–	–
Zinc	mg/L	–	< 0.02	–	–

[a] Bold type indicates that the value exceeds the applicable limits shown in Table 6.27.

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

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

TABLE 6.34

Groundwater Monitoring Results, Sanitary Landfill Well 800281, 2007

Parameter	Unit	Date of Sampling 1/16/2007	5/2/2007	7/23/2007	07/23/2007 (Duplicate)	10/8/2007
Field parameters						
Conductivity	µS/cm	**1,090**[a]	**1,156**	**1,315**	**1,315**	**1,001**
Oxid./red. potential	mV	-1	15	36	36	25
pH	pH	6.80	6.83	**6.40**	**6.40**	6.63
Temperature	ºC	6.5	11.2	15.3	15.3	17.5
Water elevation[b]	m	227.38	227.16	225.52	225.52	225.44
Filtered Samples						
Ammonia nitrogen	mg/L	0.11	< 0.05	0.33	< 0.05	< 0.05
Chloride	mg/L	**59**	**63**	**92**	**85**	**74**
Sulfate	mg/L	**165**	**108**	**66**	**66**	**61**
TDS	mg/L	**591**	**687**	**841**	**845**	**785**
Arsenic	mg/L	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
Barium	mg/L	0.052	0.056	0.082	0.082	0.083
Boron	mg/L	0.160	0.192	0.348	0.351	0.360
Cadmium	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium	mg/L	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Cobalt	mg/L	< 0.25	< 0.25	< 0.25	< 0.25	< 0.25
Copper	mg/L	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025
Iron	mg/L	< 0.021	< 0.021	< 0.021	< 0.021	< 0.021
Lead	mg/L	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004
Manganese	mg/L	0.056	**0.10**	**1.14**	**1.17**	**1.24**
Mercury	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Nickel	mg/L	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Selenium	mg/L	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
Silver	mg/L	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Zinc	mg/L	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Unfiltered Samples						
Chloride	mg/L	–[c]	63	–	–	–
Cyanide (Total)	mg/L	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Fluoride	mg/L	–	< 0.1	–	–	–
Hydrogen-3	pCi/L	164	115	210	203	184
Nitrate	mg/L	–	< 0.1	–	–	–
Phenols	mg/L	< 0.005	< 0.005	0.0061	0.01	< 0.005
Sulfate	mg/L	–	106	–	–	–
TOCs (max of 4 samples)	mg/L	2.4	2.3	**3.7**	**3.6**	**3.4**
TOXs (max. of 2 samples)	mg/L	0.027	< 0.02	0.026	0.024	0.022
Arsenic	mg/L	–	< 0.003	–	–	–
Barium	mg/L	–	0.057	–	–	–
Boron	mg/L	–	0.208	–	–	–
Cadmium	mg/L	–	< 0.0002	–	–	–
Chromium	mg/L	–	< 0.05	–	–	–
Cobalt	mg/L	–	< 0.25	–	–	–
Copper	mg/L	–	< 0.025	–	–	–
Iron	mg/L	–	0.055	–	–	–
Lead	mg/L	–	< 0.004	–	–	–
Manganese	mg/L	–	0.101	–	–	–
Mercury	mg/L	–	< 0.0002	–	–	–
Nickel	mg/L	–	< 0.05	–	–	–
Selenium	mg/L	–	< 0.003	–	–	–
Silver	mg/L	–	< 0.001	–	–	–
Zinc	mg/L	–	< 0.02	–	–	–

[a] Bold type indicates that the value exceeds the applicable limits shown in Table 6.27.

[b] Well point elevation = 224.00 m (MSL); ground surface elevation = 227.66 m (MSL); casing material = stainless steel.

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

TABLE 6.35

Groundwater Monitoring Results, Sanitary Landfill Well 800291, 2007

Parameter	Unit	Date of Sampling 1/17/2007	4/24/2007	4/24/2007 (Duplicate)	7/18/2007	10/9/2007
Field Parameters						
Conductivity	µSs/cm	**1,131**[a]	**1,055**	**1,055**	**1,051**	**825**
Oxid./red. potential	mV	-9	0	0	11	2
pH	pH	6.95	7.11	7.11	6.85	7.01
Temperature	°C	6.6	11.6	11.6	14.9	14.2
Water elevation[b]	m	229.16	228.83	228.83	227.31	227.20
Filtered Samples						
Ammonia nitrogen	mg/L	< 0.05	< 0.05	< 0.05	< 0.05	0.07
Chloride	mg/L	9	10	10	16	15
Sulfate	mg/L	**200**	**158**	**161**	**182**	**169**
TDS	mg/L	**677**	**639**	**648**	**680**	**668**
Arsenic	mg/L	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
Barium	mg/L	0.022	0.021	0.021	0.021	0.020
Boron	mg/L	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Cadmium	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium	mg/L	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Cobalt	mg/L	< 0.25	< 0.25	< 0.25	< 0.25	< 0.25
Copper	mg/L	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025
Iron	mg/L	< 0.021	0.055	0.054	< 0.021	< 0.021
Lead	mg/L	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004
Manganese	mg/L	0.016	0.068	0.066	0.088	**0.110**
Mercury	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Nickel	mg/L	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Selenium	mg/L	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
Silver	mg/L	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Zinc	mg/L	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Unfiltered Sample						
Chloride	mg/L	–[c]	13	13	–	–
Cyanide (Total)	mg/L	< 0.01	**0.021**	< 0.01	< 0.01	< 0.01
Fluoride	mg/L	–	0.38	0.42	–	–
Hydrogen-3	pCi/L	< 100	< 100	< 100	114	< 100
Nitrate	mg/L	–	0.79	0.73	–	–
Phenols	mg/L	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Sulfate	mg/L	–	157	155	–	–
TOCs (max. of 4 samples)	mg/L	2.6	2.5	2.3	2.1	1.9
TOXs (max. of 2 samples)	mg/L	< 0.02	0.054	< 0.02	< 0.02	< 0.02
Arsenic	mg/L	–	< 0.003	< 0.003	–	–
Barium	mg/L	–	0.022	0.022	–	–
Beryllium	mg/L	–	< 0.1	< 0.1	–	–
Cadmium	mg/L	–	< 0.0002	< 0.0002	–	–
Chromium	mg/L	–	< 0.05	< 0.05	–	–
Cobalt	mg/L	–	< 0.25	< 0.25	–	–
Copper	mg/L	–	< 0.025	< 0.025	–	–
Iron	mg/L	–	0.28	0.28	–	–
Lead	mg/L	–	0.004	< 0.004	–	–
Manganese	mg/L	–	0.068	0.070	–	–
Mercury	mg/L	–	< 0.0002	< 0.0002	–	–
Nickel	mg/L	–	< 0.05	< 0.05	–	–
Selenium	mg/L	–	< 0.003	< 0.003	–	–
Silver	mg/L	–	< 0.001	< 0.001	–	–
Zinc	mg/L	–	< 0.02	< 0.02	–	–

[a] Bold type indicates that the value exceeds the applicable limits shown in Table 6.27.

[b] Well point elevation = 223.48 m (MSL); ground surface elevation = 230.49 m (MSL); casing material = stainless steel.

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

TABLE 6.36

Groundwater Monitoring Results, Sanitary Landfill Well 800301, 2007

Parameter	Unit	Date of Sampling 1/22/2007	5/1/2007	7/16/2007	10/3/2007
Field Parameters					
Conductivity	µS/cm	**981**[a]	**1,020**	**1,054**	**828**
Oxid./red. potential	mV	1	11	14	7
pH	pH	6.92	6.89	6.81	6.94
Temperature	ºC	8.2	16.0	15.0	12.2
Water elevation[b]	m	231.50	232.32	229.54	228.51
Filtered Samples					
Ammonia nitrogen	mg/L	< 0.05	< 0.05	< 0.05	0.11
Chloride	mg/L	8	11	12	12
Sulfate	mg/L	**116**	**165**	**190**	**174**
TDS	mg/L	**554**	**650**	**686**	**677**
Arsenic	mg/L	0.004	< 0.003	< 0.003	< 0.003
Barium	mg/L	0.023	0.021	0.023	0.021
Boron	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
Cadmium	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Cobalt	mg/L	< 0.25	< 0.25	< 0.25	< 0.25
Copper	mg/L	< 0.025	< 0.025	< 0.025	< 0.025
Iron	mg/L	**1.41**	**0.269**	**1.00**	**0.522**
Lead	mg/L	< 0.004	< 0.004	< 0.004	< 0.004
Manganese	mg/L	0.069	**0.099**	**0.240**	**0.211**
Mercury	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Nickel	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Selenium	mg/L	< 0.003	< 0.003	< 0.003	< 0.003
Silver	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Zinc	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Unfiltered Samples					
Chloride	mg/L	–[c]	10	–	–
Cyanide (Total)	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Fluoride	mg/L	–	0.345	–	–
Hydrogen-3	pCi/L	< 100	< 100	120	< 100
Nitrate	mg/L	–	< 0.1	–	–
Phenols	mg/L	< 0.005	< 0.005	< 0.005	0.0051
Sulfate	mg/L	–	168	–	–
TOCs (max. of 4 numbers)	mg/L	1.8	1.4	1.4	1.4
TOXs (max. of 2 numbers)	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Arsenic	mg/L	–	< 0.003	–	–
Barium	mg/L	–	0.022	–	–
Boron	mg/L	–	< 0.1	–	–
Cadmium	mg/L	–	< 0.0002	–	–
Chromium	mg/L	–	< 0.05	–	–
Cobalt	mg/L	–	< 0.25	–	–
Copper	mg/L	–	< 0.025	–	–
Iron	mg/L	–	0.616	–	–
Lead	mg/L	–	< 0.004	–	–
Manganese	mg/L	–	0.128	–	–
Mercury	mg/L	–	< 0.0002	–	–
Nickel	mg/L	–	< 0.05	–	–
Selenium	mg/L	–	< 0.003	–	–
Silver	mg/L	–	< 0.001	–	–
Zinc	mg/L	–	< 0.02	–	–

[a] Bold type indicates that the value exceeds the applicable limits shown in Table 6.27.

[b] Well point elevation = 224.91 m (MSL); ground surface elevation = 232.53 m (MSL); casing material = stainless steel.

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

TABLE 6.37

Groundwater Monitoring Results, Sanitary Landfill Well 800321, 2007

Parameter	Unit	Date of Sampling 1/9/2007	4/9/2007	7/10/2007	10/15/2007
Field Parameters					
Conductivity	µS/cm	**1,433**[a]	**2,210**	**2,320**	**1,595**
Oxid./red. potential	mV	2	19	22	17
pH	pH	6.74	6.84	6.67	6.76
Temperature	ºC	9.2	8.1	11.8	13.2
Water elevation[b]	m	226.85	226.46	224.95	224.84
Filtered Samples					
Ammonia nitrogen	mg/L	0.07	0.64	< 0.05	**1.22**
Chloride	mg/L	**25**	**32**	**46**	**43**
Sulfate	mg/L	**553**	**793**	**986**	**978**
TDS	mg/L	**1,232**	**1,784**	**2,180**	**2,142**
Arsenic	mg/L	< 0.003	< 0.003	< 0.003	< 0.003
Barium	mg/L	0.012	< 0.012	< 0.012	< 0.012
Boron	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
Cadmium	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Cobalt	mg/L	< 0.25	< 0.25	< 0.25	< 0.25
Copper	mg/L	< 0.025	< 0.025	< 0.025	< 0.025
Iron	mg/L	< 0.021	< 0.021	< 0.021	< 0.021
Lead	mg/L	< 0.004	< 0.004	< 0.004	< 0.004
Manganese	mg/L	< 0.01	0.034	0.026	< 0.01
Mercury	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Nickel	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Selenium	mg/L	< 0.003	< 0.015	< 0.006	< 0.009
Silver	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Zinc	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Unfiltered Samples					
Chloride	mg/L	–[c]	31	–	–
Cyanide (Total)	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Fluoride	mg/L	–	0.506	–	–
Hydrogen-3	pCi/L	< 100	392	< 100	< 100
Nitrate	mg/L	–	< 0.1	–	–
Phenols	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Sulfate	mg/L	**–**	**666**	**–**	**–**
TOCs (max. of 4 samples)	mg/L	**2.9**	**2.8**	2.1	2.3
TOXs (max. of 2 samples)	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Arsenic	mg/L	–	0.006	–	–
Barium	mg/L	–	0.039	–	–
Boron	mg/L	–	< 0.1	–	–
Cadmium	mg/L	–	0.0002	–	–
Chromium	mg/L	–	< 0.05	–	–
Cobalt	mg/L	–	< 0.25	–	–
Copper	mg/L	–	< 0.025	–	–
Iron	mg/L	–	**12.6**	–	–
Lead	mg/L	–	**0.011**	–	–
Manganese	mg/L	–	**0.489**	–	–
Mercury	mg/L	–	< 0.0002	–	–
Nickel	mg/L	–	< 0.05	–	–
Selenium	mg/L	–	< 0.015	–	–
Silver	mg/L	–	< 0.001	–	–
Zinc	mg/L	–	< 0.02	–	–

[a] Bold type indicates that the value exceeds the applicable limits shown in Table 6.27.

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

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

TABLE 6.38

Groundwater Monitoring Results, Sanitary Landfill Well 800331, 2007

Parameter	Unit	Date of Sampling 1/15/2007	4/18/2007	7/10/2007	10/8/2007
Field Parameters					
Conductivity	µS/cm	**913**[a]	**830**	**844**	**691**
Oxid./red. potential	mV	-30	0	3	-4
pH	pH	7.25	7.12	7.00	7.15
Temperature	ºC	8.8	8.5	12.0	13.0
Water elevation[b]	m	227.51	227.48	225.73	225.42
Filtered Samples					
Ammonia nitrogen	mg/L	0.09	< 0.05	< 0.05	0.06
Chloride	mg/L	6	6	10	9
Sulfate	mg/L	**165**	**140**	**155**	**148**
TDS	mg/L	**513**	**486**	**492**	**505**
Arsenic	mg/L	< 0.003	< 0.003	< 0.003	< 0.003
Barium	mg/L	0.026	0.027	0.026	0.027
Boron	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
Cadmium	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Cobalt	mg/L	< 0.25	< 0.25	< 0.25	< 0.25
Copper	mg/L	< 0.025	< 0.025	< 0.025	< 0.025
Iron	mg/L	< 0.021	< 0.021	< 0.021	< 0.021
Lead	mg/L	< 0.004	< 0.004	< 0.004	< 0.004
Manganese	mg/L	< 0.01	< 0.01	< 0.01	0.031
Mercury	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Nickel	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Selenium	mg/L	< 0.003	< 0.003	< 0.003	< 0.003
Silver	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Zinc	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Unfiltered Samples					
Chloride	mg/L	–[c]	7	–	–
Cyanide (Total)	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Fluoride	mg/L	–	0.39	–	–
Hydrogen-3	pCi/L	< 100	113	< 100	< 100
Nitrate	mg/L	–	< 0.1	–	–
Phenols	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Sulfate	mg/L	–	147	–	–
TOCs (max. of 4 samples)	mg/L	2.2	2.1	1.6	1.3
TOXs (max. of 2 samples)	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Arsenic	mg/L	–	< 0.003	–	–
Barium	mg/L	–	0.039	–	–
Boron	mg/L	–	< 0.1	–	–
Cadmium	mg/L	–	< 0.0002	–	–
Chromium	mg/L	–	< 0.05	–	–
Cobalt	mg/L	–	< 0.25	–	–
Copper	mg/L	–	< 0.025	–	–
Iron	mg/L	–	**5.04**	–	–
Lead	mg/L	–	0.005	–	–
Manganese	mg/L	–	**0.189**	–	–
Mercury	mg/L	–	< 0.0002	–	–
Nickel	mg/L	–	< 0.05	–	–
Selenium	mg/L	–	< 0.003	–	–
Silver	mg/L	–	< 0.001	–	–
Zinc	mg/L	–	0.022	–	–

[a] Bold type indicates that the value exceeds the applicable limits shown in Table 6.27.

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

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

TABLE 6.39

Groundwater Monitoring Results, Sanitary Landfill Well 800341, 2007

Parameter	Unit	Date of Sampling 1/11/2007	4/17/2007	7/9/2007	10/8/2007
Field Parameters					
Conductivity	µS/cm	**905**[a]	**929**	**931**	**755**
Oxid./red. potential	mV	-24	-2	-7	-13
pH	pH	7.23	7.18	7.25	7.30
Temperature	ºC	7.0	9.0	12.2	14.8
Water elevation[b]	m	229.75	229.69	228.06	228.07
Filtered Samples					
Ammonia nitrogen	mg/L	0.08	< 0.05	< 0.05	0.09
Chloride	mg/L	11	11	18	17
Sulfate	mg/L	**172**	**161**	**177**	**188**
TDS	mg/L	**507**	**525**	**582**	**602**
Arsenic	mg/L	< 0.003	< 0.003	< 0.003	< 0.003
Barium	mg/L	0.029	0.028	0.034	0.035
Boron	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
Cadmium	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Cobalt	mg/L	< 0.25	< 0.25	< 0.25	< 0.25
Copper	mg/L	< 0.025	< 0.025	< 0.025	< 0.025
Iron	mg/L	< 0.021	< 0.021	< 0.021	< 0.021
Lead	mg/L	< 0.004	< 0.004	< 0.004	< 0.004
Manganese	mg/L	< 0.01	0.016	< 0.01	0.011
Mercury	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Nickel	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Selenium	mg/L	< 0.003	< 0.003	< 0.003	< 0.003
Silver	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Zinc	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Unfiltered Samples					
Chloride	mg/L	–[c]	12	–	–
Cyanide (Total)	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Fluoride	mg/L	–0	0.403	–	–
Hydrogen-3	pCi/L	< 100	< 100	< 100	< 100
Nitrate	mg/L	–	0.25	–	–
Phenols	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Sulfate	mg/L	**–**	168	**–**	**–**
TOCs (max. of 4 samples)	mg/L	**3.2**	**3.3**	2.5	2.0
TOXs (max. of 2 samples)	mg/L	0.021	< 0.02	< 0.02	< 0.02
Arsenic	mg/L	–	0.004	–	–
Barium	mg/L	–	0.034	–	–
Boron	mg/L	–	< 0.1	–	–
Cadmium	mg/L	–	< 0.0002	–	–
Chromium	mg/L	–	< 0.05	–	–
Cobalt	mg/L	–	< 0.25	–	–
Copper	mg/L	–	< 0.025	–	–
Iron	mg/L	–	1.68	–	–
Lead	mg/L	–	< 0.004	–	–
Manganese	mg/L	–	0.056	–	–
Mercury	mg/L	–	< 0.0002	–	–
Nickel	mg/L	–	< 0.05	–	–
Selenium	mg/L	–	< 0.003	–	–
Silver	mg/L	–	< 0.001	–	–
Zinc	mg/L	–	< 0.02	–	–

[a] Bold type indicates that the value exceeds the applicable limits shown in Table 6.27.

[b] Well point elevation = 226.01 m (MSL); ground surface elevation = 229.97 m (MSL); casing material = stainless steel.

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

TABLE 6.40

Groundwater Monitoring Results, Sanitary Landfill Well 800351, 2007

Parameter	Unit	Date of Sampling 1/15/2007	5/1/2007	7/16/2007	10/3/2007
Field Parameters					
Conductivity	µS/cm	**888**[a]	**872**	**865**	689
Oxid./red. potential	mV	-11	-3	-4	-5
pH	pH	6.98	7.17	7.15	7.16
Temperature	ºC	9.6	11.5	11.5	10.3
Water elevation[b]	m	224.95	230.11	227.44	226.63
Filtered Samples					
Ammonia nitrogen	mg/L	0.32	0.24	0.15	0.35
Chloride	mg/L	3	5	6	5
Sulfate	mg/L	51	47	45	47
TDS	mg/L	**1,804**	**455**	**447**	**466**
Arsenic	mg/L	0.003	0.004	0.003	< 0.003
Barium	mg/L	0.085	0.089	0.088	0.088
Boron	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
Cadmium	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Cobalt	mg/L	< 0.25	< 0.25	< 0.25	< 0.25
Copper	mg/L	< 0.025	< 0.025	< 0.025	< 0.025
Iron	mg/L	< 0.021	**0.477**	**0.448**	**1.08**
Lead	mg/L	< 0.004	< 0.004	< 0.004	< 0.004
Manganese	mg/L	0.026	0.022	0.022	0.022
Mercury	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Nickel	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Selenium	mg/L	< 0.003	< 0.003	< 0.003	< 0.003
Silver	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Zinc	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Unfiltered Samples					
Chloride	mg/L	–[c]	5	–	–
Cyanide (Total)	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Fluoride	mg/L	–	0.257	–	–
Hydrogen-3	pCi/L	< 100	< 100	< 100	< 100
Nitrate	mg/L	–	< 0.1	–	–
Phenols	mg/L	< 0.005	< 0.005	< 0.005	0.0071
Sulfate	mg/L	–	46	–	–
TOCs (max. of 4 samples)	mg/L	2.2	1.8	1.6	1.7
TOXs (max. of 2 samples)	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Arsenic	mg/L	–	0.007	–	–
Barium	mg/L	–	0.109	–	–
Boron	mg/L	–	0.105	–	–
Cadmium	mg/L	–	< 0.0002	–	–
Chromium	mg/L	–	< 0.05	–	–
Cobalt	mg/L	–	< 0.25	–	–
Copper	mg/L	–	< 0.025	–	–
Iron	mg/L	–	**7.92**	–	–
Lead	mg/L	–	0.004	–	–
Manganese	mg/L	–	0.126	–	–
Mercury	mg/L	–	< 0.0002	–	–
Nickel	mg/L	–	< 0.05	–	–
Selenium	mg/L	–	< 0.003	–	–
Silver	mg/L	–	< 0.001	–	–
Zinc	mg/L	–	< 0.02	–	–

[a] Bold type indicates that the value exceeds the applicable limits shown in Table 6.27.

[b] Well point elevation = 220.86 m (MSL); ground surface elevation = 232.75 m (MSL); casing material = stainless steel.

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

TABLE 6.41

Groundwater Monitoring Results, Sanitary Landfill Well 800361, 2007

Parameter	Unit	Date of Sampling			
		1/23/2007	4/18/2007	7/11/2007	10/15/2007
Field Parameters					
Conductivity	µS/cm	**981**[a]	**983**	**1,027**	**763**
Oxid./red. potential	mV	-3	17	-9	3
pH	pH	7.00	6.82	6.88	7.01
Temperature	ºC	6.9	9.7	12.1	14.1
Water elevation[b]	m	226.44	226.71	223.59	222.43
Filtered Samples					
Ammonia nitrogen	mg/L	0.05	0.05	0.82	0.05
Chloride	mg/L	18	14	**22**	**22**
Sulfate	mg/L	**182**	**171**	**184**	**171**
TDS	mg/L	**567**	**596**	**636**	**593**
Arsenic	mg/L	< 0.003	< 0.003	< 0.003	< 0.003
Barium	mg/L	0.025	0.024	0.029	0.028
Boron	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
Cadmium	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Cobalt	mg/L	< 0.25	< 0.25	< 0.25	< 0.25
Copper	mg/L	< 0.025	< 0.025	< 0.025	< 0.025
Iron	mg/L	< 0.021	< 0.021	< 0.021	< 0.021
Lead	mg/L	< 0.004	< 0.004	< 0.004	< 0.004
Manganese	mg/L	0.054	0.052	**0.103**	0.075
Mercury	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Nickel	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Selenium	mg/L	< 0.003	< 0.003	< 0.003	< 0.003
Silver	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Zinc	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Unfiltered Samples					
Chloride	mg/L	–[c]	17	–	–
Cyanide (Total)	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Fluoride	mg/L	–	0.322	–	–
Hydrogen-3	pCi/L	< 100	109	< 100	< 100
Nitrate	mg/L	–	< 0.1	–	–
Phenols	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Sulfate	mg/L	–	173	–	–
TOCs (max. of 4 samples)	mg/L	1.9	2.5	1.8	2.0
TOXs (max. of 2 samples)	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Arsenic	mg/L	–	< 0.003	–	–
Barium	mg/L	–	0.025	–	–
Boron	mg/L	–	< 0.1	–	–
Cadmium	mg/L	–	< 0.0002	–	–
Chromium	mg/L	–	< 0.05	–	–
Cobalt	mg/L	–	< 0.25	–	–
Copper	mg/L	–	< 0.025	–	–
Iron	mg/L	–	0.034	–	–
Lead	mg/L	–	< 0.004	–	–
Manganese	mg/L	–	0.055	–	–
Mercury	mg/L	–	< 0.0002	–	–
Nickel	mg/L	–	< 0.05	–	–
Selenium	mg/L	–	< 0.003	–	–
Silver	mg/L	–	< 0.001	–	–
Zinc	mg/L	–	< 0.02	–	–

[a] Bold type indicates that the value exceeds the applicable limits shown in Table 6.27.

[b] Well point elevation = 220.52 m (MSL); ground surface elevation = 227.24 m (MSL); casing material = stainless steel.

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

TABLE 6.42

Groundwater Monitoring Results, Sanitary Landfill Well 800371, 2007

Parameter	Unit	Date of Sampling 1/15/2007	4/18/2007	7/10/2007	10/15/2007
Field Parameters					
Conductivity	µS/cm	**2,060**[a]	**1,752**	**1,521**	**1,141**
Oxid./red. potential	mV	8	22	15	10
pH	pH	6.64	6.73	6.79	6.89
Temperature	ºC	9.0	10.4	13.6	11.3
Water elevation[b]	m	218.60	218.73	218.79	218.69
Filtered Samples					
Ammonia nitrogen	mg/L	0.89	0.28	< 0.05	0.34
Chloride	mg/L	3	1	4	5
Sulfate	mg/L	**958**	**740**	**698**	**604**
TDS	mg/L	**433**	**1,601**	**1,449**	**1,326**
Arsenic	mg/L	< 0.003	< 0.003	< 0.003	< 0.003
Barium	mg/L	0.017	0.016	0.016	0.015
Boron	mg/L	0.120	0.132	0.118	0.110
Cadmium	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Cobalt	mg/L	< 0.25	< 0.25	< 0.25	< 0.25
Copper	mg/L	< 0.025	< 0.025	< 0.025	< 0.025
Iron	mg/L	**0.563**	**1.210**	**0.543**	**0.557**
Lead	mg/L	< 0.004	< 0.004	< 0.004	< 0.004
Manganese	mg/L	**0.285**	**0.252**	**0.199**	**0.163**
Mercury	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Nickel	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Selenium	mg/L	< 0.015	< 0.003	< 0.003	< 0.009
Silver	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Zinc	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Unfiltered Samples					
Chloride	mg/L	–[c]	2.3	–	–
Cyanide (Total)	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Fluoride	mg/L	–	0.56	–	–
Hydrogen-3	pCi/L	< 100	< 100	< 100	< 100
Nitrate	mg/L	–	0.16	–	–
Phenols	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Sulfate	mg/L	**–**	**750**	**–**	**–**
TOCs (max. of 4 samples)	mg/L	1.8	2.2	1.8	1.4
TOXs (max. of 2 samples)	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Arsenic	mg/L	–	0.008	–	–
Barium	mg/L	–	0.036	–	–
Boron	mg/L	–	0.16	–	–
Cadmium	mg/L	–	< 0.0002	–	–
Chromium	mg/L	–	< 0.05	–	–
Cobalt	mg/L	–	< 0.25	–	–
Copper	mg/L	–	< 0.025	–	–
Iron	mg/L	–	**9.04**	–	–
Lead	mg/L	–	0.007	–	–
Manganese	mg/L	–	**0.392**	–	–
Mercury	mg/L	–	< 0.0002	–	–
Nickel	mg/L	–	< 0.05	–	–
Selenium	mg/L	–	< 0.015	–	–
Silver	mg/L	–	< 0.001	–	–
Zinc	mg/L	–	< 0.02	–	–

[a] Bold type indicates that the value exceeds the applicable limits shown in Table 6.27.

[b] Well point elevation = 217.44 m (MSL); ground surface elevation = 227.50 m (MSL); casing material = stainless steel.

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

TABLE 6.43

Groundwater Monitoring Results, Sanitary Landfill Well 800381, 2007

Parameter	Unit	Date of Sampling			
		1/24/2007	4/30/2007	7/24/2007	10/17/2007
Field Parameters					
Conductivity	µS/cm	**1,422**[a]	**1,308**	**1,464**	**1,121**
Oxid./red. potential	mV	10	17	19	16
pH	pH	6.75	6.77	6.71	6.78
Temperature	ºC	8.4	14.1	19.0	14.2
Water elevation[b]	m	229.84	230.39	227.51	227.20
Filtered Samples					
Ammonia nitrogen	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Chloride	mg/L	**23**	**44**	**38**	**46**
Sulfate	mg/L	**355**	**244**	**416**	**357**
TDS	mg/L	**1,005**	**899**	**1,177**	**1,106**
Arsenic	mg/L	< 0.003	< 0.003	< 0.003	< 0.003
Barium	mg/L	0.04	0.041	0.032	0.033
Boron	mg/L	< 0.1	< 0.1	< 0.1	< 0.1
Cadmium	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Cobalt	mg/L	< 0.25	< 0.25	< 0.25	< 0.25
Copper	mg/L	< 0.025	< 0.025	< 0.025	< 0.025
Iron	mg/L	< 0.021	< 0.021	< 0.021	0.155
Lead	mg/L	< 0.004	< 0.004	< 0.004	< 0.004
Manganese	mg/L	**0.143**	**0.147**	**0.236**	**0.246**
Mercury	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Nickel	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Selenium	mg/L	< 0.003	< 0.003	< 0.003	< 0.003
Silver	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Zinc	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Unfiltered Samples					
Chloride	mg/L	–[c]	38	–	–
Cyanide (Total)	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Fluoride	mg/L	–	0.379	–	–
Hydrogen-3	pCi/L	< 100	< 100	< 100	< 100
Nitrate	mg/L	–	0.13	–	–
Phenols	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Sulfate	mg/L	**–**	240	**–**	**–**
TOCs (max. of 4 samples)	mg/L	**3.7**	**3.4**	**3.4**	**3.5**
TOXs (max. of 2 samples)	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Arsenic	mg/L	–	< 0.003	–	–
Barium	mg/L	–	0.041	–	–
Boron	mg/L	–	< 0.1	–	–
Cadmium	mg/L	–	< 0.0002	–	–
Chromium	mg/L	–	< 0.05	–	–
Cobalt	mg/L	–	< 0.25	–	–
Copper	mg/L	–	< 0.025	–	–
Iron	mg/L	–	0.038	–	–
Lead	mg/L	–	< 0.004	–	–
Manganese	mg/L	–	**0.151**	–	–
Mercury	mg/L	–	< 0.0002	–	–
Nickel	mg/L	–	< 0.05	–	–
Selenium	mg/L	–	< 0.015	–	–
Silver	mg/L	–	< 0.001	–	–
Zinc	mg/L	–	< 0.02	–	–

[a] Bold type indicates that the value exceeds the applicable limits shown in Table 6.27.

[b] Well point elevation = 224.40 m (MSL); ground surface elevation = 231.21 m (MSL); casing material = stainless steel.

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

TABLE 6.44

Groundwater Monitoring Results, Sanitary Landfill Well 800173D, 2007

Parameter	Unit	Date of Sampling			
		1/17/2007	4/16/2007	7/10/2007	10/10/2007
Field Parameters					
Conductivity	µS/cm	**1,630**[a]	**1,521**	**1,448**	**1,241**
Oxid./red. potential	mV	-5	3	3	-1
pH	pH	6.89	7.07	7.01	7.08
Temperature	ºC	10.9	11.6	13.7	11.7
Water elevation[b]	m	192.92	193.14	193.02	193.05
Filtered Samples					
Ammonia nitrogen	mg/L	0.91	0.96	0.82	0.93
Chloride	mg/L	**309**	**261**	**339**	**357**
Sulfate	mg/L	95	92	98	87
TDS	mg/L	**885**	**917**	**903**	**973**
Arsenic	mg/L	< 0.003	0.004	0.003	< 0.003
Barium	mg/L	0.104	0.104	0.095	0.092
Boron	mg/L	0.14	0.15	0.15	0.15
Cadmium	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Cobalt	mg/L	< 0.25	< 0.25	< 0.25	< 0.25
Copper	mg/L	< 0.025	< 0.025	< 0.025	< 0.025
Iron	mg/L	**1.98**	**2.22**	1.18	1.22
Lead	mg/L	< 0.004	< 0.004	< 0.004	< 0.004
Manganese	mg/L	**0.064**	**0.058**	**0.052**	**0.050**
Mercury	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Nickel	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Selenium	mg/L	< 0.003	< 0.003	< 0.003	< 0.003
Silver	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Zinc	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Unfiltered Samples					
Chloride	mg/L	–[c]	**255**	–	–
Cyanide (Total)	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Fluoride	mg/L	–	0.433	–	–
Hydrogen-3	pCi/L	< 100	< 100	160	< 100
Nitrate	mg/L	–	< 0.01	–	–
Phenols	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Sulfate	mg/L	–	93	–	–
TOCs (max. of 4 samples)	mg/L	4.3	5.0	3.2	3.3
TOXs (max. of 2 samples)	mg/L	< 0.02	0.03	0.021	0.041
Arsenic	mg/L	–	0.005	–	–
Barium	mg/L	–	0.108	–	–
Boron	mg/L	–	0.162	–	–
Cadmium	mg/L	–	< 0.0002	–	–
Chromium	mg/L	–	< 0.05	–	–
Cobalt	mg/L	–	< 0.25	–	–
Copper	mg/L	–	< 0.025	–	–
Iron	mg/L	–	4.01	–	–
Lead	mg/L	–	< 0.004	–	–
Manganese	mg/L	–	0.093	–	–
Mercury	mg/L	–	< 0.0002	–	–
Nickel	mg/L	–	< 0.05	–	–
Selenium	mg/L	–	< 0.003	–	–
Silver	mg/L	–	< 0.001	–	–
Zinc	mg/L	–	< 0.02	–	–

[a] Bold type indicates that the value exceeds the applicable limits shown in Table 6.27.

[b] Well point elevation = 189.09 m (MSL); ground surface elevation = 228.40 m (MSL); casing material = stainless steel.

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

TABLE 6.45

Groundwater Monitoring Results, Sanitary Landfill Well 800183D, 2007

Parameter	Unit	Date of Sampling 1/15/2007	4/24/2007	7/17/2007	10/9/2007
Field Parameters					
Conductivity	µS/cm	1,113	1,259	1,263	1,008
Oxid./red. potential	mV	-12	0	2	-5
pH	pH	7.01	7.13	7.04	7.16
Temperature	ºC	9.0	13.2	14.8	12.7
Water elevation[a]	m	193.12	193.19	193.07	193.08
Filtered Samples					
Ammonia nitrogen	mg/L	0.66	0.94	**1.1**[b]	**1.1**
Chloride	mg/L	105	**150**	**239**	**224**
Sulfate	mg/L	94	114	114	111
TDS	mg/L	598	760	839	829
Arsenic	mg/L	< 0.003	< 0.003	< 0.003	< 0.003
Barium	mg/L	0.038	0.048	0.055	0.048
Boron	mg/L	0.120	0.164	0.172	0.180
Cadmium	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Cobalt	mg/L	< 0.25	< 0.25	< 0.25	< 0.25
Copper	mg/L	< 0.025	< 0.025	< 0.025	< 0.025
Iron	mg/L	0.361	0.401	1.060	0.758
Lead	mg/L	< 0.004	< 0.004	< 0.004	< 0.004
Manganese	mg/L	**0.041**	0.021	**0.050**	0.014
Mercury	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Nickel	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Selenium	mg/L	< 0.003	< 0.003	< 0.003	< 0.003
Silver	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Zinc	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Unfiltered Samples					
Chloride	mg/L	–[c]	164	–	–
Cyanide (Total)	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Fluoride	mg/L	–	0.347	–	–
Hydrogen-3	pCi/L	< 100	< 100	< 100	< 100
Nitrate	mg/L	–	< 0.1	–	–
Phenols	mg/L	< 0.005	< 0.005	< 0.005	< 0.005
Sulfate	mg/L	–	105	–	–
TOCs (max. of 4 samples)	mg/L	2.7	**5.6**	2.6	2.4
TOXs (max. of 2 samples)	mg/L	< 0.02	**0.095**	< 0.02	0.021
Arsenic	mg/L	–	0.003	–	–
Barium	mg/L	–	0.054	–	–
Boron	mg/L	–	0.177	–	–
Cadmium	mg/L	–	< 0.0002	–	–
Chromium	mg/L	–	< 0.05	–	–
Cobalt	mg/L	–	< 0.25	–	–
Copper	mg/L	–	< 0.025	–	–
Iron	mg/L	–	1.57	–	–
Lead	mg/L	–	< 0.004	–	–
Manganese	mg/L	–	0.056	–	–
Mercury	mg/L	–	< 0.0002	–	–
Nickel	mg/L	–	< 0.05	–	–
Selenium	mg/L	–	< 0.003	–	–
Silver	mg/L	–	< 0.001	–	–
Zinc	mg/L	–	< 0.02	–	–

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

[b] Bold type indicates that the value exceeds the applicable limits shown in Table 6.27.

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

TABLE 6.46

Groundwater Monitoring Results, Sanitary Landfill Well 800193D, 2007

Parameter	Unit	Date of Sampling			
		1/9/2007	4/9/2007	7/11/2007	10/2/2007
Field Parameters					
Conductivity	µS/cm	**1,571**[a]	**1,443**	**1,418**	1,184
Oxid./red. potential	mV	-3	3	6	0
pH	pH	6.86	7.12	6.98	7.07
Temperature	ºC	10.4	10.5	13.2	13.1
Water elevation[b]	m	193.04	192.90	193.06	193.08
Filtered Samples					
Ammonia nitrogen	mg/L	0.49	0.98	0.82	0.96
Chloride	mg/L	**248**	**201**	**281**	**317**
Sulfate	mg/L	133	144	143	134
TDS	mg/L	**969**	**890**	**954**	**1,025**
Arsenic	mg/L	< 0.003	< 0.003	< 0.003	< 0.003
Barium	mg/L	0.079	0.078	0.072	0.074
Boron	mg/L	0.15	0.17	0.166	0.16
Cadmium	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Cobalt	mg/L	< 0.25	< 0.25	< 0.25	< 0.25
Copper	mg/L	< 0.025	< 0.025	< 0.025	< 0.025
Iron	mg/L	1.43	1.53	1.26	1.42
Lead	mg/L	< 0.004	< 0.004	< 0.004	< 0.004
Manganese	mg/L	**0.022**	**0.022**	**0.022**	**0.023**
Mercury	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Nickel	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Selenium	mg/L	< 0.003	< 0.003	< 0.003	< 0.003
Silver	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Zinc	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Unfiltered Samples					
Chloride	mg/L	–[c]	**227**	–	–
Cyanide (Total)	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Fluoride	mg/L	–	0.422	–	–
Hydrogen-3	pCi/L	< 100	350	< 100	< 100
Nitrate	mg/L	–	< 0.1	–	–
Phenols	mg/L	< 0.005	< 0.005	< 0.005	0.031
Sulfate	mg/L	–	130	–	–
TOCs (max. of 4 samples)	mg/L	3.8	4.0	3.5	3.3
TOXs (max. of 2 samples)	mg/L	< 0.02	0.031	< 0.02	< 0.02
Arsenic	mg/L	–	0.004	–	–
Barium	mg/L	–	0.081	–	–
Boron	mg/L	–	0.183	–	–
Cadmium	mg/L	–	< 0.0002	–	–
Chromium	mg/L	–	< 0.05	–	–
Cobalt	mg/L	–	< 0.25	–	–
Copper	mg/L	–	< 0.025	–	–
Iron	mg/L	–	2.45	–	–
Lead	mg/L	–	< 0.004	–	–
Manganese	mg/L	–	0.031	–	–
Mercury	mg/L	–	< 0.0002	–	–
Nickel	mg/L	–	< 0.05	–	–
Selenium	mg/L	–	< 0.015	–	–
Silver	mg/L	–	< 0.001	–	–
Zinc	mg/L	–	< 0.02	–	–

[a] Bold type indicates that the value exceeds the applicable limits shown in Table 6.27.

[b] Well point elevation = 181.35 m (MSL); ground surface elevation = 227.34 m (MSL); casing material = stainless steel.

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

TABLE 6.47

Groundwater Monitoring Results, Sanitary Landfill Well 800203D, 2007

Parameter	Unit	Date of Sampling			
		1/23/2007	4/23/2007	7/24/2007	10/16/2007
Field Parameters					
Conductivity	µS/cm	1,248	1,191	1,191	917
Oxid./red. potential	mV	-6	4	2	0
pH	pH	7.06	7.05	7.02	7.06
Temperature	ºC	10.3	12.3	12.1	11.8
Water elevation[a]	m	193.22	193.29	193.04	193.08
Filtered Samples					
Ammonia nitrogen	mg/L	**1.8**[b]	**1.9**	**2.0**	**2.0**
Chloride	mg/L	**169**	**158**	**222**	**194**
Sulfate	mg/L	43	52	68	67
TDS	mg/L	667	661	713	682
Arsenic	mg/L	**0.005**	**0.005**	0.004	<0.003
Barium	mg/L	0.125	0.130	0.136	0.134
Boron	mg/L	0.140	0.155	0.162	0.160
Cadmium	mg/L	< 0.0002	< 0.0002	> 0.0002	< 0.0002
Chromium	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Cobalt	mg/L	< 0.25	< 0.25	< 0.25	< 0.25
Copper	mg/L	< 0.025	< 0.025	< 0.025	< 0.025
Iron	mg/L	1.32	1.50	1.15	1.35
Lead	mg/L	< 0.004	< 0.004	< 0.004	< 0.004
Manganese	mg/L	**0.043**	**0.037**	**0.038**	**0.035**
Mercury	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Nickel	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Selenium	mg/L	< 0.003	< 0.003	< 0.003	< 0.003
Silver	mg/L	< 0.001	< 0.001	< 0.001	< 0.001
Zinc	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Unfiltered Samples					
Chloride	mg/L	–[c]	159	–	–
Cyanide (Total)	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Fluoride	mg/L	–	0.389	–	–
Hydrogen-3	pCi/L	< 100	< 100	< 100	< 100
Nitrate	mg/L	–	< 0.1	–	–
Phenols	mg/L	0.0057	< 0.005	< 0.005	< 0.005
Sulfate	mg/L	**–**	52	**–**	**–**
TOCs (max. of 4 samples)	mg/L	**7.2**	2.7	5.2	**5.5**
TOXs (max. of 2 samples)	mg/L	**0.055**	0.031	< 0.02	< 0.02
Arsenic	mg/L	–	0.005	–	–
Barium	mg/L	–	0.132	–	–
Boron	mg/L	–	0.174	–	–
Cadmium	mg/L	–	< 0.0002	–	–
Chromium	mg/L	–	< 0.05	–	–
Cobalt	mg/L	–	< 0.25	–	–
Copper	mg/L	–	< 0.025	–	–
Iron	mg/L	–	1.9	–	–
Lead	mg/L	–	< 0.004	–	–
Manganese	mg/L	–	0.041	–	–
Mercury	mg/L	–	< 0.0002	–	–
Nickel	mg/L	–	< 0.05	–	–
Selenium	mg/L	–	< 0.003	–	–
Silver	mg/L	–	< 0.001	–	–
Zinc	mg/L	–	< 0.02	–	–

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

[b] Bold type indicates that the value exceeds the applicable limits shown in Table 6.27.

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

TABLE 6.48

Groundwater Monitoring Results, Sanitary Landfill Well 800383D, 2007

Parameter	Unit	Date of Sampling				
		1/24/2007	1/24/2007 (Duplicate)	4/30/2007	7/24/2007	10/17/2007
Field Parameters						
Conductivity	µS/cm	**1,410**[a]	**1,410**	1,299	**1,309**	1,150
Oxid./red. potential	mV	-6	-6	2	2	-2
pH	pH	7.06	7.06	7.04	7.02	7.11
Temperature	ºC	11.4	11.4	12.0	13.9	11.9
Water elevation[b]	m	192.65	192.65	192.75	192.55	192.56
Filtered Samples						
Ammonia nitrogen	mg/L	0.76	0.79	0.77	0.75	0.69
Chloride	mg/L	**207**	**220**	**216**	**256**	**319**
Sulfate	mg/L	**118**	**118**	**127**	**125**	**113**
TDS	mg/L	**784**	**787**	**776**	**866**	**1,105**
Arsenic	mg/L	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
Barium	mg/L	0.084	0.085	0.076	0.078	0.081
Boron	mg/L	0.15	0.15	0.162	0.165	0.16
Cadmium	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium	mg/L	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Cobalt	mg/L	< 0.25	< 0.25	< 0.25	< 0.25	< 0.25
Copper	mg/L	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025
Iron	mg/L	**1.52**	**1.54**	**1.26**	**1.23**	**1.31**
Lead	mg/L	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004
Manganese	mg/L	0.051	0.052	0.047	0.054	0.05
Mercury	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Nickel	mg/L	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Selenium	mg/L	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
Silver	mg/L	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Zinc	mg/L	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Unfiltered Samples						
Chloride	mg/L	–[c]	–	**203**	–	–
Cyanide (Total)	mg/L	< 0.01	< 0.01	< 0.01	< 0.01	0.01
Fluoride	mg/L	–	–	0.415	–	–
Hydrogen-3	pCi/L	< 100	< 100	< 100	< 100	< 100
Nitrate	mg/L	–	–	< 0.1	–	–
Phenols	mg/L	< 0.005	< 0.005	< 0.005	0.0075	< 0.005
Sulfate	mg/L	–	–	122	–	–
TOCs (max. of 4 samples)	mg/L	2.4	2.3	2.0	2.0	2.3
TOXs (max. of 2 samples)	mg/L	< 0.02	< 0.02	< 0.02	< 0.02	0.029
Arsenic	mg/L	–	–	0.004	–	–
Barium	mg/L	–	–	0.08	–	–
Boron	mg/L	–	–	0.187	–	–
Cadmium	mg/L	–	–	< 0.0002	–	–
Chromium	mg/L	–	–	< 0.05	–	–
Cobalt	mg/L	–	–	< 0.25	–	–
Copper	mg/L	–	–	< 0.025	–	–
Iron	mg/L	–	–	3.06	–	–
Lead	mg/L	–	–	< 0.004	–	–
Manganese	mg/L	–	–	0.097	–	–
Mercury	mg/L	–	–	< 0.0002	–	–
Nickel	mg/L	–	–	< 0.05	–	–
Selenium	mg/L	–	–	< 0.003	–	–
Silver	mg/L	–	–	< 0.001	–	–
Zinc	mg/L	–	–	< 0.02	–	–

[a] Bold type indicates that the value exceeds the applicable limits shown in Table 6.27.

[b] Well point elevation = 187.35 m (MSL); ground surface elevation = 231.24 m (MSL); casing material = stainless steel.

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

wells closest to the wetland west of the landfill (Wells 800371, 800191R, and 800321). These wells also generally exhibit the highest concentrations of dissolved iron and manganese. The lowest dissolved ion concentrations were on the southeast side of the landfill, the farthest away from the wetland. None of these elevated results appeared to correlate with the proximity of the well to the landfill. It is likely that the elevated concentrations of dissolved inorganic matter are related to the proximity of the large wetland that contains deposits of high organic-content soil. This type of soil produces slightly acidic anaerobic conditions that can increase the solubility of many naturally occurring materials that could migrate to the shallow groundwater near the wetlands. It could also be related to dissolved material in stormwater runoff (including road salt) that originates in a nearby intersection between a large highway and major surface roadway. This runoff flows through the wetlands.

The fact that all of the wells had higher levels of TDS/conductivity than the background well may be an indication that the background well is located in a region with different geochemistry than the 800 Area wells. Because of the heterogeneous nature of the glacial drift under the landfill, groundwater geochemistry could vary significantly over short distances.

Chloride levels were elevated in a number of wells east of the landfill, particularly 800171 and 800281. These wells are near roadways in the 800 Area and near a former road salt storage area that had been located in the 800 Area for a number of years. It is possible that chloride from the sodium chloride in road salt has migrated to the shallow wells in this area. The other wells with elevated chloride levels are generally near the wetlands and could be affected by road salt in runoff that flows through the wetlands.

All other inorganic results were generally consistent with background values. Three wells (800191R, 800201 and 800321) contained ammonia results above background. These wells are immediately adjacent to the wetland, but only Well 800201 is near the waste mound. The source of the ammonia may be related to decomposing vegetation in the wetland.

6.5.2.3. Metals

Metals results were obtained for both filtered (each quarter) and unfiltered samples (once per year). Some samples were collected using balers and others with the low flow sampling technique. Filtered results are compared with background concentrations and unfiltered results are compared with the GQS. Filtered samples contained many values above background for soluble iron and soluble manganese. These results may be related to the proximity of the wetland west of the wells, as discussed in the previous section. No other filtered metal results were elevated during 2007.

Unfiltered sample results included a larger number of detectable levels of several metals; however, only a few were above the GQS. The most common exceedances were iron and manganese. In addition to iron and manganese, there was one instance of elevated lead. The elevated lead result occurred in a sample with high levels of iron and manganese as well. The highest unfiltered metals results were generally found in samples collected using a bailer rather than the low flow sampler. The added turbulence caused by the bailer suspends sediment in the

well, which increases the metal results in these samples since the suspended soil particles are digested and the natural metal contained in the soil adds to the soluble metals present in solution. Thus, the presence of elevated metals levels in groundwater is likely to be a function of the sampling method and is probably not an indication of contaminants migrating from the landfill.

6.5.2.4. Organics

Groundwater samples are measured each quarter for VOCs and annually for the set of SVOCs and PCBs and pesticides listed in the permit. Consistent with previous years, none of the samples contained any measurable organic constituents in 2007. These results are not shown in the data tables to simplify the tables.

6.5.2.5. Unfiltered Miscellaneous Constituents

These parameters include cyanide, phenols (total recoverable), TOC, and TOX and are measured each quarter. The results are compared with background levels. Except for TOC, all values were consistent with background concentrations. During 2007, elevated TOC results were found in 8 of 14 wells sampled. Only one well had a result significantly higher than the background concentration of 2.7 mg/L. This well, 800201, is immediately adjacent to the landfill mound as well as the wetland. The elevated TOC content in this well could be related to organic materials leaching from the waste or naturally occurring organics coming from the wetland soil. This well also contained the highest concentration of ammonia.

6.5.2.6. Radioactive Constituents

Samples collected from the 800 Area Landfill monitoring wells were also analyzed for hydrogen-3. Although the disposal of radioactive materials was prohibited in the sanitary landfill, concentrations of hydrogen-3 were detected during the RFI. Hydrogen-3 was found above the 100 pCi/L detection limit consistently only in Wells 800191R and 800281. It was found one quarter only in five other wells, in most cases very near the analytical detection limit of 100 pCi/L. All results were well below the GQS of 20,000 pCi/L.

6.5.3. Discussion of Results — Bedrock Monitoring Wells

The monitoring wells installed in the dolomite bedrock are situated in the uppermost region of the bedrock, the layer in contact with the glacial drift above. It is a zone containing many cracks, fissures, and solution cavities. Groundwater flow in this formation moves generally to the southeast. Because of the different mineral structure of this formation, the geochemistry is significantly different from the shallow wells, which is reflected in the different values for background levels of the various constituents.

6.5.3.1 Field Parameters

Except for specific conductivity, which is discussed in the next section, all of the field parameters were consistent with the background values.

6.5.3.2 Filtered Inorganic Constituents

The amount of dissolved matter in all of the five dolomite wells was higher than background levels, as evidenced by elevated TDS, conductivity, and chloride values. All but one chloride result in the five wells was greater than background. In fact, three of the four chloride results in the background well, 800273D, were above the established background values in 2007. Only one well had consistently elevated sulfate levels. Ammonia was found to be higher than background in one or more samples from two of the five wells, with the highest value being 2.0 mg/L, compared with a background value of 1.0 mg/L. All of these constituents are naturally occurring materials and are not considered a hazard at the concentrations found. While some constituents such as TDS, chloride, and sulfate could originate in the landfill leachate, it is likely that the elevated levels detected reflect natural variation in the soil composition around and above the monitoring wells, or the presence of road salt, rather than past releases of materials from the landfill.

6.5.3.3 Metals

The only metals detected consistently above background levels in filtered samples were iron and manganese. Because of the difference in geochemistry between the two aquifers sampled, the background levels of these two metals vary considerably. Iron is much higher in the dolomite, with a background value of 1.6 mg/L compared with 0.099 mg/L in the shallow well. Manganese, on the other hand, is lower in the dolomite, with a background value of 0.021 mg/L compared with 0.097 mg/L in the shallow well. Two of the five dolomite wells had elevated iron concentrations. Three wells were consistently elevated in manganese, with the highest concentration being 0.064 mg/L. One of the four samples from the background well and two samples from one downgradient well exceeded the calculated background level for arsenic, which illustrates the natural variability in metals composition of groundwater samples.

Unfiltered metals samples were analyzed once per year for each well. None of the unfiltered metal results exceeded any of the GQSs.

6.5.3.4 Unfiltered Miscellaneous Constituents

The exceedance of groundwater quality criteria for these parameters was limited to chloride, which was elevated in three samples, and TOC and TOX in two wells. Fluoride was detected in all of the wells, but all results were well below the criterion of 4.0 mg/L. No cyanide, phenol or nitrate was detected. TOC and TOX were elevated in one or two of the four samples

from two different wells, the remainder of the samples from these wells were consistent with background values.

6.5.3.5 Organics

As with the shallow wells, no organic constituents were found above the analytical detection limits.

6.5.3.6 Radioactive Constituents

All samples were at or below the hydrogen-3 analytical detection limit of 100 pCi/L.

6.5.4. Summary of 800 Area Groundwater Monitoring Results

While a number of the constituents monitored in the wells exceeded their respective background values or the GQS, these constituents were naturally occurring materials present in the soil and groundwater. The elevated concentrations are likely the result of sampling activity disturbing sediment or natural variation in geochemistry in the highly heterogeneous soil underlying the landfill. The use of road salt in the 800 Area and nearby roads could also contribute to some exceedances. None of the contaminants detected in the landfill waste and leachate have ever been found in the groundwater, thus there is no indication that the landfill is releasing hazardous materials into the environment.

6.6. CP-5 Reactor Area

In addition to the required sampling of former waste sites, Argonne is voluntarily monitoring the condition of groundwater beneath the former CP-5 reactor. The CP-5 reactor was a 5-MW research reactor that was used from 1954 until operations ceased in 1979. In addition to the reactor vessel inside its containment dome, the CP-5 complex contained several cooling towers and an outdoor equipment yard for storing equipment and supplies. The reactor and associated yard area have been decommissioned by removal of the reactor and internal components and removal of material from the yard. The yard area surrounding the CP-5 reactor structure was classified as a SWMU and was, therefore, investigated for chemically hazardous groundwater releases under the RCRA Part B permit. The investigation and corrective actions were completed in 2002, and the IEPA issued a notice of NFA in 2003. Radioactive contamination in the yard was cleaned up in 2001 under DOE supervision.

Groundwater under and adjacent to the reactor complex has been monitored through a series of groundwater monitoring wells installed in stages beginning in 1989. Figure 6.20 shows the current monitoring well network. Table 6.49 provides information on the current set of wells. The first exploratory monitoring well (330011) was installed in 1989 behind the reactor building,

just outside the reactor fuel storage area of the complex. Additional wells were added from 1992 through 2001 to support the various characterization studies. Argonne expanded the monitoring well network to its current configuration in 2003 and replaced two existing shallow wells, 330021 and 330031, with new wells (330021R and 330031R) with shorter screens targeting thin saturated zones within the drift. One well, 330012D, is screened in the dolomite bedrock; the remainder are screened in the glacial drift. Because of the small size of this site and complex glacial geology, it is difficult to identify the shallow groundwater flow direction or to identify which wells are upgradient and which are downgradient. All wells are treated as downgradient wells in this discussion. The current network of wells is sampled quarterly and analyzed for soluble metals and chloride (filtered samples) and radioactive materials (cesium-137, hydrogen-3, and strontium-90). Field parameters are measured at the time samples are collected.

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 6.50 to 6.58. All radiological and inorganic analysis results are shown in these tables.

6.6.1 Field Parameters

Field parameters include such items as well and water depth, pH, specific conductivity, oxidation/reduction potential and temperature of water. These parameters are measured each quarter. Water from two wells (330081 and 330091) had elevated conductivity levels compared with the other wells. The conductivity of Well 330091 was higher than that of the other wells by a factor of 10. The high conductivity results corresponded to similarly elevated levels of chloride. Wells 330051 and 330061 also had elevated chloride concentrations that may be due to the use of road salt since these wells are situated near roadways and parking areas. The elevated conductivity and chloride levels in Wells 330081 and 330091 appear to be related to migration of chloride into the groundwater from a road salt storage facility near the wells. An old steel dome structure immediately southwest of the reactor was converted to a road salt storage area several years ago. The building is not closed, and trucks entering and leaving the yard spill salt in the yard and along nearby roadways. Well 330091 is immediately adjacent to the yard area where trucks are loaded. Well 330081 is located along the stormwater flow path from this area.

6.1.2 Filtered Metals

Seven of the nine wells sampled had at least one sample with soluble metals above analytical detection limits. In these wells, manganese, nickel, iron, and cadmium were detected in one or more samples. Beryllium was detected in only one sample. Nickel exceeded the GQS of 0.1 mg/L in Wells 330031R, 330051, and 330081. Manganese exceeded the GQS of 0.15 mg/L in Wells 330021, 330031R, and 330091. Well 330031R also had one exceedance of the GQS for iron (5 mg/L). In addition to natural variation of metals concentrations in shallow groundwater, it appears that these elevated levels may be associated with disturbance of fine silt in the well during sampling, thereby increasing the turbidity of the sample. All of the wells with elevated

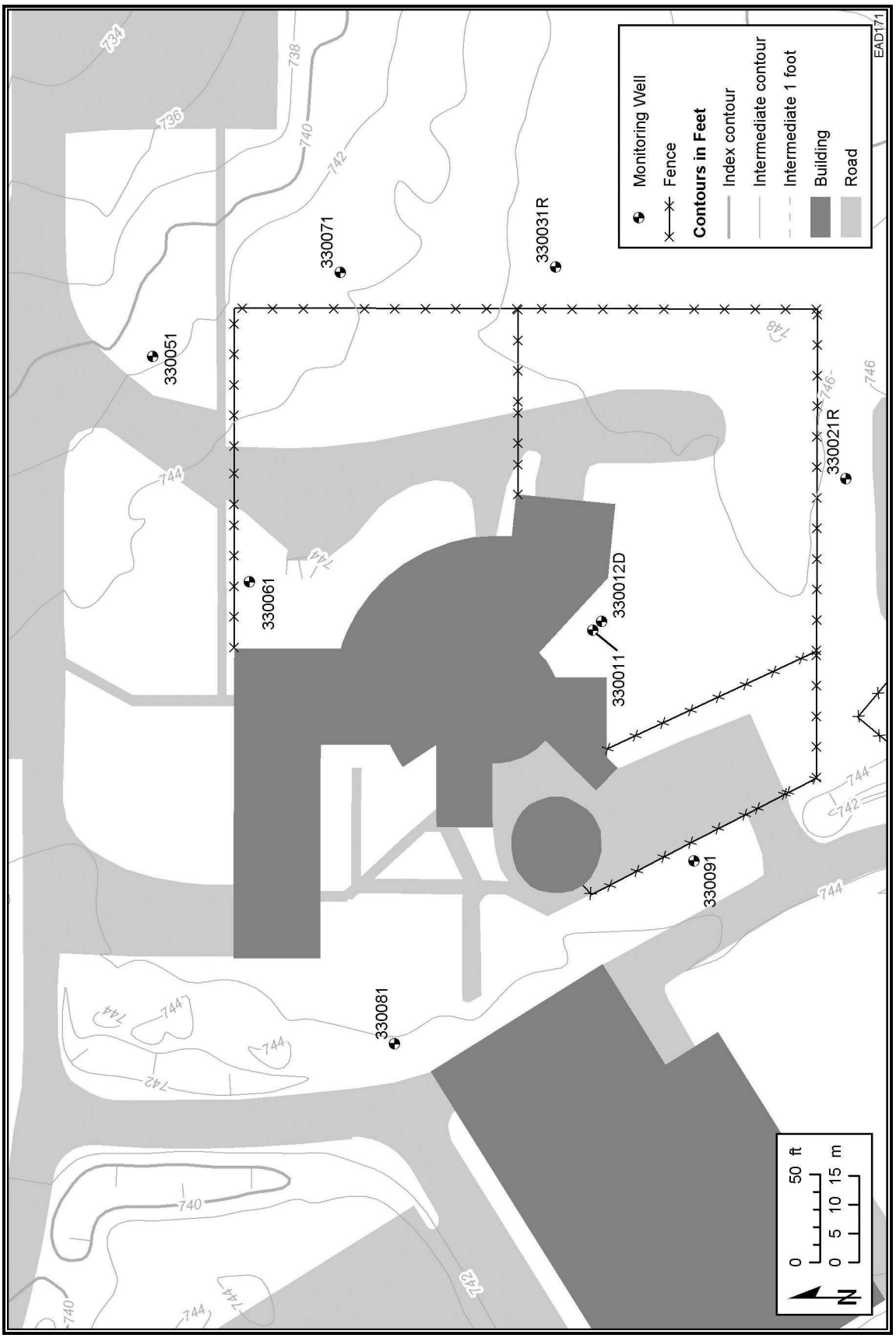


FIGURE 6.20 Monitoring Wells in the CP-5 Reactor Area

TABLE 6.49

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	227.23	224.2–221.0	0.05/PVC	8/89
330012D	41.5	227.08	191.7–185.7	0.05/SS	6/97
330021R[b]	11.9	227.04	216.6–215.2	0.05/PVC	2/03
330031R	9.8	227.65	219.4–217.9	0.05/PVC	2/03
330051	7.0	226.72	221.2–219.7	0.05/PVC	5/00
330061	9.7	227.11	218.8–217.4	0.05/PVC	2/03
330071	8.8	226.64	219.3–217.8	0.05/PVC	2/03
330081	4.5	226.60	223.5–222.0	0.05/PVC	2/03
330091	3.8	227.07	224.7–223.3	0.05/PVC	2/03

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

[b] Well not sampled in 2006 since it was dry.

metals concentrations were bailed. There are no known man-made sources of these metals near the CP-5 reactor.

6.1.3 Radioactive Constituents

Hydrogen-3 was detected during at least one quarter in all of the wells. The levels of hydrogen-3 in these wells ranged from less than 100 to 53,880 pCi/L. The only well that exceeded the GQS of 20,000 pCi/L was Well 330031R, which is a replacement well for 300031. Strontium-90 was detected during most quarters in four of the wells, with the highest value being 0.64 pCi/L in Well 33012D. All of the results are well below the GQS of 8 pCi/L. No cesium-137, or other gamma-ray-emitting radionuclides were detected above the detection limit of 2 pCi/L.

The CP-5 reactor was a heavy-water-moderated reactor. The normal operation of the reactor systems released water vapor containing hydrogen-3 from the main ventilation system. Over the years of operation, condensed water vapor, containing trace mounts of hydrogern-3, fell to the ground with precipitation, resulting in low levels of hydrogen-3 in the shallow groundwater. In addition, during its operational life, several incidents occurred that released small amounts of heavy water containing high concentrations of hydrogen-3 to the environment. In two separate incidents, one in 1964 and a second in 1971, the cooling system for the reactor failed, releasing water with hydrogen-3 into the cooling tower. Overspray, spills, and sewer disposal of this contaminated water appear to have released small amounts of hydrogen-3 to the subsurface. These activities are believed to be responsible for the low levels of hydrogen-3 that have been found in the groundwater for a number of years. The hydrogen-3 levels near the reactor (Well 330011) have been decreasing since monitoring began in 1990 due to radioactive

TABLE 6.50

Groundwater Monitoring Results, 300 Area Well 330011, 2007

Parameter	Unit	Date of Sampling			
		2/28/2007	6/5/2007	8/14/2007	11/5/2007
Field Parameters					
Water elevation[a]	m	225.85	225.50	225.29	225.15
Temperature	ºC	10.8	12.7	15.6	15.5
pH	pH	7.02	7.03	6.94	6.94
Redox	mV	-9	-1	12	4
Conductivity	µS/cm	995	939	638	645
Filtered Samples					
Chloride	mg/L	28	46	23	26
Arsenic	mg/L	< 0.025	< 0.025	< 0.025	< 0.025
Barium	mg/L	< 0.5	< 0.5	< 0.5	< 0.5
Beryllium	mg/L	< 0.0025	< 0.0025	< 0.0025	< 0.0025
Cadmium	mg/L	< 0.0025	< 0.0025	< 0.0025	< 0.0025
Chromium	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Cobalt	mg/L	< 0.25	< 0.25	< 0.25	< 0.25
Copper	mg/L	< 0.025	< 0.025	< 0.025	< 0.025
Iron	mg/L	< 0.5	< 0.5	< 0.5	< 0.5
Lead	mg/L	< 0.004	< 0.004	< 0.004	< 0.004
Manganese	mg/L	< 0.075	< 0.075	< 0.075	< 0.075
Mercury	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Nickel	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Silver	mg/L	< 0.0025	< 0.0025	< 0.0025	< 0.0025
Thallium	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium	mg/L	< 0.075	< 0.075	< 0.075	< 0.075
Zinc	mg/L	< 0.5	< 0.5	< 0.5	< 0.5
Radioactive Materials					
Cesium-137	pCi/L	< 2.0	< 2.0	< 2.0	< 2.0
Hydrogen-3	pCi/L	721	1069	549	555
Strontium-90	pCi/L	0.50	0.56	0.39	0.37

[a] Well point elevation = 220.98 m (MSL); ground surface elevation = 227.23 m (MSL); casing material = stainless steel.

TABLE 6.51

Groundwater Monitoring Results, 300 Area Well 330012D, 2007

Parameter	Unit	Date of Sampling			
		2/28/2007	6/5/2007	8/14/2007	11/5/2007
Field Parameters					
Water elevation[a]	m	191.57	191.80	191.61	191.59
Temperature	ºC	12.7	14.4	14.0	12.0
pH	pH	7.02	7.04	7.02	7.03
Redox	mV	-8	-2	8	-2
Conductivity	µS/cm	996	942	757	746
Filtered Samples					
Chloride	mg/L	18	27	151	40
Arsenic	mg/L	< 0.025	< 0.025	< 0.025	< 0.025
Barium	mg/L	< 0.5	< 0.5	< 0.5	< 0.5
Beryllium	mg/L	< 0.0025	< 0.0025	< 0.0025	< 0.0025
Cadmium	mg/L	< 0.0025	< 0.0025	< 0.0025	< 0.0025
Chromium	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Cobalt	mg/L	< 0.25	< 0.25	< 0.25	< 0.25
Copper	mg/L	< 0.025	< 0.025	< 0.025	< 0.025
Iron	mg/L	< 0.5	< 0.5	< 0.5	< 0.5
Lead	mg/L	< 0.004	< 0.004	< 0.004	< 0.004
Manganese	mg/L	< 0.075	< 0.075	< 0.075	< 0.075
Mercury	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Nickel	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Silver	mg/L	< 0.0025	< 0.0025	< 0.0025	< 0.0025
Thallium	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium	mg/L	< 0.075	< 0.075	< 0.075	< 0.075
Zinc	mg/L	< 0.5	< 0.5	< 0.5	< 0.5
Radioactive Materials					
Cesium-137	pCi/L	< 2.0	< 2.0	< 2.0	< 2.0
Hydrogen-3	pCi/L	227	< 100	200	279
Strontium-90	pCi/L	0.64	0.44	0.41	0.36

[a] Well point elevation = 185.50 m (MSL); ground surface elevation = 227.08 m (MSL); casing material = stainless steel.

TABLE 6.52

Groundwater Monitoring Results, 300 Area Well 330021, 2007

Parameter	Unit	Date of Sampling			
		2/26/2007	6/5/2007	8/16/2007	November
Field Parameters					
Water elevation[a]	m	216.13	216.65	215.78	Dry
Temperature	ºC	10.8	12.2	14.0	Dry
pH	pH	6.92	6.81	6.78	Dry
Redox	mV	2	11	22	Dry
Conductivity	µS/cm	2,240	2,090	1,763	Dry
Filtered Samples					
Chloride	mg/L	**306**[b]	**310**	**270**	Dry
Arsenic	mg/L	< 0.025	< 0.025	< 0.025	Dry
Barium	mg/L	< 0.5	< 0.5	< 0.5	Dry
Beryllium	mg/L	< 0.0025	< 0.0025	< 0.0025	Dry
Cadmium	mg/L	< 0.0025	< 0.0025	< 0.0025	Dry
Chromium	mg/L	< 0.05	< 0.05	< 0.05	Dry
Cobalt	mg/L	< 0.25	< 0.25	< 0.25	Dry
Copper	mg/L	< 0.025	< 0.025	< 0.025	Dry
Iron	mg/L	< 0.5	< 0.5	< 0.5	Dry
Lead	mg/L	< 0.004	< 0.004	< 0.004	Dry
Manganese	mg/L	**0.30**	**0.29**	**0.28**	Dry
Mercury	mg/L	< 0.0002	< 0.0002	< 0.0002	Dry
Nickel	mg/L	< 0.05	< 0.05	< 0.05	Dry
Silver	mg/L	< 0.0025	< 0.0025	< 0.0025	Dry
Thallium	mg/L	< 0.002	< 0.002	< 0.002	Dry
Vanadium	mg/L	< 0.075	< 0.075	< 0.075	Dry
Zinc	mg/L	< 0.5	< 0.5	< 0.5	Dry
Radioactive Materials					
Cesium-137	pCi/L	< 2.0	< 2.0	< 2.0	Dry
Hydrogen-3	pCi/L	304	300	227	Dry
Strontium-90	pCi/L	< 0.25	< 0.25	< 0.25	Dry

[a] Well point elevation = 221.65 m (MSL); ground surface elevation = 227.54 m (MSL); casing material = stainless steel.

[b] Bold type indicates that the value exceeds the applicable limits shown in Table 6.27.

TABLE 6.53

Groundwater Monitoring Results, 300 Area Well 330031R, 2007

Parameter	Unit	Date of Sampling			
		2/28/2007	6/6/2007	8/15/2007	11/6/2007
Field Parameters					
Water elevation[a]	m	223.24	223.07	218.08	221.21
Temperature	ºC	11.5	12.0	27.8	10.6
pH	pH	6.94	6.96	7.09	6.89
Redox	mV	-5	2	3	6
Conductivity	µS/cm	2,040	1,620	1,091	1,010
Filtered Samples					
Chloride	mg/L	**311[b]**	**247**	171	NA[c]
Arsenic	mg/L	< 0.025	< 0.025	< 0.025	< 0.025
Barium	mg/L	< 0.5	< 0.5	< 0.5	< 0.5
Beryllium	mg/L	< 0.0025	< 0.0025	< 0.0025	< 0.0025
Cadmium	mg/L	< 0.0025	< 0.0025	< 0.0025	< 0.0025
Chromium	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Cobalt	mg/L	< 0.25	< 0.25	< 0.25	< 0.25
Copper	mg/L	< 0.025	< 0.025	< 0.025	< 0.025
Iron	mg/L	0.87	0.88	< 0.5	**7.4**
Lead	mg/L	< 0.004	< 0.004	< 0.004	< 0.004
Manganese	mg/L	0.11	0.10	< 0.075	**0.34**
Mercury	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Nickel	mg/L	**0.38**	**0.46**	< 0.05	**0.17**
Silver	mg/L	< 0.0025	< 0.0025	< 0.0025	< 0.0025
Thallium	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium	mg/L	< 0.075	< 0.075	< 0.075	< 0.075
Zinc	mg/L	< 0.5	< 0.5	< 0.5	< 0.5
Radioactive Materials					
Cesium-137	pCi/L	<2.0	<2.0	<2.0	NA
Hydrogen-3	pCi/L	**41,400**	**40,090**	**49,320**	**52,880**
Strontium-90	pCi/L	< 0.25	< 0.25	< 0.25	NA

[a] Well point elevation = 217.89 m (MSL); ground surface elevation = 227.65 m (MSL); casing material = stainless steel.

[b] Bold type indicates that the value exceeds the applicable limits shown in Table 6.27.

[c] NA means the data for this sample are not available due to low water volume in the well.

TABLE 6.54

Groundwater Monitoring Results, 300 Area Well 330051, 2007

Parameter	Unit	Date of Sampling				
		2/28/2007	6/6/2007	8/16/2007	8/16/2007 (Duplicate)	11/6/2007
Field Parameters						
Water elevation[a]	m	222.67	222.64	222.55	222.55	221.94
Temperature	ºC	12.0	13.3	13.9	13.9	13.1
pH	pH	6.95	6.96	7.00	7.00	6.95
Redox	mV	-4	2	9	9	5
Conductivity	µS/cm	2,370	2,250	1,770	1,770	1,739
Filtered Samples						
Chloride	mg/L	**607[b]**	**697**	**583**	**567**	**731**
Arsenic	mg/L	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025
Barium	mg/L	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Beryllium	mg/L	< 0.0025	< 0.0025	< 0.0025	< 0.0025	< 0.0025
Cadmium	mg/L	< 0.0025	< 0.0025	< 0.0025	< 0.0025	< 0.0025
Chromium	mg/L	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Cobalt	mg/L	< 0.25	< 0.25	< 0.25	< 0.25	< 0.25
Copper	mg/L	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025
Iron	mg/L	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Lead	mg/L	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004
Manganese	mg/L	0.081	0.10	0.12	0.081	0.14
Mercury	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Nickel	mg/L	0.074	**0.15**	0.061	< 0.05	0.099
Silver	mg/L	< 0.0025	< 0.0025	< 0.0025	< 0.0025	< 0.0025
Thallium	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium	mg/L	< 0.075	< 0.075	< 0.075	< 0.075	< 0.075
Zinc	mg/L	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Radioactive Materials						
Cesium-137	pCi/L	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Hydrogen-3	pCi/L	203	219	213	284	241
Strontium-90	pCi/L	< 0.25	< 0.25	< 0.25	< 0.25	< 0.25

[a] Well point elevation = 219.71 m (MSL); ground surface elevation = 226.72 m (MSL); casing material = PVC.

[b] Bold type indicates that the value exceeds the applicable limits shown in Table 6.27.

TABLE 6.55

Groundwater Monitoring Results, 300 Area Well 330061, 2007

Parameter	Unit	Date of Sampling				
		3/1/2007	6/6/2007	8/15/2007	11/6/2007	11/6/2007
Field Parameters						
Water elevation[a]	m	221.30	221.46	221.22	220.93	220.93
Temperature	ºC	13.8	15.0	14.5	13.8	13.8
pH	pH	6.79	6.71	6.79	6.67	6.67
Redox	mV	4	15	21	18	18
Conductivity	µS/cm	2,710	2,690	2,420	2,260	2,260
Filtered Samples						
Chloride	mg/L	**774[b]**	**828**	**825**	**1,068**	**1,048**
Arsenic	mg/L	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025
Barium	mg/L	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Beryllium	mg/L	< 0.0025	< 0.0025	< 0.0025	< 0.0025	< 0.0025
Cadmium	mg/L	0.0028	< 0.0025	< 0.0025	< 0.0025	< 0.0025
Chromium	mg/L	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Cobalt	mg/L	< 0.25	< 0.25	< 0.25	< 0.25	< 0.25
Copper	mg/L	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025
Iron	mg/L	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Lead	mg/L	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004
Manganese	mg/L	0.13	0.092	0.13	0.11	0.11
Mercury	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Nickel	mg/L	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Silver	mg/L	< 0.0025	< 0.0025	< 0.0025	< 0.0025	< 0.0025
Thallium	mg/L	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium	mg/L	< 0.075	< 0.075	< 0.075	< 0.075	< 0.075
Zinc	mg/L	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Radioactive Materials						
Cesium-137	pCi/L	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Hydrogen-3	pCi/L	994	1049	1081	1022	1058
Strontium-90	pCi/L	< 0.25	< 0.25	< 0.25	< 0.25	< 0.25

[a] Well point elevation = 217.28 m (MSL); ground surface elevation = 227.11 m (MSL); casing material = PVC.

[b] Bold type indicates that the value exceeds the applicable limits shown in Table 6.27.

TABLE 6.56

Groundwater Monitoring Results, 300 Area Well 330071, 2007

Parameter	Unit	Date of Sampling			
		2/27/2007	6/5/2007	8/15/2007	11/6/2007
Field Parameters					
Water elevation[a]	m	222.80	222.53	221.49	221.00
Temperature	ºC	10.0	11.5	14.3	11.3
pH	pH	7.01	7.08	7.03	6.92
Redox	mV	-9	-3	6	5
Conductivity	µS/cm	992	937	716	694
Filtered Samples					
Chloride	mg/L	10	12	14	37
Arsenic	mg/L	< 0.025	< 0.025	< 0.025	< 0.025
Barium	mg/L	< 0.5	< 0.5	< 0.5	< 0.5
Beryllium	mg/L	< 0.0025	< 0.0025	< 0.0025	< 0.0025
Cadmium	mg/L	< 0.0025	< 0.0025	< 0.0025	< 0.0025
Chromium	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Cobalt	mg/L	< 0.25	< 0.25	< 0.25	< 0.25
Copper	mg/L	< 0.025	< 0.025	< 0.025	< 0.025
Iron	mg/L	< 0.5	< 0.5	< 0.5	< 0.5
Lead	mg/L	< 0.004	< 0.004	< 0.004	< 0.004
Manganese	mg/L	< 0.075	< 0.075	< 0.075	< 0.075
Mercury	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Nickel	mg/L	< 0.05	< 0.05	< 0.05	0.067
Silver	mg/L	< 0.0025	< 0.0025	< 0.0025	< 0.0025
Thallium	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium	mg/L	< 0.075	< 0.075	< 0.075	< 0.075
Zinc	mg/L	< 0.5	< 0.5	< 0.5	< 0.5
Radioactive Materials					
Cesium-137	pCi/L	< 2.0	< 2.0	< 2.0	< 2.0
Hydrogen-3	pCi/L	404	505	442	500
Strontium-90	pCi/L	< 0.25	< 0.25	< 0.25	< 0.25

[a] Well point elevation = 217.80 m (MSL); ground surface elevation = 226.64 m (MSL); casing material = PVC.

TABLE 6.57

Groundwater Monitoring Results, 300 Area Well 330081, 2007

Parameter	Unit	Date of Sampling			
		2/26/2007	6/6/2007	8/16/2007	11/6/2007
Field Parameters					
Water elevation[a]	m	224.35	224.10	224.20	224.03
Temperature	ºC	10.4	13.0	17.3	16.5
pH	pH	7.13	7.04	7.12	7.08
Redox	mV	-10	-1	2	-3
Conductivity	µS/cm	4,650	4,940	2,950	2,680
Filtered Samples					
Chloride	mg/L	**1,662[b]**	**1,873**	**1,091**	**1,169**
Arsenic	mg/L	< 0.025	< 0.025	< 0.025	< 0.025
Barium	mg/L	< 0.5	< 0.5	< 0.5	< 0.5
Beryllium	mg/L	< 0.0025	< 0.0025	< 0.0025	< 0.0025
Cadmium	mg/L	< 0.0025	< 0.0025	< 0.0025	< 0.0025
Chromium	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Cobalt	mg/L	< 0.25	< 0.25	< 0.25	< 0.25
Copper	mg/L	< 0.025	< 0.025	< 0.025	< 0.025
Iron	mg/L	< 0.5	< 0.5	< 0.5	< 0.5
Lead	mg/L	< 0.004	< 0.004	< 0.004	< 0.004
Manganese	mg/L	0.089	0.12	< 0.075	< 0.075
Mercury	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Nickel	mg/L	**0.18**	**0.21**	0.071	< 0.05
Silver	mg/L	< 0.0025	< 0.0025	< 0.0025	< 0.0025
Thallium	mg/L	< 0.002	< 0.002	< 0.002	< 0.002
Vanadium	mg/L	< 0.075	< 0.075	< 0.075	< 0.075
Zinc	mg/L	< 0.5	< 0.5	< 0.5	< 0.5
Radioactive Materials					
Cesium-137	pCi/L	< 2.0	< 2.0	< 2.0	< 2.0
Hydrogen-3	pCi/L	109	262	119	161
Strontium-90	pCi/L	0.52	0.49	0.28	< 0.25

[a] Well point elevation = 222.03 m (MSL); ground surface elevation = 226.60 m (MSL); casing material = PVC.

[b] Bold type indicates that the value exceeds the applicable limits shown in Table 6.27.

TABLE 6.58

Groundwater Monitoring Results, 300 Area Well 330091, 2007

Parameter	Unit	Date of Sampling			
		2/26/2007	6/6/2007	8/16/2007	11/6/2007
Field Parameters					
Water elevation[a]	m	225.37	224.89	224.99	224.77
Temperature	ºC	9.3	12.3	17.1	16.9
pH	pH	6.90	6.72	6.61	6.53
Redox	mV	3	17	31	28
Conductivity	µS/cm	18,780	22,300	196,100	223,00
Filtered Samples					
Chloride	mg/L	**8,302[b]**	**10,403**	**9,580**	**15,216**
Arsenic	mg/L	< 0.025	< 0.025	< 0.025	< 0.025
Barium	mg/L	< 0.5	< 0.5	< 0.5	< 0.5
Beryllium	mg/L	0.0029	< 0.0025	< 0.0025	< 0.0025
Cadmium	mg/L	0.0027	0.0046	< 0.0025	0.0038
Chromium	mg/L	< 0.05	< 0.05	< 0.05	< 0.05
Cobalt	mg/L	< 0.25	< 0.25	< 0.25	< 0.25
Copper	mg/L	< 0.025	< 0.025	< 0.025	< 0.025
Iron	mg/L	< 0.5	< 0.5	< 0.5	< 0.5
Lead	mg/L	< 0.004	0.01	< 0.004	< 0.004
Manganese	mg/L	**2.4**	**3.8**	**4.4**	**5.1**
Mercury	mg/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Nickel	mg/L	< 0.05	0.088	< 0.05	< 0.05
Silver	mg/L	< 0.0025	< 0.0025	< 0.0025	< 0.0025
Thallium	mg/L	< 0.01	< 0.01	< 0.01	< 0.004
Vanadium	mg/L	< 0.075	< 0.075	< 0.075	< 0.075
Zinc	mg/L	< 0.5	< 0.5	< 0.5	< 0.5
Radioactive Materials					
Cesium-137	pCi/L	< 2.0	< 2.0	< 2.0	< 2.0
Hydrogen-3	pCi/L	1488	1115	947	964
Strontium-90	pCi/L	0.27	0.27	0.29	0.34

[a] Well point elevation = 223.26 m (MSL); ground surface elevation = 227.07 m (MSL); casing material = PVC.

[b] Bold type indicates that the value exceeds the applicable limits shown in Table 6.27.

decay as well as dilution. Figure 6.21 shows hydrogen-3 and strontium-90 levels in Well 330011 since monitoring started. It also contains a projection of hydrogen-3 concentrations as if only radioactive decay had been occurring since 1999, assuming the initial concentration was 12,000 pCi/L. The reason for the sharp drop in hydrogen-3 between 1997 and 1999 is not known. Strontium-90 experienced a similar decline during those years.

The high levels of hydrogen-3 at Well 330031R may be the result of other factors as well as those mentioned above. Before replacement, Well 330031 had hydrogen-3 concentrations that averaged 260 pCi/L. After the replacement well was installed in February 2003, the hydrogen-3 concentrations averaged 3,330 pCi/L for the balance of 2003 — about a factor of 10 higher than the old well. The first quarter results in 2004 revealed that hydrogen-3 concentrations had increased by another factor of 10, to 43,670 pCi/L, and they have remained in the 30,000 to 50,000 pCi/L range since. These high levels have been traced back to the 1964 cooling tower incident. After this leak was stopped, the contaminated cooling water was disposed of by diluting it, in batches, with large amounts of ordinary, uncontaminated wastewater and processing the mixture through the regular wastewater disposal system. This discharge was conducted over a period of about 3 months. The contaminated cooling water was pumped to a laboratory sewer manhole near the cooling tower. The sewer line ran east to the CP-5 yard fence and then north to Bluff Road where it connected to a larger sewer and eventually flowed to the LWTP. A manhole exists at the point where the sewer line turns north. This manhole is located within 10 m (33 ft) of monitoring Well 330031R. It is theorized that a small amount of leakage from this sewer mixed with groundwater in an isolated porous region of soil near the sewer, thereby creating a pocket of relatively high levels of hydrogen-3. The hydrogen-3 appears to have remained isolated at this location since 1964. Apparently replacement Well 330031R happened to penetrate this isolated zone. An investigation performed in 2006 confirmed that the hydrogen-3 is isolated in this small porous zone and there is little migration of groundwater away from the reactor.

6.7. Groundwater Monitoring Program Summary

This chapter summarizes the information on groundwater monitoring results from various voluntary and permit-required monitoring programs. Compiling and analyzing these results supports the Argonne groundwater management strategy. The groundwater monitoring strategy focuses monitoring resources on those areas that have the potential to impact groundwater. Analytical results generated demonstrate the degree of compliance with applicable groundwater standards and limits and identify the need for groundwater remediation. Overall, groundwater quality at Argonne is good, with significant contamination present at only one location, the 317/319 Area on the extreme southern end of the site where concentrations of VOCs and hydrogen-3 in groundwater are above applicable standards. Some of this groundwater comes to the surface in several small groundwater seeps in an isolated part of the Waterfall Glen Forest Preserve. Several active remedial actions are underway in this area to reduce contaminant levels. Groundwater under the 800 Area Landfill exhibits elevated levels of a number of naturally occurring metals and inorganic constituents; however, they are probably not related to landfill operations. Elevated levels of hydrogen-3 have been found in one well adjacent to the CP-5 reactor; however, hydrogeological studies have determined that this water is not migrating away

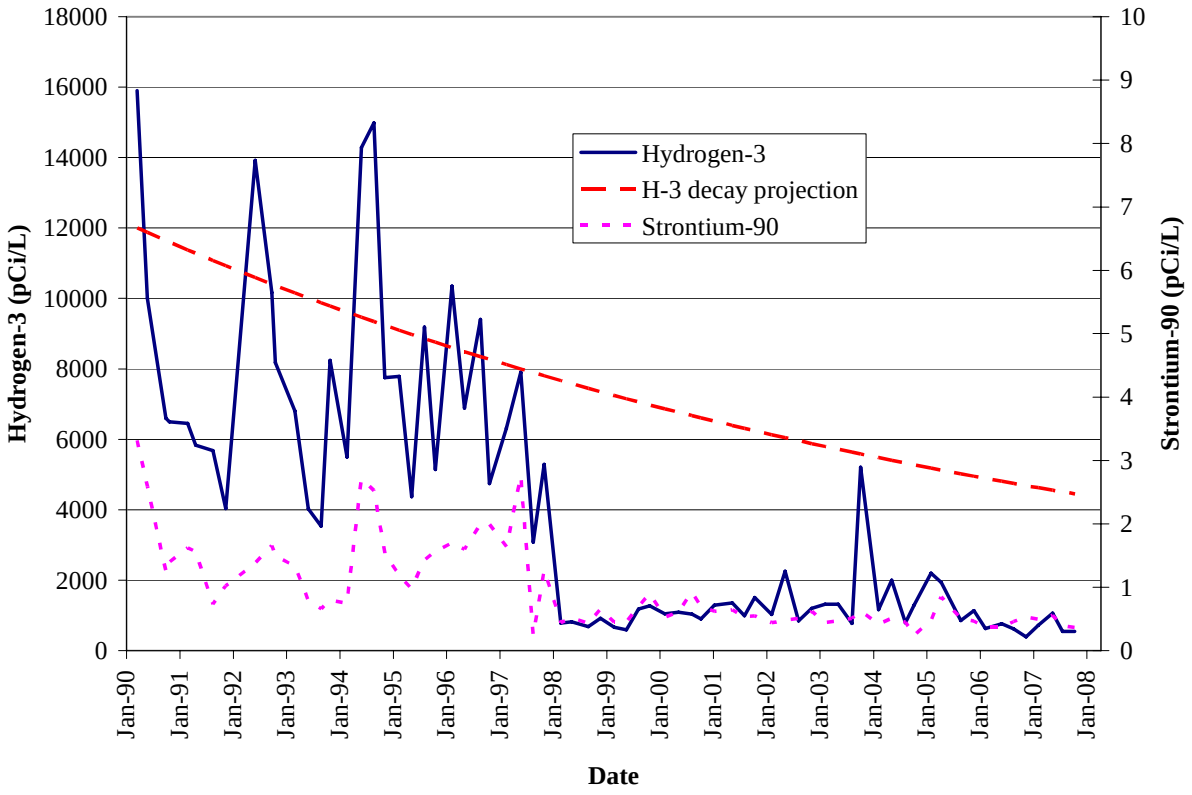


FIGURE 6.21 Hydrogen-3 and Strontium-90 in Well 330011

from the reactor and does not represent a hazard. There is little evidence of contamination in the dolomite aquifer, which is the uppermost usable aquifer under the site. Two dolomite wells in the 317 Area contain contamination above applicable limits. There is no known off-site impact to groundwater in this aquifer.

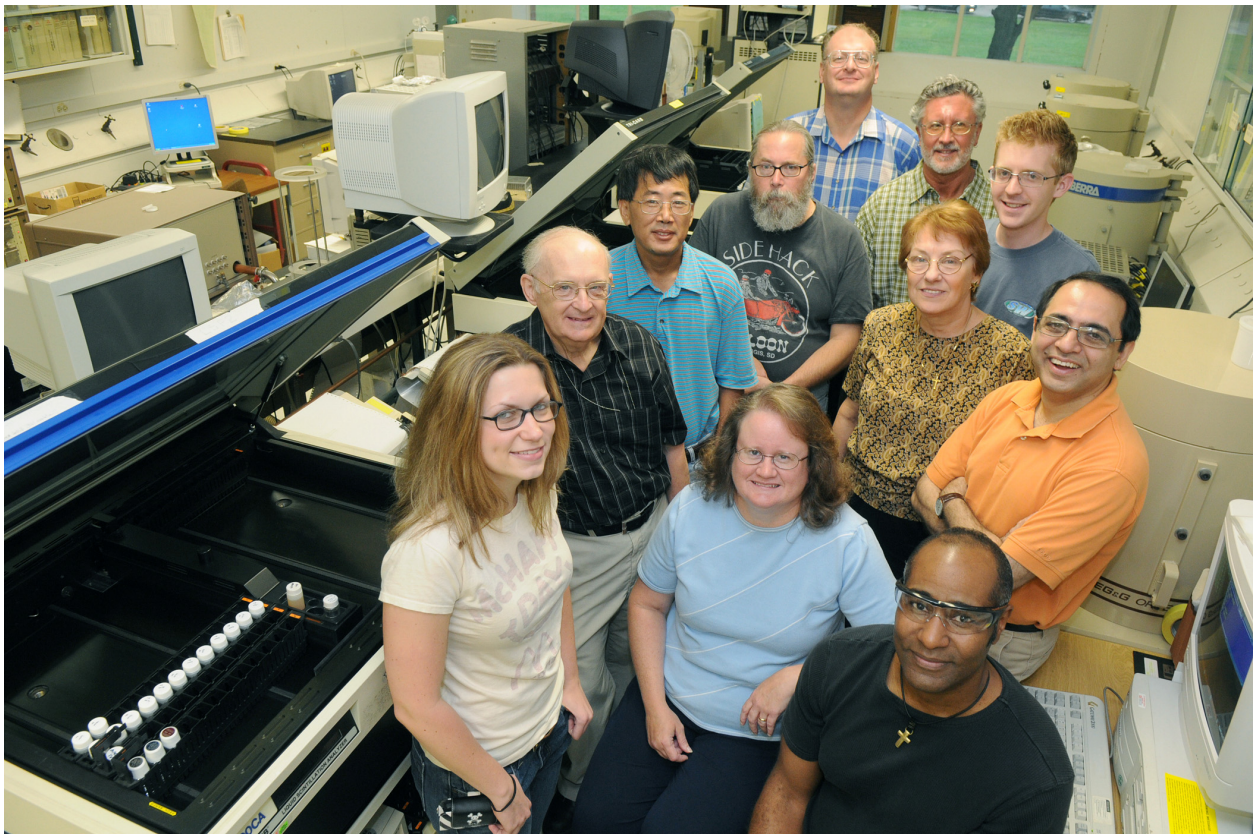
Argonne groundwater sampling activities during 2007 are summarized in Table 6.59. Because the various elements of the program are integrated into the overall monitoring schedule, some of the wells, monitoring events, and analytical results are used for multiple purposes that address different elements of the groundwater protection program. The vast majority of the analytical results were below detection limits. Only a small fraction of the detectable results represent chemical or radioactive materials above applicable groundwater quality standards. These instances are discussed in detail in other sections of this chapter.

TABLE 6.59

Summary of Groundwater Monitoring by Area, 2007

Groundwater Monitoring Element	Purpose	Number of Wells in Network	Number of Wells Sampled	Number of Sampling Events	Number of Analyses Performed	Percent of Results Nondetectable
Former water supply wells	Environmental Surveillance	4	3	12	783	95%
Dolomite wells	Environmental Surveillance	10	10	40	40	95%
317/319 Area wells and manholes	Environmental Surveillance	10	10	58	8070	98%
317/319/ENE and GMZ wells	Permit Compliance/LTS Program	111	80	184	14,646	90%
800 Area Landfill wells	Permit Compliance	21	21	105	18,480	96%
CP-5 wells	Environmental Surveillance	9	8	35	700	84%

7. QUALITY ASSURANCE



7. QUALITY ASSURANCE

Quality assurance (QA) plans and associated documents exist for both radiological and nonradiological analyses. QA documents were prepared in accordance with DOE Order 414.1C[27] and discuss who is responsible for QA and for auditing. Operating manuals have been prepared and are periodically reviewed and revised if necessary.

7.1. Sample Collection

Many factors enter into an overall QA program other than the analytical QC. 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 by using the protocols listed in the *RCRA Ground-Water Monitoring Technical Enforcement Guidance Document*.[26] 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. In a number of wells, low flow sampling equipment has been installed to minimize the turbidity created by sampling with a bailer.

Samples for parameters such as priority pollutants are collected, and field parameters for these samples (pH, specific conductivity, redox potential, and temperature) are measured per well volume while purging. For sampling 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 sample log-in information is transferred to the analytical laboratory along with a computer 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 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 2007 are given in Table 7.1.

TABLE 7.1

Air and Water Detection Limits

Parameter	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	–	0.001
Plutonium-239	–	0.001
Radium-226	–	0.02
Radium-228	–	0.02
Strontium-89	0.1	2
Strontium-90	0.01	0.25
Uranium-234	–	0.01
Uranium-235	–	0.01
Uranium-238	–	0.01
Uranium – natural	–	0.2
Alpha	0.2	0.2
Beta	0.5	1

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

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 ($\pm$) 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 $\pm$ 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 $\pm$ value accompanies an individual result in this report, it represents the statistical counting error at the 95% confidence level.

In 2007, Argonne participated in the Mixed Analyte Performance Evaluation Program (MAPEP) administered by the Radiological and Environmental Sciences Laboratory (RESL). Normally, the program consists of semiannual distribution of three different sample matrices containing combinations of radionuclides that are analyzed. However, in 2007, no samples were provided in the second half of the year. The results are provided in Table 7.2. The Argonne performance on the MAPEP intercomparison samples resulted in 100% (25 out of 25) of the analyses being in the MAPEP acceptable range.

TABLE 7.2

Summary of May MAPEP Intercomparison Samples, 2007

Parameter	Unit	Reported Value	Assigned Value	Acceptance Limits	Performance Evaluation
Air Filter					
Am-241	Bq/filter	0.099	0.098	0.068–0.127	Acceptable
Cs-134	Bq/filter	3.61	4.20	2.94–5.45	Acceptable
Cs-137	Bq/filter	2.53	2.57	1.80–3.34	Acceptable
Co-57	Bq/filter	3.46	2.89	2.02–3.75	Acceptable
Co-60	Bq/filter	3.15	2.91	2.03–3.78	Acceptable
Mn-54	Bq/filter	3.38	3.52	2.46–4.57	Acceptable
Pu-238	Bq/filter	0.064	0.067	0.047–0.087	Acceptable
Pu-239/240	Bq/filter	0.071	0.084	0.059–0.109	Acceptable
Sr-90	Bq/filter	0.58	0.61	0.42–0.79	Acceptable
U-233/234	Bq/filter	0.090	0.098	0.069–0.127	Acceptable
U-238	Bq/filter	0.094	0.102	0.071–0.133	Acceptable
Zn-65	Bq/filter	2.25	2.68	1.88–3.49	Acceptable
Water					
Am-241	Bq/L	1.59	1.71	1.20–2.22	Acceptable
Cs-134	Bq/L	70	84	58–109	Acceptable
Cs-137	Bq/L	164	163	114–212	Acceptable
Co-57	Bq/L	149	144	101–187	Acceptable
Co-60	Bq/L	28	27	19–35	Acceptable
H-3	Bq/L	287	283	198–368	Acceptable
Mn-54	Bq/L	123	124	87–161	Acceptable
Pu-238	Bq/L	1.89	2.25	1.58–2.93	Acceptable
Pu-239/240	Bq/L	1.80	2.22	1.55–2.89	Acceptable
Sr-90	Bq/L	8.20	8.87	6.21–11.5	Acceptable
U-233/234	Bq/L	2.34	2.49	1.74–3.24	Acceptable
U-238	Bq/L	2.40	2.48	1.74–3.22	Acceptable
Zn-65	Bq/L	108	115	80.4–149	Acceptable

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,[19] EPA-600/4-84-017,[28] and EPA-SW-846.[29]

Standard reference materials traceable to the NIST are utilized to ensure the accuracy of most inorganic analyses (see Table 7.3) and are replaced annually. Detection limits are determined with techniques listed in 40 CFR Part 136[19] 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 MOU 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 2007 results for VOCs and SVOCs, respectively. The recoveries listed are those required by the respective methods.

7.4. NPDES Analytical Quality Assurance

Argonne 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.[19] To demonstrate the capabilities of the Argonne laboratory for these analyses, the EPA requires that Argonne participate in the DMR-QA Program. An EPA-accredited provider sends a series of intercomparison samples to Argonne 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. Argonne has consistently performed very well on these tests. In 2007, all results were acceptable. The results of these analyses are shown in Table 7.7.

TABLE 7.3

Standard Reference Materials Used for Inorganic Analysis

Parameter	Reference Material[a]
Antimony	HP10002-2
Arsenic	HP10003-1
Barium	HP10004-1
Beryllium	HP10005-1
Boron	HP-10007-1
Cadmium	HP-10008-1
Chromium	HP100012-1
Cobalt	HP100013-1
Copper	HP100014-1
Iron	HP100026-1
Lead	HP100028-1
Manganese	HP100032-1
Mercury	N9300253
Nickel	HP100036-1
Selenium	HP100049-1
Silver	HP100051-1
Thallium	HP100058-1
Vanadium	HP100065-1
Zinc	HP100068-1
Sulfate	8110-32
Chloride	AS-CL9-2Y
Fluoride	AS-F9-1Y
Phosphorous	HACH 14204-16

[a] AS = SPEX CertiPrep; HACH = Hach Company; HP = High Purity; N = Perkin Elmer; and sulfate is from Ricca Chemical Company.

TABLE 7.4

Detection Limit for Metals Analysis, 2007

	Detection Limit (mg/L)	
Parameter	AA[a]	ICP[b]
Antimony	0.0030	NA[c]
Arsenic	0.0030	0.025
Barium	NA	0.012
Beryllium	0.0025	0.0025
Boron	NA	0.10
Cadmium	0.0025	0.0025
Chromium	0.015	0.05
Cobalt	NA	0.25
Copper	0.010	0.025
Hexavalent chromium[d]	0.011	NA
Iron	0.040	0.021
Lead	0.0040	0.09
Manganese	0.015	0.010
Mercury	0.0002	NA
Nickel	0.030	0.05
Selenium	0.010	0.121
Silver	0.0025	0.0025
Thallium	0.0020	0.082
Vanadium	NA	0.075
Zinc	0.010	0.02

[a] AA = atomic absorption spectroscopy.

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

[c] NA = not analyzed.

[d] Colorimetric measurement.

TABLE 7.5

Quality Check Sample Results: Volatile Analyses, 2007

Parameter	Recovery[a] (%)	Quality Limit (%)
Benzene	104	73–126
Bromobenzene	99	76–133
Bromodichloromethane	111	50–140
Bromoform	84	57–156
Butylbenzene	100	71–125
sec-Butylbenzene	105	71–145
t-Butylbenzene	106	69–134
Carbon tetrachloride	99	86–118
Chlorobenzene	103	80–137
Chloroform	100	68–120
o-Chlorotoluene	101	81–146
p-Chlorotoluene	98	73–144
1,2-Dibromo-3-chloropropane	94	36–154
Dibromochloromethane	95	68–130
1,2-Dibromoethane	112	75–149
Dibromomethane	112	65–143
1,2-Dichlorobenzene	99	59–174
1,3-Dichlorobenzene	97	84–143
1,4-Dichlorobenzene	96	58–172
1,1-Dichloroethane	106	71–142
1,2-Dichloroethane	123	70–134
1,1-Dichloroethene	119	18–209
cis-1,2-Dichloroethene	109	85–124
trans-1,2-Dichloroethene	115	67–141
1,2-Dichloropropane	123	19–179
1,3-Dichloropropane	122	73–145
1,1-Dichloropropene	101	71–133
Ethyl benzene	104	84–130
Isopropylbenzene	107	70–144
4-Isopropyltoluene	99	72–140
Methylene chloride	117	D–197[b]
n-Propylbenzene	106	78–139
1,1,1,2-Tetrachloroethane	108	88–133
Tetrachloroethene	102	84–132
Toluene	102	81–130
1,1,1-Trichloroethane	116	68–149
1,1,2-Trichloroethane	113	70–133
Trichloroethene	100	91–135
1,2,3-Trichloropropane	111	50–158
1,2,4-Trimethylbenzene	109	80–144
1,3,5-Trimethylbenzene	109	76–142
o-Xylene	108	79–141
p-Xylene	101	74–138

[a] Average of two determinations.

[b] D denotes that the compound was detected.

TABLE 7.6

Quality Check Sample Results:
Semivolatile Analyses, 2007

Parameter	Recovery[a] (%)	Quality Limit (%)
2-Fluorophenol[b]	34.9	21–100
Phenol-d5[b]	24.2	10–94
Phenol	24.8	17–100
2-Chlorophenol	54.1	36–120
1,3-Dichlorobenzene	52.3	33–95
1,4-Dichlorobenzene	51.2	37–106
n-Nitroso-n-propylamine	72.8	24–198
Nitrobenzene-d5[b]	52.0	35–114
1,2,4-Trichlorobenzene	63.5	57–129
4-Chloro-3-methylphenol	42.0	41–128
2-Fluorobiphenyl[b]	66.6	43–116
2-Methylnaphthalene	111.8	45–113
Acenaphthene	64.9	47–145
2,4-Dinitrotoluene	59.6	48–127
2,4,6-Tribromophenol[b]	50.4	10–123
Pentachlorophenol	61.5	38–152
Pyrene	83.6	70–100
Terphenyl-d14[b]	68.1	33–141

[a] Average of three independent determinations.

[b] Required surrogates.

TABLE 7.7

Summary of DMR-QA Intercomparison Samples, 2007

Parameter	Unit	Reported Value	Assigned Value	Acceptance Limits	Performance Evaluation
Antimony	µg/L	342	366	252–442	Acceptable
Arsenic	µg/L	618	612	514–716	Acceptable
Barium	µg/L	410	406	352–458	Acceptable
Beryllium	µg/L	451	476	404–538	Acceptable
Boron	µg/L	994	993	819–1,160	Acceptable
Cadmium	µg/L	396	425	362–483	Acceptable
Chromium	µg/L	388	401	348–454	Acceptable
Cobalt	µg/L	554	541	475–606	Acceptable
Copper	µg/L	709	716	644–788	Acceptable
Iron	µg/L	834	833	735–942	Acceptable
Lead	µg/L	556	571	498–642	Acceptable
Manganese	µg/L	865	844	758–938	Acceptable
Mercury	µg/L	9.16	8.38	5.16–11.4	Acceptable
Nickel	µg/L	887	899	809–1,000	Acceptable
Selenium	µg/L	586	609	482–706	Acceptable
Silver	µg/L	338	345	296–395	Acceptable
Thallium	µg/L	616	644	525–768	Acceptable
Vanadium	µg/L	443	455	398–509	Acceptable
Zinc	µg/L	358	360	308–418	Acceptable
Hexavalent chromium	µg/L	398	384	311–453	Acceptable
Chloride	mg/L	58.6	55.2	46.9–64.0	Acceptable
Fluoride	mg/L	3.15	3.13	2.62–3.65	Acceptable
Sulfate	mg/L	15.0	18.6	14.4–22.4	Acceptable
Phosphorus	mg/L	3.29	3.16	2.58–3.76	Acceptable
Biochemical oxygen demand	mg/L	106.0	88.6	44.7–132	Acceptable
Chemical oxygen demand	mg/L	137	143	109–164	Acceptable
Ammonia nitrogen	mg/L	6.82	3.47	4.74–8.19	Acceptable
Total residual chlorine	mg/L	1.3	1.32	0.948–1.64	Acceptable
Total cyanide	mg/L	0.400	0.360	0.193–0.532	Acceptable
pH	S.U.	5.68	5.70	5.50–5.90	Acceptable
Total phenolics	mg/L	0.260	0.268	0.141–0.396	Acceptable
Total suspended solids	mg/L	57.3	66.8	53.6–75.1	Acceptable
Total dissolved solids	mg/L	309	310	233–387	Acceptable
Oil and grease	mg/L	64.8	67.5	45.8–80.3	Acceptable
Fathead minnow acute toxicity	LC_{50}	34.2	27.2	9.16–45.3	Acceptable
Water flea acute toxicity	LC_{50}	32.6	44.8	0.00–>100	Acceptable

8. APPENDIX

8. APPENDIX

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8. APPENDIX