PRS-ENM-0002
Volume I

PADUCAH SITE

Annual Site Environmental Report

2005

Fractions and Multiples of Units

Multiple	Decimal Equivalent	Prefix	Symbol	Engineering Format
10^{6}	1,000,000	mega-	M	E+06
10^{3}	1,000	kilo-	k	E+03
10^{2}	100	hecto-	h	E+02
10	10	deka-	da	E+01
10^{-1}	0.1	deci-	d	E-01
10^{-2}	0.01	centi-	c	E-02
10^{-3}	0.001	milli-	m	E-03
10^{-6}	0.000001	micro-	µ	E-06
10^{-9}	0.000000001	nano-	n	E-09
10^{-12}	0.000000000001	pico-	p	E-12
10^{-15}	0.000000000000001	femto-	f	E-15
10^{-18}	0.000000000000000001	atto-	a	E-18

This report is intended to fulfill the requirements of U. S. Department of Energy (DOE) Order 231.1 Change 2. The data and information contained in this report were collected in accordance with the Paducah Site Environmental Monitoring Plan (BJC 2003a) approved by DOE. This report is not intended to provide the results of all sampling conducted at the Paducah Site. Additional data collected for other site purposes, such as environmental restoration, remedial investigation reports, and waste management characterization sampling, are presented in other documents that have been prepared in accordance with applicable DOE guidance and/or federal or state laws.

PRS-ENM-0002

Paducah Site

Annual Site Environmental Report for Calendar Year 2005

August 2007

Prepared for the
U.S. DEPARTMENT OF ENERGY
Office of Environmental Management

Prepared by
PADUCAH REMEDIATION SERVICES, LLC
managing the
Environmental Remediation Activities at the
Paducah Gaseous Diffusion Plant
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Contents

Figures iv
Tables v
Acronyms and Abbreviations vii
Request for Comments xi

Site Operation and Overview 1-1
Introduction 1-1
Background 1-2
Description of Site Locale 1-3
Ecological Resources 1-5
Site Program Missions 1-5

Environmental Compliance 2-1
Introduction 2-1
Compliance Activities 2-1

Environmental Program Information 3-1
Environmental Monitoring Program 3-1
Environmental Restoration Program 3-1
Waste Operations Program 3-9
Depleted Uranium Hexafluoride Cylinder Program 3-11
Decontamination and Decommissioning 3-11
DOE Material Storage Areas 3-12
Public Awareness Program 3-13

Radiological Effluent Monitoring 4-1
Introduction 4-1
Airborne Effluents 4-1
Liquid Effluents 4-3

Radiological Environmental Surveillance 5-1
Introduction 5-1
Ambient Air 5-1
Surface Water 5-3
Sediment 5-7
Terrestrial Wildlife 5-9
Direct Radiation 5-10

Dose 6-1
Introduction 6-1
Terminology and Internal Dose Factors 6-2
Authorized Limits 6-2

Direct Radiation 6-2
Surface Water 6-3
Contaminated Sediment 6-3
Ingestion of Deer 6-3
Airborne Radionuclides 6-4
Conclusions 6-5

Nonradiological Effluent Monitoring 7-1
Introduction 7-1
Airborne Effluents 7-1
Liquid Effluents 7-2

Nonradiological Environmental Surveillance 8-1
Introduction 8-1
Ambient Air 8-1
Surface Water 8-1
Sediment 8-2
Soil 8-6
Vegetation 8-6
Terrestrial Wildlife 8-6
Fish and Other Aquatic Life 8-6

Groundwater 9-1
Introduction 9-1
Groundwater Hydrology 9-3
Geologic and Hydrogeologic Setting 9-4
Uses of Groundwater in the Vicinity 9-5
Groundwater Monitoring Program 9-5
Environmental Restoration Activities 9-11
Groundwater Monitoring Results 9-14

Quality Assurance 10-1
Introduction 10-1
Field Sampling Quality Control 10-1
Analytical Laboratory Quality Control 10-2
Data Management 10-3

References R-1

Glossary G-1

Appendix A: Radiation A-1

Appendix B: Radionuclide and Chemical Nomenclature B-1

Figures

Figure **Page**

1.1 Location of the Paducah Site 1-4

3.1 Surface Water OU SI Sampling 3-7
3.2 Scrap Metal Removal Project Disposition during 2005 3-8
3.3 Legacy Waste Disposition 3-9
3.4 Legacy Waste Disposition during 2005 3-10
3.5 DUF_6 Facility Construction Activities 3-11
3.6 C-603 Tank Removal 3-12
3.7 Removal of Railcar 3-13

4.1 Loading of Scrap Metal 4-2
4.2 KPDES Outfalls and Landfill Surface Water Monitoring Locations 4-4
4.3 Uranium Concentrations Discharged to Surface Water, 2001–2005 4-6
4.4 Technetium-99 Activity Discharged to Surface Water, 2001–2005 4-7

5.1 Paducah Site Ambient Air Monitoring Stations 5-2
5.2 Surface Water Monitoring Locations 5-4
5.3 Sediment Monitoring Locations 5-8
5.4 TLD Locations in the Vicinity of PGDP 5-11

6.1 Potential Radiological Dose from DOE Activities at the Paducah Site, 2001–2005 6-6

8.1 Biological Monitoring Locations 8-8

9.1 Off-site Extent of Groundwater Plumes 9-2
9.2 Typical Path for Rainwater Accumulation as Groundwater 9-3
9.3 MW Construction Showing the Relationship between the Screened Zone and the Water Level in Wells Where Limited Flow in the Aquifer Is to the Right 9-3
9.4 Monitoring Well Locations near the Landfills 9-6
9.5 Northwest Plume Monitoring Wells 9-13
9.6 Northeast Plume Monitoring Wells 9-16

Tables

Table **Page**

2.1 2005 Environmental Permit and Compliance Agreement Summary 2-2
2.2 Federally Listed, Proposed, and Candidate Species Potentially Occurring within the Paducah Site Study Area in 2005 2-5
2.3 Summary of PCB Equipment in Service at the End of 2005 2-7

4.1 Total Uranium Concentration in DOE Outfalls for 2005 4-5
4.2 Technetium-99 Activity in DOE Outfalls for 2005 4-6

5.1 Radiological Parameters for Surface Water Samples 5-3
5.2 Average Radiological Parameter Concentrations for Surface Water Surveillance Samples 5-6
5.3 Average Radiological Concentrations for Seep Locations in Little Bayou Creek 5-6
5.4 Radiological Parameters for Sediment Samples 5-7
5.5 Average Radiological Parameter Concentrations for Sediment Surveillance Samples 5-9
5.6 Net Annual Exposure from Direct Radiation Attributed to the Paducah Site for 2005 (Mr) 5-11

6.1 Annual Dose Estimates for 2005 Incidental Ingestion of Sediment from Bayou Creek and Little Bayou Creek 6-4
6.2 Summary of Potential Radiological Dose from the Paducah Site for 2005 (Worst-Case Combined Exposure Pathways) 6-5

7.1 KPDES Permit Exceedence Summary for 2005 7-3
7.2 KPDES Permit Sampling Nonradiological Maximum Detected Analyses 7-3

8.1 Nonradiological Parameters for Surface Water Samples 8-2
8.2 Nonradiological Parameters for Surface Water Seep-Sampling Locations 8-2
8.3 Selected Routine Nonradiological Surface Water Surveillance Results (Average Concentrations) 8-3
8.4 Selected Routine Nonradiological Surface Water Seep-Sampling Surveillance Results (Average Concentrations) 8-4
8.5 Semiannual Nonradiological Parameters for Sediment Samples 8-5
8.6 Selected Routine Nonradiological Sediment Surveillance Results (Average Concentrations) 8-5
8.7 Summary of PCB Detections In Deer 2005 8-6

9.1 Summary of Maximum Groundwater Results from the RGA at C-404 Landfill 9-7
9.2 Summary of Maximum Groundwater Results for C-746-S&T Landfills 9-8
9.3 Summary of Maximum Groundwater Results at C-746-U Landfill 9-9
9.4 Summary of Maximum Groundwater Results at C-746-K Landfill 9-10
9.5 Summary of Maximum Groundwater Results from Residential Monthly Monitoring 9-11
9.6 Summary of Maximum Groundwater Results from Environmental Surveillance Monitoring 9-12
9.7 Summary of Maximum Groundwater Results from the Northwest Plume North Field Groundwater Monitoring 9-15
9.8 Summary of Maximum Groundwater Results from the Northwest Plume South Field Groundwater Monitoring 9-15
9.9 Summary of Maximum Groundwater Results from the Northeast Plume Groundwater Monitoring 9-17

Table **Page**

10.1 Types of QC Samples 10-3

Acronyms and Abbreviations

ACO	Administrative Order by Consent
AIP	Agreement in Principle
AO	Agreed Order
AOC	Area of Concern
ASER	Annual Site Environmental Report
ASTM	American Society of Testing and Materials
ATSDR	Agency for Toxic Substances and Disease Registry
BCHT	Blended Chemical Heat TreatmentTM
BJC	Bechtel Jacobs Company LLC
CAA	Clean Air Act
CAB	Paducah Citizens Advisory Board
CEDE	committed effective dose equivalent
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
Ci	Curie
COE	U.S. Army Corps of Engineers
^{137}Cs	cesium-137
CSOU	comprehensive sitewide operable unit
CWA	Clean Water Act
CX	categorical exclusion
CY	calendar year
D&D	decontamination and decommissioning
DCG	derived concentration guide
DMSA	DOE Material Storage Area
DNAPL	dense nonaqueous-phase liquid
DOD	U.S. Department of Defense
DOE	U.S. Department of Energy
DQO	data quality objective
DUF_6	depleted uranium hexafluoride
EA	environmental assessment
EDD	electronic data deliverable
EIC	DOE Environmental Information Center

EIS	environmental impact statement
EM	Environmental Management
EPA	U.S. Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
EQADMP	Environmental Services Quality Assurance and Data Management Plan
FFA	Federal Facility Agreement
FFC Act	Federal Facility Compliance Act
FFCA	Federal Facility Compliance Agreement
FS	feasibility study
ft	foot (feet)
GDP	gaseous diffusion plant
HAP	hazardous air pollutant
HSWA	Hazardous and Solid Waste Amendments
ICRP	International Commission on Radiological Protection
IRA	interim remedial action
KCHFS	Kentucky Cabinet for Health and Family Services
KDAQ	Kentucky Division for Air Quality
KDEP	Kentucky Department for Environmental Protection
KDOW	Kentucky Division of Water
KDWM	Kentucky Division of Waste Management
kg	kilogram(s)
km	kilometer(s)
KOW	Kentucky Ordnance Works
KPDES	Kentucky Pollutant Discharge Elimination System
L	liter(s)
LLW	low-level waste
LRGA	Lower Regional Gravel Aquifer
LUC	land use control
m	meter(s)
MCL	maximum contaminant level
mHBI	modified Hilsenhoff Biotic Index
µg	microgram(s)
mg	milligrams(s)
mR	milliRoentgen(s)

mrem	millirem(s)
MLLW	mixed low-level waste
mt	metric ton(s)
MW	monitoring well
NCP	National Contingency Plan
ND	not detected
NEPA	National Environmental Policy Act
NEPCS	Northeast Plume Containment System
NESHAP	National Emission Standards for Hazardous Air Pollutants
NHPA	National Historic Preservation Act
NOV	notice of violation
^{237}Np	neptunium-237
NPL	National Priorities List
NSDD	North-South Diversion Ditch
NWPGS	Northwest Plume Groundwater System
OREIS	Oak Ridge Environmental Information System
OU	operable unit
PCB	polychlorinated biphenyl
pCi	picoCurie(s)
PEMS	Project Environmental Measurement Systems
PGDP	Paducah Gaseous Diffusion Plant
pH	hydrogen-ion concentration
PHA	public health assessment
ppb	parts per billion
PPE	personal protective equipment
ppm	part per million
^{239}Pu	plutonium-239
QA	Quality Assurance
QC	Quality Control
RCRA	Resource Conservation and Recovery Act
RD/RAWP	Remedial Design/Remedial Action Work Plan
RGA	Regional Gravel Aquifer
RI	remedial investigation
ROD	Record of Decision

SDWA	Safe Drinking Water Act
SI	site investigation
SMO	Sample Management Office
SMP	Site Management Plan
SOW	statement of work
^{90}Sr	strontium-90
STP	Site Treatment Plan
SVOC	semivolatile organic compound
SWMU	solid waste management unit
^{99}Tc	technetium-99
TCE	trichloroethene
^{230}Th	thorium-230
TLD	thermoluminescent dosimeter
TRE	Toxicity Reduction Evaluation
TSCA	Toxic Substances Control Act
TU	toxicity unit
^{234}U	uranium-234
^{235}U	uranium-235
^{238}U	uranium-238
UCRS	Upper Continental Recharge System
UE	uranium enrichment
UF_4	uranium tetrafluoride
UF_6	uranium hexafluoride
URGA	Upper Regional Gravel Aquifer
USEC	United States Enrichment Corporation
UST	underground storage tank
VOC	volatile organic compound
WAG	waste area group
WKWMA	West Kentucky Wildlife Management Area
WMP	Watershed Monitoring Program
WM/PP	Waste Minimization/Pollution Prevention

Request for Comments

The U.S. Department of Energy (DOE) requires an annual site environmental report from each of the sites operating under its authority. This report presents the results from the various environmental monitoring programs and activities carried out during the year. This *Paducah Site Annual Site Environmental Report for Calendar Year 2005* was prepared to fulfill DOE requirements. This report is a public document, distributed to government regulators, businesses, special interest groups, and members of the public.

This report is based on thousands of environmental samples collected at or near the Paducah Site. Significant efforts were made to provide the data collected and details of the site environmental management programs in a clear and concise manner. The editors of this report encourage comments in order to better address the needs of our readers in future site environmental reports. Please send comments to the following address:

U.S. Department of Energy

Portsmouth/Paducah Project Office

1017 Majestic Drive, Suite 200

Lexington, Kentucky 40513

1 Site Operation and Overview

Abstract

The Paducah Gaseous Diffusion Plant (PGDP), located in McCracken County, Kentucky, has been producing enriched uranium since 1952. In July 1993, the U.S. Department of Energy (DOE) leased the production areas of the site to the United States Enrichment Corporation (USEC), a private company. The DOE maintains responsibility for the environmental restoration, legacy waste management, nonleased facilities management, uranium hexafluoride (UF6) cylinder management, and decontamination and decommissioning (D&D)/DOE Material Storage Area (DMSA) programs. The DOE also implements an environmental monitoring and management program to ensure protection of human health and the environment and compliance with all applicable regulatory requirements. This document summarizes calendar year (CY) 2005 environmental management (EM) activities, including effluent monitoring, environmental surveillance, and environmental compliance status. It also highlights significant site program efforts conducted by DOE and its contractors and subcontractors at the Paducah Site. This report does not include USEC environmental monitoring activities.

Introduction

The DOE requires that environmental monitoring be conducted and documented for all of its facilities under the purview of DOE Order 231.1 Change 2, *Environment, Safety and Health Reporting* (DOE 1996). Several other laws, regulations, and DOE directives require compliance with environmental standards. The purpose of this Annual Site Environmental Report (ASER) is to summarize CY 2005 environmental management activities at the Paducah Site, including effluent monitoring, environmental surveillance, and environmental compliance status, and to highlight significant site program efforts. Paducah Site programs were coordinated by DOE's managing and integrating contractor, Bechtel Jacobs Company LLC (BJC), beginning April 1, 1998. BJC was the managing and integrating contractor in CY 2005. Paducah Remediation Services, LLC, (PRS) succeded BJC as DOE's environmental remediation contractor in 2006. PRS was involved in the preparation of this report. References in this report to the Paducah Site generally mean the property, programs, and facilities at or near PGDP for which DOE has ultimate responsibility.

Environmental monitoring consists of the following two major activities: effluent monitoring and environmental surveillance. Effluent monitoring is the direct measurement or the collection and analysis of samples of liquid and gaseous discharges to the environment. Environmental surveillance is the direct measurement or the collection and analysis of samples consisting of air, water, soil, biota, and other media. Environmental monitoring is

performed to characterize and quantify contaminants, assess radiation exposure, demonstrate compliance with applicable standards and permit requirements, and detect and assess the effects, if any, on the local population and environment. Multiple samples are collected throughout the year and are analyzed for radioactivity, chemical content, and various physical attributes.

The overall goal for EM is to protect site personnel, the environment, the Paducah Site's neighbors, and to maintain full compliance with all current environmental regulations. The current environmental strategy is to prevent future compliance issues, to identify any current compliance issues, and to develop a system for resolution. The long-range goal of environmental management is to reduce exposures of the public, workers, and biota to harmful chemicals and radiation.

Background

Before World War II, the area now occupied by PGDP was used for agricultural purposes. Numerous small farms produced various grain crops and provided pasture for livestock. During World War II, a 16,126-acre tract was assembled for construction of the Kentucky Ordnance Works (KOW), which subsequently was operated by the Atlas Powder Company until the end of the war. At that time, it was turned over to the Federal Farm Mortgage Corporation, and then to the General Services Administration.

In 1950, the U.S. Department of Defense (DOD) and DOE's predecessor, the Atomic Energy Commission, began efforts to expand fissionable material production capacity. As part of this effort, the National Security Resources Board was instructed to designate power areas within a strategically safe area of the United States. Eight government-owned sites initially were selected as candidate areas. In October 1950, as a result of joint recommendations from the DOD, Department of State, and the Atomic Energy Commission, President Truman directed the Atomic Energy Commission to further expand production of atomic weapons. One of the principal facets of this expansion program was the provision for a new gaseous diffusion plant. On October 18, 1950, the Atomic Energy Commission approved the Paducah Site for uranium enrichment operations and formally requested the Department of the Army to transfer the site from the General Services Administration to the Atomic Energy Commission. Although construction of PGDP was not complete until 1954, production of enriched uranium began in 1952.

The plant's mission of uranium enrichment has continued unchanged, and the original facilities are still in operation, albeit with substantial upgrading and refurbishment. Of the 7,566 acres acquired by the Atomic Energy Commission, 1,361 acres subsequently were transferred to the Tennessee Valley Authority (Shawnee Steam Plant site) and 2,781 acres were conveyed to the Commonwealth of Kentucky for wildlife conservation and for recreational purposes [West Kentucky Wildlife Management Area (WKWMA)]. DOE's current holdings at the Paducah Site total 3,424 acres.

At Paducah's uranium enrichment plant, recycled uranium from nuclear reactors was introduced into the PGDP enrichment "cascade" in 1953 and continued through 1964. In 1964, cascade feed material was switched solely to virgin-mined uranium. Use of recycled uranium resumed in 1969 and continued through 1976. In 1976, the practice of recycling uranium feed material from nuclear reactors was halted and never resumed. During the recycling time periods, Paducah received approximately 100,000 tons of recycled uranium containing an estimated 328 grams of plutonium-239 (^{239}Pu), 18,400 grams of neptunium-237 (^{237}Np), and 661,000 grams of technetium-99 (^{99}Tc). The majority of the ^{239}Pu and ^{237}Np was separated out during the initial chemical conversion to UF_6. Concentrations of transuranics (e.g., ^{239}Pu and ^{237}Np) and ^{99}Tc are believed to have been deposited on internal surfaces of process equipment and in waste products.

In October 1992, congressional passage of the National Energy Policy Act established USEC. Effective July 1, 1993, DOE leased the plant production operation facilities to USEC. Under the terms of the lease, USEC assumed responsibility for environmental compliance

activities directly associated with uranium enrichment operations.

Under the lease agreement with USEC, DOE retained responsibility for the site Environmental Restoration Program; the Enrichment Facilities Program; and the Legacy Waste Management Program, including all waste inventories predating July 1, 1993; and wastes generated by subsequent DOE activities. The DOE is responsible for Kentucky Pollutant Discharge Elimination System (KPDES) compliance at outfalls not leased to USEC. The DOE also has retained manager and cooperator status of facilities not leased to USEC. The DOE and USEC have negotiated the lease of specific plant site facilities, written memoranda of agreement to define their respective roles and responsibilities under the lease, and developed organizations and budgets to support their respective functions. The DOE is the owner, and DOE and its contractor are co-operators for Resource Conservation and Recovery Act (RCRA)-permitted facilities and are responsible for compliance with the RCRA permit.

Description of Site Locale

Location

The Paducah Site is located in a generally rural area of McCracken County, Kentucky. The center of PGDP is about 10 miles west of Paducah, Kentucky, and 3.5 miles south of the Ohio River (Figure 1.1). The industrial portion of PGDP is situated within a fenced security area and constitutes about 748 acres. Within this area, designated as secured industrial land use, are numerous active and inactive production buildings, offices, equipment and material storage areas, active and inactive waste management units, and other support facilities. Of the remaining 2676 acres, there is a 689-acre "buffer zone" that surrounds PGDP and it is designated as unsecured industrial land. There are no residences on DOE property at the Paducah Site.

Three small communities are located within 3 miles of the DOE property boundary at PGDP: Heath and Grahamville to the east, and Kevil to the southwest. The closest commercial airport is Barkley Regional Airport, approximately 5 miles to the southeast. The population within a 50-mile radius of PGDP is about 500,000. Within a 10-mile radius of PGDP, the population is about 66,000 (DOC 1994).

Climate

The Paducah Site is located in the humid continental zone where summers are warm (July averages 79 °F) and winters are moderately cold (January averages 35 °F). Yearly precipitation averages about 49 inches. The prevailing wind is from the south-southwest at approximately 10 miles per hour.

Surface Water Drainage

The Paducah Site is situated in the western part of the Ohio River basin. The confluence of the Ohio River with the Tennessee River is about 15 miles upstream of the site, and the confluence of the Ohio River with the Mississippi River is about 35 miles downstream. PGDP is located on a local drainage divide. Surface water from the east side of the plant flows east-northeast toward Little Bayou Creek, and surface water from the west side of the plant flows west-northwest toward Bayou Creek (commonly referred to as "Big Bayou Creek").

Bayou Creek is a perennial stream that flows toward the Ohio River along a 9-mile course. Little Bayou Creek is an intermittent stream that flows north toward the Ohio River along a 7-mile course. The two creeks converge 3 miles north of the plant before emptying into the Ohio River.

Flooding in the area is associated with Bayou Creek, Little Bayou Creek, and the Ohio River. Maps of the calculated 100-year flood elevations show that all three drainage systems have 100-year floodplains located within the DOE boundary at PGDP. These 100-year floodplains range from approximately 340 to 380 feet (ft) above mean sea level. Plant elevations range from about 370 to 385 ft above mean sea level [U.S. Army Corps of Engineers (COE) 1994].

Wetlands

More than 1100 separate wetlands, totaling

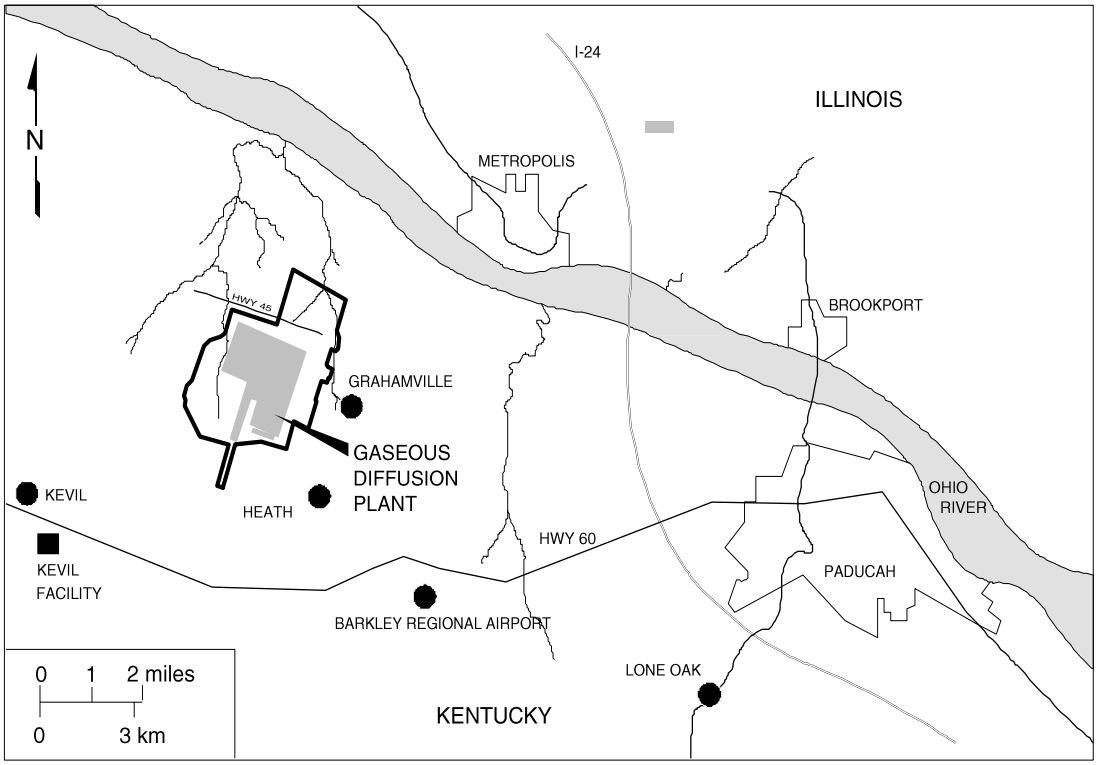

Figure 1.1 Location of the Paducah Site

over 1600 acres, were found in a study area of about 12,000 acres in and around the Paducah Site (COE 1994 and CDM 1994). These wetlands have been classified into 16 cover types. More than 60 percent of the total wetland area is forested.

Soils and Hydrogeology

Soils of the area are predominantly silt loams that are poorly drained, acidic, and have little organic content. Of the six primary soil types associated with the Paducah Site, five commonly have the characteristics necessary to be considered prime farmland by the Natural Resources Conservation Service, formerly the Soil Conservation Service (Humphrey 1976).

The local groundwater flow system at the Paducah Site contains the following four major components (listed from shallowest to deepest): (1) the terrace gravels, (2) the Upper Continental Recharge System (UCRS), (3) the Regional Gravel Aquifer (RGA), and (4) the McNairy flow system.

The terrace gravels consist of shallow Pliocene gravel deposits in the southern portion of the plant site. These deposits usually lack sufficient thickness and saturation to constitute an aquifer, but may be an important source of groundwater recharge to the RGA.

The UCRS consists mainly of clay silt with interbedded sand and gravel in the upper continental deposits. The system is so named because of its characteristic recharge to the RGA.

The RGA consists of coarse-grained sediments at the base of the upper continental deposits, sand and gravel facies in the lower continental deposits, gravel and coarse sand portions of the upper McNairy that are directly adjacent to the lower continental deposits, and alluvium adjacent to the Ohio River. These deposits have an average thickness of 30 ft and can be more than 70 ft thick along an axis that trends east-west through the site. The RGA is the uppermost and primary aquifer, formerly used by private residences north of the Paducah Site.

The McNairy flow system is composed of interbedded and interlensing sand, silt accessory, and clay. Near PGDP, the McNairy Formation can be subdivided into three members: (1) a 60-ft thick sand-dominant lower member; (2) a 100- to 130-ft thick middle member, composed predominately of silty and clayey fine sand; and (3) a 30- to 50-ft thick upper member consisting of

interbedded sands, silts, clays, and occasional gravel. Sand facies account for 40 to 50 percent of the total formation thickness of approximately 225 ft.

Groundwater flow originates south of the Paducah Site within eocene sands and the terrace gravels. Groundwater within the terrace gravels either discharges to local streams or recharges the RGA, although the flow regime of the terrace gravels is not understood fully. Groundwater flow through the UCRS predominantly is downward, also recharging the RGA. From the plant site, groundwater generally flows northward in the RGA toward the Ohio River, which is the local base level for the system.

Ecological Resources

Vegetation

Much of the Paducah Site has been impacted by human activity. Vegetation communities on the reservation are indicative of old field succession (e.g., grassy fields, field scrub-shrub, and upland mixed hardwoods). The open grassland areas, most of which are managed by WKWMA personnel, are mowed periodically or burned to maintain early successional vegetation, which is dominated by members of the compositae family and various grasses. Management practices on the WKWMA encourage reestablishment of once common native grasses such as eastern gama grass and Indian grass. Other species commonly cultivated for wildlife forage are corn, millet, milo, and soybean (CH2M Hill 1992a).

Field scrub-shrub communities consist of suntolerant wooded species such as persimmon, maples, black locust, sumac, and oaks (CH2M Hill 1991a). The undergrowth varies depending on the location of the woodlands. Wooded areas near maintained grasslands have an undergrowth dominated by grasses. Other communities contain a thick undergrowth of shrubs, including sumac, pokeweed, honeysuckle, blackberry, and grape.

Upland mixed hardwoods contain a variety of upland and transitional species. Dominant species include oaks, shagbark and shellbark hickory, and sugarberry (CH2M Hill 1991a). Undergrowth vary from open, with limited vegetation for more mature stands of trees, to dense undergrowth similar to that described for a scrub-shrub community.

Wildlife

Wildlife species indigenous to hardwood forests, scrub-shrub, and open grassland communities are present at the Paducah Site. Grassy fields are frequented by rabbits, mice, songbirds, and a variety of other small mammals and birds. Redwing blackbirds, killdeer, cardinals, mourning doves, bobwhite quail, meadowlarks, warblers, sparrows, and red-tailed hawks have been observed in such areas. Scrub-shrub communities support a variety of wildlife including opossums, voles, moles, raccoons, gray squirrels, killdeer, bluejays, redwing blackbirds, bluebirds, cardinals, mourning doves, shrike, warblers, turkeys, and meadowlarks. Deer, squirrels, raccoons, turkeys, songbirds, and great horned owls are found within the mature woodlands of the DOE reservation (CH2M Hill 1991a). In addition, the Ohio River serves as a major flyway for migratory birds, which are seen occasionally on the Paducah Site (DOE 1995).

Amphibians and reptiles are common throughout the Paducah Site. Amphibians likely to inhabit the area include the American and Woodhouse toads. Reptiles include the eastern box turtle and several species of snakes. Also, fish populations in Bayou Creek and Little Bayou Creek numerically are dominated by various species of sunfish (DOE 1995).

Threatened and Endangered Species

A threatened and endangered species investigation identified federally listed, proposed, or candidate species potentially occurring at or near the Paducah Site (COE 1994). Updated information is obtained on a regular basis from federal and state sources. Currently, potential habitat for seven species of federal concern exists in the study area (Section 2, Table 2.3). Six of these species are listed as “endangered” under the Endangered Species Act of 1973 and one is listed as “threatened.” Of note, significant potential summer habitat exists at the Paducah Site for the Indiana bat, a federally listed endangered

species; however, neither the Indiana bat, nor any other federally listed or candidate species have been found on DOE property at the Paducah Site. Also, no property at the Paducah Site has been designated as "critical habitat" in accordance with the Endangered Species Act.

Site Program Missions

The following two major programs are operated by DOE at the Paducah Site: (1) EM and (2) Uranium Programs. Environmental Restoration, Waste Operations, and D&D are projects under the EM Program. The mission of the Environmental Restoration Program is to ensure that releases from past operations at the Paducah Site are investigated and that appropriate remedial action is taken for protection to human health and the environment in accordance with the Federal Facility Agreement (FFA) (DOE 1998). The mission of the Waste Operations Program is to characterize and dispose of the legacy waste stored on-site, including DMSAs, in compliance with the October 2003 Agreed Order (AO) between DOE and the Kentucky Division of Waste Management (KDWM) and other requirements. The primary mission of the D&D Program is to manage and characterize the areas and facilities in the program and prepare materials and/or waste for disposition. The primary missions of the Uranium Program are to maintain safe, compliant storage of the DOE depleted UF_6 (DUF_6) inventory until final disposition and to manage facilities and grounds not leased to USEC. The environmental monitoring summarized in this report supports all DOE programs/projects.

2 Environmental Compliance

Abstract

The policy of DOE and its contractors and subcontractors at the Paducah Site is to conduct operations safely and minimize or eliminate the adverse impact of operations on the environment. Protection of the environment is considered a responsibility of paramount importance. The Paducah Site maintains an environmental compliance program aimed at satisfying all applicable requirements and protecting human health and the environment.

Introduction

State and federal agencies, including DOE, are responsible for enforcing the environmental regulations at the Paducah Site. Principle regulating agencies are the U.S. Environmental Protection Agency (EPA), Region 4, and the Kentucky Department for Environmental Protection (KDEP). These agencies issue permits, review compliance reports, participate in joint monitoring programs, inspect facilities and operations, and oversee compliance with applicable laws and regulations.

The EPA develops, promulgates, and enforces environmental protection regulations and technology-based standards as directed by statutes passed by the U.S. Congress. In some instances, the EPA has delegated regulatory authority to KDEP when the Kentucky program meets or exceeds EPA requirements. Table 2.1 provides a summary of the Paducah Site environmental permits maintained by DOE in 2005.

Compliance Activities

Resource Conservation and Recovery Act

Regulatory standards for the characterization, treatment, storage, and disposal of solid and hazardous waste are established by RCRA. Waste generators must follow specific requirements outlined in RCRA regulations for handling solid and hazardous wastes. Owners and operators of hazardous waste treatment, storage, and disposal facilities are required to obtain operating and closure permits for waste treatment, storage, and disposal activities. The Paducah Site generates solid, hazardous waste, and mixed waste (i.e., hazardous waste mixed with radionuclides) and operates four permitted hazardous waste storage and treatment facilities. The closed C-404 Hazardous Waste Landfill also is managed under requirements of the RCRA regulations and permit.

Resource Conservation and Recovery Act Hazardous Waste Permit

Part A and Part B permit applications of RCRA for storage and treatment of hazardous wastes initially were submitted for the Paducah Site

Table 2.1. 2005 Environmental Permit and Compliance Agreement Summary

Permit Type	Issued By	Permit Number	Issued To
State Agency Interest ID# 3059			
Water			
KPDES	KDOW	KY0004049	DOE/BJC
Water Withdrawal Permit	KDOW	1345	DOE
Solid Waste			
Residential Landfill (closed)	KDWM	073-00014	DOE/BJC
Inert Landfill (closed)	KDWM	073-00015	DOE/BJC
Solid Waste Contained Landfill (construction/operation)	KDWM	073-00045	DOE/BJC
RCRA/Toxic Substances Control Act			
State Hazardous Waste Management Permit	KDWM	KY8-890-008-982	DOE/BJC
Federal Facility Compliance Act Site Treatment Plan: Agreed Order	EPA	NA	DOE
FFA	EPA KDWM	NA	DOE
TSCA FFCA	EPA	NA	DOE
DMSA Agreed Order DWM-31434-042, DAQ-31740-030, and DOW-26141-042	KDWM KDAQ KDOW	NA	DOE
DUF6 Agreed Order DWM-32434-030	KDWM	NA	DOE

KDOW – Kentucky Division of Water
KDWM – Kentucky Division of Waste Management
TSCA – Toxic Substances Control Act
FFCA – Federal Facility Compliance Act

in the late 1980s. At that time, EPA had authorized the Commonwealth of Kentucky to exclusively administer the RCRA-based program for treatment, storage, and disposal units, but had not given the authorization to administer 1984 Hazardous and Solid Waste Amendments (HSWA) provisions. Therefore, a permit application was submitted to EPA and the KDWM for treatment and storage of hazardous wastes.

The revised Part A and Part B permit applications were submitted to KDWM on April 13, 2004. The new hazardous waste management facility permit was issued to DOE on September 30, 2004. The permit became effective on October 31, 2004, and is valid until October 31, 2014.

Resource Conservation and Recovery Act Notices of Violation

The DOE received one RCRA notice of violation (NOV) during 2005. An NOV dated January 27, 2005, alleged that one container that was stored in a RCRA storage area was not labeled properly with the words, "Hazardous Waste." DOE immediately labeled the container properly and completed additional corrective actions to inspect all containers to ensure that they were labeled properly. A report of the corrective actions was provided to KDWM.

2003 Agreed Order with Commonwealth of Kentucky

The main accomplishments in 2005 for the AO, (DWM-31434-042, DAQ-31740-030, and DOW-26141-042) (hereafter, 2003 AO) briefly are discussed below.

- Eleven Solid Waste Management Units (SWMU) Assessment Reports were revised in accordance with the AO to identify newly discovered hazardous waste in DMSAs.
- Part A of the RCRA Permit was revised to include these areas.
- All Priority A DMSAs were characterized by September 30, 2004, in accordance with the AO. DOE continues to complete characterization of DMSAs in accordance with the schedule outlined in the AO.

- Ten closure plans were submitted to KDWM in 2005 related to DMSAs.

Modifications to the Resource Conservation and Recovery Act Hazardous Waste Permit

There were no modifications to this permit in 2005.

Federal Facility Compliance Act – Site Treatment Plan

The Federal Facility Compliance Act (FFC Act) was enacted in October 1992. This act waived the immunity from fines and penalties that had existed for federal facilities for violations of hazardous waste management as defined by RCRA. It also contained provisions for the development of site treatment plans for the treatment of DOE mixed waste and for the approval of such plans by the states. As a result of the complex issues and problems associated with the treatment of mixed chemical hazardous and radioactive waste (mixed waste), DOE and KDEP signed, after consideration of stakeholder input, an AO/Site Treatment Plan (STP) on September 10, 1997. The STP facilitates compliance with the FFC Act. A series of mixed waste treatment milestones are detailed in the STP.

Solid Waste Management

The PGDP disposes of a portion of its solid waste at its on-site contained landfill facility, C-746-U. Construction of the C-746-U Landfill began in 1995 and was completed in 1996. The operation permit was received from KDWM in November 1996. Disposal of waste at the landfill began in February 1997. During 2005, the amount of waste disposed of in the landfill was 2400 tons.

The office waste generated by DOE and its contractors at the plant site is taken off-site for disposal. Only office waste generated at the C-746-U Landfill itself was disposed at the landfill. Commercial Waste Incorporated in Mayfield, Kentucky, provides off-site disposal of the office waste. A sitewide recycling program exists for office waste (see Section 3 for details).

The DOE did not receive any NOVs during 2005 for the active C-746-U and inactive C-746-S & T landfills.

Underground Storage Tanks

Underground storage tank (UST) systems at the Paducah Site have been used to store petroleum products, such as gasoline, diesel fuel, and waste oil. These USTs are regulated under RCRA Subtitle I *[40 Code of Federal Regulations (CFR)* Part 280] and Kentucky UST regulations [401 Kentucky Administrative Regulations (KAR) Chapter 42].

The DOE is responsible for 16 of the 18 site USTs that have been reported to KDWM. At the end of 2005, all DOE USTs have received regulatory approval of the closure.

Comprehensive Environmental Response, Compensation, and Liability Act

The DOE and EPA Region 4 entered into an Administrative Order by Consent (ACO) in August 1988 under Sections 104 and 106 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The ACO was in response to the off-site groundwater contamination detected at the Paducah Site in July 1988.

On May 31, 1994, the Paducah Site was placed on the EPA National Priorities List (NPL), which is a list of sites across the nation designated by EPA as having the highest priority for site remediation. The EPA uses the Hazard Ranking System to determine which sites should be included on the NPL.

Section 120 of CERCLA requires federal facilities on the NPL to enter into a FFA with the EPA. The FFA, which was signed February 13, 1998, by DOE, EPA, and KDEP, established a decision-making process for remediation of the Paducah Site, and coordinates CERCLA remedial action requirements with RCRA corrective action requirements. The FFA parties, DOE, EPA, and KDEP, agreed to terminate the CERCLA ACO because those activities could be continued under the FFA. According to the FFA,

DOE is required to submit an annual site management plan (SMP) to EPA and KDEP. The SMP summarizes the remediation work completed to date, outlines remedial priorities, and contains schedules for completing future work. The SMP is submitted to the regulators annually in November to update the enforceable milestones and to include any new strategic approaches.

Comprehensive Environmental Response, Compensation, and Liability Act Reportable Quantities

In 2005, there were no spills that met the CERCLA reportable quantities.

National Environmental Policy Act

An evaluation of the potential environmental impact of certain proposed federal activities is required by the National Environmental Policy Act (NEPA). In addition, an examination of alternatives to certain proposed actions is required. Compliance with NEPA, as administered by DOE's NEPA Implementing Procedures (10 *CFR* 1021) and the Council on Environmental Quality Regulations (40 *CFR* 1500–1508), ensures that consideration is given to environmental values and factors in federal planning and decision making. In accordance with 10 *CFR* 1021, the Paducah Site conducts NEPA reviews for proposed actions and determines if any proposal requires preparation of an environmental impact statement (EIS), an Environmental Assessment (EA), or is categorically excluded (CX) from preparation of either an EIS or an EA. The Paducah Site maintains records of all NEPA reviews.

In 2005, three CXs were issued. In addition, numerous minor activities were within the scope of the previously approved CXs for routine maintenance, small-scale facility modifications, and site characterization. The DOE Paducah Site Office and the DOE Oak Ridge Operations Office NEPA compliance officer approve and monitor the internal applications of previously approved CX determinations.

In accordance with the 1994 DOE Secretarial Policy Statement on NEPA, preparation of separate NEPA documents for environmental restoration activities conducted under CERCLA no longer is required. Instead, DOE CERCLA documents incorporate "NEPA values," to the extent practical. The NEPA values are environmental issues that affect the quality of the human environment. Incorporation of NEPA values into CERCLA documents allows the decision makers to consider the potential effects of proposed actions on the human environment. Actions conducted under CERCLA are discussed in Section 3 of this report.

National Historic Preservation Act

The National Historic Preservation Act of 1966 (NHPA) is the primary law governing a federal agency's responsibility for identifying and protecting historic properties (cultural resources included in, or eligible for inclusion in, the National Register of Historic Places).

A Phase I archaeological reconnaissance was conducted in 1993 in McCracken County, Kentucky, by Archaeology Resources Consultant Services Inc., of Louisville, Kentucky. The reconnaissance was part of an EA by Martin Marietta Energy Systems, Inc., which was proposing to design and construct a solid waste landfill at PGDP. The entire project area was approximately 40 acres located directly north of the C-746-S&T Landfill.

Endangered Species Act

The Endangered Species Act of 1973, as amended, provides for the designation and protection of endangered and threatened animals and plants. The act also serves to protect ecosystems on which such species depend. At the Paducah Site, proposed projects are reviewed, in conjunction with NEPA project reviews, to determine if activities have the potential to impact these species. If necessary, project-specific field surveys are performed to identify threatened and endangered species and their habitats, and mitigating measures are designed, as needed. When appropriate, DOE initiates consultation with the U.S. Fish and Wildlife Service and Kentucky Department for Fish and Wildlife Resources prior to implementing a proposed project.

Table 2.2. Federally Listed, Proposed, and Candidate Species Potentially Occurring Within the Paducah Site Study Area in 2004[a]

Common Name	Scientific Name	Endangered Species Act Status
Indiana Bat[b]	*Myotis sodalis*	Listed Endangered
Interior Least Tern	*Sterna antillarum athalassos*	Listed Endangered
Pink Mucket	*Lampsilis abrupta*	Listed Endangered
Ring Pink	*Obovaria retusa*	Listed Endangered
Orangefoot Pimpleback	*Plethobasus cooperianus*	Listed Endangered
Fat Pocketbook	*Potamilus capax*	Listed Endangered
Bald Eagle	*Haliaeetus leucocephalus*	Listed Threatened

[a]All of the listed species are discussed in *Environmental Investigations at the Paducah Gaseous Diffusion Plant and Surrounding Area, McCracken County, Kentucky, Volume III,* COE Nashville District, May 1994. Note that the study area encompasses 11,719 acres and extends to include the Ohio River, which is over 3 miles north of the DOE reservation. None of these species have been reported as sighted on the DOE reservation, although potential summer habitat exists there for the Indiana bat. No critical habitat for any of these species has been designated anywhere in the study area.

[b]Specimens of the Indiana bat were collected from WKWMA property in 1991 and 1999.

Table 2.2 includes seven federally listed, proposed, or candidate species that have been identified as potentially occurring at or near the Paducah Site. Project NEPA reviews and associated field surveys indicated that in 2005, DOE projects at the Paducah Site did not impact any of these seven species. Potential habitats of these species also were not impacted.

Floodplain/Wetlands Environmental Review Requirements

Title 10 *CFR* Part 1022, establishes procedures for compliance with Executive Order 11988, "Floodplain Management," and Executive Order 11990, "Protection of Wetlands."

In 2005, no floodplain or wetlands assessments were prepared or approved. Also, no floodplain or wetlands notices of involvement were published in the *Federal Register* for the Paducah Site. In addition, DOE did not apply for any individual permits from COE or for any water quality certifications from the state. Some DOE projects were authorized through the COE nationwide permit program for activities involving waters of the United States. DOE activities did not result in significant impacts to floodplains or wetlands at the Paducah Site in 2005.

Clean Water Act

The Clean Water Act (CWA) was established primarily through the passage of the Federal Water Pollution Control Act Amendments of 1972. The CWA established the following four major programs for control of water pollution: (1) a permit program regulating point-source discharges into waters of the United States, (2) a program to control and prevent spills of oil and hazardous substances, (3) a program to regulate discharges of dredge and fill materials into "waters of the United States," and (4) a program to provide financial assistance for construction of publicly owned sewage treatment works. The Paducah Site is affected primarily by the regulations for point source discharges regulated under the KPDES permit.

Kentucky Pollutant Discharge Elimination System Permits

The CWA applies to all nonradiological DOE discharges to waters of the United States. At the Paducah Site, the regulations are applied through issuance of a KPDES permit for effluent discharges to Bayou Creek and Little Bayou Creek. The Kentucky Division of Water (KDOW) issued KPDES Permit No. KY0004049 to the Paducah Site. This permit became effective April 1, 1998, and is enforced by KDOW. This permit applies to the following four DOE outfalls: 001, 015, 017, and 019. The KPDES permit calls for chemical and biological monitoring as an indicator of discharge-related effects in the receiving streams. The permit was set to expire at the end of March 2003, but by regulation, it is extended

automatically until the regulators issue a final decision on the DOE renewal application. A permit renewal application was submitted to KDOW in September 2002 and a minor revision to the application was submitted in May 2003. As of the end of 2003, KDOW had not approved or denied the application; therefore, KPDES Permit No. KY0004049 remained in effect throughout 2005.

Samples collected at Outfall 001 February 6 through 11, 2005, failed for chronic toxicity. The toxicity was reported on the monthly discharge monitoring report as 1.80 toxicity units (TUc) for fathead minnows (the permit limit is 1.00). Chronic toxicity testing of these samples for *Ceriodaphnia dubia* passed. A retest was conducted on samples collected February 20 through 24, 2005, and fathead minnows failed at 1.20 TUc *(Ceriodaphnia dubia* passed). Samples collected March 6-11, 2005, passed for both species.

Under the revised November 2004 Toxicity Reduction Evaluation (TRE) Plan, toxicity identification efforts were initiated using the February 6 through 11 samples. A semivolatile organic compound (SVOC) was identified as the probable cause of the toxicity. Based on the results of this investigation, it would appear that the expressed chronic toxicity to fathead minnow larvae in the February 2005 samples was an artifact of the sampling procedures. The use of an unlined suction tube is the likely source of bis(2-ethylhexyl)phthalate (DEHP), which was the toxicant in these tests. DOE has implemented the following corrective actions to mitigate the toxicity exhibited in the samples:

- Utilizing Teflon-lined tubing during the sampling process;
- Having a routine maintenance program in place for replacement of the Teflon lined tubing; and
- Modifying standard operating procedures to be specific on the type of equipment to be used during toxicity sampling.

Upon implementation of these corrective actions, no additional toxicity has been exhibited at Outfall 001.

In March 2005, one acute toxicity exceedence occurred at Outfall 017; however the retest passed. No additional actions were required.

No exceedences of effluent permit limits occurred at Outfalls 015 or 019 in 2005.

Toxic Substances Control Act

In 1976, the Toxic Substances Control Act (TSCA) was enacted with a twofold purpose: (1) to ensure that information on the production, use, and environmental and health effects of chemical substances or mixtures are obtained by the EPA, and (2) to provide the means by which the EPA can regulate chemical substances/mixtures.

Polychlorinated Biphenyls

The Paducah Site complies with polychlorinated biphenyl (PCB) regulations (40 *CFR* 761) and the Uranium Enrichment (UE) FFCA. The major activities performed in 2005 to ensure compliance included the following: maintaining compliant storage of PCB waste and PCB-contaminated wastewater, shipping PCB waste for treatment and disposal, treatment and discharge of PCB-contaminated wastewater, maintenance to the troughing system, and reporting and record keeping.

The UE TSCA FFCA between EPA and DOE was signed in February 1992. To meet the compliance goals at the Paducah Site, the UE TSCA FFCA is revised periodically and updated. Under this agreement, action plans have been developed and implemented for removal and disposal of large volumes of PCB material at the Paducah Site. Table 2.3 shows a summary of PCB equipment in service at the Paducah Site at the end of 2005. These items are utilized in USEC operations.

The PCB annual document, due July 1, provides details of facility activities associated with the management of PCB materials. The annual report provides details from the previous year on all PCB items that are in use, stored for reuse, generated as waste, stored for disposal, or shipped off-site for disposal. All Paducah Site UE TSCA

FFCA milestones for 2005 were completed. In 2005, 682,072 kilograms of PCB waste were shipped off-site for disposal.

The facilities operated by USEC utilize equipment that contains PCB capacitors as well as transformers, electrical equipment, and other miscellaneous PCB equipment. Both radioactive and nonradioactive PCB wastes are stored on-site in units that meet TSCA and/or UE TSCA FFCA compliance requirements, as applicable. Upon approval, nonradioactive PCBs are transported off-site to EPA-approved facilities for disposal.

Radioactively-contaminated PCB wastes are authorized by the UE TSCA FFCA for long-term on-site storage at the Paducah Site (i.e., beyond two years). Technology for the treatment and/or disposal of radioactively contaminated PCB wastes is being evaluated.

Table 2.3. Summary of PCB Equipment in Service at the End of 2005

Type	Number in Service	Volume (gal)	PCBs (kg)
PCB Transformers	66	95,040	279,346
PCB-Contaminated Transformers	9	2,299	0.95
PCB-Contaminated Electrical Equipment	7	2,094	1.14
PCB Capacitors	616	1,838	11,255

Emergency Planning and Community Right-to-Know Act

Also referred to as Title III of the Superfund Amendments and Reauthorization Act, the Emergency Planning and Community Right-toKnow Act (EPCRA) requires reporting of emergency planning information, hazardous chemical inventories, and releases to the environment. Reports under EPCRA are submitted to federal, state, and local authorities. Executive Order 12856, signed in August 1993, subjects all federal agencies to EPCRA.

The Paducah Site did not have any releases that were subject to Section 304 notification requirements during 2004. No Section 311 notifications were required in 2004. The Section 312 Tier II report of inventories for 2004 included UF_6, uranium tetrafluoride (UF_4), iron filings, activated carbon pellets, magnesium fluoride, diesel fuel, and PCBs associated with DOE activities. The Paducah Site reported PCBs on the Section 313 report because DOE accepts legacy PCB material from USEC when disposal of electrical equipment is required.

Clean Air Act

Authority for enforcing compliance with the Clean Air Act (CAA) and subsequent amendments resides with EPA Region 4 and/or the Kentucky Division for Air Quality (KDAQ). The Paducah Site complies with federal and state rules by implementing the CAA and its amendments.

Clean Air Act Compliance Status

The Paducah Site had two air emission point sources in 2005. The Northwest Plume Groundwater System and the Northeast Plume Containment System. These systems are interim remedial actions (IRAs) under CERCLA that address the containment of groundwater contamination at the Paducah Site. These systems remove TCE contamination from the groundwater by air stripping. At the Northwest Plume Groundwater System, the TCE-laden groundwater passes through an air stripper to remove the TCE. The offgas from the air stripper then passes through a carbon adsorption system to remove the TCE prior to atmosphere discharge. At the Northeast Plume Containment System, a cooling tower system acts as an air stripper for TCE.

Asbestos Program

Numerous facilities at the Paducah Site contain asbestos materials. Compliance programs for asbestos management include identification of asbestos materials, monitoring, abatement, and disposal. Procedures and program plans are maintained that delineate scope, roles, and responsibilities for maintaining compliance, as applicable, with EPA Region 4, Occupational Safety and Health Administration, and Kentucky

regulatory requirements. There were no noncompliances with environmental protection standards identified in 2005.

Radionuclide National Emission Standards for Hazardous Air Pollutants Program

Airborne emission of radionuclides from DOE facilities are regulated under 40 *CFR* 61, Subpart H, the National Emission Standards for Hazardous Air Pollutants (NESHAP) regulations. Potential radionuclide sources at the Paducah Site in 2005 arose from scrap metal removal/handling, the Northwest Plume Groundwater System, C-410 D&D activities, and fugitive dust source emissions. The fugitive dust source emissions include piles of contaminated scrap metal, roads, and roofs. The DOE utilized ambient air monitoring data to verify insignificant levels of radionuclides in off-site ambient air. The Radiation/Environmental Monitoring Section of the Radiation Health and Toxic Agents Branch of the Department for Public Health of the Kentucky Cabinet for Health Services conducted ambient air monitoring during 2005. Ambient air data were collected at 10 sites surrounding the plant in order to measure radionuclides emitted from Paducah Site sources, including fugitive emissions. These results are discussed in Section 4.

Pollutants and Sources Subject to Regulation

Any stationary source emitting more than 10 tons/year of any hazardous air pollutant (HAP) or 25 tons/year of any combination of HAPs is considered a major source and is subject to regulation. Region 4 of the EPA must examine other sources for regulation under an "area source" program. The Paducah Site is not a major source by virtue of its individual or total HAP emissions.

Stratospheric Ozone Protection

The DOE refrigeration units contain less than 50 pounds of ozone-depleting substances; therefore, the only CAA Title VI provision that applies to the Paducah Site is the requirement to control refrigerants from leaking systems.

Clean Air Act Notices of Violation

The PGDP did not receive any CAA violations in 2005.

Kentucky/Department of Energy Agreement in Principle

The Kentucky/DOE Agreement in Principle (AIP) reflects the understanding and commitments between DOE and the Commonwealth of Kentucky regarding DOE's provision of technical and financial support to Kentucky for environmental oversight, surveillance, remediation, and emergency response activities. The goal of the AIP is to maintain an independent, impartial, and qualified assessment of the potential environmental impacts from present and future DOE activities at the Paducah Site. The AIP is intended to support nonregulated activities, whereas, the FFA covers regulated activities. The AIP includes a grant to support the Commonwealth of Kentucky in conducting independent monitoring and sampling, both on-site and off-site, and to provide support in a number of emergency response planning initiatives. Included are cooperative planning, conducting joint training exercises, and developing public information about preparedness activities.

Regulatory Inspections

Paducah Site EM programs are overseen by several organizations, both inside and outside the DOE complex. Each year, numerous appraisals, audits, and surveillances of various aspects of the environmental compliance program are conducted.

3 Environmental Program Information

Abstract

Environmental monitoring, environmental restoration, waste operations, facilities management, UF_6 cylinder management activities, and D&D/DMSA management occur at the PGDP. Several programs are conducted; therefore, they are presented in this section to inform the public.

Environmental Monitoring Program

The environmental monitoring program at the PGDP consists of effluent monitoring and environmental surveillance. Requirements for routine environmental monitoring programs were established to measure and monitor effluents from DOE operations and maintain surveillance on the effects of those operations on the environment and public health through measurement, monitoring, and calculation. The Environmental Monitoring Program is documented in the *Paducah Site Environmental Monitoring Plan* (BJC 2004a) in accordance with DOE Order 450.1, *Environmental Protection Program.* The results of this program are discussed in detail in subsequent sections of this ASER.

Before the DOE/USEC transition (described in Section 1), DOE's primary mission at the Paducah Site consisted of enriching uranium. However, since the transition on July 1, 1993, DOE's mission at the site has been focused on environmental restoration, DUF_6 cylinder management, waste management, and D&D/DMSA management. This change in mission also has changed the direction and emphasis of the environmental monitoring program. In November 1995, the site environmental monitoring plan was reissued to address DOE operations exclusively. The environmental monitoring plan is reviewed annually and updated at least every three years. The December 2004 version of the *Paducah Site Environmental Monitoring Plan* addresses the sampling events in 2005 that are reported in this ASER.

Environmental Restoration Program

The goal of the environmental restoration program is to ensure that releases from past operations and waste management activities are investigated and that the appropriate remedial action is taken for the protection of human health and the environment. In May 1994, PGDP was added to EPA's NPL. Two federal laws, RCRA and CERCLA, are the dominant regulatory drivers for EM and restoration activities at PGDP. The RCRA sets the standards for managing hazardous waste and requires permits to be obtained for DOE facilities that treat, store, or dispose of hazardous waste, and requires assessment and cleanup of hazardous waste releases at SWMUs. The CERCLA addresses uncontrolled releases of hazardous substances and requires cleanup of inactive

waste sites. As a result of the PGDP being placed on the NPL and having RCRA permits, the DOE, EPA, and KDEP entered into an FFA in 1998. The FFA coordinates compliance with both RCRA and CERCLA requirements.

The environmental restoration program supports remedial investigations (RIs) and environmental response actions, D&D of facilities no longer in use, projects designed to demonstrate or test advancements in remedial technologies, and other projects related to remedial action for the protection of human health and the environment.

Background

In July 1988, the Kentucky Radiation Control Branch, in conjunction with the Purchase District Health Department, sampled several residential groundwater wells north of the plant in response to concerns from a local citizen regarding the quality of water in a private well. Subsequent analyses of these samples revealed elevated gross beta levels indicative of possible radionuclide contamination. On August 9, 1988, these results were reported to the Paducah Site, which responded by sampling several private groundwater wells adjacent to the site on August 10, 1988. Upon analysis, some of the samples collected contained elevated levels of both TCE and ^{99}Tc. In response, DOE immediately instituted the following actions:

- Provided a temporary alternate water supply to affected residences,
- Sampled surrounding residential wells to assess the extent of contamination,
- Began extension of a municipal water line to affected residences as a long-term source of water, and
- Began routine sampling of residential wells around the Paducah Site.

Following the initial response actions, DOE and EPA entered into an ACO in August 1988 under Sections 104 and 106 of CERCLA. The major requirements of the ACO include monitoring of residential wells potentially affected by contamination, providing alternative drinking water supplies to residents with contaminated wells, and investigation of the nature and extent of off-site contamination.

Pursuant to the ACO, DOE continued routine sampling of residential wells and initiated a two-phase site investigation (SI) to identify the nature and extent of off-site contamination at the Paducah Site. Phase I of the SI, from summer 1989 to March 1991, evaluated the extent of off-site contamination through extensive groundwater monitoring and surface-water sampling. Results of these activities are reported in *Results of the Site Investigation, Phase I, at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (CH2M Hill 1991b). Phase II of the SI, from November 1990 to October 1991, focused on identification and characterization of on-site sources contributing to off-site contamination. Phase II determined the level of risk to human health and the environment from exposure to contaminated media and biota, and developed an initial list of remedial alternatives. Results are reported in *Results of the Site Investigation, Phase II, at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (CH2M Hill 1992a). Risks to human health and the environment from exposure to contamination originating at the Paducah Site were reported in *Results of the Public Health and Ecological Assessment, Phase II, at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (CH2M Hill 1992b). This report used data collected during the SI to quantitatively assess risks to human health and to qualitatively assess risks to the environment.

As part of the residential well sampling program that began when off-site contamination was discovered, DOE established a water policy in 1994. This policy provides that in the event contamination originating from the Paducah Site is detected above plant-action levels, a response would be initiated by the Paducah Site. These levels are established at the analytical laboratory detection limits of 25 picoCuries per liter (pCi/L) for ^{99}Tc and 1 part per billion (ppb) for TCE. Accordingly, residents, as well as state and EPA officials, are notified immediately of sampling results above these levels, and alternative water supplies provided to such residents through connection to the municipal water system, or in the event of a time lapse between discovery and the ability to complete connections, bottled water is made available. In accordance with the water policy of 1994, DOE

pays installation cost of water systems and the monthly charges for water service to residents within the established water policy area.

The DOE modified this water policy in 1994 to include provisions to extend a municipal water line to the entire area of the groundwater contamination originating from the Paducah Site. All residents within the defined area, regardless of whether or not their wells were contaminated, were given the option to receive municipal water at DOE's expense. The DOE also provided municipal water to new residents and some new businesses in the area. A five-year review of the water policy was issued in 2003.

The ACO activities identified two off-site groundwater contamination plumes, referred to as the Northwest and Northeast Plumes; identified several potential on-site source areas requiring additional investigation; and included the evaluation of alternatives and implementation of several interim activities. Upon signature of the FFA in February 1998, the FFA parties declared the ACO requirements satisfied and terminated the ACO because the remaining cleanup would be continued under the authority of the FFA. A series of RIs and feasibility studies (FSs) were initiated under the FFA [e.g., Waste Area Groups (WAGs) 1, 3, 6, 7, 22, 23, 27, and 28], including the ongoing evaluation of all major contaminant sources impacting groundwater and surface water. In accordance with the ACO and FFA, DOE actions have focused primarily on reducing potential risks associated with off-site contamination. Examples of the significant actions initiated and completed to date include the following (BJC 2004):

- Imposed land use controls (fencing and posting) to restrict public access to contaminated areas in certain outfall ditches and surface water areas (1993).

- Extended municipal water lines as a permanent source of drinking water to affected residents to eliminate exposure to contaminated groundwater (1995).

- Constructed and implemented groundwater treatment systems for both the Northwest and Northeast Plumes to reduce contaminant migration (1995 and 1997, respectively).

- Constructed hard-piping to reroute surface runoff around highly contaminated portions of the North-South Diversion Ditch (NSDD) to reduce potential migration of surface contamination (1995).

- Excavated soil with high concentrations of PCBs in on-site areas to reduce off-site migration and potential direct-contact risks to plant workers (1998).

- Removed and disposed of "drum mountain," a contaminated scrap pile potentially contributing to surface water contamination to eliminate potential direct-contact risks to plant workers and reduce off-site migration (2000).

- Applied *in situ* treatment of TCE-contaminated soil at the cylinder drop test site using innovative technology (i.e., the LASAGNA™ technology) to eliminate a potential source of groundwater contamination (2002).

- Removed petroleum-contaminated soil from SWMU 193 to eliminate a potential source of groundwater contamination (2002).

- Completed installation of a sediment control basin at Outfall 001 to control the potential migration of contamination during scrap removal and initiated removal and disposal of approximately 54,000 tons of scrap metal to eliminate potential direct-contact risks to plant workers and a source of surface water contamination (2002).

- Completed hard-piping and installation of a retention basin and completed excavation of the on-site portions of the NSDD, which removed a source of direct-contact risk to plant workers and surface water contamination (2004).

- Completed two key groundwater technology studies, including a successful treatability study to evaluate the effectiveness of the six-phase heating technology for *in situ* treatment of dense nonaqueous-phase liquid (DNAPL) at C-400, which resulted in a signed Record of Decision (ROD) in July 2005 (2003).

- Investigated potential source areas contributing to the Southwest Plume (2005).

- Performed a site investigation near the C-746-S&T Landfills to determine if existing TCE groundwater contamination is from an upgradient source (2005).

Operable Units

The National Contingency Plan states that owners of large, complex sites with multiple source areas, such as federal facilities, may choose to divide their sites into smaller areas to characterize them and to implement response actions, rather than conducting a single sitewide comprehensive action. These discrete actions, referred to as Operable Units (OUs), may address a geographic portion of the site, specific site problems, or include a series of interim actions followed by final actions. The PGDP site cleanup strategy adopts this approach and includes a series of high-priority actions, ongoing site characterization activities to support future response action decisions, and eventual D&D of PGDP, followed by a Comprehensive Sitewide Operable Unit (CSOU) evaluation. The timing and sequencing of these actions is based on a combination of factors, including risk, compliance, and technical considerations associated with PGDP operations and other criteria, as outlined in the *Site Management Plan*.

Groundwater is an example of an area that has unique technical factors that need special consideration in the sequencing and decision-making process. The strategy includes the following:

(1) Preventing human exposure to contaminated groundwater;

(2) Addressing source areas posing off-stie risks; and

(3) Selecting and implementing final remedial actions for the Dissolved-Phase Plumes.

This strategy is being implemented in four phases. The first phase of the on-going Paducah groundwater strategy focuses on preventing human exposure to contaminated groundwater by providing an alternate drinking water supply to certain area residents. The first phase is commonly referred to as the "water policy." The second phase of the strategy, to prevent or minimize further migration of the contaminant plumes, has been implemented through installation of the groundwater treatment systems in both the Northwest and Northeast Plumes. Current program efforts are focused on the third phase of the groundwater strategy, preventing or minimizing further migration of contaminants from source areas. The fourth phase of the groundwater strategy will evaluate the technical practicability of returning groundwater to its expected beneficial use within a reasonable time frame.

The scope of the D&D OU includes 17 currently inactive DOE facilities, those SMWUs and AOCs associated with previous GDP operations, and the currently operating GDP. The 17 inactive DOE facilities are scheduled to undergo D&D before plant shutdown. The units associated with current GDP operations will be addressed during D&D of the GDP.

The final CSOU evaluation will occur following completion of D&D of the GDP after plant shutdown. As part of the final CSOU evaluation, the land-use assumptions will be reassessed and modified, if necessary, to ensure consistency with the reasonably foreseeable land use, including any reuse initiatives that might be under consideration at that time. The final CSOU will include a sitewide baseline human health and ecological risk assessment to evaluate residual risks remaining and to identify any additional actions necessary to ensure long-term protectiveness.

Site Priorities

The DOE uses a combination of factors to prioritize work being implemented under the EM program at PGDP. These include risk-based criteria, compliance with other programs, technical considerations associated with GDP operations, mortgage reduction, and demonstrated progress toward completing the EM mission.

2005 Remedial Activities

Significant accomplishments for the environmental restoration program conducted in 2005 include, but were not limited to, the following:

- Signed a ROD and issued a remedial design work plan (RDWP) for the C-400 groundwater action.
- Submitted the SI Report for the Southwest Plume Site Investigation.
- Submitted the SI Report for the C-746S&T Landfill Site Investigation.
- Continued operation of the Northwest and Northeast Plume groundwater treatment systems.
- Received approval of the Surface Water OU Sampling and Analysis Plan and completed fieldwork of the Surface Water OU Site Investigation.
- Submitted the Burial Grounds OU Work Plan.
- Continued characterization, removal, and disposal of scrap metal.

C-400 Record of Decision

In 2005, a ROD was approved by DOE and submitted to the regulators for selecting the interim remedial action (IRA) for the Groundwater OU VOCs source zone, comprised primarily of TCE at the C-400 Cleaning Building at PGDP, and includes discussion of the contribution that this IRA will make toward the final decision for the Groundwater OU at the PGDP.

The IRA would accomplish the following:

- Prevent potential exposure to contaminated groundwater to on-site industrial workers through institutional controls (e.g., excavation/penetration permit program); and
- Reduce contamination comprised of TCE and other VOCs found in UCRS soil in the C-400 Cleaning Building area to minimize the migration of these contaminants to RGA groundwater and to off-site points of exposure.

The major components of the remedy would include the following:

- Reduce the concentration of TCE and other VOCs in the soils in the C-400 Cleaning Building area through removal and treatment using Electrical Resistance Heating in both the UCRS and RGA;
- Collect post-action sampling results;
- Conduct a remedial design support investigation to further determine areal and vertical extent of TCE and other VOC contamination in the C-400 Cleaning Building area to conclude optimum placement of the remediation system; and
- Implement land use controls (LUCs) at the C-400 Cleaning Building area.

Also, in 2005, the Remedial Design Work Plan (RDWP) was issued for C-400. The RDWP defines the scope of activities and approach that is necessary to implement the selected remedy as identified in the ROD (DOE 2005a) for this remedial action. The remedy consists of volatilization and removal of TCE and other VOCs from contaminated groundwater by application of Electrical Resistance Heating in an area located south of the C-400 Cleaning Building, therefore further reducing contribution to the off-site groundwater plumes. This plan specifically addresses the location of the project, the nature of the work, the major work activities required to perform the design for the interim remedial action, the schedule, and the special project applicable or relevant and appropriate requirements as stated in the ROD.

Southwest Plume Site Investigation

The *Site Investigation Report for the Southwest Groundwater Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky (DOE/OR/07-2180&D1)* was submitted early in

2005. The SI was conducted in accordance with the approved *Site Investigation Work Plan for the Southwest Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/07-2094&D2 (DOE 2004). The investigation evaluated the following four potential source areas of contamination to the Southwest Groundwater Plume and profiled the current level and distribution of VOCs and ^{99}Tc in the plume along the west plant boundary.

(1) C-747-C Oil Landfarm (SWMU 1)

(2) C-720 Building, specifically areas near the northeast and southeast corners of the building

(3) Storm sewer between the south side of the C-400 Building and Outfall 008 (a part of SWMU 102)

(4) C-747 Contaminated Burial Yard (SWMU 4)

Three of the four potential source areas and the dissolved-phase plume have been addressed in previous investigations. Very little investigation has focused previously on the storm sewer as a potential source of groundwater contamination.

The objectives of the current SI were to collect sufficient data to do the following:

- Determine which units are sources of contamination to the Southwest Groundwater Plume;
- Determine which units are not sources of contamination to the Southwest Groundwater Plume;
- Fill data gaps for risk assessment of the identified source areas; and
- Reduce uncertainties and increase the understanding of the Southwest Groundwater Plume and potential sources so that appropriate response actions can be identified, as necessary.

C-746-S&T Landfill Site Investigation

The DOE completed an SI that focused on the vicinity of the C-746-S&T Landfill complex. The SI Report summarizes the results from fieldwork (primarily groundwater sampling) conducted in the area of the C-746-S Landfill, the C-746-T Landfill (commonly referred to as the C-746-S&T Landfills), and the C-746-P Landfill. This investigation determined that groundwater contamination by VOCs, principally TCE observed in landfill groundwater monitoring wells (MWs), is derived from the vicinity of the C-746-S&T Landfills and the C-746-P Landfill. It appears likely that the C-746-P Landfill is the source of the groundwater TCE contamination. Investigation results also established that the radionuclide ^{99}Tc found in the RGA is migrating to the vicinity of the C-746-S&T Landfills from an upgradient source.

Northwest Plume Groundwater System

The IRA for the Northwest Plume is documented in a ROD signed by DOE and EPA in July 1993. The KDEP concurred with the ROD. The results of the IRA led to the construction of the Northwest Plume Groundwater System (NWPGS). The NWPGS consists of two extraction well fields (each containing two extraction wells) transfer pipelines, and a fully enclosed treatment system. The NWPGS began operation August 28, 1995. The NWPGS, an interim action, is designed to contain the migration of TCE and ^{99}Tc in the highconcentration portion of the Northwest Plume.

TCE is removed by an air stripping process. The TCE is volatilized in a low-profile air stripper by introducing a large volume of air into the contaminated groundwater. Activated carbon filtration beds are then used to remove the TCE from the off-gas generated by the air stripper before the air is discharged to the atmosphere. ^{99}Tc is removed from the groundwater by an ion exchange process.

The NWPGS has extracted and treated approximately 1,058,467 million gallons of contaminated groundwater from startup in 1995 through the end of 2005. The NWPGS consistently has met the treatment goals documented in the ROD of 5 ppb TCE and 900 pCi/L of ^{99}Tc. The treated groundwater is released through KPDES-permitted Outfall 001. Radiological emissions from this facility are

discussed in Section 4.

Northeast Plume Containment System

The IRA of the Northeast Plume was documented in a ROD signed by DOE and EPA in June 1995. The KDEP accepted the ROD and issued Hazardous Waste Permit Modification 8, dated June 26, 1995. The results of the IRA led to the construction of the Northeast Plume Containment System (NEPCS). The NEPCS consists of two extraction wells, an equalization tank, a transfer pump, a transfer pipeline, and instrumentation and controls. Characterization and construction activities were completed in December 1996. System startup and operational testing were conducted, and full operations began in February 1997.

System operation includes pumping groundwater contaminated with TCE from two extraction wells to the equalization tank. A transfer pump is used to pump the contaminated water from the equalization tank through a transfer pipeline (approximately 6000 linear feet) to the top of the C-637-2A or C-637-2B Cooling Tower. C-637-2A is the primary destination; however, if C-637-2A is off-line, flow is transferred to the C-637-2B tower. The cooling tower acts as an air stripper and removes the TCE from the groundwater as it moves through the tower.

Through 2005, approximately 733,539 million gallons of contaminated groundwater have been extracted and treated by the NEPCS. With the exception of July through September 1999, when the facility was taken off-line due to cooling tower maintenance, the system has been approximately 95 percent operational since startup.

Surface Water Operable Unit Site Investigation

Regulatory approval of the *Sampling and Analysis Plan of the Site Investigation and Risk Assessment of the Surface Water Operable Unit (On-Site) at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE/OR/07-2137&D2/R2) was received in May 2005, with fieldwork being initiated during the summer and completed in the fall 2005. The Surface Water OU Project included a SI to identify hot spots in on-site ditches, selected storm sewers (4), and outfalls 001, 002, 008, 010, 011, 012, 015, including Sections 3, 4, and 5 of the NSDD. The SI scope also included an evaluation of whether additional sediment control measures and/or actions for potential legacy releases associated with the storm sewer system were needed. Figure 3.1 shows sampling during the SI. The results of the SI will be documented in an SI/ Baseline Risk Assessment Report and non-time critical removal action documentation, as appropriate.

Figure 3.1. Surface Water OU SI Sampling

Burial Grounds Operable Unit Remedial Investigation/Risk Assessment

The *Work Plan for the Burial Grounds Operable Unit Remedial Investigation/ Feasibility Study at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE/OR/07-2179&D2) was issued to the regulators on December 19, 2005, for approval. The goals for the Burial Ground OU RI/FS are consistent with those established in the FFA and the Paducah SMP (DOE 2004a) negotiated among DOE, EPA, and the Kentucky Department for Environmental Protection. The goals of this RI/FS are as follows:

Goal 1: Characterize Nature of Source Zone— Characterize the nature of contaminant source materials by using existing data and, if required, by collecting additional data.

Goal 2: Define Extent of Source Zone and Contamination in Soil and Other Secondary Sources at All Units—Define the nature, extent (vertical and lateral), and magnitude of contamination in soils, sediments, surface water, and groundwater by using existing data and, if

required, by collecting additional data; determine the presence, general location (if practicable), and magnitude of any dense nonaqueous-phase liquid zones as defined in the Paducah SMP (DOE 2004a).

Goal 3: Determine Surface and Subsurface Transport Mechanisms and Pathways—Gather existing quality data and, if necessary, collect additional adequate quality data to analyze contaminant transport mechanisms, evaluate risk, and support an FS.

Goal 4: Support Evaluation of Remedial Technologies—Determine if the existing data are sufficient to evaluate alternatives that will reduce risk to human health and the environment and/or control the migration of contaminants off-site.

Scrap Metal Removal

The Paducah Site had an estimated 54,000 tons of scrap metal in 10 scrap yards, most of which are adjacent to each other and located in the northwestern portion of the plant's fenced area. An Engineering Evaluation/Cost Analysis for *Scrap Metal Disposition at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE/OR/07-1880&D2/R1), which analyzed alternatives for handling the scrap, was issued by DOE and approved by EPA and KDWM.

During 2002, DOE completed construction of a storm water control basin to support the removal action. In 2003, removal of scrap metal was initiated. The removal scope for the scrap metal project at Paducah consists of the following three major tasks:

(1) Removal action to dispose of the Northwest corner scrap yards;

(2) Removal action to dispose of the C-746-D Classified Scrap Metal Yard; and

(3) Operations and maintenance of scrap metal infrastructure, including trailers and the C-613 storm water collection basin that was constructed in 2002.

At the end of 2005, approximately 13,000 tons of scrap had been removed from the Paducah Site. Figure 3.2 shows the disposition of scrap by month during 2005.

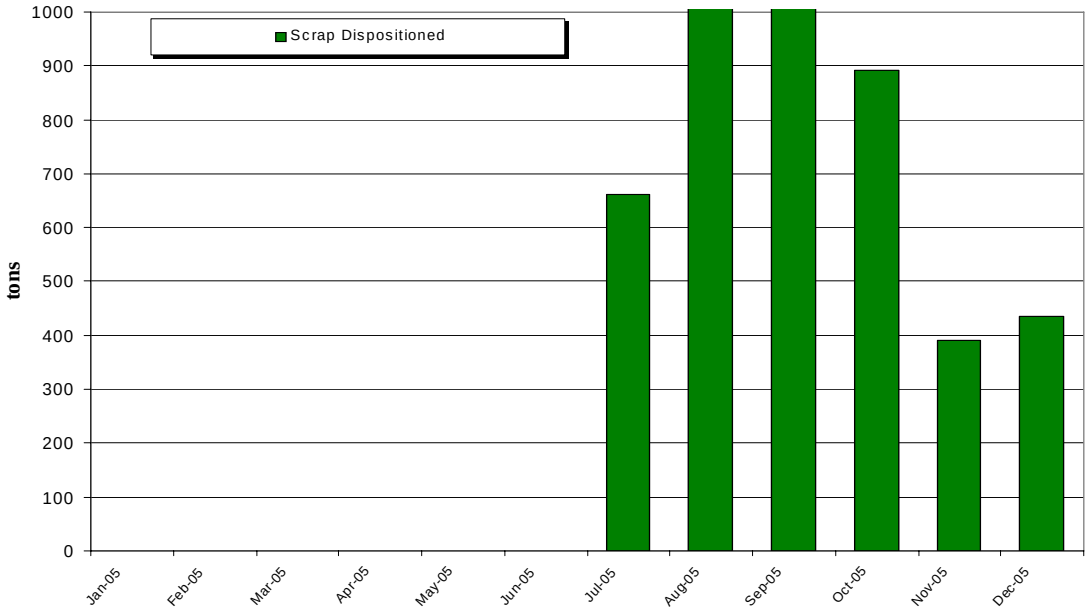

Figure 3.2 Scrap Metal Removal Project Disposition during 2005

In September 2004, shipment of waste to off-site disposal facilities was placed on hold due to issues that were identified with some shipments leaving the Paducah Site. Corrective actions were developed and implemented in order to resume shipments. Shipments resumed in July 2005.

The C-613 basin that collects storm water from the northwest corner of the scrap yards operated under normal conditions in 2005. The basin is routinely sampled, and then discharged to Outfall 001.

Waste Operations Program

The Paducah Site Waste Operations Program directs the safe treatment, storage, and disposal of waste generated before July 1, 1993 (i.e., legacy wastes), and waste from current DOE activities. Waste managed under the program is divided into the following eight categories:

(1) *Low-level radioactive waste*—radioactive waste not classified as high-level or transuranic.

(2) *Hazardous waste*—waste that contains one or more of the wastes listed as hazardous under RCRA or that exhibits one or more of the four RCRA hazardous characteristics: (1) ignitability, (2) corrosivity, (3) reactivity, and (4) toxicity

(3) *Mixed waste*—waste containing both a hazardous component regulated under RCRA and a radioactive component regulated under the Atomic Energy Act.

(4) *Transuranic waste*—waste that contains more than 100 nanoCuries of alphaemitting transuranic isotopes per gram of waste, with half-lives greater than 20 years.

(5) *PCB and PCB-contaminated waste*—waste containing or contaminated with PCBs.

(6) *Asbestos waste*—asbestos-containing materials from renovation and demolition activities.

(7) *Solid*—solid sanitary/industrial waste is basically refuse or industrial/construction debris and is disposed in landfills.

(8) *PCB/radioactive waste*—PCB waste or PCB items mixed with radioactive materials.

In addition to compliance with current regulations, supplemental policies are enacted for management of radioactive, hazardous, PCB, PCB/radioactive, and mixed wastes. These policies include reducing the amount of wastes generated; characterizing and certifying waste before it is stored, processed, treated, or disposed; and pursuing volume reduction and use of on-site storage, if safe and cost-effective, until a final disposal option is identified. In 2005, activities were focused on disposition of legacy waste—74,000 tons of waste were disposed. Some waste was disposed in the C-746-U Landfill and other waste in storage was prepared and shipped off-site. Figure 3.3 shows legacy waste disposition. Figure 3.4 shows the legacy waste disposition quantities in 2005.

Figure 3.3. Legacy Waste Disposition

Waste Minimization/ Pollution Prevention

The WM/PP Program at the Paducah Site provides guidance and objectives for minimizing waste generation. The program is set up to comply with RCRA and the Pollution Prevention Act, as well as applicable state and EPA rules, DOE Orders, and Executive Orders.

The program strives to minimize waste using the following strategies:

- Source reduction,
- Segregation,
- Reuse of materials,
- Recycling, and

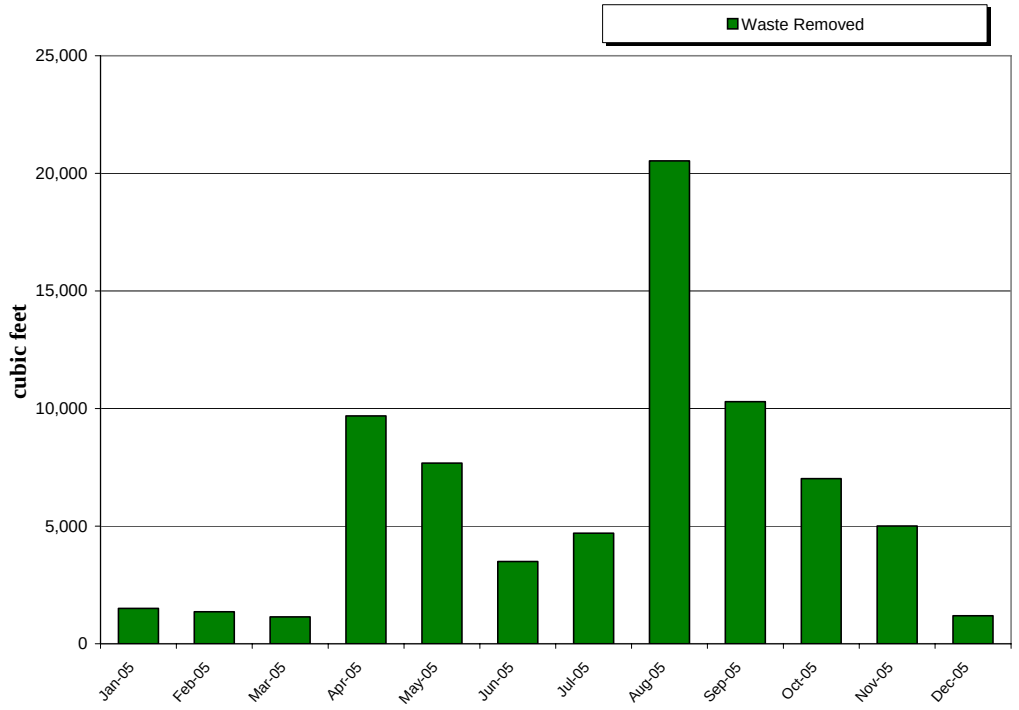

Figure 3.4 Legacy Waste Disposition during 2005

- Procurement of recycled-content products.

The program has the following objectives:

- Identify waste reduction opportunities,
- Establish site-specific goals,
- Establish employee awareness of WM/PP principles,
- Integrate WM/PP technologies into ongoing projects,
- Coordinate recycling programs,
- Identify WM/PP responsibilities and resource requirements, and
- Track and report results.

All PGDP projects are evaluated for waste minimization and pollution prevention (WM/PP) opportunities. WM/PP activities at PGDP related to the STP WM/PP goals include (1) reducing the quantity of wastes generated at their sources; (2) draining, drying, dewatering, evaporating, and otherwise removing liquid from wastes when possible; (3) segregating, sorting, consolidating, and reducing the volume of like wastes; (4) reusing or recycling spent materials; and (5) reevaluating wastes determined to be hazardous or radioactive. The main accomplishments in 2005 briefly are discussed below.

Hazardous waste generation continued to be reduced by using nonhazardous materials in place of hazardous ones. All wastes found and/or generated as a result of DMSA investigations were evaluated to determine if they were hazardous or mixed wastes, and then were segregated appropriately. There were procedures in place that required employees to reduce the amount of personal protective equipment (PPE) that became mixed waste. Specific practices included segregating individual items of PPE according to the type of contaminants on them and placing contaminated PPE into the waste containers that were the original contamination source of the PPE. Returned laboratory samples were managed to reduce waste by consolidating them into collection drums or returning them to their original containers when feasible. Collection areas and profiles were set up for the recycling of certain items that were not radiologically

contaminated, such as various types of batteries, fuses, and circuit boards.

Recycling efforts in 2005 included 12.9 metric tons (mt) (28,400 pounds) of office paper; 0.70 mt (1500 pounds) of aluminum cans; 0.17 mt (370 pounds) of telephone books; 0.53 mt (1200 pounds) of printer and fax toner cartridges; 3.7 mt (8200 pounds) of carbon used in the NWPGS; 0.1 mt (200 pounds) of plastic bottles; and 89.8 mt (198,000 pounds) of iron filings. Also, a nitrogen generating unit and three associated storage/receiver tanks were provided to an outside organization for reuse/ recycling, resulting in a cost avoidance for disposal of approximately $300,000.

Efforts also are ongoing to reduce waste generation and expand recycling/reuse opportunities.

Depleted Uranium Hexafluoride Cylinder Program

A product of the UE process, DUF_6 is a solid at ambient temperatures, and is stored in large metal cylinders. At the end of 2003, the Paducah Site managed an inventory of approximately 38,000 cylinders containing approximately 454,000 mt of UF_6 (most containing DUF_6) stored in outdoor facilities, commonly referred to as cylinder storage yards. Additional cylinders are added to the DOE inventory annually as a result of formal agreements with the USEC.

Stored as a crystalline solid at less than atmospheric pressure, when DUF_6 is exposed to moisture in the atmosphere, hydrogen fluoride and uranium reaction products form. The uranium byproducts form a hard crystalline solid that acts as a self-sealant within the storage cylinder. The acute hazard potential of DUF_6 is primarily chemical toxicity from any released hydrogen fluoride.

The mission of the DUF_6 Cylinder Program is to safely store the DOE-owned DUF_6 inventory until its ultimate disposition. The DOE has an active cylinder management program that includes cylinder and cylinder yard maintenance, routine inspections, cylinder yard construction and improvement, and other programmatic activities such as cylinder corrosion studies. The program maintains a cylinder inventory database that serves as a systematic repository for all cylinder inspection data.

On April 15, 1999, DOE issued the Final Programmatic Environmental Impact Statement for Alternative Strategies for the Long-Term Management and Use of Depleted Uranium Hexafluoride, in response to the Defense Nuclear Facility Safety Board's request to analyze alternative chemical forms for the storage of DUF_6. In 2002, DOE selected Uranium Disposition Services, LLC, to design, build, and operate facilities at Paducah, Kentucky, and Portsmouth, Ohio. The facilities would convert the inventory of DUF_6 to triuranium octoxide (U_3O_8), a more stable form of uranium that is suitable for disposal or reuse. Consistent with Public Law 107-206, construction began in July 2004 and continued through 2005. Initial construction activities included site excavation, construction of a detention basin to control storm run-off, and installation of underground utilities. In 2005, building installation began (Figure 3.5).

Figure 3.5. DUF_6 Facility Construction Activities

Decontamination and Decommissioning

D&D is conducted for facilities and other structures contaminated with radiological and hazardous material. Facilities are accepted for D&D when they are no longer required to fulfill a site mission. Two major facilities comprising approximately 46,450 square meters (m^2) (500,000 square feet) have been accepted for D&D at PGDP. These facilities are the C-340 Metal Reduction Plant complex, where UF_6 was

converted to uranium metal and hydrogen fluoride, and the C-410 Feed Plant complex, where uranium trioxide was converted to UF_6. Contaminants at these facilities include depleted uranium, natural uranium and transuranic radionuclides, UF_4, PCBs, asbestos, and lead paint. Fifteen additional inactive facilities are included in the D&D program at Paducah.

CERCLA documentation for removal of the C-410 Complex infrastructure has been completed as a non-time-critical removal action. Additional documentation will be required for the C-410 building demolition and for the C-340 complex. Actual D&D of the C-410/C-420 complex has been initiated.

Other D&D accomplishments in 2005 included the following:

- Completed D&D of Sector 1 of the C-410 complex and continued shipping debris for disposal at off-site facilities;
- Completed removal of cold box (tower) and nitrogen tank from the C-603 Nitrogen Generating Facility (see Figure 3.6); and
- Completed removal of fluorine cell stands and platforms in Sector 2 of the C-410 complex;
- Continued characterization of C-402 Limehouse in preparation for D&D;
- Continued preparation of Remedial Action Work Plans for the C-402 Limehouse and the C-405 Incinerator, and C-746-A West End Smelter.

Activities performed during the year at the C-340 Complex were limited to surveillance and maintenance of the structures to ensure containment of residual materials.

DOE Material Storage Areas

DMSAs are areas at PGDP containing material and equipment. They are undergoing a characterization process consistent with requirements associated with Nuclear Criticality Safety, RCRA, TSCA, and solid waste concerns. The 160 DMSAs originally were included with PGDP facilities leased to USEC. To facilitate Nuclear Regulatory Commission certification of the PGDP, the DMSAs were returned to DOE from USEC December 31, 1996. The DMSAs are located either in nonleased areas inside buildings leased to USEC or in nonleased outdoor areas.

Figure 3.6. C-603 Tank Removal

The Kentucky Environmental and Public Protection Cabinet filed an administrative complaint in October 2001 regarding the enforcement of NOVs that alleged violations of Kentucky's hazardous waste management program. Most of these NOVs alleged the failure to characterize materials in the DMSAs at PGDP or the unpermitted storage of hazardous waste in the DMSAs.

In October 2003, an AO between DOE and the Commonwealth of Kentucky was signed that resolved the administrative complaint. The AO established regulatory deadlines for characterization and removal of hazardous waste from the DMSAs and also established requirements relating to RCRA closure for the DMSAs that are found to contain hazardous waste. A total of 270,000 cubic feet (ft^3) of DMSA material have been disposed and 643,000 of 856,000 ft^3 have been characterized. Fourteen outdoor DMSAs have been emptied. The three remaining active outdoor DMSAs have been

characterized fully and plans are underway to complete material disposition of those areas. Figure 3.7 shows the removal of an old railcar from a DMSA.

Figure 3.7. Removal of Railcar

As described in Chapter 2, the AO commitments for Priority A DMSAs have been met. Fieldwork gives priority to DMSAs located outside or those that may contain hazardous waste. The DOE notifies the Commonwealth of Kentucky when hazardous waste is identified during the DMSA project.

Public Awareness Program

A comprehensive community relations and public participation program on DOE activities exists at the Paducah Site. The purpose of the program is to provide the public with opportunities to become involved in decisions affecting environmental issues at the site. The program uses proactive public involvement to foster a spirit of openness and credibility among local citizens and various segments of the public.

Community/Educational Outreach

The DOE and BJC Public Affairs supported several educational and community outreach activities during 2005. DOE managers spoke with civic groups, business leaders, and residents at pre-arranged events.

Citizens Advisory Board

The PGDP Citizens Advisory Board (CAB), a Site-Specific Advisory Board chartered by DOE under the Federal Advisory Committees Act, completed its ninth full year of operation in September 2005. During the year, the CAB held 11 regular board meetings and one retreat. The board includes three task forces and three subcommittees, which meet as necessary.

The task forces review issues for the following areas:

- Water Quality,
- Waste Disposition,
- Community Outreach, and
- Long-Range Strategy and Stewardship.

All meetings are open to the public and all regular board meetings are publicly advertised.

In 2005, the CAB had nine voting members, four ex-officio members, a deputy-designated federal official, and a federal coordinator.

The Paducah CAB is made up of individuals with diverse backgrounds and interests. It meets monthly to focus on early citizen participation in environmental cleanup priorities and related issues at the DOE facility. Additional information concerning the CAB may be obtained at www.pgdpcab.org.

End State Vision Document

The End State Vision Process for PGDP was initiated in 2004. The End State Vision Document was developed and issued in August 2005 as a planning tool to assure that today's environmental cleanup efforts are protective for tomorrow's future use. This process identifies the condition of the property after cleanup that would be protective of human health and the environment while taking into account the future use of the property (e.g., industrial or recreational) and any potential contaminants and hazards. The process also identifies any variances between the currently planned end state and the potential alternative end state.

Environmental Information Center

The public has access to Administrative Records and programmatic documents at the DOE Environmental Information Center (EIC) in the Barkley Centre, 115 Memorial Drive, Paducah, Kentucky. The EIC is open Monday

through Friday from 9 a.m. to 5 p.m. and by appointment. The EIC's phone number is (270) 554-6979.

Documents for public comment also are placed in the McCracken County Public Library (formerly the Paducah Public Library), 555 Washington Street, Paducah, Kentucky. The library is open Monday through Thursday from 9 a.m. to 9 p.m., Friday through Saturday from 9 a.m. to 6 p.m., and Sunday from 1 p.m. to 6 p.m.

The EIC and other public web pages related to DOE work at the PGDP can be accessed at www.prs-llc.net.

4 Radiological Effluent Monitoring

Abstract

Releases to the atmosphere from the NWPGS, NEPCS,scrap metal removal projects, and the fluorine cell blasting project were estimated for 2005. The calculated emissions for each activity were less than the 40 CFR 61 Subpart H limit of 0.1 millirem (mrem) dose to the maximally exposed individual. Dose to the public from airborne radionuclides is discussed in Section 6.

Introduction

Effluents are monitored for radionuclides known to be emitted or to have been present at the Paducah Site. Monitoring of radioactivity in liquid and airborne effluents is described fully in the *Paducah Site Environmental Monitoring Plan* (BJC 2004a). Dose calculations are provided in Section 6.

Airborne Effluents

In accordance with DOE Order 450.1, effluent monitoring is to be conducted to meet *General Environmental Protection Program Standards*. DOE Order 5400.5, *Radiation Protection of the Public and the Environment*, sets dose standards for members of the public at 10 mrem per year from airborne releases and at 100 mrem per year through all exposure pathways resulting from routine DOE operations.

Radiological airborne releases from DOE facilities are also regulated under 40 CFR 61, Subpart H, which governs radionuclide emissions, other than radon. 40 CFR 61 was amended in 1989 to include specific sampling requirements for each emission point that has the potential to emit radionuclides at an effective dose equivalent of 0.1 mrem to the most potentially affected off-site resident.

The DOE had four sources of airborne radionuclides in 2005. These sources were the NWPGS, the Scrap Yards Removal Projects, the C-410 D&D Fluorine Cell Blasting Project, and NEPCS. The DOE also had fugitive air sources that were measured by air monitoring stations around the site.

Northwest Plume Groundwater System

The CERCLA ROD, signed July 22, 1993, established the NWPGS. Although administrative requirements (e.g., permits) of environmental regulations do not apply to projects conducted under CERCLA, DOE has continued to provide pertinent information about emissions to the regulators. The Operations and Maintenance Plan, originally approved by EPA in March 1995 (since revised and approved), describes sampling and methodologies to be used at the NWPGS. The air emissions methodology is to sample the water stream influent and effluent to the air stripper. The

difference in contaminant concentration is then used to calculate air emissions. The analysis of the air stripper influent and effluent water provides a more accurate measurement of airborne discharges than actual stack measurements due to the low, practically immeasurable, radionuclide airborne effluents associated with the facility.

On August 28, 1995, DOE began operation of the NWPGS. The facility is located just outside of the northwest corner of the PGDP security area. The facility consists of an air stripper to remove volatile organics from water and an ion exchange unit for the removal of ^{99}Tc. The air stripper is located upstream of the ion-exchange unit. The ^{99}Tc (radionuclide) concentration in the influent and effluent water of the air stripper and the quantity of the water passing through the air stripper were used to calculate total ^{99}Tc emissions from the facility in 2004. The emissions are then used to calculate dose rates associated with these operations.

Northeast Plume Containment System

The NEPCS is a CERCLA interim action to remediate contaminated groundwater. Although administrative requirements (e.g., permits) of environmental regulations do not apply to on-site projects conducted under CERCLA, DOE has continued to provide pertinent information about emissions to the regulators. In 2005, ^{99}Tc was detected in small amounts in the groundwater that was extracted.

The wells and pumping facility are located northeast of the PGDP security area. The water is pumped to the C-637-A Cooling Tower where the contaminants evaporate from the groundwater. The ^{99}Tc (radionuclide) concentration and the quantity of the water pumped to the cooling tower were used to calculate total ^{99}Tc emissions from the facility in 2005.

Scrap Yards Removal Projects

During 2005, the Scrap Metal Removal Project continued sorting and characterizing materials contained within the scrap yards, packaging, and shipment of materials off-site. Similar activities took place for DMSA OS-12 and, therefore, also are included in the calculations for the Scrap Metal Project for 2005. There were approximately 54,000 tons of scrap materials in the scrap yards. Most of the metal is iron, nickel, or aluminum. The most common contaminant is uranium. Approximately 5250 tons of scrap were processed during 2005. Figure 4.1 shows loading of scrap metal into gondola boxes.

Figure 4.1 Loading of Scrap Metal

C-410 Decontamination and Decommissioning Activities

Fluorine cells were removed and prepared for off-site shipment. This preparation required removal of the paint on the exterior of the cells due to concerns about possible contaminants in the paint. The paint was removed by a sponge blasting process. A small amount of radionuclide contamination was present in the removed paint. The blasting occurred within a facility; however, room ventilation was exhausted through a highefficiency particulate air filter. The amount of radionuclides released was estimated based on 40 CFR Subpart H Appendix D emission factors.

Airborne Effluent Results Summary

In 2005, releases to the atmosphere from the NWPGS were estimated to be 9.85 x 10^{-5} Curies of ^{99}Tc. The estimated emissions from the NEPCS were estimated to be 1.25 x 10^{-4} Curies of ^{99}Tc. The estimated emissions from the scrap metal removal projects were 5.86 x 10^{-4} Curies.

The estimated emissions from the fluorine cell blasting project were 1.9 x 10^{-7} Curies. The calculated emissions for each activity were less than the 40 CFR 61 Subpart H limit of 0.1 mrem dose to the maximally exposed individual. Dose to the public from airborne radionuclides is discussed in Section 6.

Liquid Effluents

The CWA for the Paducah Site is administered by KDOW through the KPDES Wastewater Discharge Permitting Program. The sitewide KPDES permit (KY0004049) became effective April 1, 1998. A renewal permit application has been submitted to KDOW. This permit contains discharge limits based on water quality criteria for a zero flow receiving stream.

In addition to nonradiological parameters on the KPDES permit, specific radionuclide analyses and indicator-gross-activity analyses are conducted on liquid effluent samples. Grab samples and composite samples at various frequencies are used to measure discharges.

DOE Orders 450.1 and 5400.5 establish effluent monitoring requirements to provide confidence that radiation exposure limits are not exceeded. DOE Order 5400.5 sets guidelines for allowable concentrations of radionuclides in various effluents and requires radiological monitoring to protect public health. This protection is achieved at the Paducah Site by meeting DOE Order 5400.5-derived concentration guidelines (DCGs), which are the concentrations of given radionuclides that would result in an effective dose equivalent of 100 mrem per year. The DCGs are based on the assumption that a member of the public has continuous, direct access to the liquid effluents. This conservative exposure scenario is very unlikely to exist. Because exposure is not continuous, this results in conservatively low concentrations for the DCGs. Further information on DCGs is provided in Appendix B.

For monitoring purposes, the Paducah Site uses estimates of DCG levels and outfall flow characteristics (rainfall dependent) to determine sampling frequencies. Neither continuous monitoring nor continuous sampling is required by DOE Order 5400.5. Uranium and ^{99}Tc are the primary radionuclides of concern. Analyses also are performed routinely for dissolved alpha, suspended alpha, dissolved beta, and suspended beta concentrations. The KPDES permit requires additional sampling (two events in five years) for priority pollutants at the DOE outfalls. This sampling was conducted in 2000 and 2002. Radiological standards in liquid effluents were not exceeded in 2005.

Other effluent monitoring is required by KDWM landfill permits 073-00014, 073-00015, and 073-00045 for the C-746-S, C-746-T, and C-746-U landfills, respectively. Surface runoff is analyzed to determine if landfill constituents are being discharged into nearby receiving streams.

DOE Outfalls

The DOE was responsible for a total of four outfalls in 2005 (Figure 4.2). Under KPDES permit number KY0004049, Outfall 001 is a continuous flow outfall that received discharges from USEC's Liquid Pollution Abatement Facility, a once-through cooling water system, and DOE's NWPGS. The DOE's NEPCS is treated through the C-637 cooling tower system at PGDP. The cooling tower basin water then is transferred to C-616 through a process known as blowdown. Next, the water is transferred by an underground pipeline to C-616, a water treatment facility, and ultimately discharged into Outfall 001. In addition, surface-water runoff from the northeast side of the plant is collected in a sedimentation basin, and then discharged into Outfall 001. Outfall 015 receives surface-water runoff from the east-central sections of the plant. Outfall 017 receives surface-water runoff from the southeast section of the plant (primarily the cylinder storage yards). Outfall 019 receives surface-water runoff from C-746-U (DOE's operational landfill). Data are presented in Section 1, Tables 1.1 through 1.4, of the *Environmental Monitoring Results Annual Site Environmental Report for Calendar Year 2005, Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (PRS-ENM-0002, Volume II).

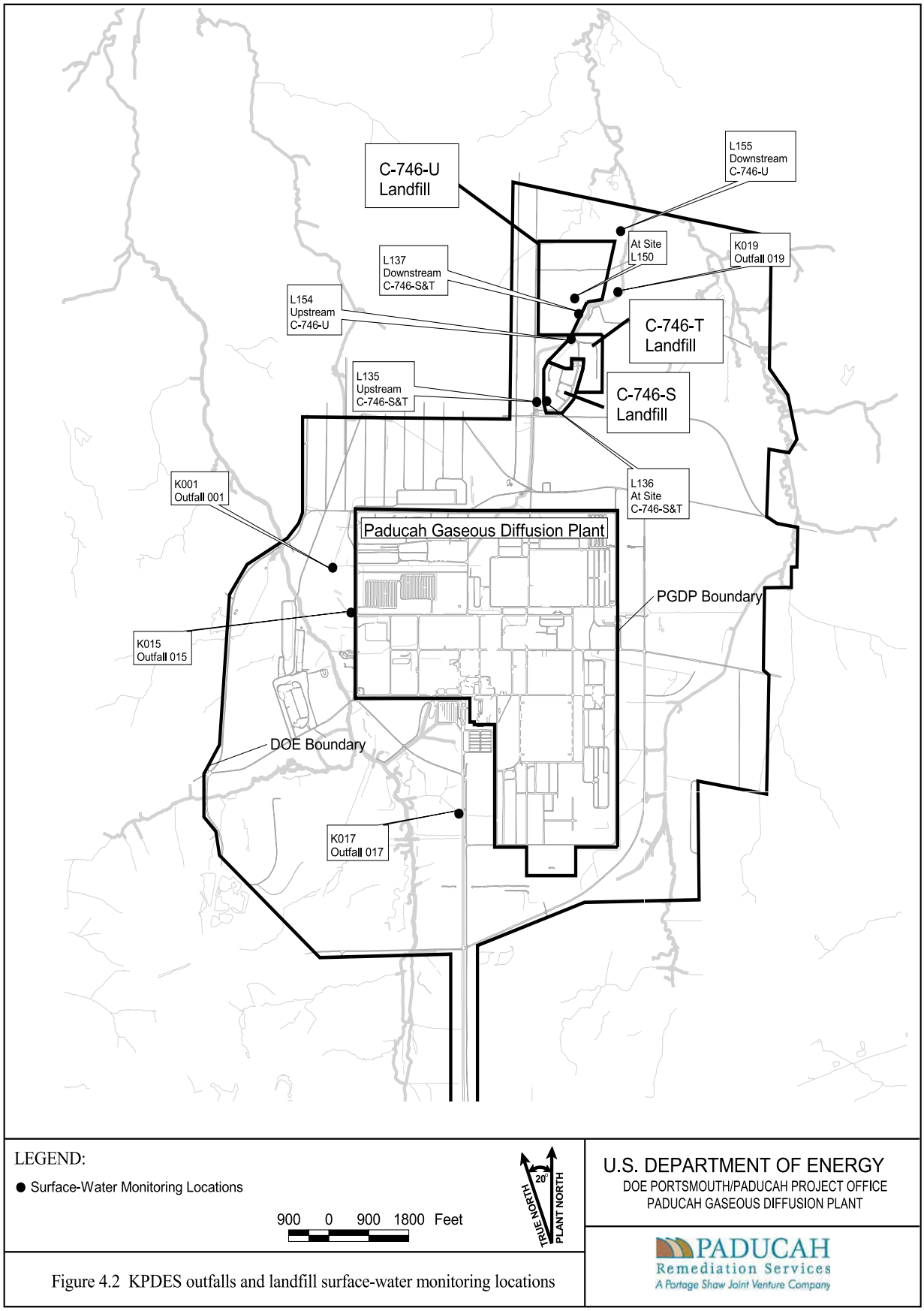

Figure 4.2 KPDES outfalls and landfill surface-water monitoring locations

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Landfill Surface Runoff

Surface runoff from the closed C-746-S Residential Landfill and the C-746-T Inert Landfill is monitored quarterly. Due to their close proximity, the C-746-S&T landfills are monitored as one landfill ("L" locations shown in Figure 4.2). Also, surface runoff is monitored from the operating C-746-U Contained Landfill. Surface runoff from these landfills is monitored for gross alpha and gross beta concentrations. Grab samples are taken from the landfill runoff, the receiving ditch upstream of the runoff discharge point, and the receiving ditch downstream of the runoff discharge point. Sampling is performed to comply with KDWM permit for landfill operations. Data are presented in Section 1, Tables 1.5 through 1.10, of the *Environmental Monitoring Results Annual Site Environmental Report for Calendar Year 2005, Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (PRS-ENM-0002, Volume II).

Analytical results of samples of landfill surface water runoff are consistent with levels seen in previous years' data. These areas are within DOE-controlled areas and, therefore, pose no threat to human health and the environment.

Liquid Effluent Monitoring Results

Tables 4.1 and 4.2 include the yearly minimum, maximum, and average concentrations of uranium and ^{99}Tc at each outfall monitoring location. Each radionuclide is compared with the corresponding DCG and is presented as a percentage of DCG. The combined average concentrations at all outfalls were small percentages of the corresponding DCG. The average concentration of uranium being discharged to Outfall 015 was 3.8 percent of the DCG. The average concentration of uranium being discharged to Outfall 001 was 0.26 percent of the DCG. The average concentration of uranium being discharged to Outfalls 017 and 019 was less than 1 percent of the DCG. Outfall 015 received runoff from the uranium burial ground with small quantities of surface contamination from uranium compounds. Runoff from the burial ground is suspected to be responsible for the elevated uranium concentrations associated with Outfall 015. Technetium-99 averages for 2005 for all four outfalls were well below 0.1 percent of the DCG. Data for 2005 do not indicate a significant change in relation to DCG levels for any radionuclide compared to data for the past five years.

Figures 4.3 and 4.4 show the five-year summary of average concentrations of uranium and ^{99}Tc. Uranium concentrations were slightly lower in 2005 at Outfalls 001 and 015 versus 2004 levels. Uranium concentrations for 2005are well below the DCG of 600 pCi/L, established by DOE Order 5400.5 for the protection of members of the public and the environment. Activities for ^{99}Tc are slightly lower than those seen in 2005. Activities for ^{99}Tc in 2005 are well below the DCG of 100,000 pCi/L.

Table 4.1. Total Uranium Concentration in DOE Outfalls for 2005

Outfall	Number of Samples	Minimum (mg/L)	Maximum (mg/L)	Average (mg/L)	Average (pCi/L)	% of ^{235}U	% of DCG[a]
001	5	0.002	0.15	0.032	1.56	0.60	0.26
015	6	0.016	0.34	0.16	22.6	0.28	3.8
017	6	< 0.001	0.0026	0.0015	1.0	0.60[b]	0.17
019	3	< 0.001	0.0055	0.0022	1.6	0.60[b]	0.27

[a] DCG for uranium is 600 pCi/L.
[b] Insufficient uranium quantities to analyze for assay. Assay based on past data.

Table 4.2. Technetium-99 Activity in DOE Outfalls for 2005

Outfall	Number of Samples	Minimum (pCi/L)[a]	Maximum (pCi/L)[a]	Average (pCi/L)[a]	% of DCG[a]
001	5	-6.6	13	2.5	0.0025
015	6	8.3	31	18	0.018
017	6	-7.9	9.3	1.1	0.0011
019	3	-3.0	2.7	-0.046	0

[a] DCG for ^{99}Tc is 100,000 pCi/L.

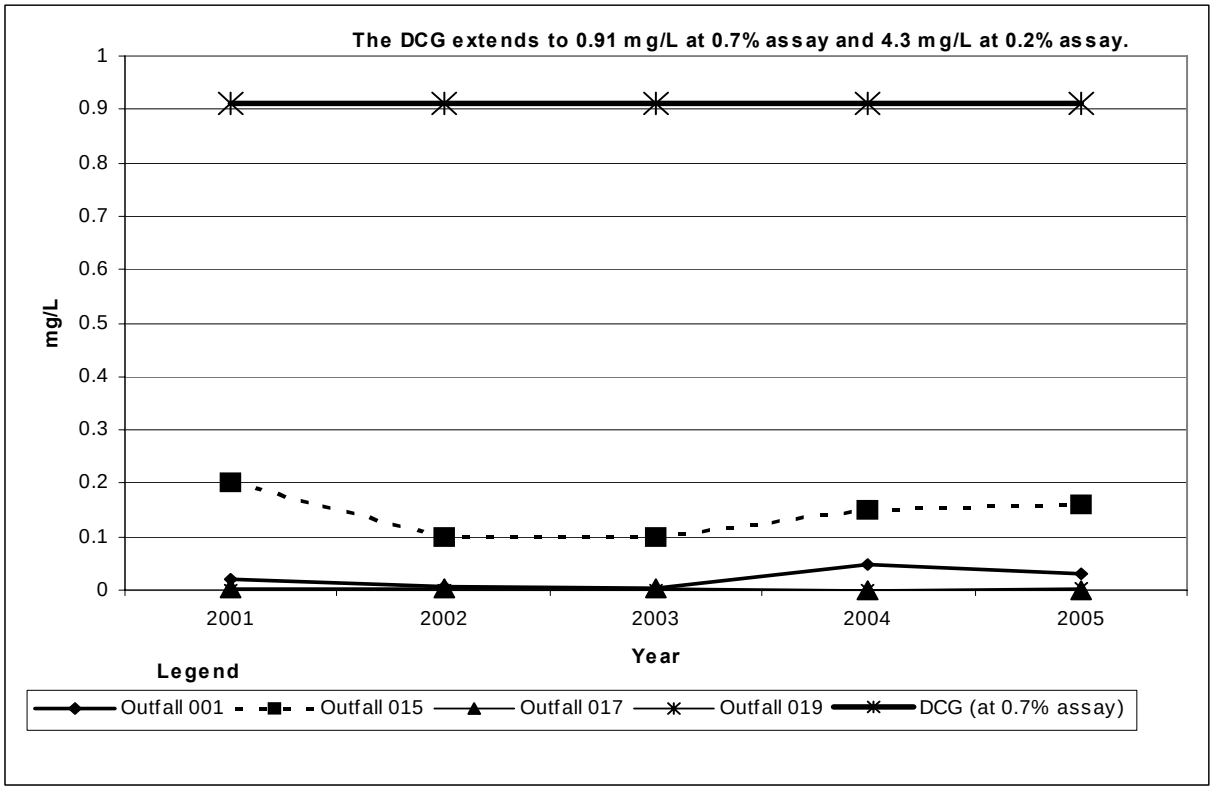

Figure 4.3. Uranium Concentrations Discharged to Surface Water, 2001–2005

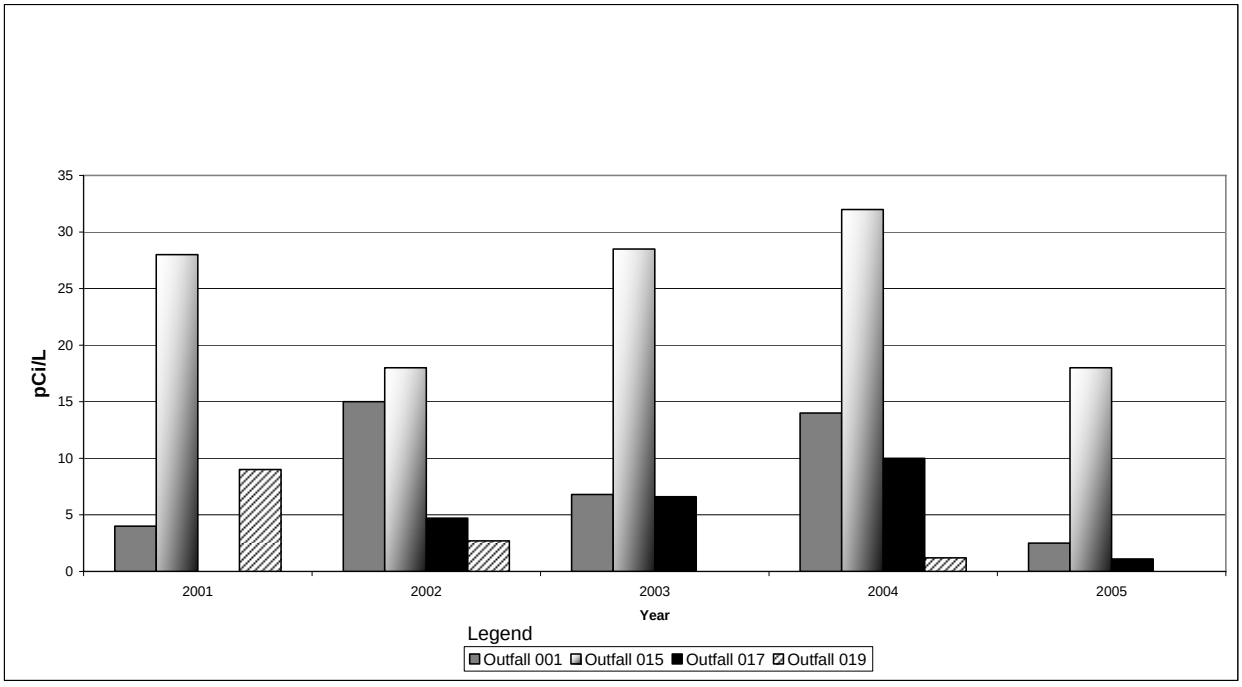

Figure 4.4. Technetium-99 Activity Discharged to Surface Water, 2001–2005

5 Radiological Environmental Surveillance

Abstract

The radiological environmental surveillance program assesses the effects of DOE's activities on the surrounding population and environment. Surveillance includes analyses of surface water, groundwater, sediment, terrestrial wildlife, direct radiation, and ambient air. Surveillance results from 2005 indicate that radionuclide concentrations in sampled media were within applicable DOE standards, such as DOE 5400.5. and DCGs.

Introduction

The Radiological Environmental Surveillance Program at the Paducah Site is based on DOE Orders 450.1, *Environmental Protection Program,* and 5400.5, *Radiation Protection of the Public and the Environment.* These orders require that an environmental surveillance program be established at all DOE sites to monitor the radiological effects, if any, of DOE activities on the surrounding population and environment. Surveillance includes analyses of surface water, groundwater (Section 9), sediment, terrestrial wildlife, direct radiation, and ambient air. Surveillance results from 2005 indicate that radionuclide concentrations in sampled media were within applicable DOE standards, such as DOE 5400.5 and derived concentration guides (DCGs).

Ambient Air

In accordance with the 1993 DOE/USEC lease agreement, USEC is responsible for the existing radionuclide airborne point-source discharges at PGDP, with the exception of DOE's NWPGS, the NEPCS, the Scrap Metal Removal Project, and C-410 D&D activities. The DOE monitors fugitive emission sources [using Kentucky Cabinet for Health and Family Services (KCHFS)-operated air monitors] including building roof tops, piles of contaminated scrap metal, roads, and concrete rubble piles. A potential fugitive or diffuse source of radionuclides could result from the decontamination of machinery and equipment used in remediation activities, such as well drilling. Machinery and equipment are washed with high-power sprayers to remove any contaminants originating from the soil and from groundwater. The concentrations of radionuclides on the equipment are so small that, under most circumstances, contamination levels cannot be distinguished from background levels.

The DOE utilized ambient air monitoring data to verify radionuclide levels in off-site ambient air. Ambient air samples are collected at 10 sites surrounding the plant (See Figure 5.1) in order to measure the radionuclides emitted from Paducah Site sources, including fugitive emissions. The Radiation/Environmental Monitoring Section of the Radiation Health and Toxic Agents Branch of the KCHFS Department for Public Health conducted ambient air monitoring during 2005. Based on 2005 results, plant-derived radionuclides were not detected by the Radiation Health and Toxic Agents Branch's air monitoring network. The monitoring results for

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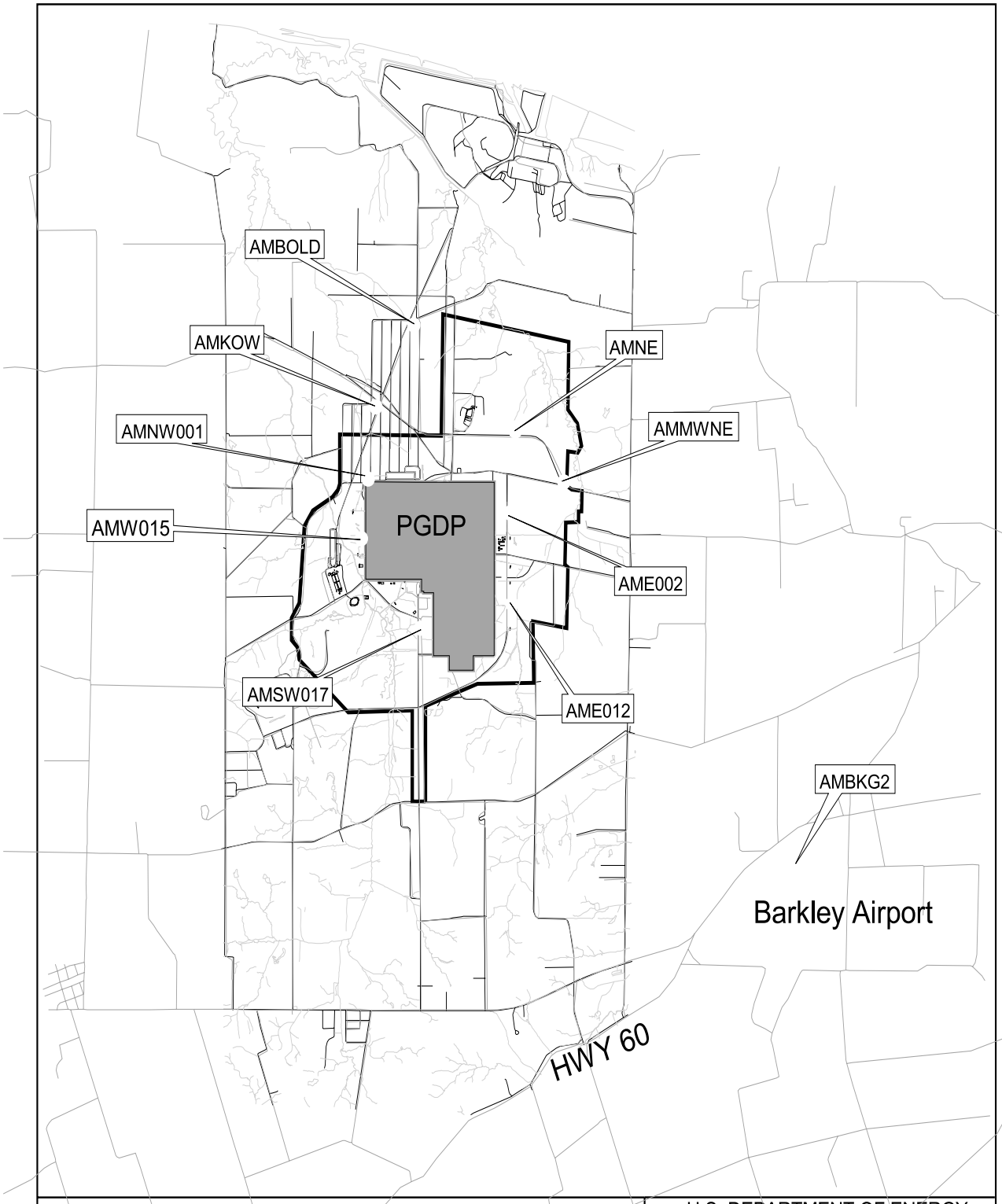

Figure 5.1 Paducah Site ambient air monitoring stations

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2005 are listed in Section 2, Table 2.1, of the *Environmental Monitoring Results Annual Site Environmental Report for CY 2005* (PRS 2006). Airborne radionuclides emitted from the Paducah Site (including both DOE and USEC emissions) were at or below background as measured by the ambient air monitors (KCHFS 2006).

Meteorological Monitoring

Historic on-site meteorological data are used as input to calculate radiation dose to the public (Section 6). Additional meteorological data from Barkley Regional Airport are used by some groups for inputs into reporting. For example, the Environmental Restoration Program uses these data to correlate precipitation with groundwater flow.

Computer-aided atmospheric-dispersion modeling uses emission and meteorological data to determine the impacts of plant operations to the community. Modeling is used to simulate the transport of air contaminants and predict the effects of abnormal airborne emissions from a given source. In addition, a multitude of emergency scenarios can be developed to estimate the effects of unplanned releases to employees and population centers downwind of the source.

Surface Water

Paducah Site surface-water runoff is released through plant outfalls either to the west in Bayou Creek or to the east in Little Bayou Creek. These merge north of the site and discharge into the Ohio River. The net impact of the Paducah Site on surface waters is evaluated by comparing data from samples collected upstream of the site with data from samples collected downstream of the site or from background waterways. Bayou Creek and Little Bayou Creek are not used as drinking water supplies, and EPA safe-drinking-water standards do not apply. Radioactive effluents are managed in accordance with DOE Order 5400.5.

Table 5.1 shows the radiological analytical parameters analyzed under the quarterly surveillance surface-water sampling program. This table does not include the quarterly seep locations, which are upwellings of groundwater in the Little Bayou Creek bed. Similar to the groundwater sampling program, fewer radiological analytical parameters, alpha activity, beta activity, and ^{99}Tc are collected.

Figure 5.2 shows 21 surveillance surface-water sampling and two seep locations. Radiological sampling is conducted at upstream Bayou Creek (L1); downstream Bayou Creek (L5 and L6), downstream Little Bayou Creek (L11, L12, and L241); the convergence of both creeks (L8), upstream Ohio River (L29), downstream Ohio River (L30); downstream Ohio River at the confluence with the Mississippi River (L306), which is the closest public drinking water supply source downstream of the plant; and background stream Massac Creek (L64). Samples also were collected near the plant from Bayou Creek (C612, C616, K001, K015, S31, and L291), Little Bayou Creek (L10 and L194), and at the C-746-K Landfill (C746K-5 and C746KTB1). No sample point exists for upstream Little Bayou Creek because the watershed is insufficient to develop adequate flow to monitor. Nearly all water in Little Bayou Creek is comprised of discharges from plant outfalls; therefore, background water quality for Little Bayou Creek is based on L1 (upstream Bayou Creek). Sampling locations L29 (Ohio River) and L64 (Massac Creek) are background waterways that also are used for comparison with data from Little Bayou Creek. Locations in Little Bayou Creek (LBCSP5 and LBCSP6), known as seeps, are upwellings of groundwater in the Little Bayou Creek bed. Two locations were chosen to sample each quarter to trend and observe changes in data. These seeps are located downstream of the plant site approximately halfway between the site and the Ohio River (Figure 5.2).

The surface water results are compared to the DCGs that are given in DOE order 5400.5. These values are concentrations that would result in a dose of 1 mrem from one isotope and one exposure pathway.

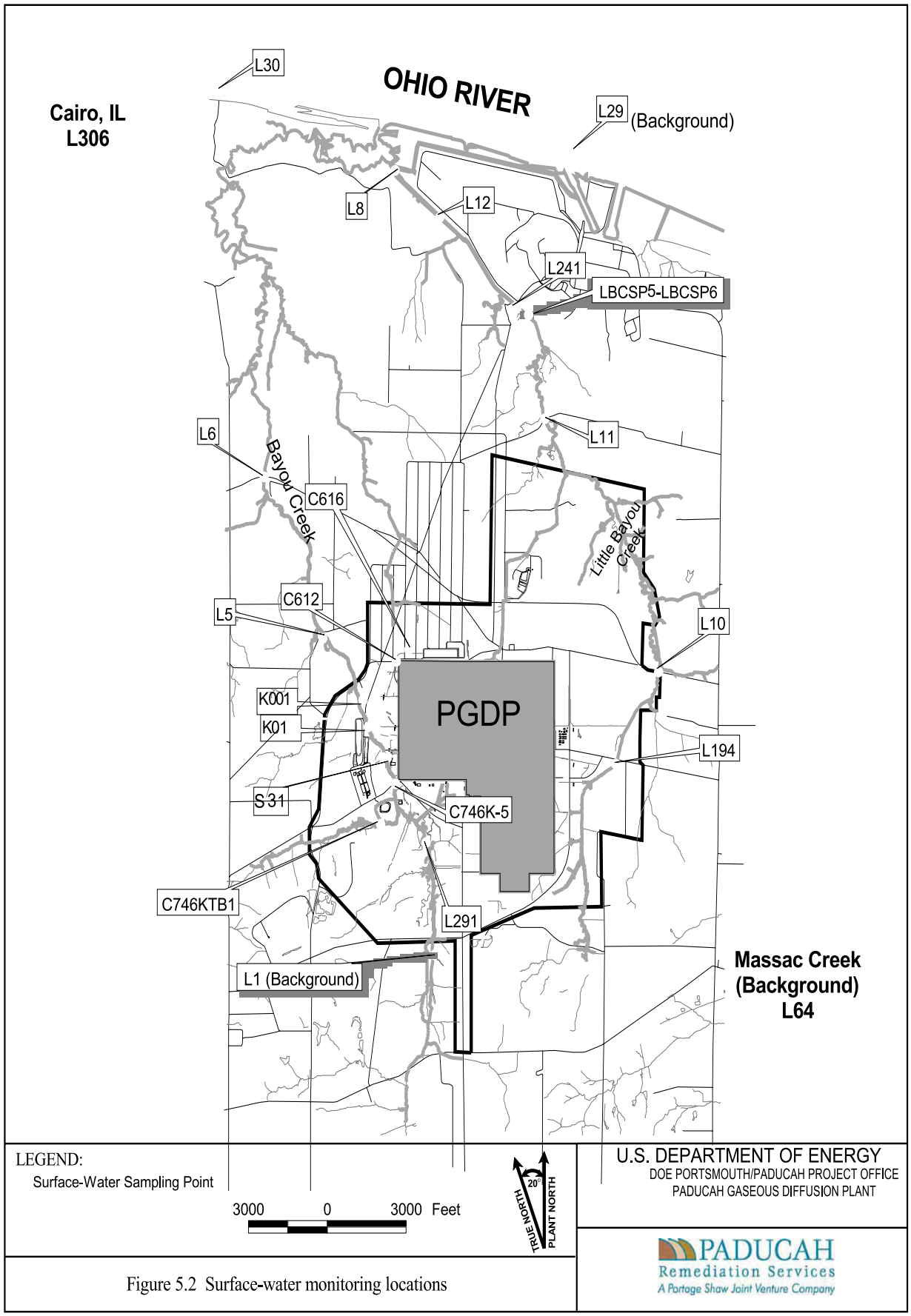

Figure 5.2 Surface-water monitoring locations

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Table 5.1. Radiological Parameters for Surface Water Samples

Parameter
Americium-241
Cesium-134
Cesium-137
Cobalt-60
Dissolved Alpha
Dissolved Beta
Neptunium-237
Plutonium-238
Plutonium-239/240
Potassium-40
Suspended Alpha
Suspended Beta
Technetium-99
Thorium-228
Thorium-230
Thorium-232
Thorium-234
Uranium
Uranium-234
Uranium-235
Uranium-238

Surface Water Surveillance Results

Table 5.2 provides the average concentrations of radionuclides upstream and downstream of plant effluents in Bayou Creek, downstream of plant effluents in Little Bayou Creek; at the C-746-K Landfill; near the site in Bayou Creek and Little Bayou Creek; at the convergence of Bayou Creek and Little Bayou Creek; upstream and downstream in the Ohio River and at the confluence of the Mississippi River (Cairo, Illinois); and at the background stream, Massac Creek.

Comparisons of downstream data with upstream data and background waterways were made to determine the influence of plant effluents on these waterways. Concentrations of ^{99}Tc were elevated near the plant site and in downstream creek locations, including the creek convergence, with the highest concentrations found downstream of plant effluents in Little Bayou Creek (Figure 5.2). These concentrations are well below the Northwest Plume Interim Remedial Action target treament level of 900 pCi/L and below the EPA maximum contaminant limit of 900 pCi/L. Locations near the plant site and downstream Bayou and Little Bayou Creeks showed some elevated results of other radionuclides. The level of radiological parameters seen at the C746-K Landfill was similar to those found upstream of Bayou Creek. Radionuclides were not detected at Massac Creek. Uranium radionuclides were found upstream and downstream of PGDP in the Ohio River and at L306 in Cairo, Illinois (the nearest public drinking water source). Concentrations of radionuclides in surface water effluents at the Paducah Site were far below DCGs and did not pose a health risk. Appendix B provides the DCGs.

Table 5.3 provides the average concentrations of radiological parameters at the seep locations. Results indicate that higher levels of alpha and beta activity and ^{99}Tc were seen at LBCSP5 than at other surface-water locations on Little Bayou Creek; however, these concentrations are well below the Northwest Plume Interim Remedial Action target treatment level 900 pCi/L, below the EPA maximum contaminant limit of 900 pCi/L, and below the DCGs. Additional radiological surface-water data are presented in Tables 2.2 through 2.30 in Volume II, Section 2 of the *Environmental Monitoring Results Annual Site Environmental Report for CY 2005* (PRS 2006).

When compared to the DCGs, established by DOE Order 5400.5 as screening values for the protection of members of the public and the environment, radiological parametes were not found in concentrations greater than DCGs at any surface water location sampled in 2005.

Table 5.2. Average Radiological Parameter Concentrations for Surface Water Surveillance Samples[a]

Parameter	DCG[b]	Upstream Bayou[1]	Bayou Near Site[2]	Downstream Bayou[3]	Little Bayou Near Site[4]	Downstream Little Bayou[5]	Creek Convergence[6]	C-746-K Landfill Area[7]	Upstream Ohio River[8]	Downstream Ohio River[9]	Massac Creek[10]	Cairo, IL [11]
Dissolved Alpha (pCi/L)	--	ND	9	5.2	5.9	ND	5.5	ND	ND	ND	ND	ND
Dissolved Beta (pCi/L)	--	ND	33	17	15	15	17	ND	15	9.8	ND	18
Neptunium-237 (pCi/L)	30	ND	ND	ND	ND	0.21	ND	ND	ND	ND	ND	ND
Plutonium-238 (pCi/L)	--	ND	ND	ND	ND	ND	ND	0.21	ND	ND	ND	ND
Potassium-40 (pCi/L)	7000	ND	69	ND	36	39	ND	ND	ND	ND	ND	ND
Suspended Alpha (pCi/L)	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	7.7	ND
Suspended Beta (pCi/L)	--	ND	60	ND	ND	ND	ND	ND	ND	7.4	ND	ND
Technetium-99 (pCi/L)	100,000	20	24	ND	ND	39	18	ND	ND	19	ND	19
Thorium-230 (pCi/L)	300	0.39	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Thorium-232 (pCi/L)	--	ND	ND	ND	ND	0.21	ND	ND	ND	ND	ND	ND
Thorium-234 (pCi/L)	10,000	ND	110	ND	ND	ND	ND	ND	ND	ND	ND	ND
Uranium (mg/L)	--	ND	0.009	ND	0.012	0.015	0.007	ND	ND	ND	ND	ND
Uranium (pCi/L)	600	ND	11	ND	4.7	ND	3.7	ND	ND	ND	ND	ND
Uranium-234 (pCi/L)	500	0.52	3.6	0.59	0.64	0.74	0.58	ND	0.19	ND	ND	0.22
Uranium-235 (pCi/L)	600	ND	0.29	ND	0.14	ND	ND	ND	ND	ND	ND	ND
Uranium-238 (pCi/L)	600	0.52	3.1	0.55	2.7	1.2	0.95	0.16	0.15	0.17	ND	0.21

a = Average concentration for the seep locations (LBCSP5–LBCSP6) are found in Table 5.3.
b = Derived Concentration Guide (see Liquid Effluents section for definition).
c = Quantities of total uranium were found to be quite small or not detected; individual isotopes of uranium were not analyzed.
-- = DCGs for these radionuclides not provided.
ND=Not Detected

The following footnotes correspond with column titles in the above table. These are groupings of sample locations in the area described in the title.
1 = L1 (Background)
2 = C612, C616, K001, K015, L291, S31
3 = L5, L6
4 = L10, L194
5 = L11, L12, L241
6 = L8
7 = C746K-5, C746KTB1
8 = L29 (Background)
9 = L30
10 = L64 (Background)
11 = L306

Table 5.3. Average Radiological Concentrations for Seep Locations in Little Bayou Creek

Parameter	LBCSP5	LBCSP6
Alpha activity (pCi/L)	6.5	4.7
Beta activity (pCi/L)	180	124
Technetium-99 (pCi/L)	236	170
Uranium (pCi/L)	0.17	0.72

Sediment

Sediment is an important constituent of the aquatic environment. If a pollutant is a suspended solid or attached to suspended sediment, it can either settle to the bottom (thus creating the need for sediment sampling), be taken up by certain organisms, or become attached to plant surfaces. Pollutants transported by water can adsorb on suspended organic and inorganic solids or be assimilated by plants and animals. Suspended solids, dead biota, and excreta settle to the bottom and become part of the organic substrata that support the bottom-dwelling community of organisms. Sediments play a significant role in aquatic ecology by serving as a repository for radioactive or chemical substances that pass via bottom-feeding biota to the higher trophic levels.

Sediment Surveillance Program

Because DOE retained responsibility for historic environmental issues, ditch sediments are sampled semiannually through a radiological environmental surveillance program. Table 5.4 shows the radiological analytical parameters. Sediment samples were taken from 13 locations (Figure 5.3).

Table 5.4. Radiological Parameters for Sediment Samples

Parameter
Alpha Activity
Americium-241
Beta Activity
Cesium-137
Cobalt-60
Neptunium-237
Plutonium-239/240
Potassium-40
Technetium-99
Thorium-230
Uranium
Uranium-234
Uranium-235
Uranium-238

Sediment Surveillance Results

Table 5.5 shows the upstream concentrations of radionuclides in the sediments compared with concentrations downstream of all DOE outfalls for 2005. Locations S27, S33, and S34 are downstream of plant effluents. Locations S20 and S28 are considered reference, or background sites, and can be compared with downstream data. Location S20 at Bayou Creek is upstream of plant discharges, whereas S28 is located in a similar, off-site stream (Massac Creek) and provides a regional reference site. Locations K001, C616, C612, S1, S2, C746KTB2, L194, S31, and S32 are near the plant site and are downstream of certain plant discharges, but not downstream all discharges (Figure 5.3).

In general, the location with the highest readings for most radionuclides is the NSDD (Table 5.5). Remediation activities of the NSDD were completed for Sections 1 and 2. Access to this area is limited.

Uranium activity is elevated in Little Bayou Creek and Bayou Creek near the plant site and downstream. The downstream location (S34) on Little Bayou Creek corresponds with the surfacewater seep sites (LBCSP5 and LBCSP6) previously mentioned.

Other radionuclides, although present, are not significantly above background levels. Additional sediment data are presented in Tables 2.31 through 2.46 in Volume II, Section 2 of the *Environmental Monitoring Results Annual Site Environmental Report for CY 2005* (PRS 2006).

Areas that contain elevated radionuclide levels are controlled within the DOE property boundaries or are posted for protection of the public.

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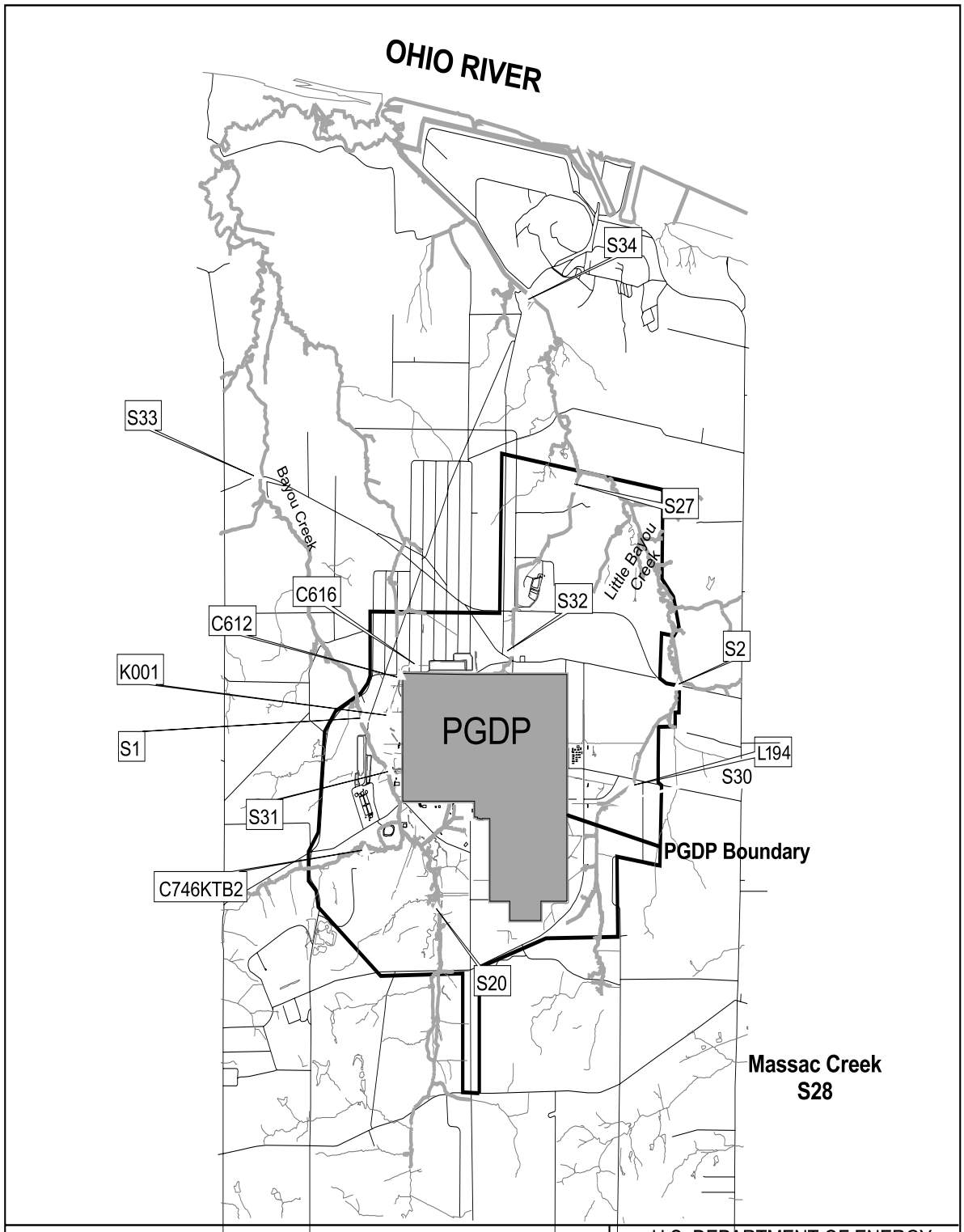

Figure 5.3 Sediment monitoring locations

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Table 5.5 Average[a] Radiological Parameter Concentrations for Sediment Surveillance Samples

Parameter	Upstream Bayou[1]	Bayou Near Site[2]	Downstream Bayou[3]	Little Bayou Near Site[4]	Downstream Little Bayou[5]	C-746-K Area[6]	NSDD[7]	Massac Creek[8]
Alpha Activity (pCi/g)	2.7	16	3.4	6.7	5.1	2.5	76	0.93
Americium-241(pCi/g)	ND	0.048	ND	0.13	0.051	ND	1.3	0.027
Beta Activity (pCi/g)	1.6	70	3.2	11	6.6	1.8	100	0.98
Cesium-137 (pCi/g)	ND	0.22	0.066	ND	0.034	0.032	1.1	ND
Neptunium-237 (pCi/g)	ND	0.21	ND	ND	0.019	ND	1.4	ND
Plutonium-239/240 (pCi/g)	ND	0.14	0.0097	0.034	0.1	ND	5.9	ND
Potassium-40 (pCi/g)	2.1	5.1	3.5	3.9	4.1	3.5	7.3	1.9
Technetium-99 (pCi/g)	0.77	8.9	0.47	0.34	0.94	0.41	30	0.26
Thorium-230 (pCi/g)	0.16	1.2	0.2	0.4	1.4	0.18	100	0.1
Uranium (pCi/kg)	290	9700	1100	6400	3200	ND	15000	450
Uranium-234 (pCi/g)	0.17	4.8	0.51	1.2	0.75	0.2	6.7	0.32
Uranium-235 (pCi/g)	0.011	0.24	0.03	0.12	0.067	ND	0.42	0.025
Uranium-238 (pCi/g)	0.12	4.7	0.57	5	2.4	0.15	8.3	0.11

a = The average within each group of locations.
ND = Not Detected

The following footnotes correspond with column titles in the above table. These are groupings of sample locations in the area described in the title.
1 = S20
2 = C612, C616, K001, S1, S31
3 = S33
4 = S2, L194
5 = S27, S34
6 = C746KTB2
7 = S32
8 = S28

Terrestrial Wildlife

Annual Deer Harvest

In 2005, a total of five deer were harvested in the WKWMA as part of DOE's ongoing effort to monitor the effects of the Paducah Site on the ecology of the surrounding area. No reference deer were collected in 2005 due to sufficient historical references information available; therefore, historical data were used for comparison. Liver, muscle, and bone samples were analyzed for several radionuclides [cesium-137 (^{137}Cs), ^{237}Np, ^{239}Pu, ^{99}Tc, thorium-230 (^{230}Th), uranium-234 (^{234}U), uranium-235 (^{235}U), uranium-238 (^{238}U), and strontium-90 (^{90}Sr) (bone samples only)]. In addition, thyroid samples were analyzed for ^{99}Tc. Because the liver and muscle tissues are considered consumable by humans, these tissues can be evaluated for radiological risks (dose) if analyses reveal detectable levels above background, or levels found in reference deer. Bone and thyroid samples are used only as indicators of contamination.

The 2005 data showed no detectable radionuclides in the edible portions of the site deer. Therefore, dose assessments conclude that there is no significant difference between the radiological dose from site deer and background deer. Dose assessments indicate that deer are acceptable for consumption and levels are consistent with previous years' data.

The thyroid and bone are not considered edible portions of deer, but rather as indicators of the presence of target radionuclides. Specifically, ^{90}Sr accumulates in the bone and ^{99}Tc accumulates to some lesser degree in the thyroid. In 2005, all results were less than the analytical detection limit for ^{90}Sr in the bone and ^{99}Tc in the thyroid for both WKWMA deer and in 2002 for background deer from Stewart Island.

Additional deer data are presented in Tables 2.48 through 2.51 in Volume II, Section 2 of the *Environmental Monitoring Results Annual Site Environmental Report for CY 2005* (PRS 2006). Section 6 discusses dose calculations associated with eating deer from the WKWMA.

Direct Radiation

A primary concern of DOE's operations at the Paducah Site is direct external radiation exposure. External radiation exposure is defined as exposure attributed to radioactive sources outside the body (e.g., cosmic gamma radiation). Sources of external radiation exposure at the Paducah Site include the cylinder storage yards, the cascade system, and small sources such as instrument check locations. Cylinder storage yards have the largest potential for a dose to the public because of their proximity to the PGDP security fence.

The *Paducah Site Environmental Monitoring Plan* (BJC 2004a) establishes DOE's program for monitoring external gamma radiation at areas accessible to members of the public. The External Radiation Exposure Monitoring Program has the following three objectives:

1. To establish the potential radiation dose a member of the public may receive from direct exposure to DOE operations at the boundary of the DOE perimeter fence;

2. To establish the potential dose a member of the public may receive while visiting or passing through accessible portions of the DOE reservation; and

3. To calculate the radiation dose equivalent for the maximally exposed individual member of the public.

In 2005, monitoring consisted of quarterly placement, collection, and analysis of environmental thermoluminescent dosimeters (TLDs). These monitoring locations are shown in Figure 5.4. Monitoring results indicate that nine of 46 locations were consistently above background levels (BJC 2006a). These locations were all at or near the PGDP security fence in the vicinity of UF_6 cylinder storage yards, in areas not accessible to members of the public.

Annual dose rates for the background locations and nine locations above background were calculated. Based on the analysis of TLDs placed away from DOE property, the mean annual background exposure was determined to be 95 milliRoentgen (mR) (BJC 2006). See the *Annual Report on External Gamma Radiation Monitoring for Calendar Year 2005, Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (BJC/ PAD-763). For each location, the mean background exposure was subtracted from the annualized total exposure to obtain a net annual exposure. The net annual exposure represents the total exposure at that location, for the entire CY 2005 attributed to the Paducah Site (Table 5.6). Exposure measured at these locations is assumed to result from DOE operations. Since the locations shown in Table 5.6 are in areas not accessible to members of the public, dose from direct radiation exposure to the maximally exposed individual member of the public from DOE operations is zero. Detailed information is discussed further in Section 6. Additional data are presented in Section 2, Table 2.47 of the *Environmental Monitoring Results Annual Site Environmental Report for CY 2005* (PRS 2006). Section 6 discusses dose calculations associated with direct radiation exposure.

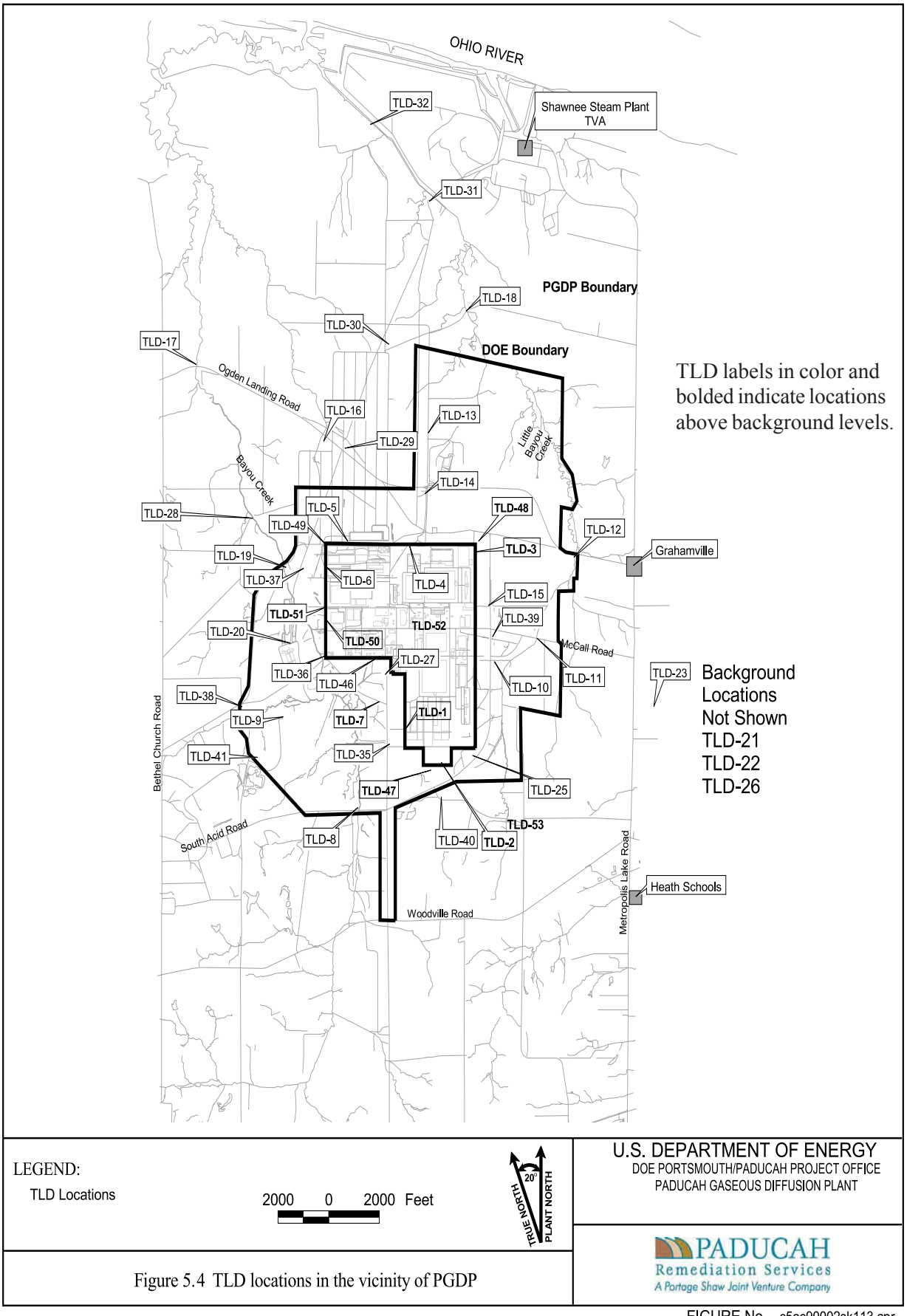

Figure 5.4 TLD locations in the vicinity of PGDP

FIGURE No. c5ac90002sk113.apr
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Table 5.6. Net Annual Exposure from Direct Radiation Attributed to the Paducah Site for 2005 (mR)

Location	TLD-1	TLD-2	TLD-3	TLD-25	TLD-47	TLD-48	TLD-50	TLD-52	TLD-53
Total annual exposure	1114	980	213	123	340	126	122	106	408
Background[a]	95	95	95	95	95	95	95	95	95
Net annual exposure[b]	1019	885	118	28	245	31	27	11	313

a Background is calculated based on the analysis of TLDs placed away from DOE property (BJC 2006). See the *Annual Report on External Gamma Radiation Monitoring for Calendar Year 2005, Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (BJC/PAD-763).

b Locations above with net annual exposure from direct radiation above background levels are in areas not accessible to the public.

6 Dose

Abstract

For 2005, exposure pathways potentially contributing to dose were determined to include ingestion of surface water, ingestion of sediments, ingestion of deer meat, direct radiation, and atmospheric releases. The highest estimated dose a maximally exposed individual might have received from all combined DOE exposure pathways (worst-case scenario) was 0.55 mrem. This dose is less than 1 percent of the applicable federal standard of 100 mrem per year.

Introduction

This section presents the calculated doses to individuals and the surrounding population from atmospheric and liquid releases from the Paducah Site, as well as direct radiation (Sections 4 and 5). In addition, potential doses from special-case exposure scenarios, such as deer meat consumption, were calculated based upon deer sample analyses. Doses from naturally occurring sources are discussed in Appendix A. The highest estimated dose a maximally exposed individual might have received from all combined DOE exposure pathways (worst-case scenario) was 0.55 mrem. This dose is less than 1 percent of the applicable federal standard of 100 mrem per year.

DOE Order 5400.5, *Radiation Protection of the Public and the Environment,* limits the dose to members of the public to less than 100 mrem per year total effective dose equivalent from all pathways resulting from operation of a DOE facility. Information on the demography and land use of the area surrounding the plant and identification of on-site sources have indicated radionuclides and exposure pathways of concern.

For the Phase I Remedial Action SI, a preliminary assessment of risk to public health from contaminants at the Paducah Site was conducted. This study identified the following four primary pathways that each could contribute greater than 1 percent to the total off-site dose: (1) groundwater ingestion, (2) sediment ingestion, (3) wildlife ingestion, and (4) exposure to direct radiation. Since that preliminary assessment, groundwater wells that supplied drinking water in the downgradient direction from PGDP have been replaced with public drinking water, resulting in the loss of that pathway. Surface water is not considered to be the primary pathway for water ingestion. In addition, the NWPGS began operation in 1995, resulting in an airborne pathway that now is included in the dose calculations. In 2005, the NEPCS, the Scrap Metal Removal Projects, and the C-410 D&D activities also were added to the airborne dose. Furthermore, in 1999, a drinking water pathway was added for consumption of surface water at the nearest public drinking water source [Ohio River at Cairo, Illinois (L306)].

To fully assess the potential dose to the public, a hypothetical group of extreme characteristics was used to postulate an upper limit to the dose of any

real group. This is referred to as the worst-case scenario. The actual dose received is likely to be considerably less than the dose calculated.

Terminology and Internal Dose Factors

Most consequences associated with radionuclides released to the environment are caused by interactions between human tissue and various types of radiation emitted by the radionuclides. These interactions involve the transfer of energy from radiation to tissue and could result in tissue damage. Radiation may come from radionuclides outside the body or from radionuclides deposited inside the body (by inhalation, ingestion, and, in a few cases, absorption through the skin). Exposures to radiation from radionuclides outside the body are called external exposures; exposures to radiation from radionuclides inside the body are called internal exposures. This distinction is important because external exposure occurs only as long as a person is near the external radionuclide; simply leaving the area of the source will stop the exposure. Internal exposure continues as long as the radionuclide remains inside the body.

A number of specialized terms or quantities have been defined for characterizing exposures to radiation as defined in Appendix A. Because the damage associated with such exposures results primarily from the deposition of radiant energy in tissue, the exposure is defined in terms of the amount of incident radiant energy absorbed by tissue and the biological consequences of that absorbed energy. These terms or quantities include the following:

- *Committed effective dose equivalent (CEDE)*—the total internal dose (measured in mrem) received over a 50-year period resulting from the intake of radionuclides in a one-year period. The CEDE is the product of the annual intake (pCi) and the dose conversion factor for each radionuclide (mrem/pCi).

- *Effective dose equivalent*—includes the CEDE from internal deposition of radionuclides and the dose from penetrating radiation from sources external to the body. This is a risk-equivalent value and can be used to estimate the health-effects risk to the exposed individual.

- *Total effective dose equivalent*—includes the sum of the effective dose equivalent (for external exposures) and the CEDE (for internal exposures). For purposes of compliance, dose equivalent to the whole body may be used as the effective dose equivalent for external exposures.

Internal dose factors for several radionuclides of interest at the Paducah Site are included in Appendix A.

Authorized Limits

DOE Authorized Limits were established for the landfill in May 2004 under DOE Order 5400.5. The limits are based on conservative modeling to assure that the annual dose to workers will not exceed 2.1 mrem per year, and that other potential users of the site and members of the public will not receive more than one mrem of additional radiation per year as a result of landfill operations. The authorized limits apply to the disposal into the C-746-U Landfill of soil, metal and debris wastes generated from construction, maintenance, environmental restoration, and D&D activities at the PGDP.

Direct Radiation

In 2005, DOE conducted continuous monitoring for direct external radiation exposure (Section 5). Access to PGDP is limited due to the increased security boundary implemented in September 2001. The monitoring results indicate due to limited access of the public to radioactive source areas, that the dose to the maximally exposed individual member of the public (i.e., the neighbor living closest to the PGDP security fence) from DOE operations did not vary statistically from background (BJC 2006a).

For purposes of this ASER, an additional potential receptor was considered. In a conservative exposure scenario, this receptor is assumed to be exposed to the location at TLD-14 for 8.3 hours for the year. The 8.3 hours-per-year assumption is based on an individual driving past this location

twice per day at 1 minute per trip, five days per week, 50 weeks per year. It is likely that actual exposure at this location is probably much less than assumed because any shielding from the receptor's vehicle is not considered. The closest location that would be accessible to the public in 2005 was TLD14, which is near Harmony Cemetery located north of the plant security fence and south of Ogden Landing Road (Figure 5.6). This location resulted in external radiation exposures below background. Based on results from this location and other data obtained from all locations, the dose to the maximally exposed individual member of the public from DOE operations was zero.

Surface Water

The most common surface water pathway for exposure is through drinking water containing radionuclides. Surface water pathway dose was calculated for an individual assumed to consume water from the public drinking water supply at Cairo, Illinois (L306). Cairo is the closest drinking water system (approximately 30 miles downstream) that uses water downstream of PGDP effluents. Cairo is located at the confluence of the Ohio and Upper Mississippi Rivers. The average concentrations of radionuclides that were detected in Cairo were used to calculate the dose resulting from consumption of surface water. The radionuclides that were detected in Cairo were ^{234}U, ^{238}U, and ^{99}Tc. ^{99}Tc was only detected in one out of four sampling events and ^{234}U was detected in two of the four events. The maximally exposed receptor was assumed to consume all of their daily required water, 8 glasses each containing 8 ounces (a total of approximately 2 L), 365 days a year from the public drinking water supply. The maximum dose to an individual, without subtracting the background dose, was determined to be 0.07 mrem in 2005. The background dose, taken at Massac Creek, was determined to be 0.022 mrem in 2005. Therefore, the resulting net exposure to the maximally exposed receptor from the Paducah Site was 0.048 mrem, which is significantly less than the 100 mrem allowed by DOE Order.

Contaminated Sediment

Exposure to contaminated sediment in Bayou Creek and Little Bayou Creek could occur during fishing, hunting, or other recreational activities. Exposure is possible through incidental ingestion of contaminated sediment. The worst-case ingestion assumption is that an individual would splash around in one of the creeks every other day during the hunting season and ingest a small amount of sediment each visit (50 mg/day). A dose is then calculated based on the radionuclide concentrations and the amount of exposure via ingestion. Massac Creek samples are assumed to be background and are subtracted from downstream sample results to arrive at a dose associated with site releases. The downstream location with the maximum dose is assumed to represent the dose received from this pathway by the maximally exposed individual.

Doses are calculated for ingestion of sediments for both Bayou Creek and Little Bayou Creek. The worst-case dose was calculated to be at S32, the NSDD (Figure 5.3). The estimated worst-case dose above background from sediment ingestion was 0.50 mrem in 2005. This exposure pathway is by far the major contributor to the worst-case combined exposure to the public and it is significantly less than the DOE annual dose limit of 100 mrem/year. Sediment sample locations were shown in Figure 5.3. Dose results for all locations are provided in Table 6.1.

Ingestion of Deer

The effect of an intake of a radionuclide by ingestion depends on the concentration of the radionuclide in food and drinking water and on the individual's consumption patterns. The estimated intake of a radionuclide is multiplied by the appropriate ingestion dose factor to provide the estimate of CEDE resulting from the intake.

Terrestrial wildlife, such as deer, can come into contact with contaminated soil, ingest plants that have taken up contaminants, or ingest contaminated water. Hunting is permitted in the WKWMA surrounding the Paducah Site, and the limit for deer harvest is two deer per person per season. Approximately 100 deer are harvested per year from WKWMA. The Paducah Site dose calculations assume that an individual kills two average-weight deer and consumes the edible

Table 6.1 Annual Dose Estimates for 2005 Incidental Ingestion of Sediment from Bayou Creek and Little Bayou Creek.

Location	Committed Effective Dose Equivalent (mrem)										Total (mrem)
	^{241}Am	^{137}Cs	^{237}Np	$^{239/240}$Pu	^{40}K	^{99}Tc	^{230}Th	^{234}U	^{235}U	^{238}U	
S1	---	---	0.0016	0.00033	0.00019	9.6E-06	0.00071	0.0019	0.0011	0.0022	0.008
S2	0.0014	---	---	---	0.00034	2.6E-06	0.0006	0.0016	0.0024	0.0079	0.012
S20	---	---	---	---	0.00022	5.3E-06	0.00045	0.00023	---	0.00015	0.0031
S27	0.0019	0.000011	0.00051	0.0037	0.0004	6.8E-06	0.005	0.0013	0.00457	0.0042	0.018
S28 (Background)	0.00064	---	---	---	0.0002	1.8E-06	0.00029	0.00045	---	0.00014	0.0058
S31	0.0016	0.000072	0.003	0.01	0.00043	0.000017	0.011	0.014	0.002	0.0057	0.048
S32 (Maximum)	0.031	0.0003	0.029	0.13	0.00073	0.00021	0.29	0.0092	0.0011	0.01	0.51
S33	---	0.000018	---	0.00022	0.00035	3.2E-06	0.00056	0.00071	0.00096	0.0007	0.0035
S34	0.00054	8.3E-06	0.00027	0.0014	0.00042	6.2E-06	0.0026	0.00071	0.00074	0.0018	0.0085
C612	0.0009	0.00015	0.013	0.0027	0.0008	0.00023	0.0027	0.011	0.00081	0.014	0.046
C616	0.00064	0.000017	0.0024	0.0018	0.0005	0.000034	0.0019	0.0042	0.00086	0.0048	0.017
C746KTB2	---	8.4E-06	---	---	0.00035	2.8E-06	0.00051	0.00028	---	0.00018	0.0013
L194	0.005	---	---	0.00076	0.00045	2.1E-06	0.0016	0.0018	0.00063	0.0044	0.015
K001	---	0.000016	0.00065	0.00066	0.00063	0.000019	0.0012	0.0019	0.00089	0.0023	0.0083
	[a]Net exposure from Paducah Site to maximally exposed individual (S32—S28) =										**5.0e-1**

--- nondetect
^{241}Am Americium-241
$^{239/240}$Pu Plutonium-239/240
^{40}K Potassium-40
[a]Maximum allowable exposure is 100 mrem/year for all contributing pathways (DOE Order 5400.5).

portions of those deer during the year (approximately 100 pounds of meat and five pounds of liver). The dose is calculated for each deer sampled.

In 2005, five deer from the Paducah Site were sampled. No reference deer was collected in 2005; therefore, historical data were used for comparison. In 2005, the results of the site deer did not vary significantly from the background deer values. The site dose contribution is essentially less than 0 mrem (Hampshire 2006).

Airborne Radionuclides

The DOE's radionuclide airborne point-sources that contributed to the public dose in 2005 included four sources. These sources were the NWPGS, the NEPCS, the Scrap Metal Removal Projects, and the C-410 D&D Fluorine Cell Blasting Project. The four point sources were discussed in Section 4. These point-sources were reviewed or monitored to determine the extent to which the general public could be exposed and to demonstrate compliance with EPA regulations that are based on International Commission on Radiological Protection (ICRP) publications (ICRP 1980).

The 50-year CEDE (internal) from DOE air sources to the maximally exposed individual, who under most circumstances is the person living closest to the plant in the predominant wind direction, is calculated each year. EPA-supplied CAP-88 software was used to calculate the off-site dose from PGDP air emissions. This software provides a framework for developing dose and risk assessments for the purpose of demonstrating compliance with 40 *CFR* 61.93(a). It assesses both collective populations and maximally exposed individuals. The dose to the maximally exposed individual from DOE radioactive air emissions was calculated to be 1.8×10^{-5} mrem from the NWPGS; 6.3×10^{-6} mrem from the NEPCS, 2.2×10^{-4} mrem from the Scrap Metal Removal Projects, and 1.1×10^{-7} mrem from the C-410 D&D Activities. If an individual was to receive the maximum dose from each of these sources, it would add up to approximately

0.00024 mrem, which is well below the 10 mrem limit of 40 *CFR* Part 61, Subpart H.

Conclusions

Table 6.2 provides a summary of the dose for 2005 from the Paducah Site that could be received by a member of the public assuming worst-case exposure from all major pathways. The largest contributor to the calculated dose is from ingestion of sediment. The groundwater pathway from DOE sources is assumed to contribute no dose to the population because all residents have been supplied with public water by DOE. The worst-case combined (internal and external) dose to an individual member of the public was calculated at 0.55 mrem. This level is well below the DOE annual dose limit of 100 mrem/year to members of the public and below the EPA limit of 10 mrem airborne dose to the public.

Estimates of radiation doses presented in this report were calculated using the dose factors provided by DOE and EPA guidance documents. These dose factors are based on ICRP Publication 30 (ICRP 1980). Figure 6.1 shows the potential (worst-case) annual dose as calculated for the past five years.

Table 6.2 Summary of Potential Radiological Dose from the Paducah Site for 2005
(worst-case combined exposure pathways)

	Dose[a] (mrem/year)	Percent of total
Ingestion of surface water	0.048	10.9
Ingestion of sediments	0.50	89.1
Ingestion of deer meat	0	0
Direct radiation	0	0
Atmospheric releases[b]	2.4×10^{-4}	0
Total annual dose above background (all pathways)	**0.55**	**100**

[a] Maximum allowable exposure is 100 mrem/year (DOE Order 5400.5).

[b] DOE source emissions were from the NWPGS, the NEPCS, the Scrap Metal Removal Projects, and the C-410 D&D Fluorine Cell Blasting Activities.

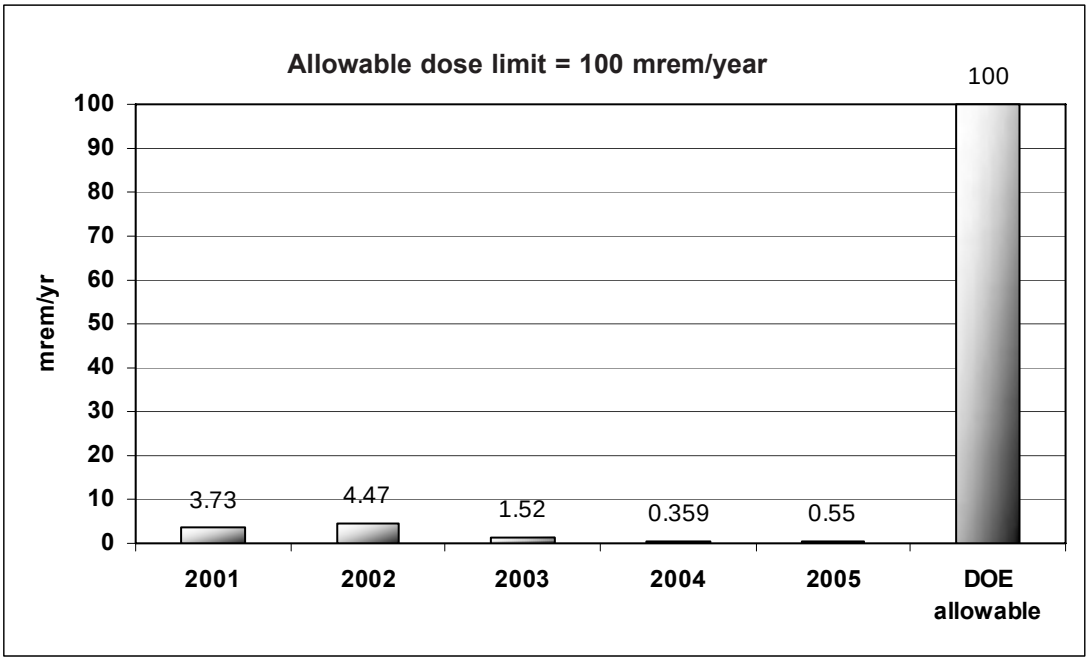

Figure 6.1. Potential Radiological Dose from DOE Activities at the Paducah Site, 2001–2005

7 Nonradiological Effluent Monitoring

Abstract

In 2005, two KPDES outfalls at the Paducah Site experienced exceedences for toxicity. Outfall 001 exceeded reportable KPDES effluent discharge permit limits for chronic toxicity. Outfall 017 exceeded reportable KPDES effluent discharge permit limits for acute toxicity. The DOE had two point sources and several fugitive sources for nonradiological air emissions. The combined emissions from these DOE sources were small; therefore, the Paducah Site is considered a minor source in accordance with the CAA.

Introduction

Responsibility for nearly all nonradioactive airborne emission sources at PGDP was turned over to USEC as a result of the 1993 lease agreement between USEC and DOE. Only a few fugitive sources, such as gravel roads, spoil piles (resulting from construction excavation), metal scrap pile windage, and three point sources remained the responsibility of DOE in 2005. The small amount of emissions from DOE sources results in CAA classification of the Paducah Site as a minor air emissions source.

Monitoring of nonradiological parameters in liquid effluents is summarized in the *Paducah Site Environmental Monitoring Plan* (BJC 2004a) and is based on KPDES Permit KY0004049, and KDWM landfill permits 073-00014, 073-00015, and 073-00045. Effluents are monitored for nonradiological parameters listed on the permit governing the discharge.

Airborne Effluents

Airborne Effluent Applicable Regulations

The KDAQ administers much of the CAA at the Paducah Site. The DOE has responsibility only for air emission sources under DOE program control; therefore, this report does not address emissions from the PGDP sources leased to USEC.

Airborne Effluent Monitoring Program

The point sources of air emissions other than radionuclides (Section 4) for the Paducah Site in 2005 were the NWPGS and the NEPCS. These systems, combined, removed approximately 1854 pounds (0.93 tons) of TCE, which is a VOC and HAP, from approximately 204,000,000 gallons of groundwater. These facilities remove TCE contamination from the groundwater by air stripping. At the NWPGS, TCE-laden air passes through activated carbon to remove TCE. The air stream then is released to the atmosphere where any remaining TCE naturally breaks down. The NEPCS uses the existing C-637-2A Cooling Tower at PGDP for

stripping the TCE from groundwater.

The NWPGS and NEPCS facilities operated in compliance with CERCLA decision documents during 2005.

Liquid Effluents

Liquid Effluent Applicable Regulations

The KDOW, through the KPDES Wastewater Discharge Permitting Program, administers the CWA for the Paducah Site. The sitewide KPDES permit (KY0004049) was effective April 1, 1998. A renewal permit application has been submitted to KDOW. A new permit has not been issued; therefore, the April 1, 1998, permit is still in effect. This sitewide KPDES permit contains discharge limits based on water quality criteria for a zero-flow receiving stream.

The KDWM specifies in landfill permits 07300014, 073-00015, and 073-00045 that surface runoff will be analyzed to ensure that landfill constituents are not discharging into nearby receiving streams.

Liquid Effluent Monitoring Program

The DOE conducts nonradiological effluent monitoring for outfalls under its jurisdiction (Section 4, Figure 4.2). Outfalls 001, 015, 017, and 019 were monitored for KPDES permit parameters. The specific sample collection, preservation, and analytical methods acceptable for the types of pollutants analyzed are listed in the permit and applicable regulations.

Surface runoff from the closed C-746-S Residential Landfill, the closed C-746-T Inert Landfill, and the operating C-746-U Landfill was monitored quarterly. Grab samples were monitored for chemical oxygen demand, chloride, conductivity, dissolved oxygen, dissolved solids, flow rate, iron, hydrogen-ion concentration (pH), sodium, sulfate, suspended solids, temperature, total organic carbon, and total solids. The samples taken included landfill runoff, the receiving ditch upstream of the runoff discharge point, and the receiving ditch downstream of the runoff discharge point (Section 4, Figure 4.2). Sampling was performed in compliance with the KDWM requirements for operation of the contained landfill.

Liquid Effluent Monitoring Results

Analytical results from the four DOE outfalls are reported to KDOW in monthly and quarterly discharge monitoring reports. Two exceedences of permit limits were reported in 2005 for DOE Outfall 001. One exceedence of permit limits was reported in 2005 for Outfall 017 (Table 7.1 and Section 2). Implementation of the TRE plan established that toxicity exceedances were likely caused by unlined sample tubing during sampling of Outfall 001 and was not indicative of instream water quality (see Section 2). Table 7.2 summarizes the maximum detected nonradiological analyses for samples collected as part of the required KPDES permit sampling. None of the detects reported in Table 7.2 resulted in KPDES permit violations.

Data for the KPDES samples and the surface runoff samples from the landfills are presented in Volume II, Section 3, tables 3.1 through 3.4 of the *Environmental Monitoring Results Annual Site Environmental Report CY 2005*, (PRS 2006).

Table 7.1. KPDES Permit Exceedence Summary for 2005

Location	Noncompliance Parameter	Species	Month Sampled	Result	KPDES Limit
Outfall 001	Chronic Toxicity	Fathead Minnow	February	1.2 TUc	1.0 TUc
Outfall 001	Chronic Toxicity	Fathead Minnow	February	1.8 TUc	1.0 TUc
Outfall 017	Acute Toxicity	*Fathead Minnow/Daphnids*[1]	March	1.4, 2.9 TUa	1.0 TUc

1 – *Ceriodaphnia dubia* (water fleas)
TUc – chronic toxicity unit
TUa – acute toxicity unit

Table 7.2. KPDES Permit Sampling Routine Nonradiological Maximum Detected Analyses

Parameter	K001	K015	K017	K019
Cadmium (mg/L)	ND	ND	ND	0.001
Chlorine, Total Residual (mg/L)	0.04	0.03	0.03	0.03
Copper (mg/L)	0.006	0.008	0.009	ND
Flow Rate (mgd)	74	27	5	0.8
Hardness - Total as CaCO3 (mg/L)	318	241	171	96
Iron (mg/L)	0.52	2.3	1.0	0.7
Nickel (mg/L)	0.009	0.009	0.007	ND
Oil and Grease (mg/L)	ND	10	ND	ND
PCB-1242 (µg/L)	0.11	ND	ND	ND
PCB-1254 (µg/L)	0.23	0.08	ND	ND
Phosphorous (mg/L)	0.36	NR	NR	NR
Suspended Solids (mg/L)	ND	ND	ND	30
Uranium (mg/L)	0.15	0.34	0.002	0.005
Zinc (mg/L)	0.03	0.03	0.19	ND

ND – not detected
NR – not reported/collected

8 Nonradiological Environmental Surveillance

Abstract

The nonradiological environmental surveillance program at the Paducah Site assesses the effects of DOE operations on the site and the surrounding environment. Surveillance includes analyses of air, surface water, groundwater (Section 9), sediment, soil, vegetation, terrestrial wildlife, fish, and other aquatic life. Surveillance results for 2005 were similar to results reported in previous ASERs.

Introduction

Nonradiological surveillance at the Paducah Site involves the sampling and analysis of surface water, groundwater (Section 9), sediment, soil, terrestrial wildlife, fish, and other aquatic life. This section discusses the nonradiological results of surveillance activities.

Ambient Air

As a result of the transfer of the operations of the plant to USEC in 1993, major air emission sources were transferred to USEC; therefore, DOE does not conduct ambient air monitoring for nonradiological parameters at the Paducah Site

.

Surface Water

Surface water monitoring (except for biological monitoring) downstream of KPDES outfalls is not required by the KPDES permit; however, it is performed at the Paducah Site as part of the Environmental Surveillance Program. Figure 5.2 shows surveillance surface water sampling locations. Table 8.1 shows the analytical parameters that are analyzed on a quarterly or semiannual basis.

As described in Chapter 5, locations in Little Bayou Creek (LBCSP5 through LBCSP6) were added to the surface water sampling program in 2002. These locations, known as seeps, are upwellings of groundwater in the Little Bayou Creek bed. Two locations were chosen to sample each quarter to trend and observe changes in data. These locations are downstream of the plant site approximately halfway between the site and the Ohio River (Figure 5.2). Table 8.1 does not apply to the quarterly seep locations. Similar to the groundwater sampling program, a different list of analytical parameters was collected, as presented in Table 8.2.

Surface Water Surveillance Results

Table 8.3 shows a water chemistry comparison between upstream and downstream locations associated with the plant by presenting the maximum average concentrations of selected parameters. Similar to 2004, in 2005 the only result of significance was TCE identified near the plant site and downstream in Little Bayou Creek. These results averaged a concentration of

Table 8.1. Nonradiological Parameters for Surface Water Samples

Parameter
Chloride
Nitrate/Nitrite as Nitrogen
Alkalinity
Conductivity
Dissolved Oxygen
Flow Rate
pH
Temperature
Aluminum
Antimony
Arsenic
Barium
Beryllium
Cadmium
Calcium
Chromium
Cobalt
Copper
Iron
Lead
Magnesium
Manganese
Mercury
Nickel
Phosphorous
Potassium
Selenium
Silver
Sodium
Thallium
Uranium
Vanadium
Zinc
PCB Aroclors
Polychlorinated biphenyl, Total
Trichloroethene
Ammonia
Cyanide
Turbidity
Suspended Solids

Table 8.2. Nonradiological Parameters for Surface Water Seep Sampling Locations

Parameter
Chloride
Sulfate
Alkalinity
Conductivity
Dissolved Oxygen
pH
Temperature
Calcium
Magnesium
Manganese
Potassium
Sodium
Uranium
1,1,1-Trichloroethane
1,1,2-Trichloroethane
1,1-Dichloroethane
1,1-Dichloroethene
1,2-Dichloroethane
1,2-Dimethylbenzene
Benzene
Bromodichloromethane
Carbon tetrachloride
Chloroform
cis-1,2-Dichloroethene
Ethylbenzene
m,p-Xylene
Tetrachloroethene
Toluene
trans-1,2-Dichloroethene
Trichloroethene
Vinyl chloride

2 and 24 µg/L, respectively, which is slightly lower than 2004. TCE also was detected at upstream Bayou Creek (L1) at 1.1 µg/L. Table 8.4 also presents the maximum average concentrations of selected parameters for the seep sampling locations. LBCSP5, had the highest maximum average for TCE at 490 µg/L, which is slightly higher than the 438 µg/L in 2004. Compared to background, TCE only is identified above background at the seep locations, which are related to groundwater contamination at the surface.

Table 8.3 Selected Routine Nonradiological Surface Water Surveillance Results (Average Concentrations)[a]

Parameter	Upstream Bayou[1]	Bayou Near Site[2]	Downstream Bayou[3]	Little Bayou Near Site[4]	Downstream Little Bayou[5]	Creek Convergence[6]	C-746-K Landfill Area[7]	Upstream Ohio River[8]	Downstream Ohio River[9]	Massac Creek[10]	Cairo, IL[11]
Aluminum (mg/L)	3	2.1	2.6	1.3	3.1	0.47	0.96	1.8	1	1.4	0.59
Ammonia (mg/L)	ND	0.53	ND	ND	ND	ND	ND	ND	ND	ND	ND
Barium (mg/L)	0.047	0.12	0.038	0.063	0.078	0.051	0.048	0.036	0.037	0.044	0.041
Calcium (mg/L)	22	87	33	27	33	32	19	31	30	11	39
Chloride (mg/L)	11	140	50	30	25	35	18	16	16	13	22
Cobalt (mg/L)	ND	0.0019	ND	ND	0.0013	ND	ND	0.0012	0.0015	ND	ND
Copper (mg/L)	ND	0.0081	ND	0.011	ND	ND	ND	ND	ND	ND	ND
Hardness ($CaCO_3$) (mg/L)	56	340	130	82	120	120	66	110	100	44	140
Iron (mg/L)	0.82	0.57	0.81	2.6	1.4	0.61	0.6	1.7	1.1	0.89	0.65
Lead (mg/L)	ND	ND	ND	0.14	ND	ND	ND	ND	ND	ND	ND
Magnesium (mg/L)	7.5	30	12	8	6.7	9.3	5.4	8.8	8.1	2.8	12
Manganese (mg/L)	0.091	0.087	0.071	0.12	0.2	0.19	0.13	0.074	0.081	0.27	0.05
Nickel (mg/L)	ND	0.01	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nitrate as Nitrogen (mg/L)	0.9	2.5	0.91	0.49	0.82	0.98	0.75	0.63	0.59	0.59	0.83
PCB-1242 (mg/L)	ND	ND	ND	ND	0.12	ND	ND	ND	ND	ND	ND
PCB-1254 (mg/L)	ND	0.32	0.14	ND	ND	ND	0.16	ND	ND	0.23	ND
PCB-1268 (mg/L)	ND	0.25	ND	ND	ND	ND	ND	ND	ND	ND	ND
Phosphorous (mg/L)	0.12	0.45	0.15	0.3	0.19	0.092	0.11	0.097	0.11	0.085	0.093
Potassium (mg/L)	5	23	7.5	6.1	3.4	4.9	3	2.2	2.2	2.3	2.6
Sodium (mg/L)	39	180	67	52	29	42	26	13	13	11	18
Suspended Solids (mg/L)	ND	ND	35	25	39	21	12	46	36	ND	28
Trichloroethene (mg/L)	1.1	2	ND	ND	24	2.9	ND	ND	ND	ND	ND
Uranium (mg/L)	ND	0.009	0.0022	0.014	0.028	0.007	0.0037	ND	ND	ND	ND
Zinc (mg/L)	ND	ND	ND	0.045	ND	ND	ND	ND	ND	ND	ND

a = The results presented in the table are the average values for the locations within the area grouping using the highest value for each location in the average calculations.
ND = Not Detected

The following footnotes correspond with column titles in the above table. These are groupings of sample locations in the area described in the title.
1 = L1
2 = C612, C616, L291, S31, K001, K015
3 = L5, L6
4 = L10, L194
5 = L11, L12, L241
6 = L8
7 = C746K-5, C746KTB1
8 = L29
9 = L30
10 = L64
11 = L306

In 2005 there were low detections of surfacewater PCBs. This is an increase in PCB concentrations from 2004, which had no detectable PCB aroclors. In 2002, there were PCBs detected at low levels near the plant site on both Bayou Creek and Little Bayou Creek.

Additional data are presented in Section 4, Tables 4.1 through 4.29, of the *Environmental Monitoring Results Annual Site Environmental Report for CY 2005 (PRS 2006)*.

Sediment

Sediment is an important constituent of the aquatic environment. If a pollutant is a suspended solid or is attached to suspended sediment, it can settle to the bottom (thus creating the need for sediment sampling), be taken up by certain organisms, or become attached to plant surfaces. Pollutants transported by water can adsorb either on organic and inorganic solids or be assimilated by plants and animals. Suspended solids, dead biota, and excreta settle to the bottom and become part of

Table 8.4. Selected Routine Nonradiological Surface Water Seep Sampling Surveillance Results (Average Concentrations)[a]

Parameter	LBCSP5	LBCSP6
Calcium (mg/L)	24	25
Magnesium (mg/L)	8.5	7.8
Manganese (mg/L)	0.013	0.064
Potassium (mg/L)	1.7	1.6
Sodium (mg/L)	34	32
Sulfate (mg/L)	16	14
Trichloroethene (µg/L)	490	260

a = The results presented in the table are the average values for the locations within the area grouping using the highest value for each location in the average calculations.

Seep sampling is representative of groundwater. Seep sampling results are compared to groundwater MCLs for evaluation. Sample results for TCE at a surface water location downstream of the seeps showed levels less than the KPDES permitted level of 81 µg/L.

the organic substrata that support the bottomdwelling community of organisms. Sediments play a significant role in aquatic ecology by serving as a repository for radioactive or chemical substances that pass via bottom-feeding biota to the higher trophic levels.

Sediment Surveillance Program

Ditch sediments are sampled semiannually as part of a nonradiological environmental surveillance program. Sediment samples were taken from 13 locations in 2005 (Figure 5.3). Sediments were sampled for the parameters listed in Table 8.5.

Sediment Surveillance Results

Table 8.6 shows the average values for locations within the area group for specific parameters. Parameters were selected to include those that showed detections. The results of detected parameters are compared to determine the difference between upstream (or background) and downstream concentrations. Aluminum, barium, calcium, chromium, cobalt, copper, iron, magnesium, manganese, potassium, and vanadium were detected at all sites. The highest levels of metals were seen at the NSDD, Bayou Creek near the plant site, and Little Bayou Creek near the plant site. Decreased from 2004, chromium was identified in the NSDD at 27 mg/kg and near the plant site on Little Bayou Creek at 21 mg/kg. Arsenic was found downstream in Bayou Creek and near the plant site. Zinc was found at all locations, except downstream in Bayou Creek. Generally, contaminants are more abundant near the plant site and decrease in areas downstream of the plant site.

PCBs were found in the NSDD, downstream Bayou Creek, and near the plant site on Bayou Creek with the highest levels seen at the NSDD. In 2004, PCBs also were found in Little Bayou Creek near the plant site, and downstream Little Bayou Creek; however, none were identified at these locations in 2005. The aroclors present were PCB-1016, PCB-1254, and PCB-1260. Additional sediment data are presented in Section 4, Tables 4.30 through 4.45, of the *Environmental Monitoring Results Annual Site Environmental Report, Calendar Year 2005, Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (PRS-ENM-0002 Volume II).

Results are consistent with levels seen in previous years' data. These areas are either within the DOE-controlled area or are posted for protection of the public.

Table 8.5. Semiannual Nonradiological Parameters for Sediment Samples.

Parameter		
Grain Size Diameter	Lead	Zinc
Aluminum	Magnesium	PCB-1016
Antimony	Manganese	PCB-1221
Arsenic	Mercury	PCB-1232
Barium	Nickel	PCB-1242
Beryllium	Potassium	PCB-1248
Cadmium	Selenium	PCB-1254
Calcium	Silver	PCB-1260
Chromium	Sodium	PCB-1268
Cobalt	Thallium	Polychlorinated Biphenyl
Copper	Uranium	Moisture
Iron	Vanadium	Total Organic Carbon (TOC)

Table 8.6. Selected Routine Nonradiological Sediment Surveillance Results (Average Concentrations)[a]

Parameter	Upstream Bayou[1]	Bayou Near Site[2]	Downstream Bayou[3]	Little Bayou Near Site[4]	Downstream Little Bayou[5]	C-746-K Area[6]	NSDD[7]	Massac Creek[8]
Aluminum (mg/kg)	2400	6500	2900	5400	6200	4400	6100	1900
Barium (mg/kg)	39	74	28	43	55	34	46	23
Beryllium (mg/kg)	0.7	0.67	ND	ND	0.59	ND	ND	ND
Cadmium (mg/kg)	ND	2.3	ND	ND	ND	ND	ND	ND
Calcium (mg/kg)	700	9400	460	1200	740	640	1900	250
Chromium (mg/kg)	13	28	7.2	21	24	8.6	27	4.2
Cobalt (mg/kg)	4.9	5.1	2.9	4.5	5	3.7	3.7	7.1
Copper (mg/kg)	4.8	44	4.7	6	7.8	4.6	28	3.5
Iron (mg/kg)	10000	14000	5400	7300	6700	7000	8100	4100
Lead (mg/kg)	ND	20	ND	ND	ND	ND	ND	ND
Magnesium (mg/kg)	230	920	300	490	490	370	670	190
Manganese (mg/kg)	290	270	180	360	100	290	210	260
Mercury (mg/kg)	ND	0.49	ND	ND	ND	ND	0.19	ND
Nickel (mg/kg)	ND	20	ND	ND	6	ND	17	6
PCB-1016 (µg/kg)	ND	ND	5700	ND	ND	ND	ND	ND
PCB-1254 (µg/kg)	ND	ND	ND	ND	ND	ND	610	ND
PCB-1260 (µg/kg)	ND	2400	ND	ND	ND	ND	480	ND
Potassium (mg/kg)	140	510	190	230	340	260	420	140
Silver (mg/kg)	ND	ND	ND	ND	ND	ND	2.5	ND
Sodium (mg/kg)	ND	240	ND	110	120	ND	110	ND
Uranium (mg/kg)	160	310	150	180	120	140	210	ND
Vanadium (mg/kg)	19	23	11	14	12	14	11	7.1
Zinc (mg/kg)	ND	120	ND	29	40	22	79	21

a = The results presented in the table are the average values for the locations within the area grouping using the highest value for each location in the average calculations.
ND = Not detected

The following footnotes correspond with column titles in the above table. These are groupings of sample locations in the area described in the title.
1 = S20 (background location to 2 and 3)
2 = C612, C616, K001, S1, S31
3 = S33
4 = S2, L194
5 = S27, S34
6 = C746KTB2 (background location to 8 and 9)
7 = S32
8 = S28

Soil

The major source of soil contamination is from air pathways. Because DOE no longer controls any major air emission sources, routine soil surveillance is not performed. However, surface soil contamination is being addressed by the Surface Soils OU (see Environmental Restoration Program in Section 3).

Vegetation

Because DOE no longer operates any major air emission sources, routine vegetation surveillance activities are not performed.

Terrestrial Wildlife

Annual Deer Harvest

The deer population in the WKWMA is sampled annually to determine levels of radionuclides (Section 5), PCBs, and inorganic elements that might be attributed to past plant practices. There were five deer harvested in 2005 from the WKWMA and one deer harvested in 2002 from the Stewart Island Habitat Restoration in Livingston County, Kentucky, to serve as a reference sample.

PCBs tend to accumulate in fat tissue. PCB-1268 was present in deer from the Paducah Site. Table 8.7 shows the PCB results. All measurable PCBs were well below the Food and Drug Administration (FDA) standard of 3 parts per million (ppm) for red meat.

A risk assessment was conducted using the concentrations of PCBs found in deer, assuming 20 percent fat content and that a hunter would eat the two deer with the highest levels of PCBs found. The risk assessment concluded that the risk to the hunter who eats 100 pounds of the two worst-case deer (50 pounds/deer) would have an average increased cancer risk of 0.0000031, or approximately 3.1 chances of cancer development (over a lifetime) per one million people who eat the deer (Hampshire 2006).

A comparison of the metals detected in the 2005 deer with the average metals data from background deer collected over the past 10 years shows no chemicals significantly above background. Overall evaluation of the results indicate that consumption of deer meat is not a threat to human health.

Additional deer data are presented in Section 4, tables 4.46 through 4.49, of the *Environmental Monitoring Results Annual Site Environmental Report, for CY 2005 (PRS 2006).*

Fish and Other Aquatic Life

Watershed (biological) monitoring was conducted, as required, by KPDES Permit KY0004049. The KPDES permit also requires toxicity monitoring of one continuous outfall and three intermittent outfalls on a quarterly basis. Watershed or biological monitoring of Bayou Creek and Little Bayou Creek has been conducted since 1987.

The objectives of the Watershed Monitoring Program are as follows:

- Determine whether discharges from the Paducah Site and its associated SWMUs are adversely affecting instream fauna,

Table 8.7. Summary of PCB Detections in Deer for 2005[a]

Parameter	Deer 1	Deer 2	Deer 3	Deer 4	Deer 5	Background Deer[b]
PCB-1268 (mg/kg)	.112	ND	ND	ND	.056	ND

[Result] = Detected at the result indicated.
mg/kg = part per million
ND = Not detected
[a] Other PCB aroclors were analyzed but not detected in any deer.
[b] Background deer were collected during 2002 from Stewart Island Habitat Restoration in Livingston County, Kentucky.

• Assess the ecological health of Bayou Creek and Little Bayou Creek,
• Assess the degree to which abatement actions ecologically benefit Bayou Creek and Little Bayou Creek,
• Provide guidance for remediation,
• Provide an evaluation of changes in potential human health concerns, and
• Provide data that could be used to assess the impact of inadvertent spills or fish kills.

Study Area and Methods

As specified according to *Big Bayou Creek and Little Bayou Creek Revised Watershed Monitoring Program, April 2003*, the fish and benthic macroinvertebrate communities were sampled in June 2004 at eight locations, including locations in Massac Creek and in the West Fork of Massac Creek, both which serve as sources of background fish [Massac Creek Mile (MAM) 8.6 and West Fork of Massac Mile (WFM) 0.5, respectively]. Figure 8.1 shows the eight locations, with the exception of MAM 8.6 and WFM 0.5 which are located several miles off-site.

Benthic macroinvertebrate samples were collected with a Surber square-foot bottom sampler from appropriate locations within a designated riffle at each site. Samplers selected locations within the reaches of the stream and samples were processed in a laboratory following EPA methods. The Modified Hilsenhoff-Biotic Index (mHBI) was used to evaluate the water quality of the sample locations. Organisms were identified to the lowest practical taxon and enumerated. Instream and riparian habitat and water quality were assessed at each site following standard procedures outlined by the EPA. An analysis of the data includes general descriptive and parametric statistics to evaluate trends in temporal and spatial changes that could be associated with abatement activities or remedial actions. Metrics of the benthic macroinvertebrate community, such as total density; total taxonomic richness; taxonomic richness of the pollutionsensitive Ephemeroptera, Plecoptera, and Trichoptera; percent community similarity index; and dominants in common are included in the analysis of the data presented in the *Watershed Monitoring Report for Calendar Year 2005, Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (BJC 2006b).

Quantitative samplings of the fish communities in the PGDP area were conducted by electrofishing. Block nets defined the sample reaches [8 to 120 m (26 to 394 feet)] of each site sampled. A three-pass depletion method was used in collecting the samples. Data from these samples were used to estimate species' richness, population size (numbers and biomass per unit area), and annual production. All fish sampling locations overlap locations used in the benthic macroinvertebrate community task. All field sampling was conducted according to standard operating procedures. The frequency for the bioaccumulation monitoring task has been changed in the Watershed Monitoring Program (WMP) to every two years and monitoring was not conducted in 2005.

Watershed Monitoring

Results of watershed monitoring are reported to KDOW annually. The 2005 monitoring is reported in the *Watershed Monitoring Report for Calendar Year 2005, Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (BJC 2006b). Additional analysis of the data can be seen in this report. The report conclusions, which meet the objectives of the WMP, are presented as follows.

As in previous years, the fish communities examined in 2005 showed some changes in density, biomass, total numbers, and species richness. The changes noted for this year are necessarily not indicative of contaminant impacts, but possibly are indicative of changes in habitat and water level. As in past years, a factor in 2005 that may be affecting fluctuating levels of fish populations at several of the sites, may be attributed to shifting stream-bed substrates that affect changes in habitat within the streams samples, by restructuring the size of runs, pools, riffles, and associated cover. All fish observed this year were found to be in good health having a condition factor of "good."

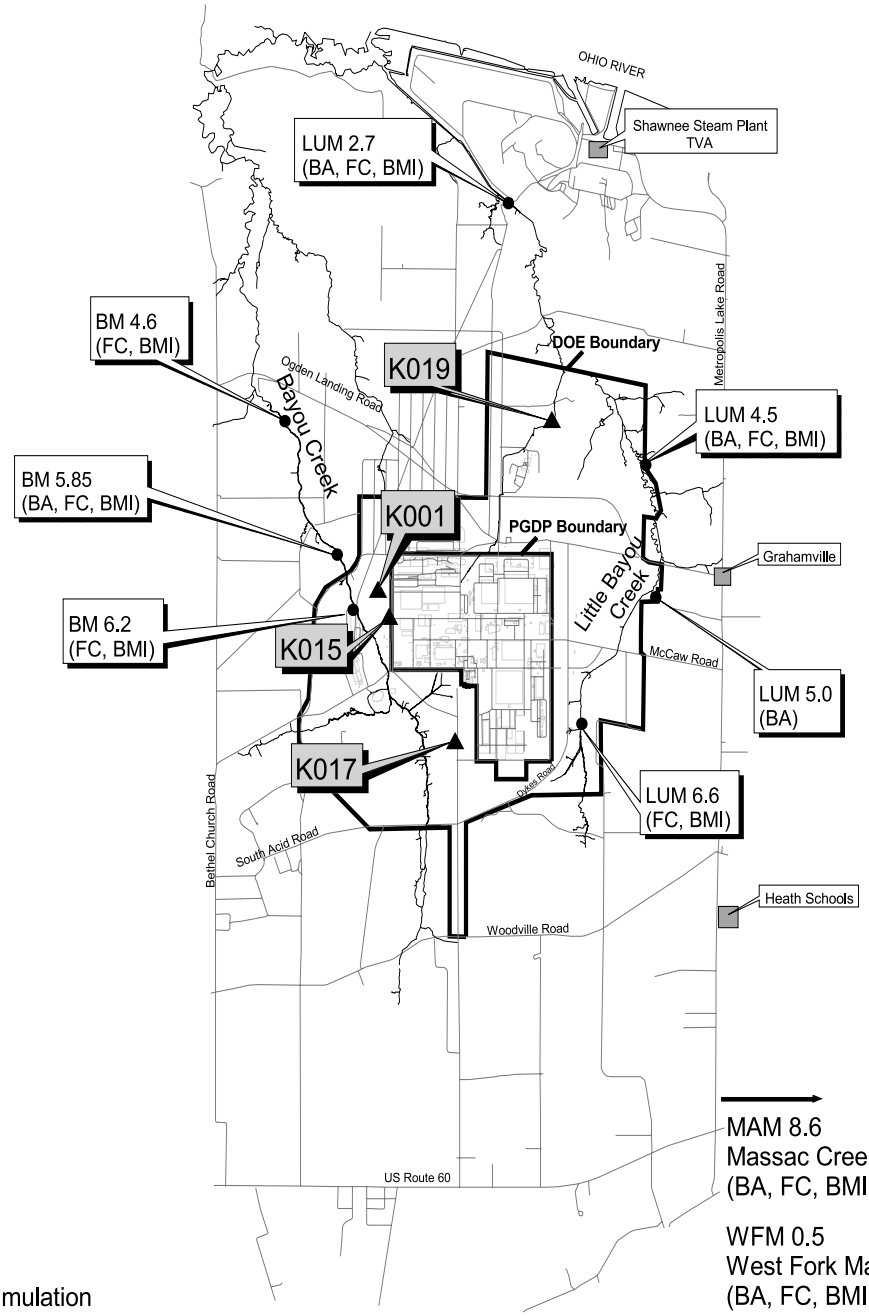

Figure 8.1 Biological monitoring locations

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9 Groundwater

Abstract

The primary objectives of groundwater monitoring at the Paducah Site are to detect contamination and provide the basis for groundwater quality assessments if contamination is detected. Monitoring includes the exit pathways at the perimeter of the plant and off-site water and monitoring wells. Primary off-site contaminants continue to be TCE, an industrial degreasing solvent, and ^{99}Tc, a fission by-product. Evidence suggests the presence of TCE as a DNAPL in groundwater beneath the site.

Introduction

Monitoring and protection of groundwater resources at the Paducah Site are required by federal and state regulations and by DOE orders. Groundwater is not used for on-site purposes and persons off-site are protected by the water policy, which provides municipal water to nearby residents.

When off-site contamination from the Paducah Site was discovered in 1988, DOE provided an alternate water supply to affected residences. A CERCLA/ACO SI, completed in 1991, determined off-site contaminants in the RGA to be TCE and ^{99}Tc. TCE was used until 1993 as an industrial degreasing solvent and ^{99}Tc is a fission byproduct contained in nuclear power reactor returns that were brought on-site several years ago for reenrichment of ^{235}U. Such reactor returns are no longer used in the enrichment process; however, because the system is closed, ^{99}Tc is still present in the system. Known or potential sources of TCE and ^{99}Tc include former test areas and other facilities, spills, leaks, buried waste, and leachate derived from contaminated scrap metal.

Investigations of the on-site source areas of TCE at the Paducah Site are ongoing. The main source of TCE contamination in the groundwater is near the C-400 Cleaning Building. A common degreasing agent, TCE may act as a DNAPL due to its low solubility and high density relative to water. DNAPLs either sink to the bottom of aquifers or come to rest on a less-permeable layer within an aquifer, forming pools. These DNAPL pools form a continuous source for the dissolved-phase contamination (plumes) that are migrating off-site toward the Ohio River (Figure 9.1). Pools of DNAPL are extremely difficult to clean due to low solubility in water and the inability to find them in the subsurface. Currently, only the highest concentrations of dissolved TCE are controlled by pump-and-treat systems (in Northwest and Northeast Plumes) at Paducah. The pump-and-treat system installed northwest of the plant also controls the highest concentrations of dissolved ^{99}Tc that would otherwise migrate off-site.

Continued groundwater monitoring serves to identify the extent of contamination, predict the possible fate of the contaminants, and

determine the movement of groundwater near the plant. This year's (CY 2005) plume map (Figure 9.1) continues the basic interpretation presented in the plume maps for CY 2004. The primary revisions for CY 2005 reflect the following: (1) decreasing TCE trends in MWs along the core of the Northeast Plume and over a large area to the west of the Northeast Plume well field, (2) decreased TCE and ^{99}Tc levels in MWs along the core of the Northwest Plume, and (3) reinterpretation of the Southwest Plume and C-746-S&T areas using data from the most recent site investigations.

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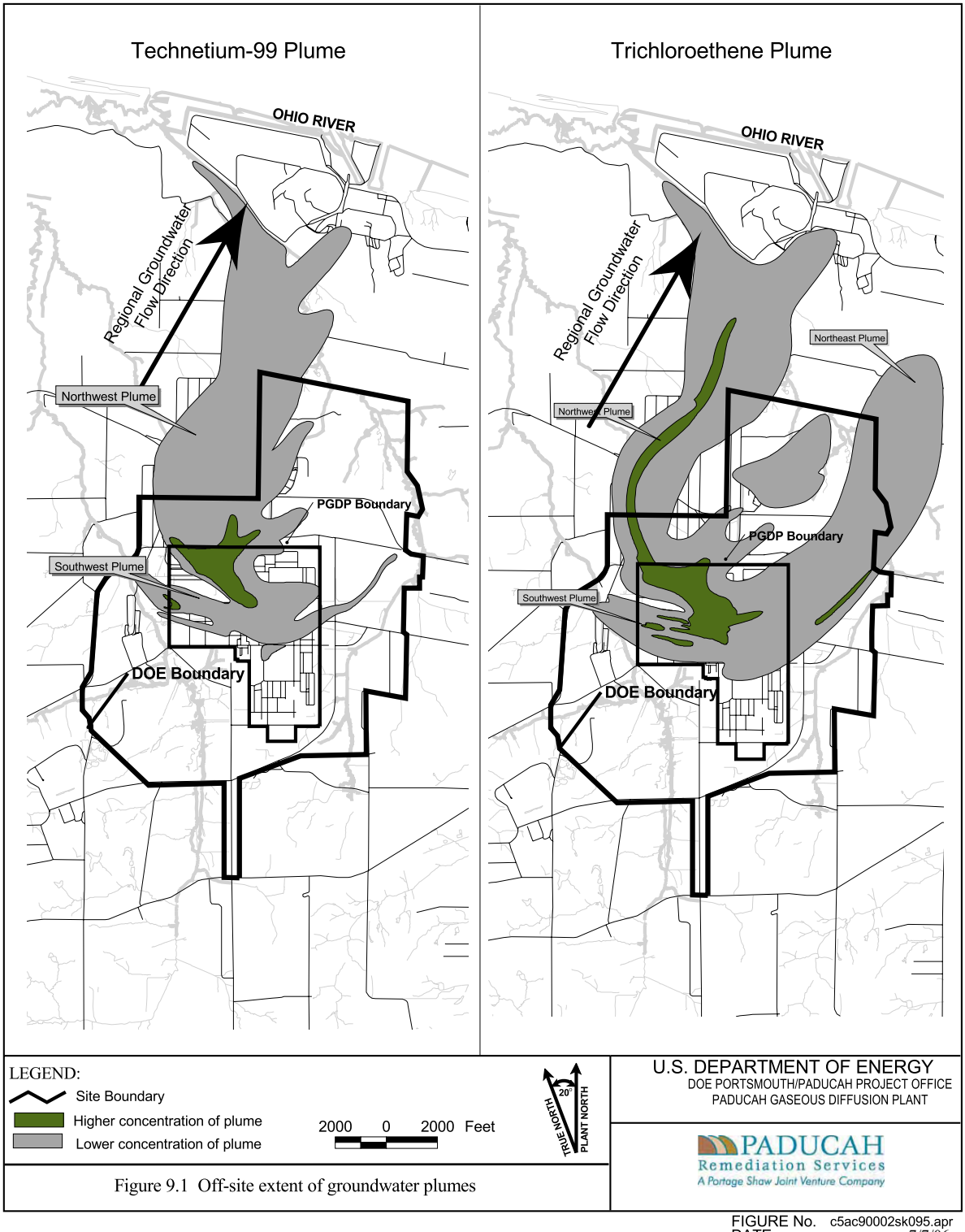

Figure 9.1 Off-site extent of groundwater plumes

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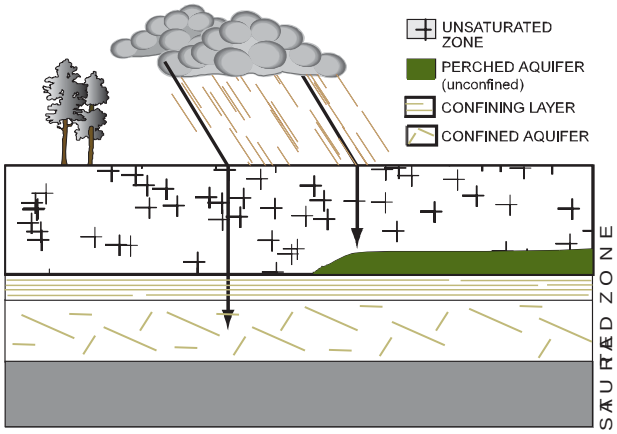

Figure 9.2. Typical Path for Rainwater Accumulation as Groundwater

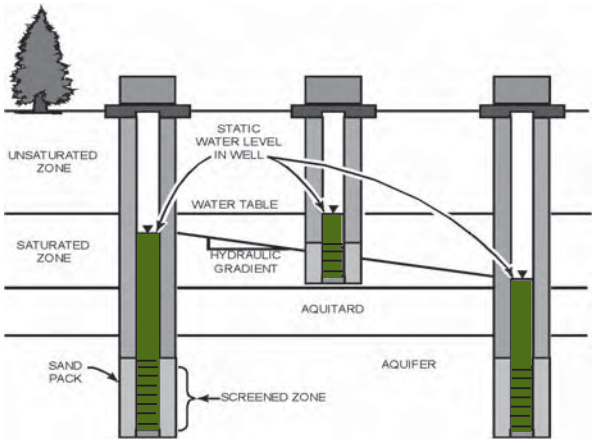

Figure 9.3 MW Construction Showing the Relationship Between the Screened Zone and the Water Level in Wells Where Limited Flow in the Aquifer Is to the Right

Groundwater monitoring at the Paducah Site complies with applicable federal and state regulations and permits and includes perimeter exit pathway monitoring and off-site water well monitoring (see Groundwater Monitoring Program).

Groundwater Hydrology

When rain falls to the ground, some of it flows along the surface as streams or lakes, some of it is used by plants, some evaporates and returns to the atmosphere, and some sinks into the ground. The water that sinks into the ground moves into the spaces between the particles of soil and sand, infiltrating porous soil and rock. Groundwater is found underground in cracks and spaces in soil, sand, and rock. Groundwater is stored in, and moves slowly through, an aquifer, which is a source of useable water. Aquifers typically consist of layers of gravel, sand, sandstone, or fractured rock. The speed at which groundwater flows through the surface depends on the size of the spaces in the soil or rock and how well the spaces are connected. Hydraulic conductivity is the physical property that describes the ease with which water can move through the pore spaces and fractures in soil, gravel, sand, and rock.

The area in the subsurface where water fills these pore spaces is called the saturated zone (Figure 9.2). The top of the saturated zone is the water table, which is the boundary between the unsaturated and saturated zones. This boundary generally gently mirrors the surface topography and is higher than natural exits such as springs, swamps, and beds of streams and rivers. Groundwater can be brought to the surface naturally, either through discharge as a spring or as flow into lakes and streams, or it can be extracted through a well drilled into the aquifer. A well is a pipe/screen assembly in the ground that fills with groundwater, which can then be brought to the surface using a pump.

Groundwater movement is determined by differences in the energy associated with the groundwater's elevation in a specific location to the elevation of other nearby groundwater. This is called hydraulic head. Hydraulic head is considered to be the total energy in any water mass resulting from three components: pressure, velocity, and elevation. Water will rise in a well casing in response to the pressure of the water surrounding the well's screened zone. The depth to water in the well is measured and the elevation calculated to determine the hydraulic head of the water in the monitored zone (Figure 9.3). The hydraulic gradient measures the difference in hydraulic head over a specified distance. By comparing the water levels in adjacent wells screened in the same zone, a horizontal hydraulic gradient can be determined and the lateral direction of groundwater flow can be predicted. Only wells

screened in the same zones are considered when determining the horizontal gradient. Wells screened above and below an aquitard (a geologic unit that inhibits groundwater flow) also can have different hydraulic heads, thus defining a vertical gradient. If the water levels in deeper wells are lower than those in shallower wells, vertical flow is primarily downward.

Groundwater aquifers are one of the primary pathways by which potentially hazardous substances can spread through the environment. Substances placed in the soil may migrate downward due to gravity or be dissolved in rainwater, which moves them downward through the unsaturated zone into the aquifer. The contaminated water then flows laterally downgradient toward the discharge point. Monitoring wells are used extensively at the Paducah Site to assess the effect of plant operations on groundwater quality. Wells positioned to sample groundwater flowing away from a site are called downgradient wells, and wells placed to sample groundwater before it flows under a site are called upgradient wells. Any contamination of the downgradient wells that is not present in the upgradient wells at a site may be determined to be a result of that site.

Wells can be drilled to various depths in the saturated zone and be screened to monitor the recharge area above the aquifer, different horizons within the aquifer, or water-bearing zones below the aquifer. Vertical and horizontal groundwater flow directions are determined by the permeability and continuity of geologic strata, in addition to hydraulic head. To effectively monitor the movement of groundwater and any hazardous constituents it may contain, hydrogeologists at the Paducah Site have undertaken many detailed studies of the geology of strata beneath the site.

Geologic and Hydrogeologic Setting

The Paducah Site, located in the Jackson Purchase region of western Kentucky, lies within the northern tip of the Mississippi Embayment portion of the Gulf Coastal Plain Province. The Mississippi embayment is a large sedimentary trough oriented nearly north-south that received sediments during the Cretaceous and Tertiary geologic time periods.

During the Cretaceous Period, sediments were deposited in a coastal marine environment, creating the McNairy/Clayton Formation. For the most part, the McNairy/Clayton Formation is sandy at the bottom and silty at the top. However, variations in the geologic make-up of the McNairy/ Clayton Formation do occur and lenses of clay, and at least one fairly continuous string of gravel, are present within the formation.

The Clayton Formation overlies the McNairy. The Clayton Formation was deposited during the early Paleocene geologic epoch in an environment so similar to that of the McNairy that the Clayton and upper portion of the McNairy are indistinguishable in lithologic samples. Later in the Paleocene, the Porters Creek Clay was deposited in marine and brackish water environments in a sea that occupied most of the Mississippi Embayment. The McNairy/ Clayton and the Porters Creek Clay formations dip 30 to 35 ft (9 to 10.5 m) per mile to the southsouthwest.

The next feature in the geologic history at the Paducah Site is a Pleistocene-age river valley, occupying approximately the same position as the present-day Ohio and Tennessee River valleys. In forming the valley, braided stream channels of the ancestral Tennessee River, and possibly several "feeder" streams, eroded any sediments deposited after the Paleocene Porters Creek Clay and before the Pleistocene. The river system also eroded portions of the Porters Creek Clay and the McNairy Formation and cut a prominent terrace in the Porters Creek Clay at the south end of the plant. The sediments deposited on this erosional surface are termed continental deposits. The lower portion of the continental deposits consists of approximately 30 ft (9 m) of stream gravel and sand.

Over time, sediments from the retreating glaciers dammed the river valley, causing the formation of a lake. Silts and clays with thin zones of sand and occasional gravel were deposited in the lake, forming the upper portion of the continental deposits. These deposits range from approximately 5 to 55 ft (1.5 to 17 m) thick.

Finally, loess, a wind-blown silt, overlies the

continental deposits throughout the site. Thickness of loess deposits varies from approximately 5 to 25 ft (1.5 to 8 m), averaging 15 ft (4.6 m).

The local groundwater flow system at the Paducah Site contains the following four major components (from shallowest to deepest): (1) the terrace gravels, (2) UCRS, (3) RGA, and (4) the McNairy flow system. The Rubble Zone is the formation underlying the McNairy. The terrace gravels consist of shallow Pliocene gravel deposits in the southern portion of PGDP. These deposits usually lack sufficient thickness and saturation to constitute an aquifer, but may be an important source of groundwater recharge to the RGA.

The UCRS consists mainly of clay silt with interbedded sand and gravel in the upper continental deposits. The system is so named because of its characteristic recharge to the RGA.

The RGA consists of coarse-grained sediments at the base of the upper continental deposits, sand and gravel facies in the lower continental deposits, gravel and coarse sand portions of the upper McNairy that are directly adjacent to the lower continental deposits, and alluvium adjacent to the Ohio River. These deposits have an average thickness of 30 ft (9 m) and can be more than 70 ft (21 m) thick along an axis that trends east-west through the site. The RGA is the uppermost and primary aquifer, formerly used by private residences north of the Paducah Site.

The McNairy flow system consists of interbedded and interlensing sand, silt, and clay of the McNairy Formation. Sand facies account for 40 to 50 percent of the total formation thickness of approximately 225 ft (69 m).

Uses of Groundwater in the Vicinity

The WKWMA and some lightly populated farmlands are in the immediate vicinity of the Paducah Site. Homes are sparsely located along rural roads in the vicinity of the site. Two communities, Grahamville and Heath, lie within 2 miles (3.2 km) east of the plant.

Both groundwater and surface water (Cairo, Illinois, only) sources have been used for water supply to residents and industries in the vicinity of the plant area. Wells in the area are screened at depths ranging from 15 to 245 ft (4.6 to 75 m). The majority of these wells are believed to be screened in the RGA. The Paducah Site continues to provide municipal water to all residents within the area of potential groundwater contamination from the site. These residents' out-of-service wells are utilized by DOE for sampling as a result of written agreements. Residential wells that are no longer sampled have been capped and locked. Water used on the plant site is provided from surface water sources.

Groundwater Monitoring Program

The primary objectives of groundwater monitoring at the Paducah Site are early detection of any contamination resulting from past and/or present land disposal of wastes and provision of the basis for developing groundwater quality assessments, if contamination is detected. Additional objectives outlined in DOE Order 450.1, *Environmental Protection Program,* require implementation of a sitewide approach for groundwater.

The sitewide approach is outlined in the following three documents related to groundwater monitoring: (1) *Groundwater Protection Management Program for Calendar Year 2006, Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (PRS 2006), (2) *Groundwater Protection Plan* (BJC 2004c), (3) and the *Paducah Site Environmental Monitoring Plan* (BJC 2004a). Scheduled sampling continues for more than 170 MWs and residential wells in accordance with DOE orders and federal, state, and local requirements. Well sampling is included in several different monitoring programs, which are described as follows.

Resource Conservation and Recovery Act Permit Monitoring Programs

The only hazardous waste facility at the Paducah Site that requires groundwater monitoring is the C-404 Landfill (Figure 9.4). The C-404 Low-Level Radioactive Waste Burial Ground was used for the disposal of uranium-contaminated

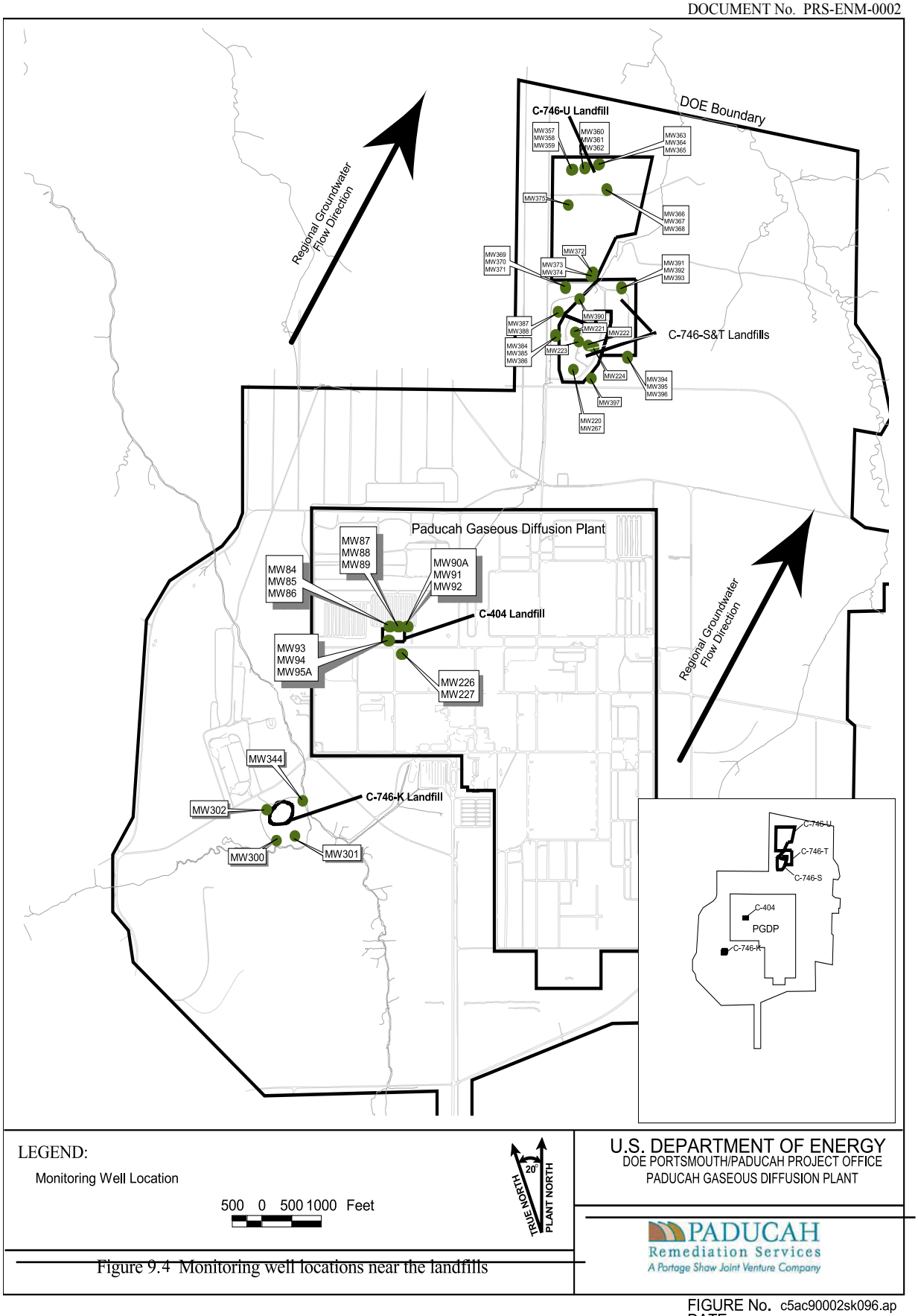

Figure 9.4 Monitoring well locations near the landfills

solid wastes until 1986 when it was determined that, of the wastes disposed there, gold dissolver precipitate was considered a hazardous waste under RCRA. The landfill was covered with a RCRA-compliant clay cap and was certified "closed" as a hazardous waste landfill in 1987. The landfill now is monitored under postclosure monitoring requirements. According to the Kentucky C-404 Post-Closure Permit, 14 wells (MWs 84–95, 226, and 227) monitor groundwater quality of the UCRS (four wells) and the underlying RGA (10 wells) during the required postclosure monitoring on a semiannual basis.

During 2005, MWs at the C-404 Landfill were sampled and analyzed for total and dissolved chromium, arsenic, cadmium, lead, mercury, selenium, and uranium. Also monitored are TCE and ^{99}Tc. TCE exceeded the MCL in four upgradient RGA wells and three downgradient RGA wells; however, this may be related to the underlying TCE plume and not C-404 itself. Chromium exceeded the MCL in two upgradient monitoring wells. No other parameters exceeded MCLs. Results are reported to KDWM semiannually. A summary of the detected maximum results for each of the wells is provided in Table 9.1. Parameters with no detections are not listed.

State Solid Waste Disposal Regulations

Post-closure groundwater monitoring continues for the C-746-S Residential Landfill. The landfill stopped receiving solid waste by July 1, 1995, and was certified closed on October 31, 1995, by an independent engineering firm. The groundwater monitoring system for the C-746-S Residential Landfill also encompasses the C-746-T Inert Landfill, which was certified closed in November 1992. The C-746-T Inert Landfill has fulfilled two years of post closure environmental monitoring and maintenance requirements.

The groundwater monitoring system for C-746-S and C-746-T consists of upgradient, sidegradient, and downgradient wells (Figure 9.4). The monitoring system is designed to monitor the UCRS, the upper portion of the RGA (URGA), and lower portion of the RGA (LRGA).

The MWs at C-746-S and C-746-T are sampled quarterly and in accordance with 401 K.A.R. 48:300. The analytes are dictated by a KDWM-approved solid waste landfill permit modification.

During 2005, beta activity exceeded contaminant levels in sidegradient and downgradient wells. TCE exceeded contaminant levels in some upgradient and downgradient wells. The KDWM was notified of the exceedences. Results were reported to KDWM on a quarterly basis. A summary of the maximum results for upgradient, sidegradient, and downgradient wells in each of the monitored portions of the groundwater system is provided in Table 9.2.

Table 9.1. Summary of Maximum Groundwater Results from the RGA at C-404 Landfill

	Upgradient Wells				Downgradient Wells						
Parameter	MW 226	MW 227	MW 93	MW 95A	MW 84	MW 86	MW 87	MW 89	MW 90A	MW92	Criteria Reference
Arsenic (mg/L)	0.002	ND	0.001	0.002	0.003	0.004	ND	0.004	ND	0.001	0.05 MCL
Chromium (mg/L)	**0.36**	**0.95**	ND	ND	ND	ND	ND	ND	ND	ND	0.1 MCL
Lead (mg/L)	ND	0.007	ND	ND	ND	ND	ND	ND	ND	ND	0.05 MCL
Selenium (mg/L)	0.008	ND	0.005	0.006	ND	ND	ND	ND	ND	ND	0.05 MCL
Uranium (mg/L)	ND	ND	ND	ND	ND	0.002	ND	ND	ND	ND	0.03 MCL
Technetium-99 (pCi/L)	130	23	ND	22	390	ND	ND	40	ND	ND	900 MCL
Uranium-238 (pCi/L)	ND	ND	ND	ND	ND	0.45	ND	ND	ND	ND	
Trichloroethene (µg/L)	**440**	**76**	**300**	**200**	**210**	**180**	**30**	4.1	2.6	2.4	5 MCL

ND - Not detected **Bold** - exceeds criteria
MCL - maximum contaminant level (for reference only)

Table 9.2. Summary of Maximum Groundwater Results at C-746-S&T Landfills

		Lower RGA MWs			UCRS MWs			Upper RGA MWs			Criteria	
	Parameter	Up-gradient	Side-gradient	Down-gradient	Up-gradient	Side-gradient	Down-gradient	Up-gradient	Side-gradient	Down-gradient	Reference	
Anion	Bromide	ND	ND	ND	1.5	2.4	ND	ND	ND	ND		
(mg/L)	Chloride	65	34	45	100	260	22	64	71	48		
	Fluoride	0.15	0.27	0.31	0.54	0.44	0.17	0.22	0.33	0.99	4	MCL
	Nitrate as Nitrogen	2	1.6	1.8	ND	1.8	ND	1.8	1.2	1.9	10	MCL
	Sulfate	21	18	17	19	22	9.7	15	32	30		
Metal	Aluminum	0.32	0.21	0.97	0.74	3.5	ND	ND	0.42	2.6		
(mg/L)	Arsenic	0.0018	0.0025	0.0035	0.0034	0.007	0.003	0.0028	0.0081	0.0033	0.05	MCL
	Barium	0.28	0.19	0.27	0.37	0.59	0.11	0.3	0.24	0.83	2	MCL
	Calcium	31	37	25	44	65	13	32	36	35		
	Chromium	ND	ND	ND	ND	0.022	ND	ND	ND	ND		
	Cobalt	ND	ND	0.035	0.0042	0.0064	ND	0.0037	0.006	0.055		
	Iron	0.52	0.18	8.7	5.5	8.6	7.3	1.8	5.7	5		
	Magnesium	13	11	10	19	27	4.1	13	14	14		
	Manganese	0.0077	0.025	4.6	0.76	1	0.045	0.071	0.57	6.8		
	Molybdenum	ND	0.0011	0.0019	0.0014	0.0051	ND	0.01	ND	0.0099		
	Nickel	ND	0.0061	0.011	0.0057	0.0084	ND	0.2	ND	0.075		
	Potassium	1.9	1.9	2	1.4	0.87	0.44	17	1.4	4.5		
	Selenium	0.0085	0.0067	0.0073	0.014	0.026	ND	0.0099	0.0091	0.01	0.05	MCL
	Sodium	39	40	53	160	120	90	42	76	65		
	Zinc	ND	ND	0.038	ND	ND	ND	0.028	ND	ND		
Dissolved Metal (mg/L)	Barium, Dissolved	0.28	0.19	0.28	0.38	0.56	0.11	0.3	0.22	0.81	2	MCL
	Uranium, Dissolved	ND	0.0015	ND	ND	ND	ND	ND	ND	ND	0.03	MCL
PHYSC	Dissolved Solids	ND	ND	ND	570	680	ND	ND	ND	ND		
(mg/L)	Suspended Solids	ND	ND	10	ND	33	ND	ND	ND	ND		
	Total Solids	300	250	500	600	700	350	380	360	390		
PCBs (µg/L)	PCB-1016	ND	ND	ND	ND	ND	ND	ND	ND	0.19	0.5	MCL
Rads	Alpha activity	ND	ND	4.1	ND	ND	ND	ND	14	5.8	15	MCL
(pCi/L)	Beta activity	11	**200**	**65**	5.8	**83**	ND	24	**280**	**190**	50	MCL
	Radium-224	ND	ND	ND	ND	ND	ND	ND	ND	0.31	5	MCL
	Radium-226	0.56	0.23	0.38	ND	0.15	ND	0.79	0.2	0.64	8	MCL
	Radium-228	ND	4.7	1.2	ND	6.1	ND	ND	ND	13		
	Technetium-99	23	210	70	ND	100	ND	30	460	280	900	MCL
	Thorium-230	ND	ND	0.67	ND	ND	ND	ND	ND	0.48		
VOC (µg/L)	Acetone	ND	ND	ND	ND	ND	ND	17	ND	170		
	Trichloroethene	**10**	ND	**11**	ND	ND	ND	**18**	1.4	**14**	5	MCL
Wetchem	Chemical Oxygen Demand (mg/L)	ND	ND	250	25	66	29	ND	400	ND		
	Total Organic Carbon (mg/L)	ND	1.3	120	6.6	24	8.9	ND	230	1.8		
	Total Organic Halides (ug/L)	19		74	140	430	110	20	75	55		
	Turbidity (NTU)	47	37	19	48	100	17	49	28	420		

MCL - maximum contaminant level (for reference only)
ND - Not detected
Bold - exceeds criteria
VOC - volatile organic compound

The C-746-U Contained Landfill, a solid waste landfill at the Paducah Site, was completed in 1996 and operation was initiated in 1997. Solid waste regulations require groundwater monitoring of the landfill. Monitoring wells were installed in clusters of three. The three well clusters had wells in the UCRS, URGA, and LRGA (Figure 9.4).

During 2005, beta activity exceeded contaminant levels in one sidegradient well and radium-228 exceeded contaminant levels in downgradient and sidgradient wells. Levels of PCB exceeded contaminant levels in two downgradient wells. TCE exceeded contaminant levels in one upgradient well and one sidegradient well. The KDWM was notified of all exceedences and the results were reported to KDWM on a quarterly basis. A summary of the maximum results for upgradient, sidegradient, and downgradient wells in each of the monitored portions of the groundwater system is provided in Table 9.3. The causes of these exceedances were the subject of the C-746-S&T Landfills Site Investigation. The results of that study remain pending in 2005.

Table 9.3. Summary of Maximum Groundwater Results at C-746-U Landfill

		Lower RGA MWs			UCRS MWs		Upper RGA MWs			Criteria	
	Parameter	Up-gradient	Side-gradient	Down-gradient	Up-gradient	Down-gradient	Up-gradient	Side-gradient	Down-gradient	Reference	
Anion	Bromide	ND	ND	ND	1.5	ND	ND	ND	ND		
(mg/L)	Chloride	53	39	30	140	24	42	48	27		
	Fluoride	0.18	0.28	0.27	0.31	1.3	0.36	0.22	0.33	4	MCL
	Nitrate as Nitrogen	1.1	ND	1	ND	2.6	ND	ND	1.6	10	MCL
	Sulfate	250	27	120	72	49	23	130	95		
Metal	Aluminum	ND	0.34	0.7	ND	2.6	0.38	0.7	1.1		
(mg/L)	Arsenic	0.0024	0.004	0.0041	0.004	0.0024	0.0072	0.0083	0.0035	0.05	MCL
	Barium	0.21	0.31	0.23	0.18	0.25	0.54	0.41	0.41	2	MCL
	Boron	1.7	ND	0.25	ND	ND	ND	1	0.46		
	Calcium	81	36	43	33	50	28	56	44		
	Cobalt	0.006	0.042	0.039	ND	0.051	0.034	0.065	0.023		
	Iron	0.67	50	15	6.2	27	19	15	7.8		
	Magnesium	33	16	17	13	21	11	23	18		
	Manganese	0.14	4	2.3	0.33	2.2	4.5	0.62	4.2		
	Molybdenum	ND	ND	ND	0.0017	0.0031	ND	ND	ND		
	Nickel	0.005	0.0069	0.014	0.0071	0.013	0.017	0.012	ND		
	Potassium	3.4	2.5	2.7	0.87	0.87	1.9	2.5	2.4		
	Selenium	0.0075	ND	0.0051	0.012	ND	0.0056	0.0065	0.0058	0.05	MCL
	Sodium	67	43	62	210	210	83	57	74		
	Uranium	ND	ND	ND	0.0048	0.013	ND	ND	ND	0.03	MCL
	Zinc	ND	ND	0.2	ND	ND	ND	ND	ND		
Dissolved Metal	Barium, Dissolved	0.21	0.33	0.23	0.19	0.24	0.58	0.41	0.43	2	MCL
(mg/L)	Uranium, Dissolved	ND	ND	ND	0.0052	0.0092	ND	ND	ND	0.03	MCL
PHYSC	Dissolved Solids	610	560	500	580	1200	300	370	310		
	Total Solids	650	630	530	610	1400	350	470	320		
PCBs (µg/L)	PCB-1016	ND	ND	ND	ND	**1.7**	ND	0.28	**1.1**	0.5	MCL
Rads	Alpha activity	ND	ND	7.2	ND	9	ND	ND	5.6	15	MCL
(pCi/L)	Beta activity	40	23	30	5.2	12	26	**51**	39	50	MCL
	Radium-226	0.31	0.69	0.18	0.3	0.4	0.18	0.18	ND	5	MCL
	Radium-228	ND	ND	**5.8**	ND	**6**	4.5	**7.4**	**8.6**	5	MCL
	Technetium-99	46	ND	50	ND	ND	23	53	59	900	MCL
	Thorium-230	ND	ND	ND	ND	ND	0.56	ND	ND		
VOC	2-Butanone	ND	ND	11	ND	ND	ND	ND	ND		
(µg/L)	Acetone	ND	ND	ND	ND	47000	ND	ND	14		
	Carbon Disulfide	ND	9	12	ND	34	ND	ND	ND		
	Trichloroethene	**11**	ND	1.2	ND	ND	ND	**8**	1.6	5	MCL
Wetchem	Chemical Oxygen Demand (mg/L)	ND	330	500	29	3200	120	49	25		
	Total Organic Carbon (mg/L)	1	150	260	9	1900	46	20	3.9		
	Total Organic Halides (µg/L)	18	ND	ND	150	160	140	32	34		
	Turbidity (NTU)	14	40	64	9.5	41	25	41	130		

MCL - maximum contaminant l+A10evel (for reference only)
ND - Not detected
Bold - exceeds criteria
VOC - volatile organic compound

C-746-K Sanitary Landfill Groundwater Monitoring

The C-746-K Sanitary Landfill was used at the PGDP between 1951 and 1981 primarily for the disposal of fly ash. Postclosure groundwater monitoring continues for the C-746-K Landfill on a quarterly basis. The UCRS and RGA are not present at the C-746-K site. Wells at the landfill are installed to monitor groundwater in the terrace gravels (Figure 9.4). A summary of the maximum results for each of the wells is provided in Table 9.4. Degradation compounds and TCE, at concentrations above their respective regulatory criterion, were identified in wells around the C-746-K site. Beta activity also was found above regulatory criteria. No metals were found above the regulatory criteria.

Table 9.4. Summary of Maximum Groundwater Results at C-746-K Landfill

	Parameter	MW300	MW301	MW302	MW344	Reference/ Criteria	
Anion (mg/L)	Chloride	12	50	11	22		
	Sulfate	1800	2400	130	180		
Metal (mg/L)	Aluminum	0.34	ND	ND	3.7		
Total	Arsenic	0.0043	0.0013	ND	0.0048	0.05	MCL
	Barium	0.018	0.025	0.076	0.081	2	MCL
	Calcium	260	530	45	68		
	Iron	200	290	0.15	7.9		
	Iron 2+	140	250	3	7		
	Lead	0.0053	ND	ND	ND	0.015	MCL
	Magnesium	68	120	26	22		
	Manganese	16	20	1.4	0.71		
	Nickel	0.085	0.0098	0.0072	0.0067		
	Potassium	15	39	0.37	1.8		
	Sodium	20	60	83	32		
	Uranium	ND	0.0029	0.0058	N	0.02	MCL
Metals (mg/L)	Arsenic	0.0034	0.0014	ND	0.004	0.05	MCL
Dissolved	Barium	0.017	0.02	0.07	0.064	2	MCL
	Beryllium	0.001	ND	ND	ND	0.004	MCL
	Lead	0.01	ND	ND	ND	0.015	MCL
	Uranium	ND	0.0026	ND	ND	0.02	MCL
Rads (pCi/L)	Beta activity	40	**130**	ND	5.9	50	MCL
	Uranium-238	ND	0.7	ND	ND		
VOC (µg/L)	1,1-Dichloroethane	ND	5.6	ND	ND		
	1,1-Dichloroethene	**65**	5.1	ND	ND	7	MCL
	cis-1,2-Dichloroethene	**530**	64	ND	ND	70	MCL
	Trichloroethene	**14**	ND	ND	ND	5	MCL
	Vinyl Chloride	**47**	**3.5**	ND	ND	2	MCL

MCL - maximum contaminant level (for reference only)

ND - Not detected

Bold - Exceeds Criteria

Residential (Federal Facility Agreement) Monitoring

The DOE conducts sampling of residential wells potentially affected by the contaminant plume (DOE 1998). Currently, only two residential wells (R294 and R302) are sampled monthly. Sixteen other residential wells are monitored semiannually. All residential wells sampled monthly were analyzed for alpha and beta activity, TCE, and ^{99}Tc. As stated previously, the hydrologic unit in which residential wells are screened is uncertain; however, most are believed to be RGA wells. Table 9.5 provides a summary of the maximum detected results for the residential well monthly monitoring program. The 17 residential wells, sampled semiannually, showed no detections of TCE or ^{99}Tc.

For one residential well, R424, DOE has provided the residents with a carbon filtering system to allow them to have safe drinking water. These filters are replaced semiannually and the groundwater is sampled before and after filter replacement. The groundwater in the well contains TCE above levels established by the EPA Safe Drinking Water Act (SDWA); however, its location relative to PGDP makes it highly improbable that the contaminants migrated from the Paducah Site. All residents whose wells were sampled were notified by mail of the results.

Environmental Surveillance Monitoring

Environmental surveillance monitoring is defined as perimeter-exit-pathway (off-site exposure) monitoring and off-site water well

Table 9.5. Summary of Maximum Groundwater Results from Residential Monthly Monitoring

Well Number	Alpha activity pCi/L	Beta activity pCi/L	^{99}Tc pCi/L	TCE µg/L
R294	ND	4	ND	ND
R302	5.8	9.5	ND	**6**
	MCL=15	MCL=50		MCL=5

ND - Not detected
MCL - maximum contaminant level (for reference only)
Bold - Exceeds Criteria

monitoring. Environmental surveillance monitoring is conducted in support of DOE orders and other laws and regulations as addressed in the *Paducah Site Environmental Monitoring Plan* (BJC 2004a).

During 2005, surveillance wells located on and off DOE property were sampled for VOCs, metals, radionuclides, alpha and beta activity, carbonaceous biochemical oxygen demand, hardness, and suspended solids. Table 9.6 provides a summary of the maximum detected results for each hydrogeologic unit sampled for the surveillance program. The maximum TCE value reported (from routine monitoring program wells) in the RGA is 67,000 micrograms per liter (µg/L) from MW 343. The well is located at the northwest corner of C-400. TCE also was detected in the McNairy at 2 µg/L in MW 356, located at the northeast corner of the PGDP boundary.

During 2005, the maximum concentration of ^{99}Tc in the RGA was 8820 pCi/L in MW 343. This exceeded the MCL of 900 pCi/L. Five other wells, MW66, MW168, MW261, MW339, and MW342 also exceeded the MCL. These RGA wells are within the secured (fenced) area of the PGDP. Water is not consumed from this area; therefore, no dose is received and there is no threat to human health.

Three wells, MW 345, MW 346, and MW 347, have been installed, penetrating the Rubble Zone, which is the formation underlying the McNairy. No TCE or ^{99}Tc detections were observed in 2005.

Monitoring Well Rehabilitation

In 2005, DOE continued an MW rehabilitation program to enhance the effectiveness of the MWs at the Paducah Site. Well rehabilitation activities were completed in 2005 for a total of 30 wells. The rehabilitation process utilized Blended Chemical Heat Treatment™ (BCHT) as either preventive maintenance or full rehabilitation depending on the severity of biofouling in the well. The BCHT method consists of three phases designed to remove the accumulated biofilm and blocking materials from the well screen, well bore, and surrounding aquifer. The shock phase uses heated chemicals, which are jetted into the screen and allowed to remain overnight. The disrupt phase continuously applies heated chemicals via jetting. The removal of biofilm and blocking material redevelops the MW using surging and airlift pumping techniques.

Environmental Restoration Activities

Northwest Plume Monitoring

The site continued operations of the NWPGS. This action, which started operation in 1995, is to contain off-site migration of the high-concentration section of the Northwest Plume. This was the first phase of the high-concentration portion of remedial action for groundwater at the Paducah Site. Two extraction wells near a source of the Northwest Plume and two additional extraction wells farther north, near the centroid of the plume, were installed. Each set of extraction wells is surrounded by an MW network (Figure 9.5). The network is used for monitoring groundwater quality and water levels to determine the effectiveness of the interim action.

Table 9.6. Summary of Maximum Groundwater Results from Environmental Surveillance Monitoring

	Parameter	Eocene	McNairy	RGA	Rubble Zone	UCRS	Reference/ Criteria	
Anion	Chloride	NS	NS	84	NS	59		
(mg/L)	Nitrate as Nitrogen	NS	NS	**11**	NS	2.5	10	MCL
	Sulfate	NS	NS	79	NS	120		
Metal	Aluminum	NS	NS	1.2	NS	0.88		
(mg/L)	Arsenic	NS	NS	0.011	NS	0.017	0.05	MCL
	Barium	NS	NS	0.91	NS	0.41	2	MCL
	Calcium	NS	NS	39	NS	40		
	Chromium	NS	NS	**2.2**	NS	0.084	0.1	MCL
	Cobalt	NS	NS	0.057	NS	0.015		
	Copper	NS	NS	0.055	NS	ND		
	Iron	NS	NS	69	NS	8		
	Iron +2	NS	NS	40	NS	8		
	Lead	NS	NS	0.0072	NS	ND	0.015	MCL
	Magnesium	NS	NS	16	NS	15		
	Manganese	NS	NS	14	NS	3.7		
	Molybdenum	NS	NS	0.096	NS	0.0042		
	Nickel	NS	NS	0.66	NS	0.23		
	Potassium	NS	NS	8.8	NS	3.6		
	Selenium	NS	NS	0.013	NS	0.0059	0.05	MCL
	Sodium	NS	NS	61	NS	57		
	Uranium	0.0022	ND	0.0071	ND	**0.086**	0.02	MCL
	Zinc	NS	NS	0.12	NS	0.045		
Rads	Alpha activity	5.7	9.8	**68**	12	**54**	15	MCL
(pCi/L)	Beta activity	4.1	14	**6400**	14	**490**	50	MCL
	Dissolved Alpha	ND	ND	**62**		**32**	15	MCL
	Dissolved Beta	ND	ND	**5700**	10	**460**	50	MCL
	Potassium-40	ND	ND	87	ND	ND		
	Radium-226	NS	NS	0.24	NS	NS		
	Radium-228	NS	NS	23	NS	NS		
	Suspended Alpha	ND	4.6	13	ND	4.6		
	Suspended Beta	ND	ND	23	ND	9.7	50	MCL
	Technetium-99	ND	ND	**8800**	ND	690	900	MCL
	Thorium-228	ND	ND	ND	ND	0.18		
	Thorium-230	ND	ND	0.74	ND	ND		
	Uranium	ND	ND	ND	ND	46		
	Uranium-234	ND	ND	1.7	ND	18		
	Uranium-235	NS	NS	NS	NS	1.1		
	Uranium-238	ND	ND	1.4	ND	27		
VOC	1,1,2-Trichloroethane	ND	ND	6.9	ND	ND		
(µg/L)	1,1-Dichloroethane	ND	ND	17	ND	ND		
	1,1-Dichloroethene	ND	ND	**28**	ND	**8.5**	7	MCL
	Carbon tetrachloride	ND	ND	**74**	ND	ND	5	MCL
	Chloroform	ND	ND	78	ND	ND		
	cis-1,2-Dichloroethene	ND	ND	**5600**	ND	15	70	MCL
	Ethanol	NS	NS	590	NS	ND		
	Ethylene	NS	NS	0.012	NS	ND		
	Methane	NS	NS	2.9	NS	ND		
	Toluene	ND	ND	21	ND	ND	1000	MCL
	Trichloroethene	ND	2	**67000**	ND	**6900**	5	MCL
	Trichlorofluoromethane	NS	NS	6	NS	NS		
	Vinyl chloride	ND	ND	**410**	ND	ND	2	MCL
Wetchem	Total Organic Compounds (mg/l)	NS	NS	1.7	NS	1.3		
	Total Organic Halides (µg/L)	NS	NS	1400	NS	NS		

MCL - maximum contaminant level (for reference only)
ND - Not detected
NS - Not sampled
Bold - Exceeds criteria

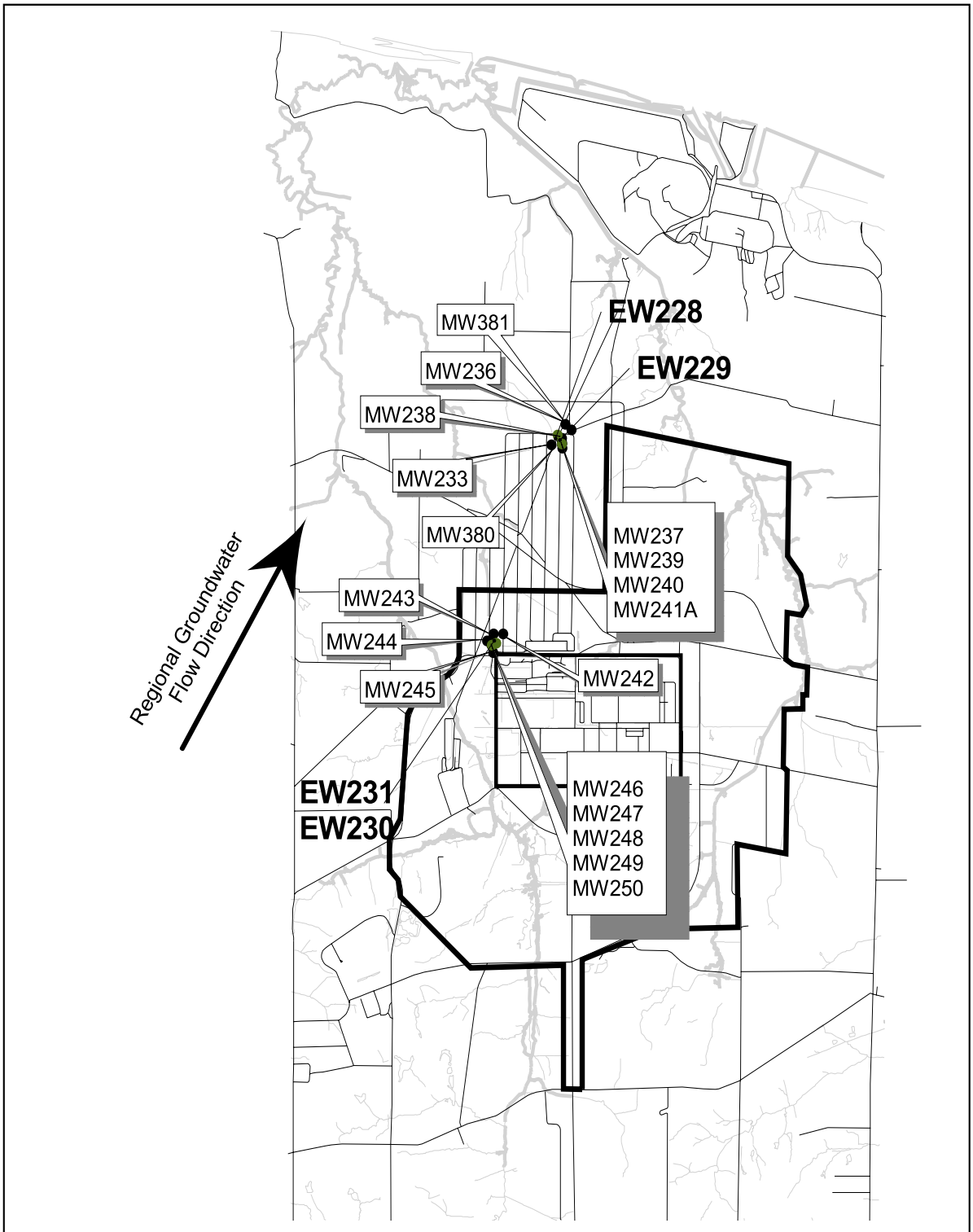

Figure 9.5 Northwest Plume monitoring wells

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The primary revision for CY 2005 is a reduction in the maximum level of TCE mapped for the Northwest Plume in the area located downgradient of the south well field. As noted in previous reports, TCE trends for the MWs of the north well field indicate that the core of the Northwest Plume has shifted eastward.

The CY 2005 ^{99}Tc maps for the Northwest Plume are consistent with the CY 2004 maps.

Summaries of the program's monitoring results are listed in Tables 9.7 and 9.8. The data for this program are reported in the FFA Semiannual Progress Report.

Northeast Plume Monitoring

The EPA approved an Interim ROD for treatment of the Northeast Plume in June of 1995. The treatment facility was completed in 1996 and operation began in 1997, which consisted of construction of two extraction wells, several MWs (Figure 9.6) with piezometers, and facilities required to transfer the TCE-contaminated water to the USEC C-637 Cooling Tower for treatment. Groundwater quality and water-level information obtained from the piezometers and MWs are used to evaluate the effectiveness of the remedial action. The upgradient MWs are used to detect possible ^{99}Tc contamination within the high-concentration area of the plume before it reaches the extraction wells.

Monitoring well data for the Northeast Plume well field and most upgradient locations within the Northeast Plume (wells MW255, MW258, MW288, and MW292) continued to document a trend of declining TCE levels, to well below 1,000 µg/L. This decline in the upgradient locations previously was attributed to both a shift of the core of the plume, away from the upgradient well locations, and an actual regression in TCE levels in the core of the plume. While both trends continue in the vicinity of MW255 (located on-site), it is now apparent that the dominant influence is the decline of TCE levels in the core of the plume.

Contaminant levels of ^{99}Tc generally are less than 25 pCi/L off-site and are greater than 100 pCi/L only at a few discrete locations. Analyses for MW256 continue to define a trend of increasing ^{99}Tc activity within the Northeast Plume near the plant boundary (131–151 pCi/L during CY 2005). The CY 2005 analyses for wells MW288 and MW292 clarify a trend of increasing ^{99}Tc activity, likewise, in the off-site Northeast Plume. Levels of ^{99}Tc in groundwater from MW288, located close to the well field, were 30 to 43 pCi/L during CY 2005.

A summary of the program's monitoring results is listed in Table 9.9. The data for this program are reported in the FFA Semiannual Progress Report.

Groundwater Monitoring Results

The primary objectives of groundwater monitoring at the Paducah Site are being met by the monitoring programs. Contamination has been detected in groundwater off-site. Through the monitoring program, in conjunction with RIs, a footprint of the groundwater contamination has been mapped and is updated annually. The program continues to expand each year to further delineate the boundaries of the footprint over time and to identify source locations for contaminants. Monitoring wells upgradient and downgradient from individual underground waste disposal facilities are sampled and analyzed for contaminants of concern. Contaminants identified by the monitoring program are evaluated by technical assessment and statistical analysis as required by permit, legal agreements, and other standard environmental practices to determine if the source of the contaminants could be from the disposal site being monitored. Beta activity, TCE, and ^{99}Tc are found in the off-site and on-site contamination plumes. Groundwater monitoring results from all sampling efforts conducted by the Paducah Site are compiled in the Paducah Oak Ridge Environmental Information System (OREIS) database. A complete listing of analytical results is available upon request from the PRS Public Affairs Department.

Table 9.7. Summary of Maximum Groundwater Results from the Northwest Plume North Field Groundwater Monitoring

Analysis		MW 233	MW 236	MW 237	MW 238	MW 239	MW 240	MW 241A	MW 380	MW 381	Reference/ Criteria	
Metals Total	Aluminum	ND	ND	2.4	0.35	ND	ND	ND	ND	ND		
	Calcium	21	22	26	22	4	23	22	24	26		
	Iron	ND	ND	4.3	0.91	21	ND	ND	ND	ND		
	Magnesium	8.9	8.8	10	8.9	2.7	9	8.9	9.3	10		
	Manganese	0.0097	0.1	0.11	0.099	0.55	0.029	ND	0.019	0.018		
	Potassium	1.5	1.4	0.46	1.4	7.7	1.5	1.4	1.4	1.5		
	Sodium	32	29	89	30	18	33	32	30	34		
Metals Dissolved (mg/L)	Calcium	21	21	26	23	4.1	22	22	25	27		
	Iron	ND	ND	1	ND	21	ND	ND	ND	ND		
	Magnesium	8.9	8.7	10	9.2	2.8	8.9	8.8	9.7	11		
	Manganese	0.0079	0.1	0.083	0.005	0.55	0.025		0.011	0.017		
	Potassium	1.5	1.3	0.41	1.5	7.9	1.5	1.4	1.4	1.6		
	Sodium	31	28	87	32	18	31	31	32	35		
Rads (pCi/L)	Alpha activity	ND	4.5	ND	ND	ND	ND	ND	ND	ND	15	MCL
	Beta activity	5.2	**59**	4.9	35	12	11	6.2	44	**100**	50	MCL
	Neptunium-237	ND	ND	ND	ND	ND	1.9	ND	ND	ND		
	Radium-226	ND	0.33	ND	ND	ND	ND	ND	ND	ND	20	MCL
	Technetium-99	ND	68	ND	51	ND	ND	22	72	150	900	MCL
	Thorium-230	ND	1.2	ND	ND	ND	2.1	ND	ND	ND		
VOC (µg/L)	Trichloroethene	4.8	**180**	ND	**97**	ND	**17**	**7.4**	**170**	**350**	5	MCL
Wetchem (mg/L)	Silica	19	18	42	16	44	16	17	16	17		

MCL - maximum contaminant level (for reference only)
ND - Not detected
Bold - Exceeds criteria

Table 9.8. Summary of Maximum Groundwater Results from the Northwest Plume South Field Groundwater Monitoring

Parameter		MW 242	MW 243	MW 244	MW 245	MW 246	MW 247	MW 248	MW 249	MW 250	Reference/ Criteria	
(mg/L)	Aluminum	0.99	0.94	ND	6	0.35	0.26	ND	0.28	ND		
	Calcium	25	27	18	30	33	12	23	21	21		
	Iron	4.5	1.1	ND	41	0.28	23	ND	0.4	ND		
	Magnesium	11	11	7.5	12	14	6.7	9.7	8.6	8.6		
	Manganese	2.3	0.022	0.011	13	ND	0.59	0.024	0.044	ND		
	Potassium	1.1	1.1	1.2	1.9	0.21	4.1	1	1.1	1.1		
	Sodium	27	25	30	26	73	27	29	31	31		
Metal Dissolved (mg/L)	Calcium	26	29	18	31	32	18	23	21	21		
	Iron	2.5	ND	ND	36	ND	21	ND	ND	21		
	Magnesium	11	12	7.4	12	14	7.3	9.7	8.6	8.7		
	Manganese	2.1	0.02	0.0052	13	ND	0.58	ND	0.017	0.55		
	Potassium	1	1.2	1.2	1.2	ND	3.9	1.1	1.2	4.1		
	Sodium	30	26	29	27	67	30	30	32	28		
RADS (pCi/L)	Alpha activity	ND	12	ND	ND	ND	ND	12	ND	3.9	15	MCL
	Beta activity	**68**	**220**	17	ND	ND	9.7	**260**	34	**100**	50	MCL
	Radon	120	160	ND	ND	ND	ND	200	ND	130	300	MCL
	Technetium-99	100	360	26	ND	40		350	55	180	900	MCL
	Thorium-230	ND	ND	1	ND	ND	ND	ND	ND	ND		
VOC (µg/L)	cis-1,2-Dichloroethene	5.3	ND	ND	ND	ND	ND	ND	ND	ND		
	Trichloroethene	**120**	**760**	**6.2**	**150**	ND	ND	**2500**	**21**	**920**	5	MCL
WETCHEM	Silica (mg/L)	16	16	18	29	31	24	16	18	18		

MCL - maximum contaminant level (for reference only)
ND - Not detected
Bold - Exceeds criteria

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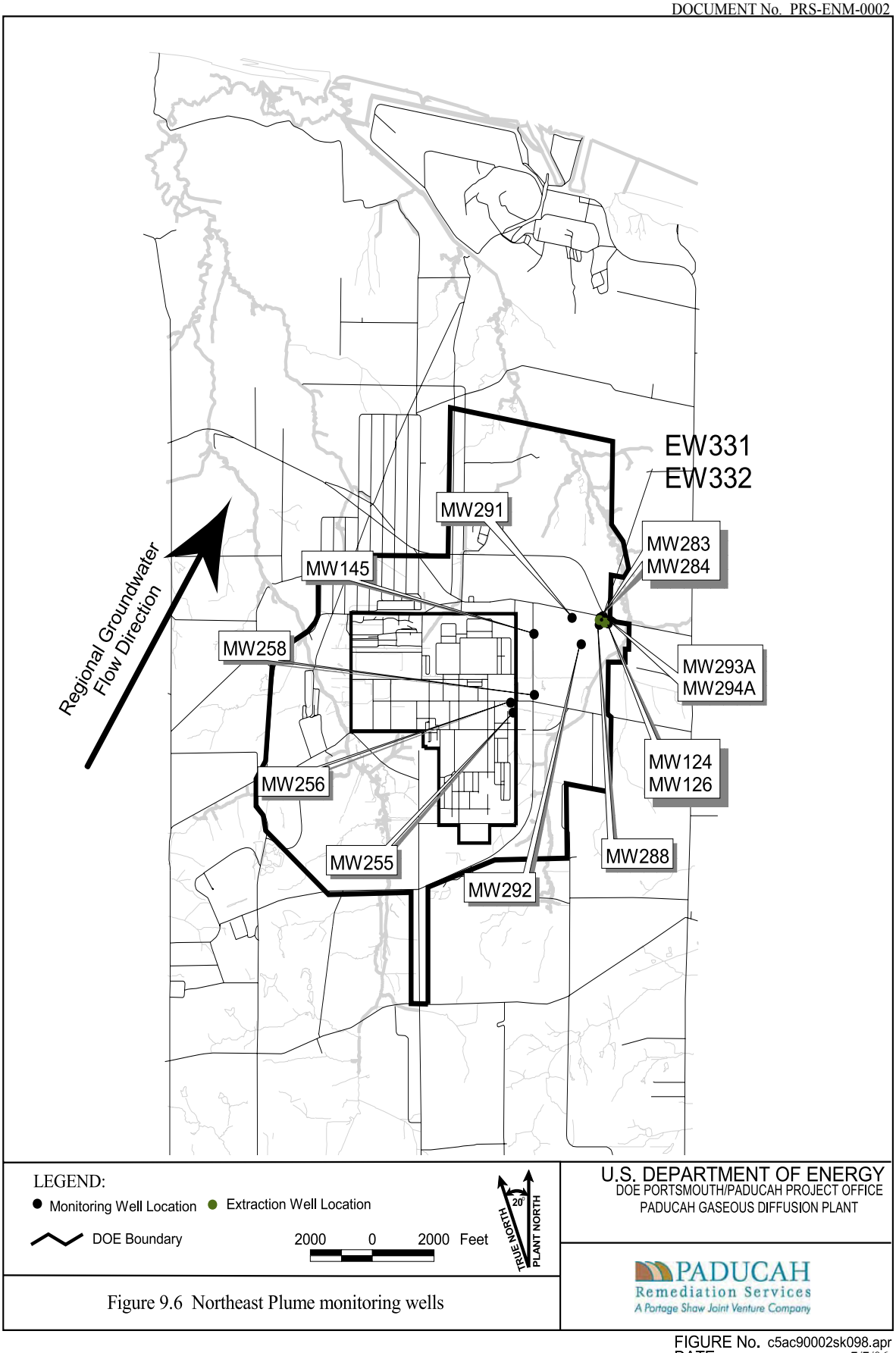

Figure 9.6 Northeast Plume monitoring wells

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Table 9.9. Summary of Maximum Groundwater Results from the Northeast Plume Groundwater Monitoring

	Parameter	MW 124	MW 126	MW 145	MW 255	MW 256	MW 258	MW 283	MW 284	MW 288	MW 291	MW 292	MW 293A	MW 294A	Criteria	
Anion	Chloride	NS	NS	88	58	52	45	NS	NS	67	60	57	NS	NS		
(mg/L)	Nitrate as Nitrogen	NS	NS	ND	ND	ND	1.2	NS	NS	1.1	1.2	1.3	NS	NS	10	MCL
	Sulfate	NS	NS	92	40	26	26	NS	NS	19	5.7	17	NS	NS		
Metal	Aluminum	NS	NS	ND	1	0.33	ND	NS	NS	ND	ND	ND	NS	NS		
Total	Arsenic	NS	NS	0.0012	0.0028	0.0016	0.0015	NS	NS	0.0022	0.0014	0.0015	NS	NS	0.05	MCL
(mg/L)	Barium	NS	NS	0.061	0.19	0.18	0.15	NS	NS	0.25	0.23	0.22	NS	NS	2	MCL
	Calcium	NS	NS	45	28	29	24	NS	NS	31	23	27	NS	NS		
	Chromium	NS	NS	0.024	ND	0.085	ND	NS	NS	**0.25**	ND	ND	NS	NS	0.1	MCL
	Cobalt	NS	NS	ND	0.012	ND	0.0012	NS	NS	ND	ND	ND	NS	NS		
	Iron	NS	NS	0.34	1.7	0.67	0.18	NS	NS	2.9	0.12	ND	NS	NS		
	Iron (2+)	NS	NS	0.05	0.78	0.14	0.1	NS	NS	0.59	0.05	0.08	NS	NS		
	Magnesium	NS	NS	18	11	11	9.4	NS	NS	13	9.3	11	NS	NS		
	Manganese	NS	NS	ND	3.2	0.01	0.011	NS	NS	ND	ND	ND	NS	NS		
	Molybdenum	NS	NS	ND	0.0033	0.0079		NS	NS	0.014	ND	ND	NS	NS		
	Nickel	NS	NS	0.0069	0.022	0.0064	0.022	NS	NS	0.013	0.0051	ND	NS	NS		
	Potassium	NS	NS	5.2	1.8	2	1.8	NS	NS	1.8	1.5	1.8	NS	NS		
	Selenium	NS	NS	0.0063	0.0077	0.0069	0.0095	NS	NS	0.012	0.0079	0.012	NS	NS	0.05	MCL
	Sodium	NS	NS	62	81	62	60	NS	NS	42	36	49	NS	NS		
Metal Dissolved	Arsenic	NS	NS	ND	0.0012	ND	ND	NS	NS	ND	ND	ND	NS	NS	0.05	MCL
(mg/L)	Barium	NS	NS	0.06	0.17	0.18	0.15	NS	NS	0.27	0.24	0.24	NS	NS	2	MCL
	Calcium	NS	NS	51	30	30	25	NS	NS	31	23	28	NS	NS		
	Cobalt	NS	NS	ND	0.011	ND	0.0011	NS	NS	ND	ND	ND	NS	NS		
	Iron	NS	NS	ND	0.53	ND	ND	NS	NS	ND	ND	ND	NS	NS		
	Magnesium	NS	NS	20	11	11	9.7	NS	NS	13	9.4	11	NS	NS		
	Manganese	NS	NS	ND	3.1	ND	0.011	NS	NS	ND	ND	ND	NS	NS		
	Molybdenum	NS	NS	ND	0.0018	ND	ND	NS	NS	ND	ND	ND	NS	NS		
	Nickel	NS	NS	0.0075	ND	ND	0.021	NS	NS	ND	ND	ND	NS	NS		
	Potassium	NS	NS	5.7	1.7	1.9	1.9	NS	NS	1.8	1.5	1.8	NS	NS		
	Selenium	NS	NS	ND	ND	ND	0.0063	NS	NS	0.0067	0.0058	0.009	NS	NS	0.05	MCL
	Sodium	NS	NS	70	85	65	65	NS	NS	45	39	51	NS	NS		
PHYSC	Dissolved Solids	NS	NS	420	350	290	270	NS	NS	260	220	260	NS	NS		
Rads	Alpha activity	ND	4.1	ND	ND	7.2	ND	ND	ND	ND	ND	ND	ND	ND	15	MCL
(pCi/L)	Beta activity	8.6	5.6	20	8.7	120	11	8.2	7.4	31	6.2	32	5.3	6.5	50	MCL
	Technetium-99	ND	ND	23	ND	150	ND	ND	ND	43	ND	41	ND	ND	900	MCL
VOC	1,1-Dichloroethene	ND	ND	ND	ND	**97**	ND	ND	ND	**17**	ND	**27**	ND	ND	7	MCL
(µg/L)	cis-1,2-Dichloroethene	ND	ND	ND	ND	ND	ND	5	ND	ND	ND	ND	ND	ND		
	Trichloroethene	**220**	2.5	**58**	**470**	**530**	**450**	**110**	**120**	**310**	**110**	**410**	**510**	**420**	5	MCL
Wetchem	Alkalinity (mg/L)	NS	NS	30	55	110	72	NS	NS	26	24	34	NS	NS		
	Silica (mg/L)	NS	NS	15	13	14	14	NS	NS	12	13	12	NS	NS		
	Total Organic Carbon (mg/L)	NS	NS	1.1	1.1	1	ND	NS	NS	ND	ND	ND	NS	NS		
	Turbidity (NTU)	260	15	31	260	22	46	29	16	130	13	33	23	16		

MCL - maximum contaminant level (for reference only)

ND - Not detected

NS - Not sampled

Bold - Exceeds criteria

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10 Quality Assurance

Abstract

The Paducah Site maintains a Quality Assurance/Quality Control (QA/QC) Program to verify the integrity of data generated within the Environmental Monitoring Program. Monitoring and sampling organizations at Paducah select sampling methods, instruments, locations, schedules, and other sampling and monitoring criteria based on applicable guidelines from various established authorities.

Introduction

The Paducah Site maintains a QA/QC Program to verify the integrity of data generated within the Environmental Monitoring Program. Each aspect of the monitoring program, from sample collection to data reporting, must address quality requirements and assessment standards. Requirements and guidelines for the QA/QC Program at the Paducah Site are established by DOE Order 414.1, *Quality Assurance*; state and federal regulations; and documentation from the EPA, the American National Standards Institute, the American Society of Mechanical Engineers, the American Society of Testing and Materials (ASTM), and the American Society for Quality Control. The QA/QC Program specifies organizational and programmatic elements to control equipment, design, documents, data, nonconformances, and records. Emphasis is placed on planning, implementing, and assessing activities. Program requirements are specified in project and subcontract documents to ensure that requirements are included in project-specific QA plans and other planning documents.

The *Environmental Services Subcontract Quality Assurance and Data Management Plan* (EQADMP) defines the relationship of each element of the Environmental Monitoring Program to key quality and data management requirements. Training requirements, sample custody, procedures, instrument calibration and maintenance, and data review are a few of the subjects discussed in the EQADMP. In 2005, a variety of functions were performed for the Environmental Monitoring Program, such as conducting surveillances, reporting problems, reviewing data, reviewing procedures, and revising the EQADMP.

Field Sampling Quality Control

Data Quality Objectives and Sample Planning

From the point of conception of any sampling program, data quality objectives (DQOs) play an important role. The number of samples, location of sampling sites, sampling methods, sampling schedules, and coordination of sampling and analytical resources to meet critical completion times are part of the DQO process and are documented in the *Paducah Site*

Environmental Monitoring Plan (BJC 2004a).

Each sampling location and sample collected is assigned a unique identification number. Each segment of the sequence is used to designate information concerning the location from which a sample is collected. In order to progress from planning to implementing the DQOs, an analytical statement of work (SOW) for the analytical laboratory is generated from a system within the Paducah Integrated Data System. From this system, the Project Environmental Measurements System (PEMS), an electronic database used for managing and streamlining field-generated and laboratory-generated data, is populated with sample identification numbers, sampling locations, sampling methods, analytical parameters, analytical methods, and sample container and preservative requirements. This information is used to produce sample bottle labels and chain-of-custody forms for each sampling event.

Field Measurements

Field measurements for the groundwater and surface water monitoring program are collected in the field and include water level measurements, pH, conductivity, flow rate, turbidity, temperature, dissolved oxygen, total residual chlorine, and barometric pressure. Environmental conditions, such as ambient temperature and weather, also are recorded. Field measurements are collected and either downloaded electronically, recorded on appropriate field forms, or recorded in logbooks, and input into PEMS.

Sampling Procedures

Samples are collected using media-specific procedures, which are written according to EPA-approved sampling methods. Sample media consist of surface water, groundwater, sediment, and biota, such as fish and deer. Sample information recorded during a sampling event consists of the following: sample identification number, station (or location), date collected, time collected, person who performed the sampling, etc. This information is documented in a logbook and on a chain-of-custody form and sample container label, and then input directly into PEMS on a weekly or other appropriate basis. Chain-of-custody forms are maintained from the point of sampling, and the samples are protected properly until they are placed in the custody of an analytical laboratory.

Field Quality Control Samples

The QC program for both groundwater and environmental monitoring activities specifies a minimum target rate of 5 percent, or one per 20 environmental samples, for field QC samples. Table 10.1 shows the types of field QC samples collected and analyzed. Analytical results of field QC samples are evaluated to determine if the sampling event had any effect on the sample results.

Analytical Laboratory Quality Control

Analytical Procedures

When available and appropriate for the sample matrix, EPA-approved SW-846 methods are used for sample analysis. When SW-846 methods are not available, other nationally recognized methods, such as those developed by DOE and ASTM, are used. Analytical methods are identified in an analytical SOW. Using guidance from EPA, laboratories document the steps in handling, analysis, and approval of results. Chain-of-custody procedures are followed until a sample is analyzed.

Laboratory Quality Control Samples

Laboratory QC samples are prepared and analyzed as required by the analytical methods used. Typical laboratory QC samples are identified in Table 10.1. If acceptance criteria are not met for the QC samples, then appropriate action, as denoted by the analytical method, is taken or the analytical data are qualified appropriately.

Independent Quality Control

The Paducah Site is required by DOE and EPA to participate in independent QC programs. The site also participates in voluntary independent programs to improve analytical QC.

Table 10.1 Types of QC samples

Field QC Samples	Laboratory QC Samples
Field blanksa	Laboratory duplicates
Field duplicates	Reagent blanks
Trip blanksa	Matrix spikesb
Equipment rinseates	Matrix spike duplicates
	Surrogates
	Performance evaluations
	Laboratory control samples

a Blanks – samples of deionized water used to assess potential contamination from a source other than the media being sampled.

b Spikes – samples that have been mixed with a known quantity of a chemical to measure instrument effectiveness during the analysis process.

These programs generate data that readily are recognizable as objective measures that allow participating laboratories and government agencies a periodic review of their performance. Results that exceed acceptable limits are investigated and documented according to formal procedures. Although participation in certain programs is mandatory, the degree of participation is voluntary, so that each laboratory can select parameters of particular interest to that facility. These programs are conducted by EPA, DOE, and commercial laboratories. The laboratories supporting the Paducah DOE KPDES program participate in a Discharge Monitoring Report QA Study conducted annually by EPA. The laboratories currently utilized all received acceptable results during 2005.

Laboratory Audits/Sample Management Office

Laboratory audits are performed periodically by the BJC Oak Ridge Sample Management Office (SMO) to ensure that the laboratory is in compliance with regulations, procedures, and the contract between the laboratory and the SMO. Findings are documented and addressed by the audited laboratory through corrective actions.

Data Management

Project Environmental Management System

The data generated from sampling events are stored in PEMS, a consolidated site data system for tracking and managing data. The system is used to manage field-generated data, import laboratory-generated data, input data qualifiers identified during the data review process, and transfer data to the Paducah OREIS for reporting. PEMS uses a variety of references and code lists to ensure consistency and standardization of the data.

Paducah OREIS

Paducah OREIS is the database used to consolidate data generated by the EM Program. Data consolidation consists of the activities necessary to prepare the evaluated data for the users. The PEMS files containing the assessed data are transferred from PEMS to Paducah OREIS for future use. The data manager is responsible for notifying the project team and other data users of the available data. Data used

in reports distributed to external agencies (e.g., the quarterly landfill reports, the ASER, and the biological monitoring program reports) are obtained from Paducah OREIS and have been through the data review process.

Electronic Data Deliverables

A "results only" Electronic Data Deliverable (EDD) is requested for all samples analyzed by each laboratory. The results and qualifier information from the EDD are checked in addition to the format of all fields provided. Discrepancies are reported immediately to the laboratory so corrections can be made or new EDDs can be issued. Approximately 10 percent of the EDDs is randomly checked to verify that the laboratory continues to provide adequate EDDs.

Data Packages

A "forms only" Level III data package is requested from the laboratory when data validation is to be performed on a specific sampling event or media. All data packages received from the fixed-base laboratory are tracked, reviewed, and maintained in a secure environment. The following information is tracked: sample delivery group number, date received, number of samples, sample analyses, receipt of any EDD, and comments. The contents of the data package and the chain-of-custody forms are compared and discrepancies identified. Discrepancies are reported immediately to the laboratory and data validators. All data packages are forwarded to the PGDP Document Management Center for permanent storage.

Laboratory Contractual Screening

Laboratory contractual screening is the process of evaluating a set of data against the requirements specified in the analytical SOW to ensure that all requested information is received.

The contractual screening includes, but is not limited to, the chain-of-custody form, number of samples, analytes requested, total number of analyses, method used, QC samples analyzed, EDDs, units, holding times, and reporting limits achieved. The contractual screening is conducted electronically upon receipt of data from the analytical laboratory. Any exception to the SOW is identified and documented.

Data Verification, Validation, and Assessment

Data verification is the process for comparing a data set against a set standard or contractual requirement. Verification is performed electronically, manually, or by a combination of both. Data verification includes contractual screening and other criteria specific to the data. Data are flagged as necessary. Verification qualifiers are stored in PEMS and transferred with the data to Paducah OREIS.

Data validation is the process performed by a qualified individual for a data set, independent from sampling, laboratory, project management, or other decision-making personnel. Data validation evaluates the laboratory adherence to analytical method requirements. Validation qualifiers are stored in PEMS and transferred with the data to Paducah OREIS. Data from routine sampling events are validated programmatically at a frequency of 5 percent of the total data packages. Each of the selected data packages, which make up 5 percent of the total number of data packages, is validated 100 percent.

Data assessment is the process for assuring that the type, quality, and quantity of data are appropriate for their intended use. It allows for the determination that a decision (or estimate) can be made with the desired level of confidence, given the quality of the data set. Data assessment follows data verification and data validation (if applicable) and must be performed at a rate of 100 percent to ensure data are useable. The data assessment is conducted by trained technical personnel in conjunction with other project team members. Assessment qualifiers are stored in PEMS and transferred with the data to Paducah OREIS. Data are made available for reporting from Paducah OREIS upon completion of the data assessment, and associated documentation is filed with the project files.

The EPA and KDOW require, as part of their QA program, a laboratory QA study. Each laboratory performing analyses to demonstrate KPDES permit compliance are required to participate. Two laboratories and one sampling organization participated in the study in 2005. Final results for the Discharge Monitoring Report QA Study Number 25 were "acceptable." These results were provided to KDOW and EPA as required.

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Glossary

absorption – The process by which the number and energy of particles or photons entering a body of matter is reduced by interaction with the matter.

adsorption – The accumulation of gases, liquids, or solutes on the surface of a solid or liquid.

activity – See radioactivity.

air stripping – The process of bubbling air through water to remove volatile organic compounds from the water.

alpha particle – A positively charged particle emitted from the nucleus of an atom having the same charge and mass as that of a helium nucleus (two protons and two neutrons).

ambient air – The atmosphere around people, plants, and structures.

analyte – A constituent or parameter being analyzed.

analytical detection limit – The lowest reasonably accurate concentration of an analyte that can be detected; this value varies depending on the method, instrument, and dilution used.

aquifer – A geologic formation, group of formations, or part of a formation capable of yielding a significant amount of groundwater to wells or springs.

aquitard – A geologic unit that inhibits the flow of water.

assimilate – To take up or absorb.

atom – Smallest particle of an element capable of entering into a chemical reaction.

beta particle – A negatively charged particle emitted from the nucleus of an atom. It has a mass and charge equal to those of an electron.

biota – The animal and plant life of a particular region considered as a total ecological entity.

CERCLA-reportable release – A release to the environment that exceeds reportable quantities as defined by the Comprehensive Environmental Response, Compensation, and Liability Act.

chain-of-custody form – A form that documents sample collection, transport, analysis, and disposal.

closure – Formal shutdown of a hazardous waste management facility under Resource Conservation and Recovery Act requirements.

compliance – Fulfillment of applicable requirements of a plan or schedule ordered or approved by government authority.

concentration – The amount of a substance contained in a unit volume or mass of a sample.

conductivity – A measure of a material's capacity to convey an electric current. For water, this property is related to the total concentration of the ionized substances in water and the temperature at which the measurement is made.

confluence – The point at which two or more streams meet; the point where a tributary joins the main stream.

congener – Any particular member of a class of chemical substances. A specific congener is denoted by a unique chemical structure.

contained landfill – A solid waste site or facility that accepts disposal of solid waste. The technical requirements for contained landfills are found in 401 K.A.R. 47:080, 48:050, and 48:070 to 48:090.

contamination – Deposition of unwanted material on the surfaces of dissolved into structures, areas, objects, or personnel.

cosmic radiation – Ionizing radiation with very high energies that originates outside the earth's atmosphere. Cosmic radiation is one contributor to natural background radiation.

Curie (Ci) – A unit of radioactivity. One Curie is defined as 3.7×10^{10} (37 billion) disintegrations per second. Several fractions and multiples of the Curie are used commonly:

- **kiloCurie (kCi)** – 10^{3} Ci, one thousand curies; 3.7×10^{13} disintegrations per second.
- **milliCurie (mCi)** – 10^{-3} Ci, one-thousandth of a curie; 3.7×10^{7} disintegrations per second.
- **microCurie (µCi)** – 10^{-6} Ci, one-millionth of a curie; 3.7×10^{4} disintegrations per second.
- **picoCurie (pCi)** – 10^{-12} Ci, one-trillionth of a curie; 3.7×10^{-2} disintegrations per second.

daughter – A nuclide formed by the radioactive decay of a parent nuclide.

decay, radioactive – The spontaneous transformation of one radionuclide into a different radioactive or nonradioactive nuclide or into a different energy state of the same radionuclide.

dense nonaqueous-phase liquid (DNAPL) – The liquid phase of chlorinated organic solvents. These liquids are denser than water and include commonly used industrial compounds such as tetrachloroethylene and trichloroethylene.

derived concentration guide (DCG) – The concentration of a radionuclide in air or water that, under conditions of continuous exposure for one year by one exposure mode (i.e., ingestion of water, submersion in air, or inhalation), would result in either an effective dose equivalent of 0.1 rem (1 mSv) or a dose equivalent of 5 rem (50 mSv) to any tissue, including skin and the lens of the eye. The guidelines for radionuclides in air and water are given in DOE Order 5400.5, *Radiation Protection of the Public and the Environment.*

disintegration, nuclear – A spontaneous nuclear transformation (radioactivity) characterized by the emission of energy and/or mass from the nucleus of an atom.

dose – The energy imparted to matter by ionizing radiation. The unit of absorbed dose is the rad, equal to 0.01 joules per kilogram in any medium.

- **absorbed dose** – The quantity of radiation energy absorbed by an organ divided by the organ's mass. Absorbed dose is expressed in units of rad (or gray) (1 rad = 0.01 Gy).
- **dose equivalent** – The product of the absorbed dose (rad) in tissue and a quality factor. Dose equivalent is expressed in units of rem (or sievert) (1 rem = 0.01 Sv).
- **committed dose equivalent** – The calculated total dose equivalent to a tissue or organ over a 50-year period after known intake of a radionuclide into the body. Contributions from external dose are not included. Committed dose equivalent is expressed in units of rem (or sievert).
- **committed effective dose equivalent** – The sum of the committed dose equivalents to various tissues in the body, each multiplied by the appropriate weighting

factor. Committed effective dose equivalent is expressed in units of rem (or sievert).

- **effective dose equivalent** – The sum of the dose equivalents received by all organs or tissues of the body after each one has been multiplied by an appropriate weighting factor. The effective dose equivalent includes the committed effective dose equivalent from internal deposition of radionuclides and the effective dose equivalent attributable to sources external to the body.
- **collective dose equivalent/collective effective dose equivalent** – The sums of the dose equivalents or effective dose equivalents of all individuals in an exposed population within a 50-mile (80-km) radius expressed in units of person-rem (or person-sievert). When the collective dose equivalent of interest is for a specific organ, the units would be organ-rem (or organ-sievert). The 50-mile distance is measured from a point located centrally with respect to major facilities or DOE program activities.

downgradient – In the direction of decreasing hydrostatic head.

downgradient well – A well that is installed hydraulically downgradient of a site and that may be capable of detecting migration of contaminants from a site.

drinking water standards (DWS) – Federal primary drinking water standards, both proposed and final, as set forth by the EPA in 40 C.F.R. 141 and 40 C.F.R. 143.

effluent – A liquid or gaseous waste discharge to the environment.

effluent monitoring – The collection and analysis of samples or measurements of liquid and gaseous effluents for purposes of characterizing and quantifying the release of contaminants, assessing radiation exposures to members of the public, and demonstrating compliance with applicable standards.

Environmental Restoration – A DOE program that directs the assessment and cleanup of its sites (remediation) and facilities (decontamination and decommissioning) contaminated with waste as a result of nuclear-related activities.

exposure (radiation) – The incidence of radiation on living or inanimate material by accident or intent. Background exposure is the exposure to natural background ionizing radiation. Occupational exposure is that exposure to ionizing radiation received at a person's workplace. Population exposure is the exposure to the total number of persons who inhabit an area.

external radiation – Exposure to ionizing radiation when the radiation source is located outside the body.

fauna – The population of animals in a given area, environment, formation, or time span.

flora – The population of plants in a given area, environment, formation, or time span.

formation – A mappable unit of consolidated or unconsolidated geologic material of a characteristic lithology or assemblage of lithologies.

gamma ray – High-energy, short-wavelength electromagnetic radiation emitted from the nucleus of an excited atom. Gamma rays are identical to X-rays except for the source of the emission.

Gaussian puff/plume model – A computer-simulated atmospheric dispersion of a release using a Gaussian (normal) statistical distribution to determine concentrations in air.

grab sample – A sample collected instantaneously with a glass or plastic bottle placed below the water surface to collect surface-water samples (also called dip samples).

groundwater, unconfined – Water that is in direct contact with the atmosphere through open spaces in permeable material.

half-life, radiological – The time required for half of a given number of atoms of a specific radionuclide to decay. Each nuclide has a unique half-life.

hardness – The amount of calcium carbonate dissolved in water, usually expressed as part of calcium carbonate per million parts of water.

hydrogeology – Hydraulic aspects of site geology.

hydrology – The science dealing with the properties, distribution, and circulation of natural water systems.

in situ – In its original place; field measurements taken without removing the sample from its origin; remediation performed while groundwater remains below the surface.

internal dose factor – A factor used to convert intakes of radionuclides to dose equivalents.

internal radiation – Occurs when natural radionuclides enter the body by ingestion of foods or liquids or by inhalation. Radon is the major contributor to the annual dose equivalent for internal radionuclides.

ion – An atom or compound that carries an electrical charge.

irradiation – Exposure to radiation.

isotopes – Forms of an element having the same number of protons but differing numbers of neutrons in their nuclei.

- **long-lived isotope** – A radionuclide that decays at such a slow rate that a quantity of it will exist for an extended period (half-life is greater than three years).

- **short-lived isotope** – A radionuclide that decays so rapidly that a given quantity is transformed almost completely into decay products within a short period (half-life is two days or less).

lower limit of detection – The smallest concentration or amount of analyte that can be reliably detected in a sample at a 95 percent confidence level.

maximally exposed individual – A hypothetical individual who remains in an uncontrolled area and would, when all potential routes of exposure from a facility's operations are considered, receive the greatest possible dose equivalent.

migration – The transfer or movement of a material through air, soil, or groundwater.

milliroentgen (mR) – A measure of X-ray or gamma radiation. The unit is one-thousandth of a roentgen.

minimum detectable concentration – The smallest amount or concentration of a radionuclide that can be distinguished in a sample by a given measurement system at a preselected counting time and at a given confidence level.

monitoring – Process whereby the quantity and quality of factors that can affect the environment or human health are measured periodically to regulate and control potential impacts.

mrem – The dose equivalent that is one-thousandth of a rem.

natural radiation – Radiation from cosmic and other naturally occurring radionuclide (such as radon) sources in the environment.

nuclide – An atom specified by its atomic weight, atomic number, and energy state. A radionuclide is a radioactive nuclide.

outfall – The point of conveyance (e.g., drain or pipe) of wastewater or other effluents into a ditch, pond, or river.

part per billion (ppb) – A unit measure of concentration equivalent to the weight/volume ratio expressed as µg/L or mg/mL.

part per million (ppm) – A unit measure of concentration equivalent to the weight/volume ratio expressed as mg/L.

pathogen – A disease-producing agent; usually refers to living organisms.

person-rem – Collective dose to a population group. For example, a dose of 1 rem to 10 individuals results in a collective dose of 10 person-rem.

pH – A measure of the hydrogen-ion concentration in an aqueous solution. Acidic solutions have a pH from 0 to 6, neutral solutions have a pH equal to 7, and basic solutions have a pH greater than 7.

piezometer – An instrument used to measure the hydraulic potential of groundwater at a given point; also, a well designed for this purpose.

polychlorinated biphenyl (PCB) - Any chemical substance that is limited to the biphenyl molecule and that has been chlorinated to varying degrees.

polynuclear aromatic hydrocarbon (PAH) – Any organic compound composed of more than one benzene ring.

process water – Water used within a system process.

purge – To remove water before sampling, generally by pumping or bailing.

quality assurance (QA) – Any action in environmental monitoring to ensure the reliability of monitoring and measurement data.

quality control (QC) – The routine application of procedures within environmental monitoring to obtain the required standards of performance in monitoring and measurement processes.

quality factor – The factor by which the absorbed dose (rad) is multiplied to obtain a quantity that expresses, on a common scale for all ionizing radiation, the biological damage to exposed persons. A quality factor is used because some types of radiation, such as alpha particles, are more biologically damaging than others.

rad – An acronym for Radiation Absorbed Dose. The rad is a basic unit of absorbed radiation dose. (This is being replaced by the "gray," which is equivalent to 100 rad.)

radiation detection instruments – Devices that detect and record the characteristics of ionizing radiation.

radioactivity – The spontaneous emission of radiation, generally alpha or beta particles or gamma rays, from the nucleus of an unstable isotope.

radioisotopes – Radioactive isotopes.

radionuclide – An unstable nuclide capable of spontaneous transformation into other nuclides by changing its nuclear configuration or energy level. This transformation is accompanied by the emission of photons or particles.

reference material – A material or substance with one or more properties that is sufficiently well established and used to calibrate an apparatus, to assess a measurement method, or to assign values to materials.

release – Any discharge to the environment. Environment is broadly defined as any water, land, or ambient air.

rem – The unit of dose equivalent (absorbed dose in rads multiplied by the radiation quality factor). Dose equivalent is frequently reported in units of millirem (mrem), which is one-thousandth of a rem.

remediation – The correction of a problem. See Environmental Restoration.

Resource Conservation and Recovery Act (RCRA) – Federal legislation that regulates the transport, treatment, and disposal of solid and hazardous wastes.

RFI Program – RCRA Facility Investigation Program; EPA-regulated investigation of a solid waste management unit with regard to its potential impact on the environment.

Roentgen – A unit of exposure from X-rays or gamma rays. One roentgen equals 2.58 x 10^4 coulombs per kilogram of air.

screen zone – In well construction, the section of a formation that contains the screen, or perforated pipe, that allows water to enter the well.

semivolatile organic analyte (SVOA) – Any organic compound with a high boiling point which will volatilize upon heating.

sievert (Sv) – The SI (International System of Units) unit of dose equivalent; 1 Sv = 100 rem.

slurry – A suspension of solid particles (sludge) in water.

source – A point or object from which radiation or contamination emanates.

specific conductance – The ability of water to conduct electricity; this ability varies in proportion to the amount of ionized minerals in the water.

stable – Not radioactive or not easily decomposed or otherwise modified chemically.

storm-water runoff – Surface streams that appear after precipitation.

strata – Beds, layers, or zones of rocks.

substrate – The substance, base, surface, or medium in which an organism lives and grows.

surface water – All water on the surface of the earth, as distinguished from groundwater.

suspended solids – Mixture of fine, nonsettling particles of any solid within a liquid or gas.

terrestrial radiation – Ionizing radiation emitted from radioactive materials, primarily ^{40}K, thorium, and uranium, in the earth's soils. Terrestrial radiation contributes to natural background radiation.

thermoluminescent dosimeter (TLD) – A device used to measure external gamma radiation.

total activity – The total quantity of radioactive decay particles that are emitted from a sample.

total solids – The sum of total dissolved solids and suspended solids.

total suspended particulates – Refers to the concentration of particulates in suspension in the air irrespective of the nature, source, or size of the particulates.

transuranic element (TRU) – An element above uranium in the Periodic Table, that is, with an atomic number greater than 92. All 11 TRUs are produced artificially and are radioactive. They are neptunium, plutonium, americium, curium, berkelium, californium, einsteinium, fermium, mendelevium, nobelium, and lawrencium.

troughing system – A collection and containment system designed to collect leaks of oil that have been contaminated with PCBs.

turbidity – A measure of the concentration of sediment or suspended particles in solution.

upgradient – In the direction of increasing hydrostatic head.

vadose zone – Soil zone located above the water table.

volatile organic compound (VOC) – Any organic compound which has a low boiling point and readily volatilizes into air (e.g., trichloroethane, tetrachloroethylene, and trichloroethylene).

watershed – The region draining into a river, river system, or body of water.

wetland – A lowland area, such as a marsh or swamp, inundated or saturated by surface or groundwater sufficiently to support hydrophytic vegetation typically adapted to life in saturated soils.

Appendix A: Radiation

This appendix gives basic information about radiation. This information is intended to be a basis for understanding normal radiation dose from sources unassociated with the Paducah Site. People are constantly exposed to radiation. For example, radon in air; potassium in food and water; and uranium, thorium, and radium in the earth's crust are all sources of radiation. The following discussion describes important aspects of radiation, including atoms and isotopes; types, sources, and pathways of radiation; radiation measurement; and dose information.

ATOMS AND ISOTOPES

All matter is made up of **atoms**. The atom is thought to consist of a dense central nucleus surrounded by a cloud of electrons. The nucleus is composed of protons and neutrons. Table A.1 summarizes the basic components of an atom. In an electrically neutral atom, the number of protons equals the number of electrons. Atoms can lose or gain electrons through ionization. The number of protons in the nucleus determines an element's atomic number, or chemical identity. With the exception of hydrogen, the nucleus of each type of atom also contains at least one neutron. Unlike protons, the number of neutrons may vary among atoms of the same element. The number of neutrons and protons determines the atomic weight of the atom.

Atoms of the same element with a different number of neutrons are called **isotopes**. Isotopes have the same chemical properties but different atomic weights. Figure A.1 depicts isotopes of the element hydrogen. Uranium, which has 92 protons, is another example of an element that has isotopes. All isotopes of uranium have 92 protons. However, each uranium isotope has a different number of neutrons. ^{234}U has 92 protons and 142 neutrons; ^{235}U has 92 protons and 143 neutrons; and ^{238}U has 92 protons and 146 neutrons.

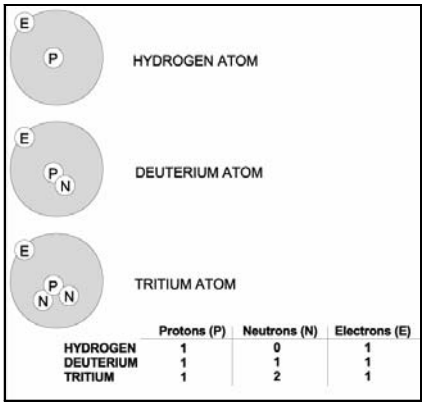

Figure A.1. Isotopes of the Element Hydrogen

Table A.1. Summary of the Basic Parts of an Atom

Particle	Location	Charge	Comments
Protons	Nucleus	+ positive	The number of protons determines the element. If the number of protons changes, the element changes.
Neutrons	Nucleus	No charge	Atoms of the same element have the same number of protons, but can have a different number of neutrons. This is called an isotope.
Electrons	Orbit nucleus	– negative	This negative charge is equal in magnitude to the proton's positive charge.

Source: Bechtel Jacobs Company, LLC. *Radiological Worker I and II Academics Training*, Student Handbook, Revision 2.

BASIC INFORMATION ABOUT RADIATION

Radioactivity was discovered in 1896 by the French physicist Antoine Henri Becquerel when he observed that the element uranium can blacken a photographic plate, even when separated from the plate by glass or black paper. In 1898, the French chemists Marie Curie and Pierre Curie concluded that radioactivity is a phenomenon associated with atoms, independent of their physical or chemical state. The Curies measured the heat associated with the decay of radium and established that 1 g (0.035 oz) of radium gives off about 100 cal of energy every hour. This release of energy continues hour after hour and year after year, whereas the complete combustion of a gram of coal results in the production of a total of only about 8000 cal of energy. Radioactivity attracted the attention of scientists throughout the world, following these early discoveries. In the ensuing decades, many aspects of the phenomenon were thoroughly investigated (Encarta 2002a).

Radiation is energy in the form of waves or particles moving through space. Radiation occurs because unstable atoms give off excess energy to become stable. **Ionization** is the process of removing electrons from neutral atoms. NOTE: Ionization should not be confused with radiation. Ionization is a result of the interaction of radiation with an atom and is what allows the radiation to be detected. **Ionizing radiation** is energy (particles or rays) emitted from radioactive atoms that can cause ionization. Ionizing radiation is capable of displacing electrons and changing the chemical state of matter and, subsequently, causing biological damage; therefore, ionizing radiation is potentially harmful to human health. Examples of ionizing radiation include alpha, beta, and gamma radiation. **Non-ionizing radiation** bounces off or passes through matter without displacing electrons. Non-ionizing radiation does not have enough energy to ionize an atom. It is unclear whether non-ionizing radiation is harmful to human health. Examples include visible light, radar waves, microwaves, and radio waves. **Radioactivity** is the process of unstable or radioactive atoms becoming stable by emitting radiant energy. Radioactivity that occurs over a period of time is called **radioactive decay**. The discovery that radium decays to produce radon proved conclusively that radioactive decay is accompanied by a change in the chemical nature of the decaying element. A **disintegration** is a single atom undergoing radioactive decay. **Radioactive half-life** is the time it takes for one-half of the radioactive atoms present to decay.

TYPES, SOURCES, AND PATHWAYS OF RADIATION

Visible light, heat, radio waves, and alpha particles are examples of radiation. When people feel warmth from the sunlight, they actually are absorbing the radiant energy emitted by the sun. Electromagnetic radiation is radiation in the form of electromagnetic waves; examples include gamma rays, ultraviolet light, and radio waves. Particulate radiation is radiation in the form of particles; examples include alpha and beta particles. The spectrum of particle and electromagnetic radiations ranges from the extremely short wavelengths of cosmic rays and electrons to very long radio waves that are hundreds of kilometers in length. Figure A.2 shows the difference between a longer wavelength and a shorter wavelength. Figure A.3 illustrates the wavelengths of several types of radiation along with an example of something that is approximately the same dimension in length.

The radiation's ability to penetrate material is an important consideration in protecting human health. Adequate shielding decreases the power of radiation by absorbing part or all of it. Figure A.4 shows the different penetrating power of alpha, beta, and gamma rays. Alpha rays are stopped by the thickness of a few sheets of paper or a rubber glove. A few centimeters of wood or a thin sheet of copper stops beta rays. Gamma rays and X-rays require thick shielding of a heavy material, such as iron, lead, or concrete (Encarta 2002b).

Radiation is everywhere. Most occurs naturally, but a small percentage is from human-made sources. Naturally occurring radiation is identical to the radiation resulting from human-made sources.

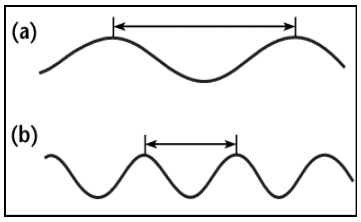

Figure A.2 Comparison between longer (a) and shorter (b) wavelengths. [a]

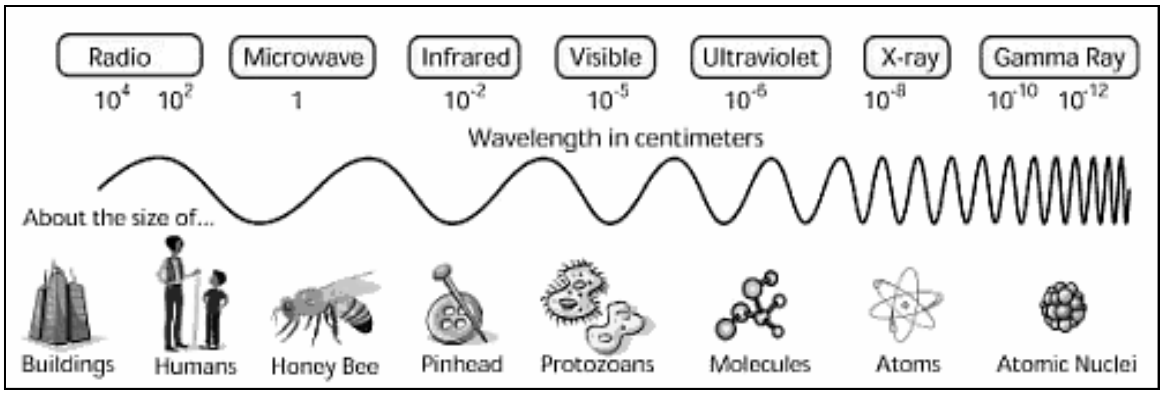

Figure A.3 The approximate wavelengths of the various regions of the electromagnetic spectrum and an example of something that is approximately the same size. [b]

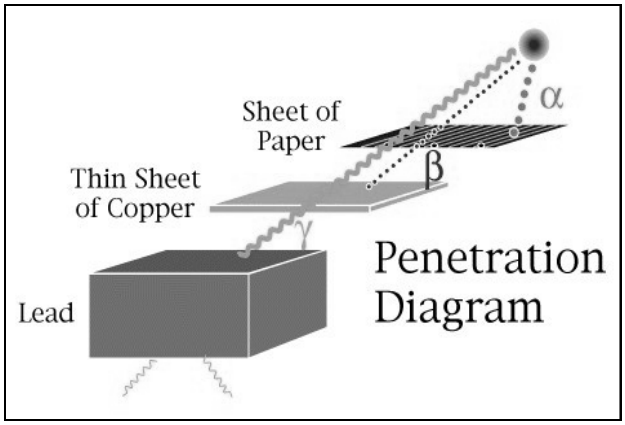

Figure A.4 The penetrating potential of the three types of ionizing radiation: alpha (α), beta (β), and gamma (γ). [c]

[a] ("Electromagnetic…" 2002, Appendix A references)
[b] ("Exploring …" 2002, Appendix A references)
[c] ("Experiment…" 2002, Appendix A references)

Naturally occurring radiation is known as **background radiation**. In fact, this naturally occurring radiation is the major source of radiation in the environment. People have little control over the amount of background radiation to which they are exposed. Background radiation remains relatively constant over time. The amount of background radiation present in the environment today is much the same as it was hundreds of years ago. Sources of background radiation include uranium in the earth, radon in the air, and potassium in food. Depending on its origin, background radiation is categorized as cosmic, terrestrial, or internal. **Cosmic radiation** comes from the sun and outer space and is made up of energetically charged particles from that continuously hit the earth's atmosphere. Because the atmosphere provides some shielding against cosmic radiation, the intensity of cosmic radiation increases with altitude above sea level. Therefore, a person in Denver, Colorado, is exposed to more cosmic radiation than a person in Paducah, Kentucky. **Terrestrial radiation** refers to radiation emitted from radioactive materials in the earth's rocks, soils, and minerals. Radon (Rn); radon progeny, the relatively short-lived decay products of radium-235 (^{235}Ra); potassium (^{40}K); isotopes of thorium (Th); and isotopes of uranium (U) are the elements responsible for most terrestrial radiation. **Internal radiation** is radiation that is inside the body and is in close contact with body tissue. Internal radiation can deposit large amounts of energy in a small amount of tissue. Radioactive material in the environment enters the body through the air people breathe, the food they eat, and even through an open wound. Natural radionuclides in the body include isotopes of U, Th, Ra, Rn, Pu, bismuth (Bi), and lead in the ^{238}U and ^{212}Th decay series. In addition, the body contains isotopes of sodium-24 (^{24}Na), ^{40}K, rubidium (Rb), and carbon-14 (^{14}C). Most of our internal exposure comes from ^{40}K.

In addition to background radiation, there are human-made sources of radiation to which most people are exposed. Examples include consumer products, medical sources, and other sources. Some **consumer products** are sources of radiation. In some of these products, such as smoke detectors and airport X-ray baggage inspection systems, the radiation is essential to the performance of the device. In other products, such as televisions and tobacco products, the radiation occurs incidentally to the product function. **Medical sources** of radiation account for the majority of the exposure people receive from human-made radiation. Radiation is an important tool of diagnostic medicine and treatment. Exposure is deliberate and directly beneficial to the patients exposed. Generally, diagnostic or therapeutic medical exposures result from X-ray beams directed to specific areas of the body. Thus, all body organs generally are not irradiated uniformly. Radiation and radioactive materials are also used in a wide variety of pharmaceuticals and in the preparation of medical instruments, including the sterilization of heat-sensitive products such as plastic heart valves. Nuclear medical examinations and treatment involve the internal administration of radioactive compounds, or radiopharmaceuticals, by injection, inhalation, consumption, or insertion. Even then, radionuclides are not distributed uniformly throughout the body. **Other sources** of radiation include fallout from atmospheric atomic weapons tests; emissions of radioactive materials from nuclear facilities such as uranium mines, fuel processing plants, and nuclear power plants; emissions from mineral extraction facilities; and transportation of radioactive materials. Atmospheric testing of atomic weapons has been suspended. About one-half of 1 percent of the United States population performs work in which radiation in some form is present.

Radiation and radioactive material in the environment can reach people through many routes. Potential routes for radiation are referred to as **pathways**. Several radiation pathways are shown in Figure A.5. For example, radioactive material in the air could fall on a pasture. Cows could then eat the grass, and the radioactive material on the grass would show up in the cow's milk. People drinking the milk would thus be exposed to this radiation, or people could simply inhale the radioactive material in the air. The same events could occur with radioactive material in water. Fish living in the water would be exposed. People eating the fish would then be exposed to the radiation in the fish, or people swimming in the water would be exposed.

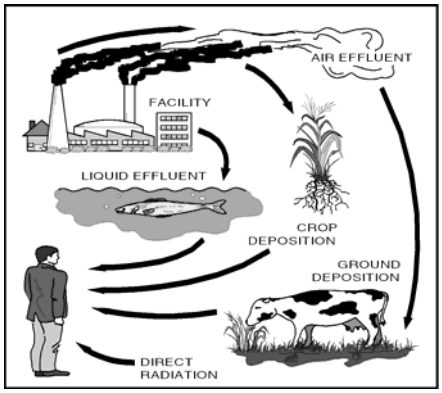

Figure A.5. Possible Radiation Pathways.

MEASURING RADIATION

To determine the possible effects of radiation on the environment and the health of people, the radiation must be measured. More precisely, its potential to cause damage must be determined. When measuring the amount of radiation in the environment, what actually is being measured is the rate of radioactive decay, or **activity**. The rate of decay varies widely among the various radioisotopes. For that reason, 1 g of one radioactive substance may contain the same amount of activity as several tons of another substance. Activity is measured by the number of disintegrations a radioactive material undergoes in a certain period of time. In the United States, activity is expressed in a unit of measure known as a **Curie (Ci)**. In the international system of units, activity is expressed in a unit of measure known as a **Becquerel (Bq)**. One disintegration per second (dps) equals one Becquerel (Bq).

One curie equals:

- 37,000,000,000 atom disintegrations per second ($3.7x10^{10}$ dps).
- 37,000,000,000 Becquerels ($3.7x10^{10}$ Bq)
- 1,000,000 microcuries ($1x10^{6}$ µCi)

DOSE INFORMATION

The total amount of energy absorbed per unit mass as a result of exposure to radiation is expressed in a unit of measure known as a **radiation absorbed dose (rad)**. In the international system of units, 100 rad = 1 gray. However, in terms of human health, it is the effect of the absorbed energy that is important because some forms of radiation are more harmful than others. The unit, rad, does not take into account the potential effects that different types of radiation have on the body. The measure of potential biological damage caused by exposure to and subsequent absorption of radiation is expressed in a unit of measure known as a **Roentgen equivalent man (rem)**. One rem of any type of radiation has the same total damaging effect and pertains to the human body. Dose is expressed in millirems (mrem), because a rem represents a fairly large dose. One millirem is equal to 1/1000 rem. The International System of Units uses the **Sievert (Sv)**, l00 rem = 1 Sievert (Sv), 100 mrem = 1 millisievert (mSv).

Many terms are used to report dose, as listed in Table A.2. Several factors are taken into account, including the amount of radiation absorbed, the organ absorbing the radiation, and the effect of the radiation over a 50-year period. The term "dose," in this report, includes the committed effective dose equivalent (EDE) and the EDE attributable to penetrating radiation from sources external to the body.

Determining dose is an involved process using complex mathematical equations based on several factors, including the type of radiation, the rate of exposure, weather conditions, and typical diet. Basically, radiant energy is generated from radioactive decay or activity. People absorb some of the energy to which they are exposed. This absorbed energy is calculated as part of an individual's dose. Whether radiation is natural or human made, its effects on people are the same.

A comparison of some dose levels is presented in Table A.3. Included is an example of the type of exposure that may cause such a dose or the special significance of such a dose. This information is intended to help the reader become familiar with the type of doses individuals may receive. The average annual dose received by residents of the United States from cosmic radiation is about 27 mrem (0.27 mSv) (NCRP 1987). The average annual dose from cosmic radiation received by residents in the Paducah area is about 45 mrem (0.45 mSv). The average annual dose received from terrestrial gamma radiation in the United States is about 28 mrem (0.28 mSv). The terrestrial dose varies geographically across the country (NCRP 1987); typical reported values are 16 mrem (0.16 mSv) at the Atlantic and Gulf coastal plains and 63 mrem (0.63 mSv) at the eastern slopes of the Rocky Mountains. In the Paducah area, background levels of radionuclides in soils are within typical levels indicating that the dose received from terrestrial gamma radiation is within the range of typical reported values (DOE 1998). The major contributors to the annual dose equivalent for internal radionuclides are the short-lived decay products of radon, mostly Rn-222. They contribute an average dose of about 200 mrem (2.00 mSv) per year. This dose estimate is based on an average radon concentration of about 1 pCi/L (0.037 Bq/L) (NCRP 1987). The average dose from other internal radionuclides is about 39 mrem (0.39 mSv) per year, most of which can be attributed to the naturally occurring isotope of potassium, ^{40}K. The concentration of radioactive potassium in human tissues is similar in all parts of the world. Table A.4 presents the internal dose factors for an adult. The United States average annual dose received by an individual from consumer products is about 10 mrem (0.10 mSv) (NCRP 1987). The dose from medical sources includes nuclear medicine examinations, which involve the internal administration of radiopharmaceuticals and generally account for the largest portion of the dose received from human-made sources; however, the radionuclides used in specific tests are not distributed uniformly throughout the body. In these cases, comparisons are made using the concept of EDE, which relates exposure of organs or body parts to one effective whole-body dose. The average annual EDE from medical examinations is 53 mrem (0.53 mSv), including 39 mrem (0.39 mSv) for diagnostic X-rays and 14 mrem (0.14mSv) for nuclear medicine procedures (NCRP 1989). The actual doses received by individuals who complete such medical exams are much higher than these values, but not everyone receives such exams each year (NCRP 1989). The dose from other sources include small doses received by individuals that occur as a result of radioactive fallout from atmospheric atomic weapons tests, emissions of radioactive materials

from nuclear facilities, emissions from certain mineral extraction facilities, and transportation of radioactive materials. The combination of these sources contributes less than 1 mrem (0.01 mSv) per year to the average dose to an individual (NCRP 1987). A comprehensive EPA report of 1984 projected the average occupational dose to monitored radiation workers in medicine, industry, the nuclear fuel cycle, government, and miscellaneous industries to be 105 mrem (1.05 mSv) per year for 1985, down slightly from 110 mrem (1.10 mSv) per year in 1980 (EPA 1984).

Table A.3. Comparison and Description of Various Dose Levels

Dose level	Description
1 mrem (0.01 mSv)	Approximate daily dose from natural background radiation, including radon.
2.5 mrem (0.025 mSv)	Cosmic dose to a person on a one-way airplane flight from New York to Los Angeles.
10 mrem (0.10 mSv)	Annual exposure limit, set by the EPA for exposures from airborne emissions from operations of nuclear fuel cycle facilities, including power plants and uranium mines and mills .
45 mrem (0.45 mSv)	Average yearly dose from cosmic radiation received by people in the Paducah area.
46 mrem (0.46 mSv)	Estimate of the largest dose any off-site person could have received from the March 28, 1979, Three Mile Island nuclear power plant accident.
66 mrem (0.66 mSv)	Average yearly dose to people in the U.S. from human-made sources.
100 mrem (1.00 mSv)	Annual limit of dose from all DOE facilities to a member of the public who is not a radiation worker.
110 mrem (1.10 mSv)	Average occupational dose received by U.S. commercial radiation workers in 1980.
244 mrem (2.44 mSv)	Average dose from an upper gastrointestinal diagnostic X-ray series.
300 mrem (3.00 mSv)	Average yearly dose to people in the U.S. from all sources of natural background radiation.
1-5 rem (0.01-0.05 Sv)	EPA protective action guidelines state that public officials should take emergency action when the dose to a member of the public from a nuclear accident will likely reach this range.
5 rem (0.05 Sv)	Annual limit for occupational exposure of radiation workers set by NRC and DOE.
10 rem (0. 10 Sv)	The BEIR V report estimated that an acute dose at this level would result in a lifetime excess risk of death from cancer, caused by the radiation, of 0.8%.
25 rem (0.25 Sv)	EPA guideline for voluntary maximum dose to emergency workers for non-lifesaving work during an emergency.
75 rem (0.75 Sv)	EPA guideline for maximum dose to emergency workers volunteering for lifesaving work.
50-600 rem (0.50-6.00 Sv)	Doses in this range received over a short period of time will produce radiation sickness in varying degrees. At the lower end of this range, people are expected to recover completely, given proper medical attention. At the top of this range, most people would die within 60 days.

Adapted from *Savannah River Site Environmental Report for 1993* (SRS 1994).

Table A.4 Internal dose factors for an adult.

Isotope	Half-life (years)	Intake[a] (mrem/pCi)			
		Inhalation (soluble)	Inhalation (slightly soluble)	Inhalation (insoluble)	Ingestion
^{237}Np	2,100,000	NA	0.49	NA	0.0039
^{239}Pu	24,000	NA	0.51	0.33	0.0043
^{99}Tc	210,000	0.00000084	0.0000075	0.12	0.0000013
^{230}Th	75,000	NA	0.32	0.26	0.00053
^{234}U	240,000	0.0027	0.0071	0.13	0.00026
^{235}U	710,000,000	0.0025	0.0067	0.12	0.00025
^{238}U	4,500,000,000	0.0024	0.0062	0.12	0.00023

[a] Source: U.S. DOE. July 1988. *Internal Dose Conversion Factors for Calculations of Dose to the Public*, DOE/EH-0071.
NA = not available in the above-referenced document

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Appendix B: Radionuclide and Chemical Nomenclature

Table B.1. Half-Life and Derived Concentration Guide for Selected Radionuclides.

Radionuclide	Symbol	Half-life	Ingested Water DCG (µCi/ml)
Americium-241	^{241}Am	432 years	3 E - 08
Bismuth-210	^{210}Bi	5.01 days	2 E - 05
Cesium-137	^{137}Cs	30.2 years	3 E - 06
Cobalt-60	^{60}Co	5.3 years	1 E - 05
Lead-206	^{206}Pb	Stable	None
Lead-210	^{210}Pb	21 years	3 E - 08
Lead-214	^{214}Pb	26.8 minutes	2 E - 04
Neptunium-237	^{237}Np	2,140,000 years	3 E - 08
Plutonium-239	^{239}Pu	24,110 years	3 E - 08
Polonium-210	^{210}Po	138.9 days	8 E - 08
Polonium-214	^{214}Po	164 microseconds	None
Polonium-218	^{218}Po	3.05 minutes	None
Potassium-40	^{40}K	1,260,000,000 years	7 E - 06
Protactinium-234m	^{234m}Pa	1. 17 minutes	None
Radium-226	^{226}Ra	1,602 years	1 E - 07
Radon-222	^{222}Rn	3.821 days	None
Technetium-99	^{99}Tc	212,000 years	1 E - 04
Thorium-230	^{230}Th	80,000 years	3 E - 07
Thorium-231	^{231}Th	25.5 hours	1 E - 04
Thorium-234	^{234}Th	24.1 days	1 E - 05
Uranium-234	^{234}U	247,000 years	5 E - 07
Uranium-235	^{235}U	710,000,000 years	6 E - 07
Uranium-236	^{236}U	23,900,000 years	5 E - 07
Uranium-238	^{238}U	4,510,000,000 years	6 E - 07

Derived Concentration Guide (DCG) is the concentration of a radionuclide in air or water that would result in an effective dose equivalent of 100 mrem under conditions of continuous exposure for one year by one exposure mode (i.e., ingestion of water, submersion in air, or inhalation). DCGs do not consider decay products when the parent radionuclide is the cause of the exposure.

Table B.2. Nomenclature for Elements and Chemical Compounds.

Constituent	Symbol	Constituent	Symbol
Aluminum	Al	Manganese	Mn
Ammonia	NH_3	Mercury	Hg
Antimony	Sb	Nickel	Ni
Arsenic	As	Nitrate	NO_3^-
Barium	Ba	Nitrite	NO_2^-
Beryllium	Be	Nitrogen	N
Cadmium	Cd	Oxygen	O
Calcium	Ca	Ozone	O_3
Calcium carbonate	$CaCO_3$	Phosphate	PO_4^{3-}
Carbon	C	Phosphorus	P
Chlorine	Cl	Potassium	K
Chromium	Cr	Radium	Ra
Chromium, hexavalent	Cr^{6+}	Radon	Rn
Cobalt	Co	Selenium	Se
Copper	Cu	Silver	Ag
Fluorine	F	Sodium	Na
Hydrogen fluoride	HF	Sulfate	SO_4^{2-}
Iron	Fe	Sulfur dioxide	SO_2
Lead	Pb	Thorium	Th
Lithium	Li	Uranium	U
Magnesium	Mg	Zinc	Zn

Units of Radiation Measure

Current System	Système International	Conversion
curie (Ci)	becquerel (Bq)	1 Ci = 3.7 x 10^{10} Bq
rad (radiation absorbed dose)	gray (Gy)	1 rad = 0.01 Gy
rem (roentgen equivalent man)	sievert (Sv)	1 rem = 0.01 Sv

Conversions

Multiply	***by***	***to obtain***	***Multiply***	***by***	***to obtain***
in	2.54	centimeters	centimeters	0.394	in
ft	0.305	m	m	3.28	ft
mile	1.61	km	km	0.621	mile
lb	0.4538	kg	kg	2.205	lb
gal	3.785	L	L	0.264	gal
ft^2	0.093	m^2	m^2	10.764	ft^2
mi^2	2.59	km^2	km^2	0.386	mi^2
ft^3	0.028	m^3	m^3	35.31	ft^3
acres	0.40468	hectares	hectares	2.471	acres
dpm	0.45	pCi	pCi	2.22	dpm
pCi	10^{-6}	µCi	µCi	10^6	pCi
pCi/L (water)	10^{-9}	µCi/mL (water)	µCi/mL (water)	10^9	pCi/L (water)
pCi/m^3 (air)	10^{-12}	µCi/mL (air)	µCi/mL (air)	10^{12}	pCi/m^3 (air)

PRS-ENM-0002
Volume II

PADUCAH SITE

Annual Site Environmental Report Data Summary

2005

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Volume II

Environmental Monitoring Results, Annual Site Environmental Report, Calendar Year 2005 Paducah Gaseous Diffusion Plant, Paducah, Kentucky

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Office of Environmental Management

List of Figures

Figure 1. Paducah Site ambient air monitoring stations i
Figure 2. Surface-water monitoring locations ii
Figure 3. Sediment monitoring locations iii
Figure 4. TLD locations in the vicinity of PGDP iv

List of Tables

1. RADIOLOGICAL EFFLUENT DATA
Table 1.1 Radiological Effluent Data for Outfall 001 1-1
Table 1.2 Radiological Effluent Data for Outfall 015 1-1
Table 1.3 Radiological Effluent Data for Outfall 017 1-1
Table 1.4 Radiological Effluent Data for Outfall 019 1-1
Table 1.5 Radiological Effluent Data for Landfill Surface Water Location L135 1-2
Table 1.6 Radiological Effluent Data for Landfill Surface Water Location L136 1-2
Table 1.7 Radiological Effluent Data for Landfill Surface Water Location L137 1-2
Table 1.8 Radiological Effluent Data for Landfill Surface Water Location L150 1-2
Table 1.9 Radiological Effluent Data for Landfill Surface Water Location L154 1-2
Table 1.10 Radiological Effluent Data for Landfill Surface Water Location L155 1-2

2. RADIOLOGICAL ENVIRONMENTAL SURVEILLANCE DATA
Table 2.1 Kentucky Radiation Health and Toxics Branch Air Monitoring 2-1
Table 2.2 Radiological Monitoring Data for Surface Water Location L1 2-2
Table 2.3 Radiological Monitoring Data for Surface Water Location L5 2-3
Table 2.4 Radiological Monitoring Data for Surface Water Location L6 2-4
Table 2.5 Radiological Monitoring Data for Surface Water Location K001 2-5
Table 2.6 Radiological Monitoring Data for Surface Water Location K015 2-6
Table 2.7 Radiological Monitoring Data for Surface Water Location C612 2-7
Table 2.8 Radiological Monitoring Data for Surface Water Location C616 2-8
Table 2.9 Radiological Monitoring Data for Surface Water Location L291 2-9
Table 2.10 Radiological Monitoring Data for Surface Water Location L10 2-10
Table 2.11 Radiological Monitoring Data for Surface Water Location L194 2-11
Table 2.12 Radiological Monitoring Data for Surface Water Location L11 2-12
Table 2.13 Radiological Monitoring Data for Surface Water Location L12 2-13
Table 2.14 Radiological Monitoring Data for Surface Water Location L241 2-14
Table 2.15 Radiological Monitoring Data for Surface Water Location C746K-5 2-15
Table 2.16 Radiological Monitoring Data for Surface Water Location C746KTB1 2-16
Table 2.17 Radiological Monitoring Data for Surface Water Location S31 2-17
Table 2.18 Radiological Monitoring Data for Surface Water Location L8 2-18
Table 2.19 Radiological Monitoring Data for Surface Water Location L29 2-19
Table 2.20 Radiological Monitoring Data for Surface Water Location L30 2-20
Table 2.21 Radiological Monitoring Data for Surface Water Location L306 2-21
Table 2.22 Radiological Monitoring Data for Surface Water Location L64 2-22
Table 2.23 Radiological Monitoring Data for Surface Water Location LBCSP5 2-22
Table 2.24 Radiological Monitoring Data for Surface Water Location LBCSP6 2-22

Table 2.25 Radiological Data for Sediment Location S20 2-23
Table 2.26 Radiological Data for Sediment Location C612 2-23
Table 2.27 Radiological Data for Sediment Location C616 2-24
Table 2.28 Radiological Data for Sediment Location K001 2-24
Table 2.29 Radiological Data for Sediment Location S1 2-25
Table 2.30 Radiological Data for Sediment Location S31 2-25
Table 2.31 Radiological Data for Sediment Location S33 2-26
Table 2.32 Radiological Data for Sediment Location L194 2-26
Table 2.33 Radiological Data for Sediment Location S2 2-27
Table 2.34 Radiological Data for Sediment Location S27 2-27
Table 2.35 Radiological Data for Sediment Location S34 2-28
Table 2.36 Radiological Data for Sediment Location C746KTB2 2-28
Table 2.37 Radiological Data for Sediment Location S32 2-29
Table 2.38 Radiological Data for Sediment Location S28 2-29
Table 2.39 Radiological Exposure Due to Gamma Radiation (mrem) 2-30
Table 2.40 Radiological Analysis of Deer Bone Tissue for 2005 2-31
Table 2.41 Radiological Analysis of Deer Thyroid Tissue for 2005 2-31
Table 2.42 Radiological Analysis of Deer Muscle Tissue for 2005 2-31
Table 2.43 Radiological Analysis of Deer Liver Tissue for 2005 2-31

3. NON-RADIOLOGICAL EFFLUENT DATA
Table 3.1 Non-Radiological Effluent Data for Outfall 001 3-1
Table 3.2 Non-Radiological Effluent Data for Outfall 015 3-2
Table 3.3 Non-Radiological Effluent Data for Outfall 017 3-3
Table 3.4 Non-Radiological Effluent Data for Outfall 019 3-4
Table 3.5 Non-Radiological Effluent Data for Landfill Surface Water Location L135 3-5
Table 3.6 Non-Radiological Effluent Data for Landfill Surface Water Location L136 3-5
Table 3.7 Non-Radiological Effluent Data for Landfill Surface Water Location L137 3-6
Table 3.8 Non-Radiological Effluent Data for Landfill Surface Water Location L150 3-6
Table 3.9 Non-Radiological Effluent Data for Landfill Surface Water Location L154 3-7
Table 3.10 Non-Radiological Effluent Data for Landfill Surface Water Location L155 3-7

4. NON-RADIOLOGICAL ENVIRONMENTAL SURVEILLANCE DATA
Table 4.1 Non-Radiological Monitoring Data for Surface Water Location L1 4-1
Table 4.2 Non-Radiological Monitoring Data for Surface Water Location L5 4-3
Table 4.3 Non-Radiological Monitoring Data for Surface Water Location L6 4-5
Table 4.4 Non-Radiological Monitoring Data for Surface Water Location C616 4-7
Table 4.5 Non-Radiological Monitoring Data for Surface Water Location K001 4-8
Table 4.6 Non-Radiological Monitoring Data for Surface Water Location K015 4-8
Table 4.7 Non-Radiological Monitoring Data for Surface Water Location C612 4-9
Table 4.8 Non-Radiological Monitoring Data for Surface Water Location L291 4-11
Table 4.9 Non-Radiological Monitoring Data for Surface Water Location L10 4-13
Table 4.10 Non-Radiological Monitoring Data for Surface Water Location L194 4-15
Table 4.11 Non-Radiological Monitoring Data for Surface Water Location L11 4-17
Table 4.12 Non-Radiological Monitoring Data for Surface Water Location L12 4-19
Table 4.13 Non-Radiological Monitoring Data for Surface Water Location L241 4-21
Table 4.14 Non-Radiological Monitoring Data for Surface Water Location C746K-5 4-23
Table 4.15 Non-Radiological Monitoring Data for Surface Water Location S31 4-25
Table 4.16 Non-Radiological Monitoring Data for Surface Water Location C746KTB1 4-27

Table 4.17 Non-Radiological Monitoring Data for Surface Water Location L8 4-29
Table 4.18 Non-Radiological Monitoring Data for Surface Water Location L29 4-31
Table 4.19 Non-Radiological Monitoring Data for Surface Water Location L30 4-33
Table 4.20 Non-Radiological Monitoring Data for Surface Water Location L306 4-35
Table 4.21 Non-Radiological Monitoring Data for Surface Water Location L64 4-37
Table 4.22 Non-Radiological Monitoring Data for Surface Water Seep Location LBCSP5 4-38
Table 4.23 Non-Radiological Monitoring Data for Surface Water Seep Location LBCSP6 4-39
Table 4.24 Non-Radiological Data for Sediment Location S20 4-40
Table 4.25 Non-Radiological Data for Sediment Location C612 4-41
Table 4.26 Non-Radiological Data for Sediment Location C616 4-42
Table 4.27 Non-Radiological Data for Sediment Location K001 4-43
Table 4.28 Non-Radiological Data for Sediment Location S1 4-44
Table 4.29 Non-Radiological Data for Sediment Location S31 4-45
Table 4.30 Non-Radiological Data for Sediment Location S33 4-46
Table 4.31 Non-Radiological Data for Sediment Location S2 4-47
Table 4.32 Non-Radiological Data for Sediment Location S27 4-48
Table 4.33 Non-Radiological Data for Sediment Location S34 4-49
Table 4.34 Non-Radiological Data for Sediment Location C746KTB2 4-50
Table 4.35 Non-Radiological Data for Sediment Location L194 4-51
Table 4.36 Non-Radiological Data for Sediment Location S32 4-52
Table 4.37 Non-Radiological Data for Sediment Location S28 4-53
Table 4.38 Non-Radiological Analysis of Deer Liver Tissue for 2005 4-54
Table 4.39 Non-Radiological Analysis of Deer Muscle Tissue for 2005 4-55
Table 4.40 Non-Radiological Analysis of Deer Kidney Tissue for 2005 4-55
Table 4.41 Non-Radiological Analysis of Deer Fat Tissue for 2005 4-56

Notes:

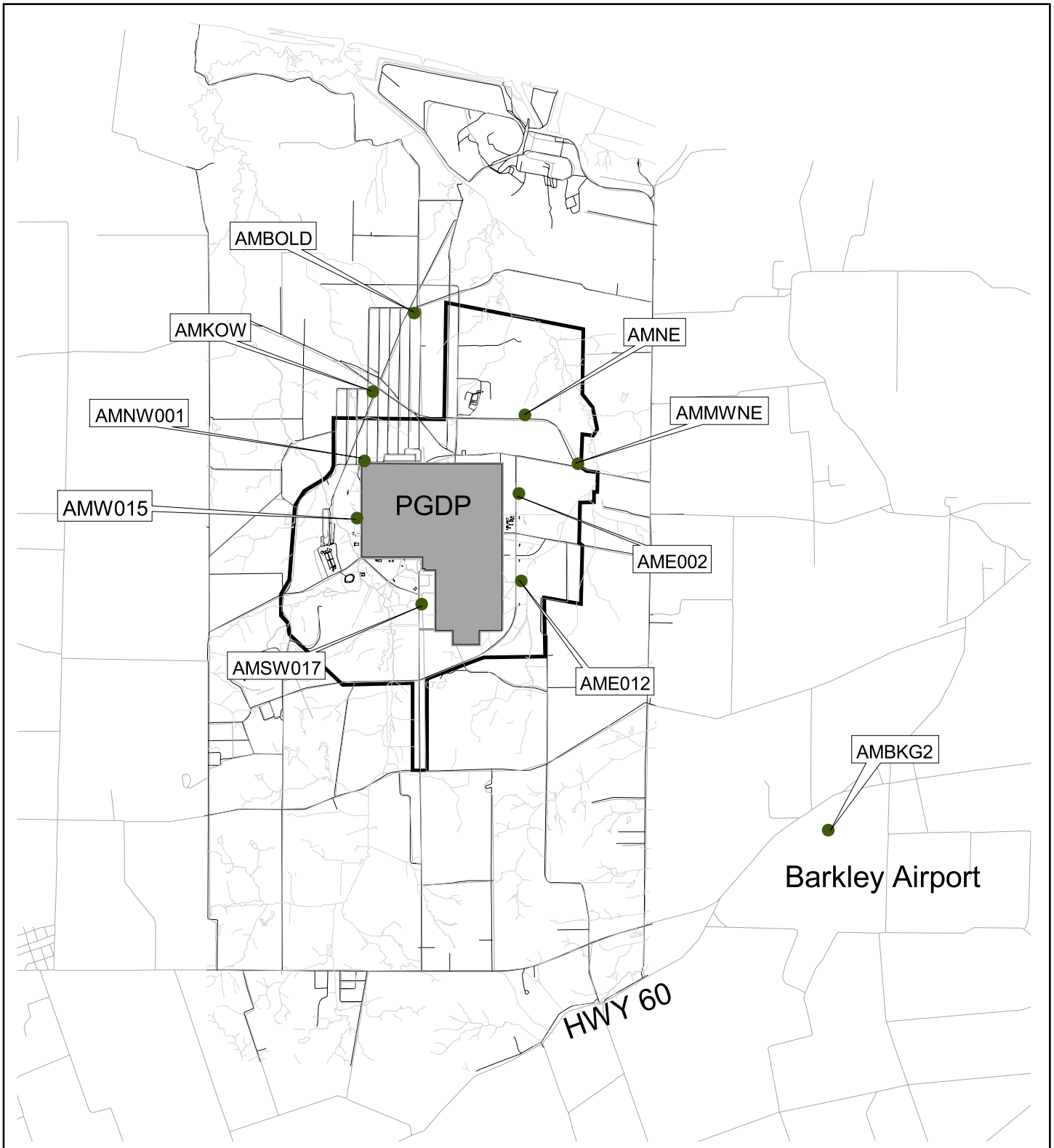
1. "ND" means the parameter was not detected. Detection limits are available in the Paducah OREIS database. The count detects column represents the number of times the contaminant was detected when sampled during the year.

2. Monitoring programs often include measurement of extremely low concentrations of radionuclides, below the detection limit of the counting instruments. Less-than-detectable data will produce numerical measurements with values below the detection limit and sometimes negative values. All of the actual values, including those that are negative, are included in the statistical analyses in accordance with DOE's *Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance* (DOE 1991).

3. For non-radiological data, average values are calculated using the actual result values from the OREIS database. Where analytical result values were below the detection level, half of the detection limit was used to calculate average concentration. For radiological data, the average concentration was calculated by using the actual result given for both detectable and non-detectable results.

4. Reference Criteria for Sections 1 and 2 are used for comparison of results to Derived Concentration Guide (DCG) levels or site action limits that have been defined by the Environmental Programs.

5. The following data volume includes monitoring results for surface water, sediment, air, and animal tissue. Groundwater results are not presented in this data volume because more significant detail and data tables are presented in the Annual Site Environmental Report, Volume I.



LEGEND:
- Ambient Air Stations
- Roads
- DOE Property Boundary

3000 0 3000 Feet

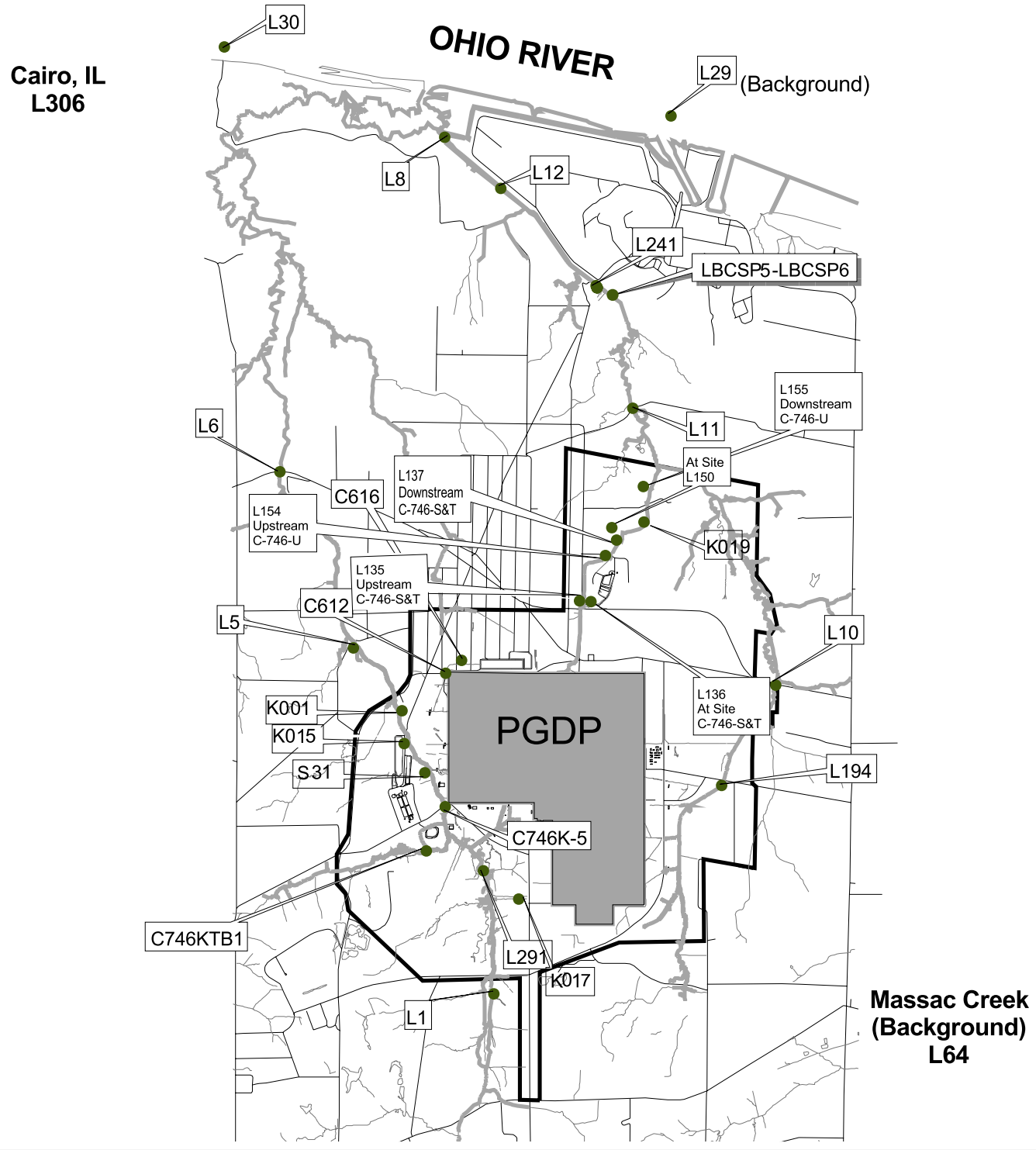
TRUE NORTH 20° PLANT NORTH

U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

PADUCAH Remediation Services
A Portage Shaw Joint Venture Company

Figure 1. Paducah Site ambient air monitoring stations

FIGURE No. c5ac90002sk124.apr
DATE 7/7/06



LEGEND:

● Surface-Water Sampling Point

3000 0 3000 Feet

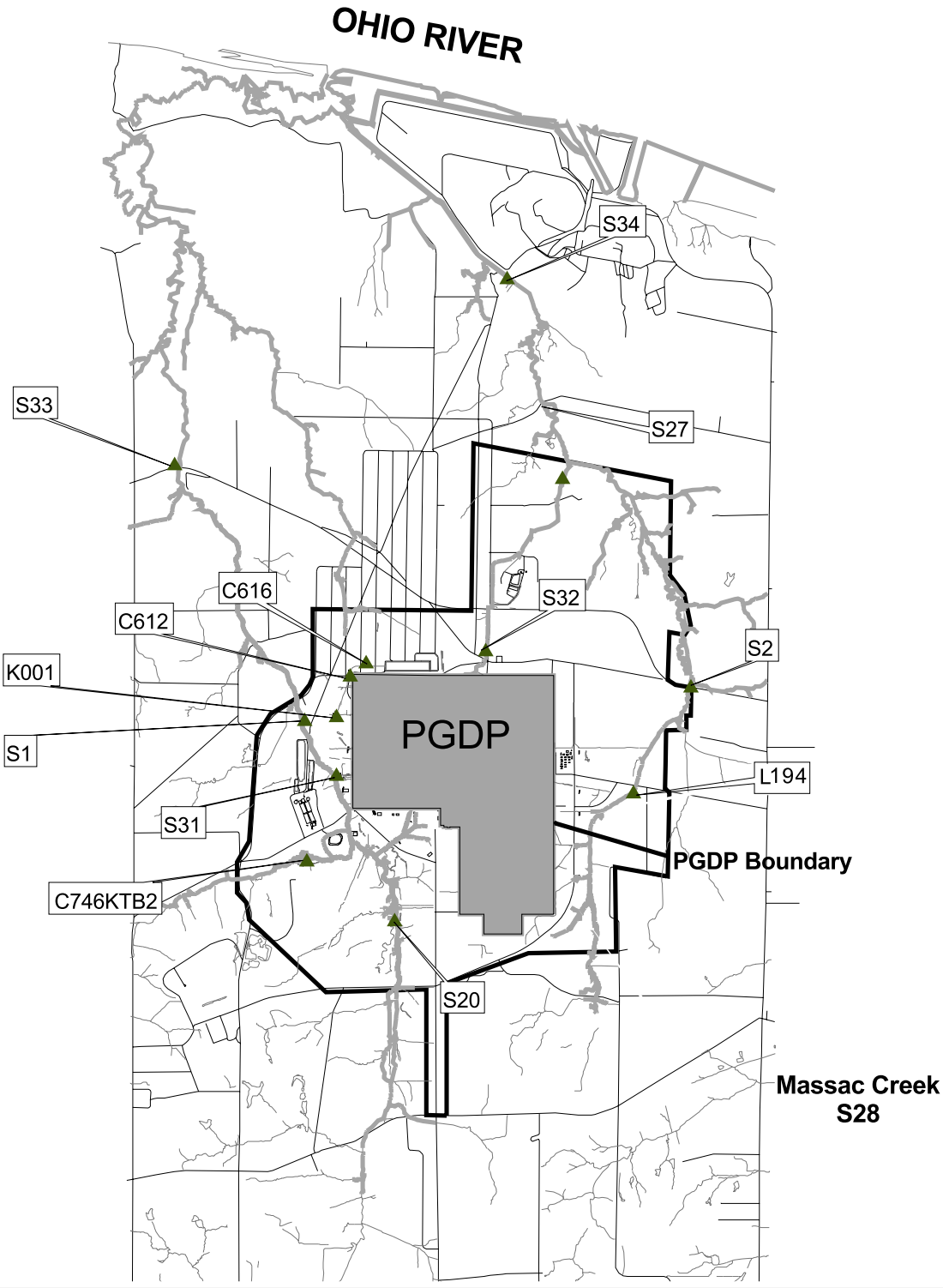
TRUE NORTH 20° PLANT NORTH

U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

PADUCAH Remediation Services
A Portage Shaw Joint Venture Company

Figure 2. Surface-water monitoring locations

FIGURE No. c5ac90002sk111.apr
DATE 7/7/06



LEGEND:

▲ Sediment Sampling Point

2000 0 2000 4000 Feet

TRUE NORTH 20° PLANT NORTH

U.S. DEPARTMENT OF ENERGY
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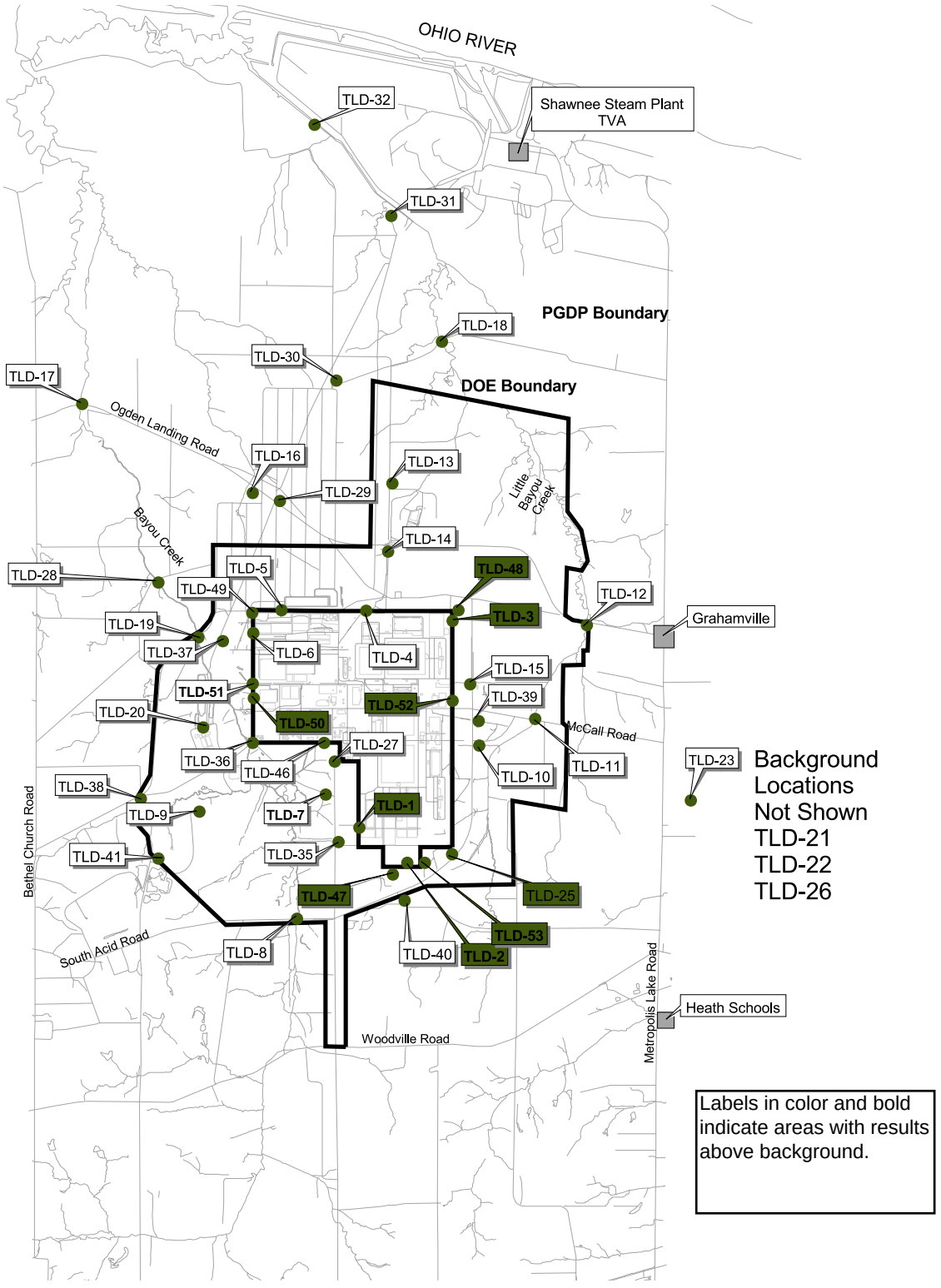
Figure 3. Sediment monitoring locations

FIGURE No. c5ac90002sk112apr
DATE 7/7/06



LEGEND:

● TLD Locations

2000 0 2000 Feet

TRUE NORTH 20° PLANT NORTH

U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

PADUCAH Remediation Services
A Portage Shaw Joint Venture Company

Figure 4. TLD locations in the vicinity of PGDP

FIGURE No. c5ac90002sk113.apr
DATE 7/7/06

1. RADIOLOGICAL EFFLUENT DATA

KPDES Radiological Data

Table 1.1 Radiological Effluent Data for Outfall 001

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Dissolved Alpha	pCi/L	-0.0528	80.4	17.9	1	5		
Dissolved Beta	pCi/L	6.17	42.3	22	3	5		
Suspended Alpha	pCi/L	-2.37	3.01	0.734	0	5		
Suspended Beta	pCi/L	-2.1	7.39	3.02	0	5		
Technetium-99	pCi/L	-6.6	12.9	2.47	0	5	ActionLimit	900

Table 1.2 Radiological Effluent Data for Outfall 015

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Dissolved Alpha	pCi/L	4.79	121	52.9	4	6		
Dissolved Beta	pCi/L	12.3	58.6	38	6	6		
Suspended Alpha	pCi/L	-1.01	7.94	3.1	1	6		
Suspended Beta	pCi/L	6.12	21.9	12.8	5	6		
Technetium-99	pCi/L	8.28	30.6	18.3	3	6	ActionLimit	900

Table 1.3 Radiological Effluent Data for Outfall 017

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Dissolved Alpha	pCi/L	-1.39	1.05	0.29	0	6		
Dissolved Beta	pCi/L	3.51	10.4	6.28	2	6		
Suspended Alpha	pCi/L	-0.59	5.73	1.25	0	6		
Suspended Beta	pCi/L	-1.05	13.2	3.08	1	6		
Technetium-99	pCi/L	-7.91	9.28	1.12	0	6	ActionLimit	900

Table 1.4 Radiological Effluent Data for Outfall 019

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Dissolved Alpha	pCi/L	1.73	3.69	2.56	0	3		
Dissolved Beta	pCi/L	1.23	8.92	4.01	1	3		
Suspended Alpha	pCi/L	2.13	2.56	2.29	0	3		
Suspended Beta	pCi/L	-1.69	2.17	0.412	0	3		
Technetium-99	pCi/L	-2.99	2.7	-0.0463	0	3	ActionLimit	900

Surface Water Radiological Data

Table 1.5 Radiological Effluent Data for Landfill Surface Water Location L135

Upstream of the C-746 S&T Closed Landfills

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Alpha activity	pCi/L	2.25	6.32	4.17	3	4		
Beta activity	pCi/L	5.82	95.8	36.8	4	4		

Table 1.6 Radiological Effluent Data for Landfill Surface Water Location L136

At the C-746 S&T Closed Landfills

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Alpha activity	pCi/L	-0.427	6.62	2.4	2	5		
Beta activity	pCi/L	4.42	10.4	6.72	4	5		

Table 1.7 Radiological Effluent Data for Landfill Surface Water Location L137

Downstream of the C-746 S&T Closed Landfills

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Alpha activity	pCi/L	-0.437	5.71	2.34	2	4		
Beta activity	pCi/L	5.85	28.6	14.1	4	4		

Table 1.8 Radiological Effluent Data for Landfill Surface Water Location L150

At the C-746 U Landfill

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Alpha activity	pCi/L	1.62	3.12	2.23	1	4		
Beta activity	pCi/L	4.19	10.6	7.61	3	4		

Table 1.9 Radiological Effluent Data for Landfill Surface Water Location L154

Upstream of the C-746 U Landfill

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Alpha activity	pCi/L	-0.572	4.4	1.08	2	5		
Beta activity	pCi/L	4.27	18.9	12.2	4	5		

Table 1.10 Radiological Effluent Data for Landfill Surface Water Location L155

Downstream of the C-746 U Landfill

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Alpha activity	pCi/L	2.14	8.81	4.75	2	4		
Beta activity	pCi/L	5.49	10.6	8.09	4	4		

2. RADIOLOGICAL ENVIRONMENTAL SURVEILLANCE DATA

Ambient Air Data

Table 2.1 Kentucky Radiation Health and Toxics Branch Air Monitoring

	AMSW017	AMW015	AMNW001	AMNE	AME002	AME012	AMBKG2	AMBOLD	AMKOW	AMMWNE
Nuclide	**Ci/m3**	**Ci/m3**	**Ci/m3**	**Ci/m3**	**Ci/m3**	**Ci/m3**	**Ci/m3**	**Ci/m3**	**Ci/m3**	**Ci/m3**
Quarter 1										
Americium-241	3.034E-18	6.032E-18	0	1.998E-18	-3.544E-18	6.25E-18	3.949E-18	3.055E-18	1.768E-18	1.124E-17
Neptunium-237	-9.524E-17	-1.597E-16	3.434E-16	2.828E-16	2.027E-16	-1.733E-16	-2.936E-16	-6.618E-17	-4.142E-16	-2.81E-16
Technetium-99	1.5172E-17	3.5458E-16	2.3718E-16	1.7414E-16	2.442E-16	2.188E-16	-1.113E-17	2.152E-16	-6.354E-17	2.4527E-16
Uranium-238	1.728E-16	1.939E-16	2.294E-16	1.949E-16	2.074E-16	2.228E-16	1.721E-16	2.1E-16	2.222E-16	1.65E-16
Sum of ratios	-0.06	-0.10	0.32	0.26	0.19	-0.11	-0.22	-0.03	-0.32	-0.21
Quarter 2										
Americium-241	5.145E-18	-4.42E-18	7.356E-18	1.297E-17	5.38E-18	-1.841E-18	6.547E-18	2.072E-18	-1.772E-18	-3.703E-18
Neptunium-237	6.156E-18	-9.724E-17	7.55E-18	7.072E-18	7.158E-18	5.726E-18	3.901E-17	7.55E-18	-6.64E-18	-3.706E-17
Technetium-99	2.834E-16	3.3444E-16	8.8632E-16	6.9015E-16	1.3997E-15	8.2971E-16	1.0331E-15	9.6932E-16	1.0435E-15	6.1308E-16
U-238	1.746E-16	1.959E-16	1.689E-16	2.115E-16	2.004E-16	1.772E-16	1.237E-16	1.985E-16	1.669E-16	1.771E-16
Sum of ratios	0.03	-0.06	0.04	0.04	0.04	0.03	0.06	0.04	0.02	-0.01
Quarter 3										
Americium-241	9.743E-23	-6.207E-18	-5.211E-18	0	0	4.964E-18	0	1.447E-17	-7.774E-18	-1.814E-18
Neptunium-237	9.579E-18	-2.748E-17	7.726E-18	9.716E-18	5.812E-18	-3.287E-18	2.215E-17	2.354E-18	-2.055E-18	-2.359E-17
Technetium-99	1.0683E-15	2.5044E-16	7.1662E-16	3.0959E-16	7.6409E-16	4.3182E-16	2.4754E-16	4.1709E-16	7.0027E-16	3.9388E-16
Uranium-238	3.122E-16	2.517E-16	2.068E-16	2.543E-16	2.854E-16	2.345E-16	1.866E-16	2.349E-16	2.416E-16	2.292E-16
Sum of ratios	0.05	0.01	0.03	0.04	0.04	0.03	0.04	0.04	0.03	0.01
Quarter 4										
Americium-241	1.21E-17	6.749E-18	8.225E-18	-1.832E-18	7.598E-18	1.34E-17	9.206E-18	-8.629E-18	1.065E-17	-1.664E-18
Neptunium-237	-2.383E-18	-4.125E-18	2.101E-18	1.179E-17	7.668E-18	2.19E-17	1.03E-17	2.163E-18	-1.507E-17	-2.633E-17
Technetium-99	4.8641E-16	6.2782E-16	1.0307E-15	1.049E-15	4.4946E-16	2.673E-16	1.9145E-16	4.4225E-16	8.7717E-16	6.1109E-16
Uranium-238	1.739E-16	1.694E-16	1.401E-16	1.945E-16	1.324E-16	1.7E-16	1.356E-16	2.182E-16	1.986E-16	1.606E-16
Sum of ratios	0.03	0.03	0.03	0.04	0.03	0.05	0.03	0.03	0.02	0.00

*Sum of Ratios: The ratio of the measured concentration to the allowable concentration is added for all radionuclides for each quarter for each location. A value of less than one indicates regulatory compliance.

40 CFR 61, Table 2, Limiting Values *Ci/m3): ^{241}Am 1.9E-15, ^{237}Np 1.2E-15, ^{99}Tc 1.4E-13, and ^{238}U 8.3E-15

Surface Water Radiological Data

Table 2.2 Radiological Monitoring Data for Surface Water Location L1

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/L	-0.0165	0.027	0.0027	0	4		
Americium-241	pCi/L	-0.00306	0.0721	0.0499	0	4	10%DCG	3
Cesium-134	pCi/L	-1.17	0.843	-0.409	0	4		
Cesium-137	pCi/L	-1.68	-0.00956	-0.722	0	4	10%DCG	300
Cobalt-60	pCi/L	-1.55	1.27	0.089	0	4	10%DCG	1000
Dissolved Alpha	pCi/L	-1.05	3.29	0.385	0	4		
Dissolved Beta	pCi/L	-0.988	3.32	1.47	0	4		
Neptunium-237	pCi/L	-0.00167	0.0189	0.00756	0	4	10%DCG	3
Plutonium-238	pCi/L	-0.00206	0.0275	0.0121	0	4		
Plutonium-239/240	pCi/L	-0.00176	0.0167	0.00495	0	4	10%DCG	3
Potassium-40	pCi/L	-86.1	10.1	-26.4	0	4		
Suspended Alpha	pCi/L	0.0106	2.4	1.04	0	4		
Suspended Beta	pCi/L	-3.99	4.78	-0.459	0	4		
Technetium-99	pCi/L	-1.46	20.4	4.28	1	4	ActionLimit	900
Thorium-228	pCi/L	0.0164	0.0744	0.0464	0	4		
Thorium-230	pCi/L	0.0255	0.393	0.16	1	4	10%DCG	30
Thorium-232	pCi/L	-0.0439	0.0291	-0.0026	0	4		
Thorium-234	pCi/L	-50.1	4.66	-17.4	0	4		
Uranium	mg/L	0.005	0.005	0.005	0	4	10%DCG	0.0901
Uranium	pCi/L	-0.0345	1.07	0.316	0	4	10%DCG	60
Uranium-234	pCi/L	0.0122	0.523	0.161	1	4	10%DCG	50
Uranium-238	pCi/L	-0.0301	0.515	0.151	1	4	10%DCG	60

Surface Water Radiological Data

Table 2.3 Radiological Monitoring Data for Surface Water Location L5

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/L	-0.000657	0.0534	0.028	0	4		
Americium-241	pCi/L	0.00806	0.125	0.0522	0	4	10%DCG	3
Cesium-134	pCi/L	-0.701	-0.351	-0.54	0	4		
Cesium-137	pCi/L	-2.14	1.54	-0.198	0	4	10%DCG	300
Cobalt-60	pCi/L	-0.874	0.675	-0.166	0	4	10%DCG	1000
Dissolved Alpha	pCi/L	-1.23	5.15	1.82	1	4		
Dissolved Beta	pCi/L	6.37	20.9	10.8	1	4		
Neptunium-237	pCi/L	-0.0272	0.0171	-0.0102	0	4	10%DCG	3
Plutonium-238	pCi/L	0.00249	0.038	0.0182	0	4		
Plutonium-239/240	pCi/L	-0.00359	0.026	0.0102	0	4	10%DCG	3
Potassium-40	pCi/L	-25.8	7.89	-9.56	0	4		
Suspended Alpha	pCi/L	-3.48	1.89	-0.133	0	4		
Suspended Beta	pCi/L	-6.7	4.23	0.237	0	4		
Technetium-99	pCi/L	-6.51	12.3	4.17	0	4	ActionLimit	900
Thorium-228	pCi/L	-0.108	0.067	0.00975	0	4		
Thorium-230	pCi/L	-0.0688	0.261	0.0525	0	4	10%DCG	30
Thorium-232	pCi/L	0.00143	0.0795	0.0226	0	4		
Thorium-234	pCi/L	-32.3	2.45	-9.29	0	4		
Uranium	pCi/L	0.755	1.6	1.11	0	4	10%DCG	60
Uranium	mg/L	0.005	0.005	0.005	0	4	10%DCG	0.0901
Uranium-234	pCi/L	0.485	0.757	0.588	3	4	10%DCG	50
Uranium-238	pCi/L	0.26	0.791	0.496	3	4	10%DCG	60

Surface Water Radiological Data

Table 2.4 Radiological Monitoring Data for Surface Water Location L6

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/L	-0.0132	0.0365	0.0177	0	4		
Americium-241	pCi/L	-0.00717	0.0494	0.0229	0	4	10%DCG	3
Cesium-134	pCi/L	-1.51	0.495	-0.524	0	4		
Cesium-137	pCi/L	-2.02	0.526	-0.674	0	4	10%DCG	300
Cobalt-60	pCi/L	-0.682	0.275	-0.244	0	4	10%DCG	1000
Dissolved Alpha	pCi/L	-1.73	2.62	0.343	0	4		
Dissolved Beta	pCi/L	-0.824	18.4	8.95	2	4		
Neptunium-237	pCi/L	-0.00118	0.022	0.00778	0	4	10%DCG	3
Plutonium-238	pCi/L	0.00987	0.0215	0.0143	0	4		
Plutonium-239/240	pCi/L	-0.00412	0.0191	0.00583	0	4	10%DCG	3
Potassium-40	pCi/L	-5.9	11.5	2.19	0	4		
Suspended Alpha	pCi/L	-3.53	1.03	-0.302	0	4		
Suspended Beta	pCi/L	-4.31	4.93	0.815	0	4		
Technetium-99	pCi/L	-3.27	7.48	1.11	0	4	ActionLimit	900
Thorium-228	pCi/L	-0.0616	0.119	0.0171	0	4		
Thorium-230	pCi/L	-0.072	0.15	0.0509	0	4	10%DCG	30
Thorium-232	pCi/L	-0.0516	0.0345	-0.00743	0	4		
Thorium-234	pCi/L	-43.3	30.6	-1.96	0	4		
Uranium	pCi/L	0.764	1.45	1.08	0	4	10%DCG	60
Uranium	mg/L	0.005	0.005	0.005	0	4	10%DCG	0.0901
Uranium-234	pCi/L	0.417	0.744	0.522	3	4	10%DCG	50
Uranium-238	pCi/L	0.272	0.699	0.539	4	4	10%DCG	60

Surface Water Radiological Data

Table 2.5 Radiological Monitoring Data for Surface Water Location K001

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/L	0.0315	0.0315	0.0315	0	1		
Americium-241	pCi/L	0.0413	0.0413	0.0413	0	1	10%DCG	3
Cesium-134	pCi/L	0.609	0.609	0.609	0	1		
Cesium-137	pCi/L	-0.373	-0.373	-0.373	0	1	10%DCG	300
Cobalt-60	pCi/L	3.68	3.68	3.68	0	1	10%DCG	1000
Dissolved Alpha	pCi/L	-4.41	-4.41	-4.41	0	1		
Dissolved Beta	pCi/L	34.6	34.6	34.6	1	1		
Neptunium-237	pCi/L	0.00389	0.00389	0.00389	0	1	10%DCG	3
Plutonium-238	pCi/L	0.0519	0.0519	0.0519	0	1		
Plutonium-239/240	pCi/L	0.0163	0.0163	0.0163	0	1	10%DCG	3
Potassium-40	pCi/L	-7.86	-7.86	-7.86	0	1		
Suspended Alpha	pCi/L	-0.885	-0.885	-0.885	0	1		
Suspended Beta	pCi/L	1.49	1.49	1.49	0	1		
Technetium-99	pCi/L	1.84	1.84	1.84	0	1	ActionLimit	900
Thorium-228	pCi/L	0.0442	0.0442	0.0442	0	1		
Thorium-230	pCi/L	0.00633	0.00633	0.00633	0	1	10%DCG	30
Thorium-232	pCi/L	-0.0141	-0.0141	-0.0141	0	1		
Thorium-234	pCi/L	-36.1	-36.1	-36.1	0	1		
Uranium	pCi/L	1.56	1.56	1.56	0	1	10%DCG	60
Uranium-234	pCi/L	0.556	0.556	0.556	1	1	10%DCG	50
Uranium-238	pCi/L	0.976	0.976	0.976	1	1	10%DCG	60

Surface Water Radiological Data

Table 2.6 Radiological Monitoring Data for Surface Water Location K015

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/L	0.392	0.392	0.392	1	1		
Americium-241	pCi/L	0.0153	0.0153	0.0153	0	1	10%DCG	3
Cesium-134	pCi/L	0.431	0.431	0.431	0	1		
Cesium-137	pCi/L	0.83	0.83	0.83	0	1	10%DCG	300
Cobalt-60	pCi/L	0.304	0.304	0.304	0	1	10%DCG	1000
Dissolved Alpha	pCi/L	11.1	11.1	11.1	1	1		
Dissolved Beta	pCi/L	20	20	20	1	1		
Neptunium-237	pCi/L	0.0263	0.0263	0.0263	0	1	10%DCG	3
Plutonium-238	pCi/L	0.00342	0.00342	0.00342	0	1		
Plutonium-239/240	pCi/L	0.0138	0.0138	0.0138	0	1	10%DCG	3
Potassium-40	pCi/L	2.07	2.07	2.07	0	1		
Suspended Alpha	pCi/L	1.45	1.45	1.45	0	1		
Suspended Beta	pCi/L	9.56	9.56	9.56	1	1		
Technetium-99	pCi/L	27.7	27.7	27.7	1	1	ActionLimit	900
Thorium-228	pCi/L	0.0921	0.0921	0.0921	0	1		
Thorium-230	pCi/L	0.0635	0.0635	0.0635	0	1	10%DCG	30
Thorium-232	pCi/L	0.0332	0.0332	0.0332	0	1		
Thorium-234	pCi/L	-16	-16	-16	0	1		
Uranium	pCi/L	22.6	22.6	22.6	1	1	10%DCG	60
Uranium-234	pCi/L	5.25	5.25	5.25	1	1	10%DCG	50
Uranium-238	pCi/L	16.9	16.9	16.9	1	1	10%DCG	60

Surface Water Radiological Data

Table 2.7 Radiological Monitoring Data for Surface Water Location C612

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/L	-0.0263	0.0134	-0.00571	0	4		
Americium-241	pCi/L	-0.00805	0.028	0.00988	0	4	10%DCG	3
Cesium-134	pCi/L	-1.6	-0.156	-0.764	0	4		
Cesium-137	pCi/L	-1.79	0.677	-0.496	0	4	10%DCG	300
Cobalt-60	pCi/L	-1.66	1.33	0.105	0	4	10%DCG	1000
Dissolved Alpha	pCi/L	-3.77	2.48	-0.23	0	4		
Dissolved Beta	pCi/L	-6.08	8.32	2.24	1	4		
Neptunium-237	pCi/L	0.00236	0.0343	0.015	0	4	10%DCG	3
Plutonium-238	pCi/L	-0.0103	0.0346	0.0113	0	4		
Plutonium-239/240	pCi/L	-0.00347	0.0157	0.00402	0	4	10%DCG	3
Potassium-40	pCi/L	-35.8	60.8	4.04	1	4		
Suspended Alpha	pCi/L	-2.84	1.92	0.217	0	4		
Suspended Beta	pCi/L	-4.94	1.41	-0.677	0	4		
Technetium-99	pCi/L	-1.83	14.9	3.69	0	4	ActionLimit	900
Thorium-228	pCi/L	-0.0837	0.0494	-0.00797	0	4		
Thorium-230	pCi/L	-0.186	0.111	-0.00737	0	4	10%DCG	30
Thorium-232	pCi/L	0.000763	0.0191	0.0114	0	4		
Thorium-234	pCi/L	-61.3	21.6	-12	0	4		
Uranium	pCi/L	-0.0381	0.0752	0.0169	0	4	10%DCG	60
Uranium	mg/L	0.005	0.005	0.005	0	4	10%DCG	0.0901
Uranium-234	pCi/L	-0.0106	0.0679	0.0242	0	4	10%DCG	50
Uranium-238	pCi/L	-0.0238	0.0336	-0.00156	0	4	10%DCG	60

Surface Water Radiological Data

Table 2.8 Radiological Monitoring Data for Surface Water Location C616

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/L	-0.00663	0.0299	0.00958	0	5		
Americium-241	pCi/L	-0.00225	0.0411	0.0131	0	5	10%DCG	3
Cesium-134	pCi/L	-1.16	0.269	-0.474	0	5		
Cesium-137	pCi/L	-2.54	1.74	-0.498	0	5	10%DCG	300
Cobalt-60	pCi/L	-0.77	1.88	0.221	0	5	10%DCG	1000
Dissolved Alpha	pCi/L	-8.77	4.88	-1.26	0	5		
Dissolved Beta	pCi/L	22.5	41.9	30.2	5	5		
Neptunium-237	pCi/L	-0.0168	0.061	0.0143	0	5	10%DCG	3
Plutonium-238	pCi/L	-0.0155	0.0331	0.0113	0	5		
Plutonium-239/240	pCi/L	-0.041	0.031	-0.00399	0	5	10%DCG	3
Potassium-40	pCi/L	-6.3	78.1	35.7	2	5		
Suspended Alpha	pCi/L	-1.92	2.42	1.11	0	5		
Suspended Beta	pCi/L	-5.4	1.41	-2.18	0	5		
Technetium-99	pCi/L	-4.34	11	1.69	0	5	ActionLimit	900
Thorium-228	pCi/L	-0.102	0.0615	-0.0233	0	5		
Thorium-230	pCi/L	-0.0644	0.235	0.022	0	5	10%DCG	30
Thorium-232	pCi/L	-0.0145	0.045	0.00261	0	5		
Thorium-234	pCi/L	-45.9	12	-3.66	0	5		
Uranium	pCi/L	0.303	1.66	0.837	0	5	10%DCG	60
Uranium	mg/L	0.005	0.009	0.0058	1	5	10%DCG	0.0901
Uranium-234	pCi/L	0.161	0.781	0.392	2	5	10%DCG	50
Uranium-238	pCi/L	0.135	0.846	0.435	3	5	10%DCG	60

Surface Water Radiological Data

Table 2.9 Radiological Monitoring Data for Surface Water Location L291

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/L	-0.00626	0.0221	0.0083	0	4		
Americium-241	pCi/L	0.00493	0.101	0.0447	0	4	10%DCG	3
Cesium-134	pCi/L	-1.26	-0.491	-0.855	0	4		
Cesium-137	pCi/L	-2.67	-0.325	-1.08	0	4	10%DCG	300
Cobalt-60	pCi/L	-1.74	1.51	0.164	0	4	10%DCG	1000
Dissolved Alpha	pCi/L	-4	2.2	-0.135	0	4		
Dissolved Beta	pCi/L	0.258	6.98	4.57	0	4		
Neptunium-237	pCi/L	-0.0202	0.00758	-0.00458	0	4	10%DCG	3
Plutonium-238	pCi/L	-0.00823	0.0606	0.0129	0	4		
Plutonium-239/240	pCi/L	-0.0082	0.0277	0.0124	0	4	10%DCG	3
Potassium-40	pCi/L	-96.9	20.3	-34.5	0	4		
Suspended Alpha	pCi/L	-1.74	3.6	1.44	0	4		
Suspended Beta	pCi/L	-3.58	3.26	-1.11	0	4		
Technetium-99	pCi/L	-6.88	2.42	-1.13	0	4	ActionLimit	900
Thorium-228	pCi/L	-0.0563	0.0817	0.0174	0	4		
Thorium-230	pCi/L	-0.0788	0.257	0.0506	0	4	10%DCG	30
Thorium-232	pCi/L	-0.013	0.00137	-0.00578	0	4		
Thorium-234	pCi/L	-39.6	25.3	-10.7	0	4		
Uranium	pCi/L	0.0256	0.245	0.129	0	4	10%DCG	60
Uranium	mg/L	0.005	0.005	0.005	0	4	10%DCG	0.0901
Uranium-234	pCi/L	0.014	0.132	0.0765	0	4	10%DCG	50
Uranium-238	pCi/L	-0.0104	0.119	0.0444	0	4	10%DCG	60

Surface Water Radiological Data

Table 2.10 Radiological Monitoring Data for Surface Water Location L10

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/L	0.0244	0.0783	0.0444	0	4		
Americium-241	pCi/L	0.00158	0.122	0.0436	0	4	10%DCG	3
Cesium-134	pCi/L	-0.985	-0.0157	-0.544	0	4		
Cesium-137	pCi/L	-1.94	0.347	-0.512	0	4	10%DCG	300
Cobalt-60	pCi/L	-0.432	2.22	0.858	0	4	10%DCG	1000
Dissolved Alpha	pCi/L	1.26	6.36	4.85	2	4		
Dissolved Beta	pCi/L	5.15	7.2	5.91	0	4		
Neptunium-237	pCi/L	-0.015	0.0528	0.0289	0	4	10%DCG	3
Plutonium-238	pCi/L	0.023	0.0978	0.0482	0	4		
Plutonium-239/240	pCi/L	-0.00978	0.00803	-0.00219	0	4	10%DCG	3
Potassium-40	pCi/L	-35.8	35.8	-5.35	1	4		
Suspended Alpha	pCi/L	0.0477	2.78	1.14	0	4		
Suspended Beta	pCi/L	-3.27	2.26	-0.378	0	4		
Technetium-99	pCi/L	-4.93	16.2	4.8	0	4	ActionLimit	900
Thorium-228	pCi/L	-0.0147	0.059	0.0321	0	4		
Thorium-230	pCi/L	-0.0858	0.132	0.0383	0	4	10%DCG	30
Thorium-232	pCi/L	-0.00569	0.0264	0.00988	0	4		
Thorium-234	pCi/L	-20.1	20.2	-2.64	0	4		
Uranium	pCi/L	1.46	7.91	3.86	0	4	10%DCG	60
Uranium	mg/L	0.005	0.021	0.0102	3	4	10%DCG	0.0901
Uranium-234	pCi/L	0.165	1.42	0.619	2	4	10%DCG	50
Uranium-238	pCi/L	1.27	6.45	3.2	4	4	10%DCG	60

Surface Water Radiological Data

Table 2.11 Radiological Monitoring Data for Surface Water Location L194

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/L	0.0146	0.145	0.064	1	4		
Americium-241	pCi/L	0.000847	0.115	0.0398	0	4	10%DCG	3
Cesium-134	pCi/L	-1.46	0.295	-0.387	0	4		
Cesium-137	pCi/L	-1.83	-0.0815	-0.813	0	4	10%DCG	300
Cobalt-60	pCi/L	-1.43	0.641	-0.508	0	4	10%DCG	1000
Dissolved Alpha	pCi/L	-1.33	5.54	2.62	0	4		
Dissolved Beta	pCi/L	2.93	14.9	6.81	1	4		
Neptunium-237	pCi/L	-0.0133	0.00621	-0.00272	0	4	10%DCG	3
Plutonium-238	pCi/L	0.0033	0.0336	0.0183	0	4		
Plutonium-239/240	pCi/L	-0.00233	0.0216	0.00696	0	4	10%DCG	3
Potassium-40	pCi/L	-12.5	6.26	-5.73	0	4		
Suspended Alpha	pCi/L	-0.554	1.86	0.415	0	4		
Suspended Beta	pCi/L	-4.43	3.06	0.24	0	4		
Technetium-99	pCi/L	-1.93	11.6	6.69	0	4	ActionLimit	900
Thorium-228	pCi/L	-0.0071	0.0464	0.0263	0	4		
Thorium-230	pCi/L	-0.118	0.357	0.165	0	4	10%DCG	30
Thorium-232	pCi/L	-0.00878	0.148	0.0473	0	4		
Thorium-234	pCi/L	-25.8	8.49	-5.39	0	4		
Uranium	mg/L	0.005	0.014	0.00875	2	4	10%DCG	0.0901
Uranium	pCi/L	0.761	4.75	2.73	1	4	10%DCG	60
Uranium-234	pCi/L	0.177	0.697	0.437	3	4	10%DCG	50
Uranium-238	pCi/L	0.56	3.91	2.22	4	4	10%DCG	60

Surface Water Radiological Data

Table 2.12 Radiological Monitoring Data for Surface Water Location L11

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/L	0.000813	0.0691	0.0298	0	5		
Americium-241	pCi/L	0.0397	0.0891	0.0611	0	5	10%DCG	3
Cesium-134	pCi/L	-0.682	0.346	-0.196	0	5		
Cesium-137	pCi/L	-1.48	0.428	-0.548	0	5	10%DCG	300
Cobalt-60	pCi/L	-0.758	1.69	0.487	0	5	10%DCG	1000
Dissolved Alpha	pCi/L	-2.09	4.51	1.65	0	5		
Dissolved Beta	pCi/L	1.32	8.23	4.93	1	5		
Neptunium-237	pCi/L	-0.0351	0.0155	-0.00348	0	5	10%DCG	3
Plutonium-238	pCi/L	-0.00795	0.0499	0.0239	0	5		
Plutonium-239/240	pCi/L	-0.00934	0.0403	0.017	0	5	10%DCG	3
Potassium-40	pCi/L	-90.6	-11.5	-29.7	0	5		
Suspended Alpha	pCi/L	-2.75	2.9	0.63	0	5		
Suspended Beta	pCi/L	-5	4.78	-1.13	0	5		
Technetium-99	pCi/L	-0.263	14.1	7.54	0	5	ActionLimit	900
Thorium-228	pCi/L	0.00991	0.0685	0.0383	0	5		
Thorium-230	pCi/L	-0.0338	0.241	0.0771	0	5	10%DCG	30
Thorium-232	pCi/L	-0.0374	0.0155	-0.0091	0	5		
Thorium-234	pCi/L	-32.1	31.2	-9.34	0	5		
Uranium	pCi/L	0.829	4.53	2.08	0	5	10%DCG	60
Uranium	mg/L	0.005	0.012	0.0064	1	5	10%DCG	0.0901
Uranium-234	pCi/L	0.157	0.739	0.387	1	5	10%DCG	50
Uranium-238	pCi/L	0.634	3.72	1.66	5	5	10%DCG	60

Surface Water Radiological Data

Table 2.13 Radiological Monitoring Data for Surface Water Location L12

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/L	-0.0132	0.0307	0.0131	0	5		
Americium-241	pCi/L	0.0252	0.0959	0.0569	0	5	10%DCG	3
Cesium-134	pCi/L	-1	1.29	-0.345	0	5		
Cesium-137	pCi/L	-1.54	0.692	-0.24	0	5	10%DCG	300
Cobalt-60	pCi/L	-0.929	1.53	0.231	0	5	10%DCG	1000
Dissolved Alpha	pCi/L	-1.22	2.47	0.97	0	5		
Dissolved Beta	pCi/L	8.71	21.5	13.8	5	5		
Neptunium-237	pCi/L	-0.00662	0.213	0.0472	1	5	10%DCG	3
Plutonium-238	pCi/L	0.0136	0.0342	0.0237	0	5		
Plutonium-239/240	pCi/L	0.00437	0.0357	0.0183	0	5	10%DCG	3
Potassium-40	pCi/L	-74.8	-3.91	-30.8	0	5		
Suspended Alpha	pCi/L	-0.308	2.36	1.11	0	5		
Suspended Beta	pCi/L	-1.09	4.94	0.549	0	5		
Technetium-99	pCi/L	0.368	36.7	21.2	3	5	ActionLimit	900
Thorium-228	pCi/L	-0.0567	0.228	0.0667	0	5		
Thorium-230	pCi/L	0.0175	0.484	0.243	0	5	10%DCG	30
Thorium-232	pCi/L	-0.0238	0.214	0.0565	1	5		
Thorium-234	pCi/L	-46	7.18	-23.1	0	5		
Uranium	pCi/L	0.414	2.72	1.24	0	5	10%DCG	60
Uranium	mg/L	0.005	0.028	0.0096	1	5	10%DCG	0.0901
Uranium-234	pCi/L	0.0741	0.548	0.264	0	5	10%DCG	50
Uranium-238	pCi/L	0.332	2.16	0.968	5	5	10%DCG	60

Surface Water Radiological Data

Table 2.14 Radiological Monitoring Data for Surface Water Location L241

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/L	0.00765	0.0353	0.0266	0	4		
Americium-241	pCi/L	0.00295	0.0772	0.0342	0	4	10%DCG	3
Cesium-134	pCi/L	-1.15	0.238	-0.499	0	4		
Cesium-137	pCi/L	-2.06	-0.731	-1.45	0	4	10%DCG	300
Cobalt-60	pCi/L	-0.574	0.164	-0.215	0	4	10%DCG	1000
Dissolved Alpha	pCi/L	-0.986	5.41	1.69	0	4		
Dissolved Beta	pCi/L	12.3	32.5	18.5	4	4		
Neptunium-237	pCi/L	0.00821	0.0189	0.0135	0	4	10%DCG	3
Plutonium-238	pCi/L	-0.00993	0.0588	0.0243	0	4		
Plutonium-239/240	pCi/L	0.00151	0.0156	0.0103	0	4	10%DCG	3
Potassium-40	pCi/L	-24.9	38.9	-5.28	1	4		
Suspended Alpha	pCi/L	-2.38	2.67	-0.0165	0	4		
Suspended Beta	pCi/L	0.24	1.55	1.07	0	4		
Technetium-99	pCi/L	12.7	58	31.1	2	4	ActionLimit	900
Thorium-228	pCi/L	-0.0554	0.102	0.0336	0	4		
Thorium-230	pCi/L	-0.0346	0.498	0.143	0	4	10%DCG	30
Thorium-232	pCi/L	0.035	0.0704	0.0479	0	4		
Thorium-234	pCi/L	-41.6	8.34	-14.3	0	4		
Uranium	pCi/L	0.691	2.14	1.27	0	4	10%DCG	60
Uranium	mg/L	0.005	0.006	0.00525	1	4	10%DCG	0.0901
Uranium-234	pCi/L	0.0951	0.378	0.234	0	4	10%DCG	50
Uranium-238	pCi/L	0.588	1.74	1.01	4	4	10%DCG	60

Surface Water Radiological Data

Table 2.15 Radiological Monitoring Data for Surface Water Location C746K-5

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/L	-0.00962	0.0301	0.00927	0	5		
Americium-241	pCi/L	-0.000561	0.0495	0.0197	0	5	10%DCG	3
Cesium-134	pCi/L	-2.76	0.285	-0.779	0	5		
Cesium-137	pCi/L	-1.52	-0.162	-0.932	0	5	10%DCG	300
Cobalt-60	pCi/L	-1.77	0.525	-0.517	0	5	10%DCG	1000
Dissolved Alpha	pCi/L	-0.945	2.44	0.755	0	5		
Dissolved Beta	pCi/L	-1.06	5.43	2.42	0	5		
Neptunium-237	pCi/L	-0.0236	0.0436	0.00716	0	5	10%DCG	3
Plutonium-238	pCi/L	-0.00385	0.213	0.0484	1	5		
Plutonium-239/240	pCi/L	0.00202	0.0298	0.0173	0	5	10%DCG	3
Potassium-40	pCi/L	-79.5	6.79	-26.4	0	5		
Suspended Alpha	pCi/L	-2.1	3.1	0.226	0	5		
Suspended Beta	pCi/L	-3.34	4.23	0.503	0	5		
Technetium-99	pCi/L	-0.998	17.3	5	0	5	ActionLimit	900
Thorium-228	pCi/L	-0.063	0.11	0.00788	0	5		
Thorium-230	pCi/L	-0.00963	0.211	0.0918	0	5	10%DCG	30
Thorium-232	pCi/L	-0.0594	0.0445	0.0045	0	5		
Thorium-234	pCi/L	-39.6	18.5	-8.55	0	5		
Uranium	pCi/L	0.194	0.359	0.273	0	5	10%DCG	60
Uranium	mg/L	0.005	0.005	0.005	0	5	10%DCG	0.0901
Uranium-234	pCi/L	0.134	0.181	0.153	0	5	10%DCG	50
Uranium-238	pCi/L	0.015	0.181	0.111	1	5	10%DCG	60

Surface Water Radiological Data

Table 2.16 Radiological Monitoring Data for Surface Water Location C746KTB1

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/L	-0.0277	0.011	-0.00225	0	4		
Americium-241	pCi/L	-0.0103	0.0331	0.0134	0	4	10%DCG	3
Cesium-134	pCi/L	-0.349	1.19	0.125	0	4		
Cesium-137	pCi/L	-1.69	-0.635	-1.04	0	4	10%DCG	300
Cobalt-60	pCi/L	-0.819	1.31	0.211	0	4	10%DCG	1000
Dissolved Alpha	pCi/L	0.228	2.97	1.47	0	4		
Dissolved Beta	pCi/L	2.45	5.78	4.5	0	4		
Neptunium-237	pCi/L	-0.0106	0.0144	0.003	0	4	10%DCG	3
Plutonium-238	pCi/L	-0.0159	0.0311	-0.00072	0	4		
Plutonium-239/240	pCi/L	-0.00356	0.0372	0.008	0	4	10%DCG	3
Potassium-40	pCi/L	-15	26.5	0.254	0	4		
Suspended Alpha	pCi/L	0.128	1.01	0.458	0	4		
Suspended Beta	pCi/L	-6.17	2.62	-1.26	0	4		
Technetium-99	pCi/L	-1.86	14.4	3.67	0	4	ActionLimit	900
Thorium-228	pCi/L	-0.0817	0.0938	0.0288	0	4		
Thorium-230	pCi/L	-0.0684	0.101	0.00572	0	4	10%DCG	30
Thorium-232	pCi/L	0.00027	0.0255	0.0157	0	4		
Thorium-234	pCi/L	-18.4	6.44	-8.78	0	4		
Uranium	mg/L	0.005	0.005	0.005	0	4	10%DCG	0.0901
Uranium	pCi/L	0.0326	0.128	0.0698	0	4	10%DCG	60
Uranium-234	pCi/L	0.0152	0.0543	0.037	0	4	10%DCG	50
Uranium-238	pCi/L	0.00243	0.0743	0.035	0	4	10%DCG	60

Surface Water Radiological Data

Table 2.17 Radiological Monitoring Data for Surface Water Location S31

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/L	0.159	0.328	0.262	4	4		
Americium-241	pCi/L	0.0365	0.08	0.0572	0	4	10%DCG	3
Cesium-134	pCi/L	-0.706	0.825	-0.126	0	4		
Cesium-137	pCi/L	-2.49	0.583	-0.901	0	4	10%DCG	300
Cobalt-60	pCi/L	-0.846	1.22	-0.299	0	4	10%DCG	1000
Dissolved Alpha	pCi/L	0.645	11.1	4.98	2	4		
Dissolved Beta	pCi/L	2.3	79.1	23.5	1	4		
Neptunium-237	pCi/L	-0.068	0.0249	-0.00352	0	4	10%DCG	3
Plutonium-238	pCi/L	-0.0146	0.0656	0.0179	0	4		
Plutonium-239/240	pCi/L	0.00453	0.0258	0.0174	0	4	10%DCG	3
Potassium-40	pCi/L	-83.1	25.8	-20.9	0	4		
Suspended Alpha	pCi/L	-1.55	1.35	-0.738	0	4		
Suspended Beta	pCi/L	1.43	110	30.7	1	4		
Technetium-99	pCi/L	-2.31	20.1	6.48	1	4	ActionLimit	900
Thorium-228	pCi/L	-0.107	0.0587	-0.0247	0	4		
Thorium-230	pCi/L	-0.178	0.197	0.00155	0	4	10%DCG	30
Thorium-232	pCi/L	-0.0235	0.124	0.0513	0	4		
Thorium-234	pCi/L	-27.1	110	16.9	1	4		
Uranium	mg/L	0.005	0.009	0.006	1	4	10%DCG	0.0901
Uranium	pCi/L	4.92	10.6	7.85	4	4	10%DCG	60
Uranium-234	pCi/L	3.73	7.26	5.5	4	4	10%DCG	50
Uranium-238	pCi/L	1.03	3.13	2.08	4	4	10%DCG	60

Surface Water Radiological Data

Table 2.18 Radiological Monitoring Data for Surface Water Location L8

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/L	0.0135	0.0893	0.0355	0	4		
Americium-241	pCi/L	-0.0289	0.0417	0.0104	0	4	10%DCG	3
Cesium-134	pCi/L	0.0811	0.575	0.339	0	4		
Cesium-137	pCi/L	-1.79	-0.133	-0.867	0	4	10%DCG	300
Cobalt-60	pCi/L	-1.76	0.489	-0.628	0	4	10%DCG	1000
Dissolved Alpha	pCi/L	-1.5	5.55	1.81	1	4		
Dissolved Beta	pCi/L	4.73	27.6	13.7	3	4		
Neptunium-237	pCi/L	-0.0253	0.0383	0.00986	0	4	10%DCG	3
Plutonium-238	pCi/L	0.00204	0.0264	0.0137	0	4		
Plutonium-239/240	pCi/L	-0.0206	0.0108	-0.00167	0	4	10%DCG	3
Potassium-40	pCi/L	-24.4	35.8	-5.78	0	4		
Suspended Alpha	pCi/L	-0.0121	3.24	0.957	0	4		
Suspended Beta	pCi/L	-0.479	5.19	2.13	0	4		
Technetium-99	pCi/L	-0.589	18.4	6.16	1	4	ActionLimit	900
Thorium-228	pCi/L	-0.0658	0.0695	0.0128	0	4		
Thorium-230	pCi/L	-0.0979	0.289	0.0503	0	4	10%DCG	30
Thorium-232	pCi/L	-0.0344	0.0155	-0.00916	0	4		
Thorium-234	pCi/L	-41.8	5.63	-21.5	0	4		
Uranium	mg/L	0.005	0.007	0.0055	1	4	10%DCG	0.0901
Uranium	pCi/L	0.629	3.69	1.51	1	4	10%DCG	60
Uranium-234	pCi/L	0.237	1.18	0.526	3	4	10%DCG	50
Uranium-238	pCi/L	0.376	2.42	0.946	4	4	10%DCG	60

Surface Water Radiological Data

Table 2.19 Radiological Monitoring Data for Surface Water Location L29

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/L	-0.00992	0.014	0.00658	0	4		
Americium-241	pCi/L	-0.0138	0.00567	-0.00303	0	4	10%DCG	3
Cesium-134	pCi/L	-1.72	1.99	-0.097	0	4		
Cesium-137	pCi/L	-0.809	0.514	-0.149	0	4	10%DCG	300
Cobalt-60	pCi/L	-1.68	0.999	-0.214	0	4	10%DCG	1000
Dissolved Alpha	pCi/L	-1.42	2.51	0.776	0	4		
Dissolved Beta	pCi/L	2.62	14.8	6.49	1	4		
Neptunium-237	pCi/L	-0.014	0.0236	0.00504	0	4	10%DCG	3
Plutonium-238	pCi/L	-0.0088	0.0102	0.00262	0	4		
Plutonium-239/240	pCi/L	-0.00937	0.0142	-0.000298	0	4	10%DCG	3
Potassium-40	pCi/L	-28.5	-7.83	-14.3	0	4		
Suspended Alpha	pCi/L	-1.18	1.28	0.189	0	4		
Suspended Beta	pCi/L	0.651	4.39	2.22	0	4		
Technetium-99	pCi/L	-5.92	9.28	0.912	0	4	ActionLimit	900
Thorium-228	pCi/L	-0.0233	0.0183	-0.00277	0	4		
Thorium-230	pCi/L	-0.0418	0.0598	-0.000613	0	4	10%DCG	30
Thorium-232	pCi/L	-0.0145	0.0227	0.000699	0	4		
Thorium-234	pCi/L	-39.3	6.8	-14.9	0	4		
Uranium	mg/L	0.005	0.005	0.005	0	4	10%DCG	0.0901
Uranium	pCi/L	0.154	0.357	0.263	0	4	10%DCG	60
Uranium-234	pCi/L	0.103	0.193	0.14	1	4	10%DCG	50
Uranium-238	pCi/L	0.0388	0.155	0.117	1	4	10%DCG	60

Surface Water Radiological Data

Table 2.20 Radiological Monitoring Data for Surface Water Location L30

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/L	-0.0275	0.0156	-0.0117	0	4		
Americium-241	pCi/L	-0.0327	0.0389	0.00201	0	4	10%DCG	3
Cesium-134	pCi/L	-0.751	0.022	-0.384	0	4		
Cesium-137	pCi/L	-1.35	0.047	-0.614	0	4	10%DCG	300
Cobalt-60	pCi/L	-1.53	1.03	-0.244	0	4	10%DCG	1000
Dissolved Alpha	pCi/L	-0.327	3.88	1.32	0	4		
Dissolved Beta	pCi/L	1.78	9.85	5.58	1	4		
Neptunium-237	pCi/L	-0.0374	0.000912	-0.0158	0	4	10%DCG	3
Plutonium-238	pCi/L	-0.00454	0.0877	0.0268	0	4		
Plutonium-239/240	pCi/L	-0.0042	0.00995	0.00261	0	4	10%DCG	3
Potassium-40	pCi/L	-30	-9.06	-21.1	0	4		
Suspended Alpha	pCi/L	-1.55	2.17	-0.197	0	4		
Suspended Beta	pCi/L	0	7.36	3.91	1	4		
Technetium-99	pCi/L	-7.59	18.6	3.86	1	4	ActionLimit	900
Thorium-228	pCi/L	-0.0587	0.112	0.0234	0	4		
Thorium-230	pCi/L	-0.0909	0.0598	-0.0388	0	4	10%DCG	30
Thorium-232	pCi/L	-0.00546	0.00678	0.000852	0	4		
Thorium-234	pCi/L	-40.3	-4.66	-16.7	0	4		
Uranium	pCi/L	0.167	0.399	0.252	0	4	10%DCG	60
Uranium	mg/L	0.005	0.005	0.005	0	4	10%DCG	0.0901
Uranium-234	pCi/L	0.0913	0.217	0.154	0	4	10%DCG	50
Uranium-238	pCi/L	0.0537	0.167	0.11	1	4	10%DCG	60

Surface Water Radiological Data

Table 2.21 Radiological Monitoring Data for Surface Water Location L306

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/L	-0.00188	0.0149	0.00492	0	4		
Americium-241	pCi/L	-0.000837	0.0854	0.0481	0	4	10%DCG	3
Cesium-134	pCi/L	-1.12	1.4	0.316	0	4		
Cesium-137	pCi/L	-0.562	1.66	0.136	0	4	10%DCG	300
Cobalt-60	pCi/L	-1.35	-1.2	-1.28	0	4	10%DCG	1000
Dissolved Alpha	pCi/L	-2.06	3.04	0.429	0	4		
Dissolved Beta	pCi/L	5.14	17.9	8.56	1	4		
Neptunium-237	pCi/L	-0.0127	0.00125	-0.00435	0	4	10%DCG	3
Plutonium-238	pCi/L	-0.00231	0.0775	0.0302	0	4		
Plutonium-239/240	pCi/L	0.00682	0.0165	0.00973	0	4	10%DCG	3
Potassium-40	pCi/L	-34.3	17.2	-19.4	0	4		
Suspended Alpha	pCi/L	-2.23	0.454	-0.758	0	4		
Suspended Beta	pCi/L	0.725	3.3	2.26	0	4		
Technetium-99	pCi/L	-0.735	18.6	7.31	1	4	ActionLimit	900
Thorium-228	pCi/L	-0.00695	0.0398	0.0243	0	4		
Thorium-230	pCi/L	-0.105	0.412	0.0849	0	4	10%DCG	30
Thorium-232	pCi/L	-0.0187	0.00964	-0.00014	0	4		
Thorium-234	pCi/L	-42.2	-21	-29.1	0	4		
Uranium	pCi/L	0.283	0.431	0.35	0	4	10%DCG	60
Uranium	mg/L	0.005	0.005	0.005	0	4	10%DCG	0.0901
Uranium-234	pCi/L	0.147	0.222	0.181	1	4	10%DCG	50
Uranium-238	pCi/L	0.0878	0.221	0.164	2	4	10%DCG	60

Surface Water Radiological Data

Table 2.22 Radiological Monitoring Data for Surface Water Location L64

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/L	-0.0121	0.0231	-0.00101	0	4		
Americium-241	pCi/L	0.0214	0.126	0.0617	0	4	10%DCG	3
Cesium-134	pCi/L	-0.496	0.321	-0.103	0	4		
Cesium-137	pCi/L	-3.45	0.141	-1.11	0	4	10%DCG	300
Cobalt-60	pCi/L	-0.0746	0.362	0.197	0	4	10%DCG	1000
Dissolved Alpha	pCi/L	-1.15	2.29	0.558	0	4		
Dissolved Beta	pCi/L	-0.771	5.09	1.65	0	4		
Neptunium-237	pCi/L	-0.0166	0.00312	-0.00351	0	4	10%DCG	3
Plutonium-238	pCi/L	-0.0102	0.121	0.0415	0	4		
Plutonium-239/240	pCi/L	-0.00342	0.0388	0.0161	0	4	10%DCG	3
Potassium-40	pCi/L	-22.9	-0.342	-7.91	0	4		
Suspended Alpha	pCi/L	-0.106	7.68	2.49	1	4		
Suspended Beta	pCi/L	-5.97	2.26	-1.45	0	4		
Technetium-99	pCi/L	-7.01	10.1	2.24	0	4	ActionLimit	900
Thorium-228	pCi/L	-0.111	0.0968	0.0264	0	4		
Thorium-230	pCi/L	0.0982	0.35	0.204	0	4	10%DCG	30
Thorium-232	pCi/L	0.00239	0.0354	0.0227	0	4		
Thorium-234	pCi/L	-23.9	25.3	-1.69	0	4		
Uranium	mg/L	0.005	0.005	0.005	0	4	10%DCG	0.0901
Uranium	pCi/L	0.0393	0.246	0.111	0	4	10%DCG	60
Uranium-234	pCi/L	0.0121	0.0989	0.0587	0	4	10%DCG	50
Uranium-238	pCi/L	0.00411	0.159	0.0532	0	4	10%DCG	60

Table 2.23 Radiological Monitoring Data for Surface Water Seep Location LBCSP5

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Alpha activity	pCi/L	1.85	10.7	6.49	3	4		
Beta activity	pCi/L	159	202	180	4	4		
Technetium-99	pCi/L	196	267	236	4	4	ActionLimit	900
Uranium	pCi/L	0.0502	0.378	0.166	0	4	10%DCG	60

Table 2.24 Radiological Monitoring Data for Surface Water Seep Location LBCSP6

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Alpha activity	pCi/L	2.97	9.51	4.66	1	4		
Beta activity	pCi/L	110	145	124	4	4		
Technetium-99	pCi/L	155	201	170	4	4	ActionLimit	900
Uranium	pCi/L	0.128	2.29	0.715	0	4	10%DCG	60

Sediment Radiological Data

Table 2.25 Radiological Data for Sediment Location S20

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/g	0.0106	0.0118	0.0112	2	2		
Alpha activity	pCi/g	2.17	3.24	2.71	2	2		
Americium-241	pCi/g	0.00446	0.0117	0.00808	0	2		
Beta activity	pCi/g	1.47	1.82	1.64	2	2		
Cesium-137	pCi/g	0.018	0.0236	0.0208	0	2		
Cobalt-60	pCi/g	-0.00126	0.00311	0.000925	0	2		
Neptunium-237	pCi/g	0.000569	0.00365	0.00211	0	2		
Plutonium-239/240	pCi/g	0.00182	0.00729	0.00455	0	2		
Potassium-40	pCi/g	1.85	2.43	2.14	2	2		
Technetium-99	pCi/g	0.511	1.02	0.765	2	2		
Thorium-230	pCi/g	0.146	0.175	0.161	2	2		
Uranium	pCi/kg	289	299	294	2	2		
Uranium-234	pCi/g	0.154	0.181	0.168	2	2		
Uranium-238	pCi/g	0.0961	0.134	0.115	2	2		

Table 2.26 Radiological Data for Sediment Location C612

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/g	0.0984	0.706	0.402	2	2		
Alpha activity	pCi/g	6.82	41.3	24.1	2	2		
Americium-241	pCi/g	0.0276	0.0481	0.0378	2	2		
Beta activity	pCi/g	44	491	268	2	2		
Cesium-137	pCi/g	0.0307	0.581	0.306	1	2		
Cobalt-60	pCi/g	-0.0147	0.0049	-0.0049	0	2		
Neptunium-237	pCi/g	0.112	1.15	0.631	2	2		
Plutonium-239/240	pCi/g	0.0227	0.215	0.119	2	2		
Potassium-40	pCi/g	7.56	8.38	7.97	2	2		
Technetium-99	pCi/g	9.51	56.2	32.9	2	2		
Thorium-230	pCi/g	0.347	1.61	0.979	2	2		
Uranium	pCi/kg	3890	34600	19200	2	2		
Uranium-234	pCi/g	1.55	13.8	7.67	2	2		
Uranium-238	pCi/g	2.24	20.1	11.2	2	2		

Sediment Radiological Data

Table 2.27 Radiological Data for Sediment Location C616

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/g	0.17	0.176	0.173	2	2		
Alpha activity	pCi/g	8.76	13.5	11.1	2	2		
Americium-241	pCi/g	0.0223	0.0269	0.0246	1	2		
Beta activity	pCi/g	15.3	40.6	27.9	2	2		
Cesium-137	pCi/g	0.0357	0.0942	0.0649	2	2		
Cobalt-60	pCi/g	-0.00185	0.00227	0.00021	0	2		
Neptunium-237	pCi/g	0.0974	0.139	0.118	2	2		
Plutonium-239/240	pCi/g	0.0548	0.103	0.0789	2	2		
Potassium-40	pCi/g	3.49	6.36	4.92	2	2		
Technetium-99	pCi/g	3.63	6.12	4.87	2	2		
Thorium-230	pCi/g	0.562	0.806	0.684	2	2		
Uranium	pCi/kg	6580	7660	7120	2	2		
Uranium-234	pCi/g	2.61	3.49	3.05	2	2		
Uranium-238	pCi/g	3.8	4	3.9	2	2		

Table 2.28 Radiological Data for Sediment Location K001

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/g	0.0707	0.0915	0.0811	2	2		
Alpha activity	pCi/g	3.23	7.81	5.52	2	2		
Americium-241	pCi/g	0.00758	0.0127	0.0101	0	2		
Beta activity	pCi/g	9.65	12.5	11.1	2	2		
Cesium-137	pCi/g	0.0355	0.0585	0.047	1	2		
Cobalt-60	pCi/g	-0.0136	-0.00298	-0.00829	0	2		
Neptunium-237	pCi/g	0.0278	0.0348	0.0313	2	2		
Plutonium-239/240	pCi/g	0.0252	0.033	0.0291	2	2		
Potassium-40	pCi/g	5.66	6.81	6.24	2	2		
Technetium-99	pCi/g	1.34	4.27	2.81	2	2		
Thorium-230	pCi/g	0.412	0.436	0.424	2	2		
Uranium	pCi/kg	2660	4100	3380	2	2		
Uranium-234	pCi/g	1.01	1.82	1.42	2	2		
Uranium-238	pCi/g	1.58	2.19	1.88	2	2		

Sediment Radiological Data

Table 2.29 Radiological Data for Sediment Location S1

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/g	0.0568	0.0909	0.0738	2	2		
Alpha activity	pCi/g	2.96	6.24	4.6	2	2		
Americium-241	pCi/g	0.00491	0.0116	0.00825	0	2		
Beta activity	pCi/g	5.36	15.9	10.6	2	2		
Cesium-137	pCi/g	0.0148	0.0282	0.0215	0	2		
Cobalt-60	pCi/g	-0.00489	-0.00475	-0.00482	0	2		
Neptunium-237	pCi/g	0.00862	0.075	0.0418	1	2		
Plutonium-239/240	pCi/g	0.0129	0.0157	0.0143	2	2		
Potassium-40	pCi/g	1.71	2.11	1.91	2	2		
Technetium-99	pCi/g	0.56	2.22	1.39	2	2		
Thorium-230	pCi/g	0.24	0.262	0.251	2	2		
Uranium	pCi/kg	1930	4580	3260	2	2		
Uranium-234	pCi/g	1.12	1.65	1.38	2	2		
Uranium-238	pCi/g	0.753	2.84	1.8	2	2		

Table 2.30 Radiological Data for Sediment Location S31

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/g	0.383	0.576	0.479	2	2		
Alpha activity	pCi/g	28.7	42.5	35.6	2	2		
Americium-241	pCi/g	0.0317	0.105	0.0683	2	2		
Beta activity	pCi/g	27.6	37.1	32.3	2	2		
Cesium-137	pCi/g	0.131	0.411	0.271	2	2		
Cobalt-60	pCi/g	-0.0027	0.000281	-0.00121	0	2		
Neptunium-237	pCi/g	0.0896	0.197	0.143	2	2		
Plutonium-239/240	pCi/g	0.199	0.716	0.458	2	2		
Potassium-40	pCi/g	3.36	5.26	4.31	2	2		
Technetium-99	pCi/g	1.14	3.79	2.46	2	2		
Thorium-230	pCi/g	1.43	6.21	3.82	2	2		
Uranium	pCi/kg	11900	19200	15600	2	2		
Uranium-234	pCi/g	8.28	12.6	10.4	2	2		
Uranium-238	pCi/g	3.26	6.02	4.64	2	2		

Sediment Radiological Data

Table 2.31 Radiological Data for Sediment Location S33

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/g	0.0275	0.0319	0.0297	2	2		
Alpha activity	pCi/g	1.93	4.89	3.41	2	2		
Americium-241	pCi/g	0.00293	0.00726	0.00509	0	2		
Beta activity	pCi/g	2.91	3.57	3.24	2	2		
Cesium-137	pCi/g	0.0291	0.0661	0.0476	1	2		
Cobalt-60	pCi/g	-0.0135	0.0043	-0.0046	0	2		
Neptunium-237	pCi/g	0.004	0.00662	0.00531	0	2		
Plutonium-239/240	pCi/g	0.00959	0.00972	0.00965	1	2		
Potassium-40	pCi/g	3.29	3.62	3.45	2	2		
Technetium-99	pCi/g	0.283	0.656	0.469	2	2		
Thorium-230	pCi/g	0.174	0.225	0.2	2	2		
Uranium	pCi/kg	1110	1120	1120	2	2		
Uranium-234	pCi/g	0.492	0.537	0.514	2	2		
Uranium-238	pCi/g	0.55	0.591	0.57	2	2		

Table 2.32 Radiological Data for Sediment Location L194

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/g	0.0997	0.117	0.108	2	2		
Alpha activity	pCi/g	3.12	8.17	5.64	2	2		
Americium-241	pCi/g	0.00806	0.208	0.108	1	2		
Beta activity	pCi/g	5.6	8.73	7.16	2	2		
Cesium-137	pCi/g	-0.0192	0.000232	-0.00948	0	2		
Cobalt-60	pCi/g	0.00307	0.00925	0.00616	0	2		
Neptunium-237	pCi/g	0.00474	0.00744	0.00609	0	2		
Plutonium-239/240	pCi/g	0.00357	0.0335	0.0185	1	2		
Potassium-40	pCi/g	4.1	4.76	4.43	2	2		
Technetium-99	pCi/g	0.293	0.306	0.299	2	2		
Thorium-230	pCi/g	0.229	0.939	0.584	2	2		
Uranium	pCi/kg	4550	5440	5000	2	2		
Uranium-234	pCi/g	1.25	1.32	1.28	2	2		
Uranium-238	pCi/g	3.18	4.02	3.6	2	2		

Sediment Radiological Data

Table 2.33 Radiological Data for Sediment Location S2

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/g	0.111	0.145	0.128	2	2		
Alpha activity	pCi/g	6.08	9.46	7.77	2	2		
Americium-241	pCi/g	0.00348	0.0581	0.0308	1	2		
Beta activity	pCi/g	13.4	14.9	14.1	2	2		
Cesium-137	pCi/g	0.00596	0.0232	0.0146	0	2		
Cobalt-60	pCi/g	-0.00338	0.00138	-0.001	0	2		
Neptunium-237	pCi/g	0.00135	0.00572	0.00353	0	2		
Plutonium-239/240	pCi/g	0.00111	0.00584	0.00347	0	2		
Potassium-40	pCi/g	2.79	4	3.39	2	2		
Technetium-99	pCi/g	0.336	0.428	0.382	2	2		
Thorium-230	pCi/g	0.193	0.232	0.212	2	2		
Uranium	pCi/kg	6780	8830	7800	2	2		
Uranium-234	pCi/g	0.832	1.52	1.18	2	2		
Uranium-238	pCi/g	5.84	7.16	6.5	2	2		

Table 2.34 Radiological Data for Sediment Location S27

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/g	0.0187	0.195	0.0836	3	3		
Alpha activity	pCi/g	2.19	8.68	6.07	3	3		
Americium-241	pCi/g	0.0112	0.0795	0.038	1	3		
Beta activity	pCi/g	2.17	9.02	6.43	3	3		
Cesium-137	pCi/g	0.00354	0.0408	0.0218	1	3		
Cobalt-60	pCi/g	-0.00442	0.00173	-0.00101	0	3		
Neptunium-237	pCi/g	0.00207	0.0329	0.0171	2	3		
Plutonium-239/240	pCi/g	0.00795	0.249	0.11	2	3		
Potassium-40	pCi/g	3.51	4.36	3.97	3	3		
Technetium-99	pCi/g	0.784	1.34	0.984	3	3		
Thorium-230	pCi/g	0.246	3.82	1.78	3	3		
Uranium	pCi/kg	786	9650	4470	3	3		
Uranium-234	pCi/g	0.32	1.97	0.975	3	3		
Uranium-238	pCi/g	0.447	7.48	3.41	3	3		

Sediment Radiological Data

Table 2.35 Radiological Data for Sediment Location S34

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/g	0.0419	0.0652	0.0512	3	3		
Alpha activity	pCi/g	2.39	7.07	4.05	3	3		
Americium-241	pCi/g	0.0129	0.0226	0.0175	1	3		
Beta activity	pCi/g	4.85	9.52	6.69	3	3		
Cesium-137	pCi/g	0.021	0.0316	0.0278	2	3		
Cobalt-60	pCi/g	-0.000573	0.00967	0.00466	0	3		
Neptunium-237	pCi/g	0.00533	0.0142	0.0104	2	3		
Plutonium-239/240	pCi/g	0.0459	0.0804	0.0608	3	3		
Potassium-40	pCi/g	3.78	4.77	4.21	3	3		
Technetium-99	pCi/g	0.785	1.06	0.903	3	3		
Thorium-230	pCi/g	0.788	1.24	0.939	3	3		
Uranium	pCi/kg	1560	2800	2030	3	3		
Uranium-234	pCi/g	0.384	0.719	0.516	3	3		
Uranium-238	pCi/g	1.13	2.02	1.46	3	3		

Table 2.36 Radiological Data for Sediment Location C746KTB2

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/g	0.0046	0.00562	0.00511	0	2		
Alpha activity	pCi/g	1.53	3.43	2.48	2	2		
Americium-241	pCi/g	0.0069	0.0104	0.00865	0	2		
Beta activity	pCi/g	1.71	1.85	1.78	2	2		
Cesium-137	pCi/g	-0.000379	0.0317	0.0157	1	2		
Cobalt-60	pCi/g	-0.00979	-0.00606	-0.00792	0	2		
Neptunium-237	pCi/g	0.00266	0.00387	0.00326	0	2		
Plutonium-239/240	pCi/g	0.00385	0.00528	0.00456	0	2		
Potassium-40	pCi/g	2.41	4.57	3.49	2	2		
Technetium-99	pCi/g	0.154	0.41	0.282	1	2		
Thorium-230	pCi/g	0.153	0.213	0.183	2	2		
Uranium	pCi/kg	332	382	357	0	2		
Uranium-234	pCi/g	0.17	0.234	0.202	2	2		
Uranium-238	pCi/g	0.143	0.156	0.149	2	2		

Sediment Radiological Data

Table 2.37 Radiological Data for Sediment Location S32

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/g	0.201	0.632	0.416	2	2		
Alpha activity	pCi/g	52.9	99.1	76	2	2		
Americium-241	pCi/g	0.923	1.67	1.3	2	2		
Beta activity	pCi/g	78.9	121	99.9	2	2		
Cesium-137	pCi/g	1.09	1.14	1.11	2	2		
Cobalt-60	pCi/g	-0.00369	0.0296	0.013	0	2		
Neptunium-237	pCi/g	1.04	1.79	1.42	2	2		
Plutonium-239/240	pCi/g	5.01	6.73	5.87	2	2		
Potassium-40	pCi/g	7.01	7.55	7.28	2	2		
Technetium-99	pCi/g	20	40.2	30.1	2	2		
Thorium-230	pCi/g	95.2	112	104	2	2		
Uranium	pCi/kg	4860	26000	15400	2	2		
Uranium-234	pCi/g	1.94	11.4	6.67	2	2		
Uranium-238	pCi/g	2.72	13.9	8.31	2	2		

Table 2.38 Radiological Data for Sediment Location S28

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Activity of U-235	pCi/g	0.00709	0.0249	0.016	1	2		
Alpha activity	pCi/g	0.82	0.934	0.877	1	2		
Americium-241	pCi/g	0.00684	0.0267	0.0168	1	2		
Beta activity	pCi/g	0.846	0.985	0.915	1	2		
Cesium-137	pCi/g	-0.0127	-0.000261	-0.00648	0	2		
Cobalt-60	pCi/g	-0.00912	-0.00202	-0.00557	0	2		
Neptunium-237	pCi/g	-0.00129	0.00252	0.000615	0	2		
Plutonium-239/240	pCi/g	0.00362	0.00734	0.00548	0	2		
Potassium-40	pCi/g	1.37	2.53	1.95	2	2		
Technetium-99	pCi/g	0.165	0.259	0.212	1	2		
Thorium-230	pCi/g	0.091	0.114	0.102	2	2		
Uranium	pCi/kg	207	691	449	2	2		
Uranium-234	pCi/g	0.106	0.543	0.325	2	2		
Uranium-238	pCi/g	0.0938	0.123	0.108	2	2		

Direct Gamma Radiation (TLD) Data

Table 2.39 Radiological Exposure Due to Gamma Radiation (mrem)

Location	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	Annualized[1]
TLD-1	149	349	319	254	1113.7
TLD-2	185	261	246	250	979.6
TLD-3	51	63	45	46	213.2
TLD-4	22	23	20	23	91.8
TLD-5	21	23	21	22	90.5
TLD-6	20	19	20	20	82.2
TLD-7	23	26	24	24	101.2
TLD-8	18	19	16	18	73.8
TLD-9	20	19	18	18	78.0
TLD-10	19	20	19	19	80.1
TLD-11	23	23	20	23	92.5
TLD-12	19	21	19	19	80.4
TLD-13	25	23.5	21	25	97.4
TLD-14	19	20	18	18	78.2
TLD-15	18	17	15	18	70.7
TLD-16	23	22	19	22	89.4
TLD-17	21	21	19	19	82.5
TLD-18	21	20	18	19	80.4
TLD-19	19.5	19	18	19	78.3
TLD-20	24	23	20	22	92.5
TLD-25	28	32	30	28	122.7
TLD-27	23	22	21	21	90.5
TLD-28	21	26	20	21	91.3
TLD-29	20	18	19	20	80.1
TLD-30	23	20	19	20	84.5
TLD-31	26	26	23	24	102.1
TLD-32	20	24	23	23.5	94.1
TLD-35	22.5	21	21	21	88.9
TLD-36	20	18	16	17	73.8
TLD-37	18	21	18	20	79.2
TLD-38	19	21	17	17	76.7
TLD-39	19	19	15	17	72.8
TLD-40	23	24	23	23	96.7
TLD-41	20	20	18	18	78.8
TLD-46	19	19	18	19	78.0
TLD-47	71	96	80	80	340.0
TLD-48	31	33	28	29	125.8
TLD-49	24	19.5	18	20	84.8
TLD-50	29	35	26	28	122.4
TLD-51	24	26	20.5	22	96.2
TLD-52	27	28	22	25	106.1
TLD-53	85	107	101	100	407.5
TLD-21	25	23	24	22	98.9
TLD-22	27	24	24	22	95.9
TLD-23	27	26	22	22	101.2
TLD-26	22	20	21	20	82.1

[1]Note: Annualized results represent a summation of the quarters adjusted to ensure that there is a correlation between the results and 1 year (365 days). TLDs may not have been collected on the last day of each quarter so this accounts for varying number of days.

Deer Radiological Data

Table 2.40 Radiological Analysis of Deer Bone Tissue for 2005

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Neptunium-237	pCi/g	-0.012	0.00358	-0.00561	0	6		
Plutonium-239/240	pCi/g	-0.012	0.00715	0.000458	0	6		
Technetium-99	pCi/g	0.00249	0.486	0.191	0	6		
Thorium-228	pCi/g	0.129	0.374	0.272	6	6		
Thorium-230	pCi/g	0.00495	0.00839	0.00685	0	6		
Thorium-232	pCi/g	-0.00143	0.0167	0.00481	1	6		
Uranium-233/234	pCi/g	0.00235	0.02	0.00856	0	6		
Uranium-235	pCi/g	-0.00336	0.00411	0.000693	0	6		
Uranium-238	pCi/g	-0.00276	0.0233	0.00757	0	6		

Table 2.41 Radiological Analysis of Deer Thyroid Tissue for 2005

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Technetium-99	pCi/g	0.309	0.864	0.542	0	5		

Table 2.42 Radiological Analysis of Deer Muscle Tissue for 2005

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Neptunium-237	pCi/g	-0.00548	0.00533	-0.0000242	0	6		
Plutonium-238	pCi/g	0.00000364	0.00304	0.00161	0	3		
Plutonium-239/240	pCi/g	-0.00352	0.00197	-0.00115	0	6		
Technetium-99	pCi/g	-0.00361	0.241	0.138	0	6		
Thorium-230	pCi/g	0.00148	0.026	0.0104	0	6		
Uranium-233/234	pCi/g	-0.0134	0.00505	-0.00141	0	6		
Uranium-235	pCi/g	-0.00207	0.00202	0.000281	0	6		
Uranium-238	pCi/g	-0.00165	0.00489	0.00207	0	6		

Table 2.43 Radiological Analysis of Deer Liver Tissue for 2005

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples	Reference Criteria	Reference Value
Neptunium-237	pCi/g	-0.00508	0.00501	-0.000833	0	6		
Plutonium-238	pCi/g	0.00306	0.00507	0.00383	0	3		
Plutonium-239/240	pCi/g	-0.00169	0.00201	0.000571	0	6		
Technetium-99	pCi/g	-0.0162	0.318	0.168	0	6		
Thorium-230	pCi/g	0.0000124	0.0177	0.0104	0	6		
Uranium-233/234	pCi/g	-0.00307	0.0196	0.00455	0	6		
Uranium-235	pCi/g	0	0.00241	0.00103	0	6		
Uranium-238	pCi/g	-0.00158	0.00595	0.00158	0	6		

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3. NON-RADIOLOGICAL EFFLUENT DATA

KPDES Outfall Non-Radiological Data

Table 3.1 Non-Radiological Effluent Data for Outfall 001

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Antimony	mg/L	ND	0.005	0.0025	0	5
Arsenic	mg/L	ND	0.01	0.005	0	5
Beryllium	mg/L	ND	0.001	0.0005	0	5
Cadmium	mg/L	ND	0.001	0.0005	0	5
Chlorine, Total Residual	mg/L	0.03	0.04	0.0302	96	96
Chromium	mg/L	ND	0.02	0.01	0	5
Conductivity	umho/cm	157	1630	952	96	96
Copper	mg/L	ND	0.00632	0.0047	3	5
Dissolved Oxygen	mg/L	5.18	11.9	8.42	96	96
Flow Rate	mgd	0.7	74	3.71	96	96
Hardness - Total as CaCO3	mg/L	114	318	240	15	15
Iron	mg/L	0.262	0.522	0.41	5	5
Lead	mg/L	ND	0.005	0.0025	0	5
Mercury	mg/L	ND	0.0002	0.0001	0	5
Nickel	mg/L	ND	0.00995	0.0049	2	5
Oil and Grease	mg/L	ND	10	4.37	0	52
PCB-1016	ug/L	ND	0.17	0.0836	0	14
PCB-1221	ug/L	ND	0.18	0.0886	0	14
PCB-1232	ug/L	ND	0.14	0.0693	0	14
PCB-1242	ug/L	ND	0.11	0.0543	1	14
PCB-1248	ug/L	ND	0.12	0.0593	0	14
PCB-1254	ug/L	ND	0.23	0.0529	2	14
PCB-1260	ug/L	ND	0.05	0.025	0	14
PCB-1268	ug/L	ND	0.09	0.045	0	14
pH	Std Unit	6.77	8.4	7.31	96	96
Phosphorous	mg/L	0.1	0.36	0.209	52	52
Polychlorinated biphenyl	ug/L	ND	0.23	0.106	2	14
Selenium	mg/L	ND	0.005	0.0025	0	5
Silver	mg/L	ND	0.001	0.0005	0	5
Temperature	deg F	46.5	90.9	66.7	96	96
Thallium	mg/L	ND	0.01	0.005	0	5
Total Metals	mg/L	ND	5	1.69	2	5
Trichloroethene	ug/L	ND	1	0.5	0	14
Uranium	mg/L	0.00205	0.146	0.0319	5	5
Zinc	mg/L	ND	0.0293	0.0168	2	5

KPDES Outfall Non-Radiological Data

Table 3.2 Non-Radiological Effluent Data for Outfall 015

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Antimony	mg/L	ND	0.005	0.0025	0	6
Arsenic	mg/L	ND	0.01	0.005	0	6
Beryllium	mg/L	ND	0.001	0.0005	0	6
Cadmium	mg/L	ND	0.001	0.0005	0	6
Chlorine, Total Residual	mg/L	0.03	0.03	0.03	11	11
Chromium	mg/L	ND	0.02	0.01	0	6
Conductivity	umho/cm	135	637	426	22	22
Copper	mg/L	ND	0.00888	0.0047	3	6
Dissolved Oxygen	mg/L	6.27	11.4	8.25	22	22
Flow Rate	mgd	0.0006	27.4	5.44	22	22
Hardness - Total as CaCO3	mg/L	74	241	169	11	11
Iron	mg/L	0.417	2.26	1.21	6	6
Lead	mg/L	ND	0.005	0.0025	0	6
Mercury	mg/L	ND	0.0002	0.0001	0	6
Nickel	mg/L	ND	0.00928	0.0072	5	6
Oil and Grease	mg/L	ND	10	4.77	1	11
PCB-1016	ug/L	ND	0.17	0.0838	0	12
PCB-1221	ug/L	ND	0.18	0.0887	0	12
PCB-1232	ug/L	ND	0.14	0.07	0	12
PCB-1242	ug/L	ND	0.1	0.05	0	12
PCB-1248	ug/L	ND	0.12	0.06	0	12
PCB-1254	ug/L	ND	0.075	0.0383	1	12
PCB-1260	ug/L	ND	0.05	0.025	0	12
PCB-1268	ug/L	ND	0.09	0.045	0	12
pH	Std Unit	7	7.9	7.62	22	22
Polychlorinated biphenyl	ug/L	ND	0.18	0.0875	1	12
Selenium	mg/L	ND	0.005	0.0025	0	6
Silver	mg/L	ND	0.001	0.0005	0	6
Temperature	deg F	42.4	75.5	62	22	22
Thallium	mg/L	ND	0.01	0.005	0	6
Total Metals	mg/L	ND	5	2.26	1	6
Uranium	mg/L	0.0163	0.344	0.163	6	6
Zinc	mg/L	ND	0.0276	0.0184	3	6

KPDES Outfall Non-Radiological Data

Table 3.3 Non-Radiological Effluent Data for Outfall 017

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Antimony	mg/L	ND	0.005	0.0025	0	6
Arsenic	mg/L	ND	0.01	0.005	0	6
Beryllium	mg/L	ND	0.001	0.0005	0	6
Cadmium	mg/L	ND	0.001	0.0005	0	6
Chlorine, Total Residual	mg/L	0.03	0.03	0.03	9	9
Chromium	mg/L	ND	0.02	0.01	0	6
Conductivity	umho/cm	155	397	260	25	25
Copper	mg/L	ND	0.00941	0.0037	1	6
Dissolved Oxygen	mg/L	6.09	12.5	8.82	25	25
Flow Rate	mgd	0.0016	5.04	0.775	25	25
Hardness - Total as CaCO3	mg/L	60	171	110	12	12
Iron	mg/L	0.441	0.965	0.701	6	6
Lead	mg/L	ND	0.005	0.0025	0	6
Mercury	mg/L	ND	0.0002	0.0001	0	6
Nickel	mg/L	ND	0.007	0.0032	1	6
Oil and Grease	mg/L	ND	10	4.37	0	12
PCB-1016	ug/L	ND	0.17	0.0833	0	12
PCB-1221	ug/L	ND	0.18	0.0883	0	12
PCB-1232	ug/L	ND	0.14	0.07	0	12
PCB-1242	ug/L	ND	0.1	0.05	0	12
PCB-1248	ug/L	ND	0.12	0.06	0	12
PCB-1254	ug/L	ND	0.07	0.035	0	12
PCB-1260	ug/L	ND	0.05	0.025	0	12
PCB-1268	ug/L	ND	0.09	0.045	0	12
pH	Std Unit	7.26	8.34	7.84	25	25
Polychlorinated biphenyl	ug/L	ND	0.18	0.0883	0	12
Selenium	mg/L	ND	0.005	0.0025	0	6
Silver	mg/L	ND	0.001	0.0005	0	6
Temperature	deg F	43.7	77.3	61	25	25
Thallium	mg/L	ND	0.01	0.005	0	6
Total Metals	mg/L	ND	5	2.17	1	6
Uranium	mg/L	ND	0.00265	0.0015	4	6
Zinc	mg/L	0.0524	0.188	0.0826	6	6

KPDES Outfall Non-Radiological Data

Table 3.4 Non-Radiological Effluent Data for Outfall 019

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Antimony	mg/L	ND	0.005	0.0025	0	3
Arsenic	mg/L	ND	0.01	0.005	0	3
Beryllium	mg/L	ND	0.001	0.0005	0	3
Cadmium	mg/L	ND	0.00138	0.0007	1	3
Chlorine, Total Residual	mg/L	0.03	0.03	0.03	3	3
Chromium	mg/L	ND	0.02	0.01	0	3
Conductivity	umho/cm	176	228	205	9	9
Copper	mg/L	ND	0.0052	0.0026	0	3
Dissolved Oxygen	mg/L	6.25	10.6	8.91	9	9
Flow Rate	mgd	0.15	0.8	0.46	9	9
Hardness - Total as CaCO3	mg/L	83	96	90.3	3	3
Iron	mg/L	0.292	0.697	0.548	3	3
Lead	mg/L	ND	0.0154	0.0068	1	3
Mercury	mg/L	ND	0.0002	0.0001	0	3
Nickel	mg/L	ND	0.005	0.0025	0	3
Oil and Grease	mg/L	ND	10	4.17	0	3
PCB-1016	ug/L	ND	0.17	0.0833	0	3
PCB-1221	ug/L	ND	0.18	0.0883	0	3
PCB-1232	ug/L	ND	0.14	0.07	0	3
PCB-1242	ug/L	ND	0.1	0.05	0	3
PCB-1248	ug/L	ND	0.12	0.06	0	3
PCB-1254	ug/L	ND	0.07	0.035	0	3
PCB-1260	ug/L	ND	0.05	0.025	0	3
PCB-1268	ug/L	ND	0.09	0.045	0	3
pH	Std Unit	7.9	8.7	8.26	9	9
Polychlorinated biphenyl	ug/L	ND	0.18	0.0883	0	3
Selenium	mg/L	ND	0.005	0.0025	0	3
Silver	mg/L	ND	0.001	0.0005	0	3
Suspended Solids	mg/L	ND	30	13.7	1	3
Temperature	deg F	42	65	57.2	9	9
Thallium	mg/L	ND	0.01	0.005	0	3
Total Metals	mg/L	ND	5	1.9	1	3
Uranium	mg/L	ND	0.00549	0.0021	1	3
Zinc	mg/L	ND	0.02	0.01	0	3

Surface Water Non-Radiological Data

Table 3.5 Non-Radiological Effluent Data for Landfill Surface Water Location L135

Upstream of the C-746 S&T Closed Landfills

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Chemical Oxygen Demand (COD)	mg/L	ND	57	35	2	4
Chloride	mg/L	ND	13	5.1	3	4
Conductivity	umho/cm	91	187	152	4	4
Dissolved Oxygen	mg/L	6.65	932	239	4	4
Dissolved Solids	mg/L	106	158	140	4	4
Flow Rate	mgd	1.1	10.1	3.69	4	4
Iron	mg/L	ND	2.35	1.54	3	4
pH	Std Unit	7.2	7.33	7.25	4	4
Sodium	mg/L	ND	7.31	2.92	3	4
Sulfate	mg/L	3.6	14	9.47	4	4
Suspended Solids	mg/L	ND	30	16.9	1	4
Temperature	deg F	53.1	73.7	59.5	4	4
Total Organic Carbon (TOC)	mg/L	16.3	22.3	19.1	4	4
Total Solids	mg/L	149	179	164	4	4
Uranium	mg/L	0.00247	0.0088	0.0045	4	4

Table 3.6 Non-Radiological Effluent Data for Landfill Surface Water Location L136

At the C-746 S&T Closed Landfills

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Chemical Oxygen Demand (COD)	mg/L	ND	39	26.2	3	5
Chloride	mg/L	1.1	2.7	2.28	5	5
Conductivity	umho/cm	172	377	256	5	5
Dissolved Oxygen	mg/L	6.83	10.1	8.28	5	5
Dissolved Solids	mg/L	148	247	187	5	5
Flow Rate	mgd	0.1	0.46	0.272	5	5
Iron	mg/L	ND	0.308	0.223	3	5
pH	Std Unit	7.6	8.14	7.78	5	5
Sodium	mg/L	1.22	3.54	1.8	5	5
Sulfate	mg/L	6.5	36	20.3	5	5
Suspended Solids	mg/L	ND	25	12.5	0	5
Temperature	deg F	53.7	72.3	60.2	5	5
Total Organic Carbon (TOC)	mg/L	8.9	14.6	12.5	5	5
Total Solids	mg/L	ND	277	164	3	5
Uranium	mg/L	ND	0.00543	0.0018	2	5

Surface Water Non-Radiological Data

Table 3.7 Non-Radiological Effluent Data for Landfill Surface Water Location L137

Downstream of the C-746 S&T Closed Landfills

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Chemical Oxygen Demand (COD)	mg/L	ND	54	33.2	2	4
Chloride	mg/L	ND	8.5	3.62	3	4
Conductivity	umho/cm	81	167	124	4	4
Dissolved Oxygen	mg/L	7.57	10.1	8.89	4	4
Dissolved Solids	mg/L	94	146	124	4	4
Flow Rate	mgd	1.4	8.08	4.39	4	4
Iron	mg/L	0.424	2.56	1.67	4	4
pH	Std Unit	6.7	7.57	7.13	4	4
Sodium	mg/L	ND	5.05	2.01	2	4
Sulfate	mg/L	3.5	8.8	6.75	4	4
Suspended Solids	mg/L	ND	41	30.1	3	4
Temperature	deg F	53.1	71.7	58.8	4	4
Total Organic Carbon (TOC)	mg/L	8.5	23.1	15.9	4	4
Total Solids	mg/L	159	173	166	4	4
Uranium	mg/L	ND	0.00311	0.0017	3	4

Table 3.8 Non-Radiological Effluent Data for Landfill Surface Water Location L150

At the C-746 U Landfill

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Chemical Oxygen Demand (COD)	mg/L	ND	35	22.7	2	4
Chloride	mg/L	1.3	2.9	2.33	4	4
Conductivity	umho/cm	141	198	166	4	4
Dissolved Oxygen	mg/L	7.43	10.8	9.81	4	4
Dissolved Solids	mg/L	86	151	126	4	4
Flow Rate	mgd	0.09	0.65	0.275	4	4
Iron	mg/L	1.91	4.69	3.17	4	4
pH	Std Unit	7.52	8.27	7.88	4	4
Sodium	mg/L	1.18	2.27	1.8	4	4
Sulfate	mg/L	11	23	16.5	4	4
Suspended Solids	mg/L	46	99	64.5	4	4
Temperature	deg F	53	73.2	59.3	4	4
Total Organic Carbon (TOC)	mg/L	4.2	14.2	7.9	4	4
Total Solids	mg/L	200	223	208	4	4
Uranium	mg/L	ND	0.00151	0.0007	1	4

Surface Water Non-Radiological Data

Table 3.9 Non-Radiological Effluent Data for Landfill Surface Water Location L154

Upstream of the C-746 U Landfill

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Chemical Oxygen Demand (COD)	mg/L	ND	68	37.2	3	5
Chloride	mg/L	ND	8.6	4.92	4	5
Conductivity	umho/cm	83	212	152	5	5
Dissolved Oxygen	mg/L	5.77	9.7	8.32	5	5
Dissolved Solids	mg/L	104	145	134	5	5
Flow Rate	mgd	1.15	10.7	5.02	5	5
Iron	mg/L	0.65	2.41	1.31	5	5
pH	Std Unit	6.9	7.81	7.32	5	5
Sodium	mg/L	1.23	5.1	2.24	5	5
Sulfate	mg/L	3.7	10	8.32	5	5
Suspended Solids	mg/L	ND	33	20.7	2	5
Temperature	deg F	53.1	73.8	58.4	5	5
Total Organic Carbon (TOC)	mg/L	6.7	27.7	18.1	5	5
Total Solids	mg/L	ND	174	145	4	5
Uranium	mg/L	ND	0.00308	0.0012	2	5

Table 3.10 Non-Radiological Effluent Data for Landfill Surface Water Location L155

Downstream of the C-746 U Landfill

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Chemical Oxygen Demand (COD)	mg/L	ND	35	13.7	0	4
Chloride	mg/L	1	11	5.9	4	4
Conductivity	umho/cm	53	219	128	4	4
Dissolved Oxygen	mg/L	7.25	9.91	8.54	4	4
Dissolved Solids	mg/L	ND	167	106	3	4
Flow Rate	mgd	1.99	40.4	17.1	4	4
Iron	mg/L	3.27	7.58	5.04	4	4
pH	Std Unit	6.7	7.39	7.16	4	4
Sodium	mg/L	1.22	14.2	6.86	4	4
Sulfate	mg/L	4	38	16.7	4	4
Suspended Solids	mg/L	128	375	258	4	4
Temperature	deg F	53.5	74	59.9	4	4
Total Organic Carbon (TOC)	mg/L	5.3	13	9.45	4	4
Total Solids	mg/L	223	501	389	4	4
Uranium	mg/L	0.00507	0.0142	0.0084	4	4

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4. NON-RADIOLOGICAL ENVIRONMENTAL SURVEILLANCE DATA

Surface Water Non-Radiological Data

Table 4.1 Non-Radiological Monitoring Data for Surface Water Location L1

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Alkalinity	mg/L	17	33	25.5	4	4
Aluminum	mg/L	ND	3.05	0.838	1	4
Ammonia	mg/L	ND	0.2	0.1	0	3
Ammonia as Nitrogen	mg/L	ND	0.2	0.1	0	1
Antimony	mg/L	ND	0.005	0.0025	0	4
Arsenic	mg/L	ND	0.01	0.005	0	4
Barium	mg/L	0.0359	0.0609	0.0473	4	4
Beryllium	mg/L	ND	0.001	0.0005	0	4
Cadmium	mg/L	ND	0.001	0.0005	0	4
Calcium	mg/L	11.6	45	21.9	4	4
Chloride	mg/L	4.8	14	10.9	4	4
Chromium	mg/L	ND	0.02	0.01	0	4
Cobalt	mg/L	ND	0.001	0.0005	0	4
Conductivity	umho/cm	120	297	223	4	4
Copper	mg/L	ND	0.0052	0.0026	0	4
Cyanide	mg/L	ND	0.05	0.025	0	4
Dissolved Oxygen	mg/L	5.82	9.93	7.83	4	4
Flow Rate	mgd	0.11	9.09	2.44	4	4
Hardness - Total as CaCO3	mg/L	47	62	55.5	4	4
Iron	mg/L	ND	1.94	0.641	3	4
Lead	mg/L	ND	0.005	0.0025	0	4
Magnesium	mg/L	2.36	20.1	7.53	4	4
Manganese	mg/L	0.03	0.154	0.0909	4	4
Mercury	mg/L	ND	0.0002	0.0001	0	4
Nickel	mg/L	ND	0.005	0.0025	0	4
Nitrate/Nitrite as Nitrogen	mg/L	ND	1	0.487	2	4
PCB-1016	ug/L	ND	0.17	0.0825	0	4
PCB-1221	ug/L	ND	0.18	0.0875	0	4
PCB-1232	ug/L	ND	0.14	0.0688	0	4
PCB-1242	ug/L	ND	0.1	0.05	0	4
PCB-1248	ug/L	ND	0.12	0.0587	0	4
PCB-1254	ug/L	ND	0.07	0.035	0	4
PCB-1260	ug/L	ND	0.05	0.025	0	4
PCB-1268	ug/L	ND	0.09	0.045	0	4
pH	Std Unit	6.9	7.52	7.18	4	4
Phosphorous	mg/L	0.07	0.19	0.12	4	4
Polychlorinated biphenyl	ug/L	ND	0.18	0.0875	0	4
Potassium	mg/L	1.88	11	4.96	4	4
Selenium	mg/L	ND	0.005	0.0025	0	4
Silver	mg/L	ND	0.001	0.0005	0	4
Sodium	mg/L	4.67	93.3	38.8	4	4
Suspended Solids	mg/L	ND	20	6.62	0	4
Temperature	deg F	45.9	74.4	60.7	4	4
Thallium	mg/L	ND	0.01	0.005	0	4
Trichloroethene	ug/L	ND	1.1	0.65	1	4

Surface Water Non-Radiological Data

Table 4.1 Non-Radiological Monitoring Data for Surface Water Location L1

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Turbidity	NTU	2.4	40.5	22.7	3	3
Uranium	mg/L	ND	0.005	0.0015	0	8
Vanadium	mg/L	ND	0.02	0.01	0	4
Zinc	mg/L	ND	0.02	0.01	0	4

Surface Water Non-Radiological Data

Table 4.2 Non-Radiological Monitoring Data for Surface Water Location L5

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Alkalinity	mg/L	19	33	24.7	4	4
Aluminum	mg/L	ND	1.99	0.601	2	4
Ammonia	mg/L	ND	0.2	0.1	0	3
Ammonia as Nitrogen	mg/L	ND	0.2	0.1	0	1
Antimony	mg/L	ND	0.005	0.0025	0	4
Arsenic	mg/L	ND	0.01	0.005	0	4
Barium	mg/L	0.0229	0.0465	0.0332	4	4
Beryllium	mg/L	ND	0.001	0.0005	0	4
Cadmium	mg/L	ND	0.001	0.0005	0	4
Calcium	mg/L	21.3	43.9	32.7	4	4
Chloride	mg/L	18	90	50.5	4	4
Chromium	mg/L	ND	0.02	0.01	0	4
Cobalt	mg/L	ND	0.001	0.0005	0	4
Conductivity	umho/cm	303	965	611	4	4
Copper	mg/L	ND	0.0052	0.0026	0	4
Cyanide	mg/L	ND	0.05	0.025	0	4
Dissolved Oxygen	mg/L	7.33	10.1	8.27	4	4
Flow Rate	mgd	8.17	14.9	11	4	4
Hardness - Total as CaCO3	mg/L	81	195	131	4	4
Iron	mg/L	ND	1.42	0.524	3	4
Lead	mg/L	ND	0.005	0.0025	0	4
Magnesium	mg/L	5.26	20.2	11.8	4	4
Manganese	mg/L	0.0294	0.0456	0.0386	4	4
Mercury	mg/L	ND	0.0002	0.0001	0	4
Nickel	mg/L	ND	0.005	0.0025	0	4
Nitrate/Nitrite as Nitrogen	mg/L	0.54	1.1	0.905	4	4
PCB-1016	ug/L	ND	0.17	0.0838	0	4
PCB-1221	ug/L	ND	0.18	0.0887	0	4
PCB-1232	ug/L	ND	0.14	0.07	0	4
PCB-1242	ug/L	ND	0.1	0.05	0	4
PCB-1248	ug/L	ND	0.12	0.06	0	4
PCB-1254	ug/L	ND	0.13	0.0587	1	4
PCB-1260	ug/L	ND	0.05	0.025	0	4
PCB-1268	ug/L	ND	0.09	0.045	0	4
pH	Std Unit	7.03	7.36	7.23	4	4
Phosphorous	mg/L	0.12	0.2	0.147	4	4
Polychlorinated biphenyl	ug/L	ND	0.18	0.0987	1	4
Potassium	mg/L	4.49	11.2	7.49	4	4
Selenium	mg/L	ND	0.005	0.0025	0	4
Silver	mg/L	ND	0.001	0.0005	0	4
Sodium	mg/L	ND	93.8	50.4	3	4
Suspended Solids	mg/L	ND	20	6.62	0	4
Temperature	deg F	48	86.9	68.2	4	4
Thallium	mg/L	ND	0.01	0.005	0	4
Trichloroethene	ug/L	ND	1	0.5	0	4
Turbidity	NTU	5.8	18.9	13.2	3	3
Uranium	mg/L	ND	0.005	0.00194	2	8

Surface Water Non-Radiological Data

Table 4.2 Non-Radiological Monitoring Data for Surface Water Location L5

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Vanadium	mg/L	ND	0.02	0.01	0	4
Zinc	mg/L	ND	0.02	0.01	0	4

Surface Water Non-Radiological Data

Table 4.3 Non-Radiological Monitoring Data for Surface Water Location L6

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Alkalinity	mg/L	18	50	30.2	4	4
Aluminum	mg/L	ND	2.58	0.72	1	4
Ammonia	mg/L	ND	0.2	0.1	0	3
Ammonia as Nitrogen	mg/L	ND	0.2	0.1	0	1
Antimony	mg/L	ND	0.005	0.0025	0	4
Arsenic	mg/L	ND	0.01	0.005	0	4
Barium	mg/L	0.0232	0.0532	0.0382	4	4
Beryllium	mg/L	ND	0.001	0.0005	0	4
Cadmium	mg/L	ND	0.001	0.0005	0	4
Calcium	mg/L	20.2	40.7	30.1	4	4
Chloride	mg/L	16	87	48.7	4	4
Chromium	mg/L	ND	0.02	0.01	0	4
Cobalt	mg/L	ND	0.001	0.0005	0	4
Conductivity	umho/cm	283	875	574	4	4
Copper	mg/L	ND	0.0052	0.0026	0	4
Cyanide	mg/L	ND	0.05	0.025	0	4
Dissolved Oxygen	mg/L	8.31	9.8	9.1	4	4
Flow Rate	mgd	5.12	14.9	9.56	4	4
Hardness - Total as CaCO3	mg/L	75	195	129	4	4
Iron	mg/L	ND	1.88	0.632	3	4
Lead	mg/L	ND	0.005	0.0025	0	4
Magnesium	mg/L	4.82	22	12.3	4	4
Manganese	mg/L	0.0597	0.0832	0.0709	4	4
Mercury	mg/L	ND	0.0002	0.0001	0	4
Nickel	mg/L	ND	0.005	0.0025	0	4
Nitrate/Nitrite as Nitrogen	mg/L	0.35	1.2	0.858	4	4
PCB-1016	ug/L	ND	0.17	0.085	0	4
PCB-1221	ug/L	ND	0.18	0.09	0	4
PCB-1232	ug/L	ND	0.14	0.07	0	4
PCB-1242	ug/L	ND	0.1	0.05	0	4
PCB-1248	ug/L	ND	0.12	0.06	0	4
PCB-1254	ug/L	ND	0.14	0.0612	1	4
PCB-1260	ug/L	ND	0.05	0.025	0	4
PCB-1268	ug/L	ND	0.09	0.045	0	4
pH	Std Unit	7.17	7.62	7.31	4	4
Phosphorous	mg/L	0.08	0.19	0.14	4	4
Polychlorinated biphenyl	ug/L	ND	0.18	0.102	1	4
Potassium	mg/L	4.52	11.2	7.51	4	4
Selenium	mg/L	ND	0.005	0.0025	0	4
Silver	mg/L	ND	0.001	0.0005	0	4
Sodium	mg/L	20.3	104	62.6	4	4
Suspended Solids	mg/L	ND	60	20.9	2	4
Temperature	deg F	47.7	86.1	66.8	4	4
Thallium	mg/L	ND	0.01	0.005	0	4
Trichloroethene	ug/L	ND	1	0.5	0	4
Turbidity	NTU	14.3	21.3	16.8	3	3
Uranium	mg/L	ND	0.005	0.0019	2	8

Surface Water Non-Radiological Data

Table 4.3 Non-Radiological Monitoring Data for Surface Water Location L6

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Vanadium	mg/L	ND	0.02	0.01	0	4
Zinc	mg/L	ND	0.02	0.01	0	4

Surface Water Non-Radiological Data

Table 4.4 Non-Radiological Monitoring Data for Surface Water Location C616

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Alkalinity	mg/L	20	27	22.8	5	5
Aluminum	mg/L	ND	0.2	0.1	0	5
Ammonia	mg/L	ND	0.29	0.182	2	4
Ammonia as Nitrogen	mg/L	ND	0.2	0.1	0	1
Antimony	mg/L	ND	0.005	0.0025	0	5
Arsenic	mg/L	ND	0.01	0.005	0	5
Barium	mg/L	0.0199	0.0338	0.0264	5	5
Beryllium	mg/L	ND	0.001	0.0005	0	5
Cadmium	mg/L	ND	0.001	0.0005	0	5
Calcium	mg/L	53.7	151	86.8	5	5
Chloride	mg/L	108	180	141	5	5
Chromium	mg/L	ND	0.02	0.01	0	5
Cobalt	mg/L	ND	0.00216	0.00161	4	5
Conductivity	umho/cm	160	1500	883	5	5
Copper	mg/L	ND	0.00997	0.00701	4	5
Cyanide	mg/L	ND	0.05	0.025	0	5
Dissolved Oxygen	mg/L	7.21	10.2	8.21	5	5
Flow Rate	mgd	1.29	2.81	2.26	5	5
Hardness - Total as CaCO3	mg/L	229	512	341	5	5
Iron	mg/L	0.217	0.558	0.426	5	5
Lead	mg/L	ND	0.005	0.0025	0	5
Magnesium	mg/L	21.6	34.8	30.3	5	5
Manganese	mg/L	0.0366	0.0992	0.0707	5	5
Mercury	mg/L	ND	0.0002	0.0001	0	5
Nickel	mg/L	ND	0.0129	0.00556	2	5
Nitrate/Nitrite as Nitrogen	mg/L	ND	3.9	2.03	4	5
PCB-1016	ug/L	ND	0.17	0.084	0	5
PCB-1221	ug/L	ND	0.18	0.089	0	5
PCB-1232	ug/L	ND	0.14	0.07	0	5
PCB-1242	ug/L	ND	0.1	0.05	0	5
PCB-1248	ug/L	ND	0.12	0.06	0	5
PCB-1254	ug/L	ND	0.07	0.035	0	5
PCB-1260	ug/L	ND	0.05	0.025	0	5
PCB-1268	ug/L	ND	0.09	0.045	0	5
pH	Std Unit	6.74	7.27	6.91	5	5
Phosphorous	mg/L	0.19	0.45	0.284	5	5
Polychlorinated biphenyl	ug/L	ND	0.18	0.089	0	5
Potassium	mg/L	16.7	32.4	23.5	5	5
Selenium	mg/L	ND	0.005	0.0025	0	5
Silver	mg/L	ND	0.001	0.0005	0	5
Sodium	mg/L	123	207	178	5	5
Suspended Solids	mg/L	ND	25	7.8	0	5
Temperature	deg F	58.5	90.1	73.7	5	5
Thallium	mg/L	ND	0.01	0.005	0	5
Trichloroethene	ug/L	ND	1	0.5	0	5
Turbidity	NTU	16.8	22	20.3	3	3
Uranium	mg/L	ND	0.009	0.00254	3	10

Surface Water Non-Radiological Data

Table 4.4 Non-Radiological Monitoring Data for Surface Water Location C616

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Vanadium	mg/L	ND	0.02	0.01	0	5
Zinc	mg/L	ND	0.02	0.01	0	5

Table 4.5 Non-Radiological Monitoring Data for Surface Water Location K001

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Alkalinity	mg/L	35	35	35	1	1
Conductivity	umho/cm	161	161	161	1	1
Dissolved Oxygen	mg/L	8.17	8.17	8.17	1	1
Flow Rate	mgd	2.8	2.8	2.8	1	1
pH	Std Unit	7.01	7.01	7.01	1	1
Temperature	deg F	56.1	56.1	56.1	1	1

Table 4.6 Non-Radiological Monitoring Data for Surface Water Location K015

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Alkalinity	mg/L	32	32	32	1	1
Chlorine, Total Residual	mg/L	0.03	0.03	0.03	1	1
Conductivity	umho/cm	271	271	271	1	1
Dissolved Oxygen	mg/L	8.18	8.18	8.18	1	1
Flow Rate	mgd	0.0186	0.0186	0.0186	1	1
pH	Std Unit	7.8	7.8	7.8	1	1
Temperature	deg F	61.1	61.1	61.1	1	1

Surface Water Non-Radiological Data

Table 4.7 Non-Radiological Monitoring Data for Surface Water Location C612

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Alkalinity	mg/L	32	70	54	3	3
Aluminum	mg/L	ND	0.2	0.1	0	4
Ammonia	mg/L	ND	0.2	0.1	0	3
Ammonia as Nitrogen	mg/L	ND	0.2	0.1	0	1
Antimony	mg/L	ND	0.005	0.0025	0	4
Arsenic	mg/L	ND	0.01	0.005	0	4
Barium	mg/L	0.114	0.133	0.124	4	4
Beryllium	mg/L	ND	0.001	0.0005	0	4
Cadmium	mg/L	ND	0.001	0.0005	0	4
Calcium	mg/L	21.7	24.7	23.3	4	4
Chloride	mg/L	36	42	38.7	4	4
Chromium	mg/L	ND	0.02	0.01	0	4
Cobalt	mg/L	ND	0.001	0.0005	0	4
Conductivity	umho/cm	331	348	338	4	4
Copper	mg/L	ND	0.0052	0.0026	0	4
Cyanide	mg/L	ND	0.05	0.025	0	4
Dissolved Oxygen	mg/L	6.24	9.87	8.18	4	4
Hardness - Total as CaCO3	mg/L	90	102	96.5	4	4
Iron	mg/L	ND	0.2	0.1	0	4
Lead	mg/L	ND	0.005	0.0025	0	4
Magnesium	mg/L	8.17	9.77	8.82	4	4
Manganese	mg/L	ND	0.005	0.0025	0	4
Mercury	mg/L	ND	0.0002	0.0001	0	4
Nickel	mg/L	ND	0.005	0.0025	0	4
Nitrate/Nitrite as Nitrogen	mg/L	1.4	2.15	1.71	4	4
PCB-1016	ug/L	ND	0.17	0.0838	0	4
PCB-1221	ug/L	ND	0.18	0.0887	0	4
PCB-1232	ug/L	ND	0.14	0.0688	0	4
PCB-1242	ug/L	ND	0.1	0.05	0	4
PCB-1248	ug/L	ND	0.12	0.0587	0	4
PCB-1254	ug/L	ND	0.22	0.0812	1	4
PCB-1260	ug/L	ND	0.05	0.025	0	4
PCB-1268	ug/L	ND	0.25	0.0962	1	4
pH	Std Unit	7.52	8.15	7.87	4	4
Phosphorous	mg/L	ND	0.05	0.025	0	4
Polychlorinated biphenyl	ug/L	ND	0.46	0.181	1	4
Potassium	mg/L	1.08	1.26	1.13	4	4
Selenium	mg/L	ND	0.005	0.0025	0	4
Silver	mg/L	ND	0.001	0.0005	0	4
Sodium	mg/L	24.9	32.3	27.9	4	4
Suspended Solids	mg/L	ND	14	5.5	0	4
Temperature	deg F	58.6	67.4	61.7	4	4
Thallium	mg/L	ND	0.01	0.005	0	4
Trichloroethene	ug/L	1.5	2.7	2	4	4
Turbidity	NTU	2.6	14.4	8.5	2	2
Uranium	mg/L	ND	0.005	0.0015	0	8
Vanadium	mg/L	ND	0.02	0.01	0	4

Surface Water Non-Radiological Data

Table 4.7 Non-Radiological Monitoring Data for Surface Water Location C612

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Zinc	mg/L	ND	0.02	0.01	0	4

Surface Water Non-Radiological Data

Table 4.8 Non-Radiological Monitoring Data for Surface Water Location L291

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Alkalinity	mg/L	13	30	24.2	4	4
Aluminum	mg/L	ND	2.1	0.6	1	4
Ammonia	mg/L	ND	0.53	0.243	1	3
Ammonia as Nitrogen	mg/L	ND	0.2	0.1	0	1
Antimony	mg/L	ND	0.005	0.0025	0	4
Arsenic	mg/L	ND	0.01	0.005	0	4
Barium	mg/L	0.0418	0.0568	0.0485	4	4
Beryllium	mg/L	ND	0.001	0.0005	0	4
Cadmium	mg/L	ND	0.001	0.0005	0	4
Calcium	mg/L	11.5	22.3	16	4	4
Chloride	mg/L	5.8	14	11.2	4	4
Chromium	mg/L	ND	0.02	0.01	0	4
Cobalt	mg/L	ND	0.001	0.0005	0	4
Conductivity	umho/cm	137	301	232	4	4
Copper	mg/L	ND	0.00544	0.00331	1	4
Cyanide	mg/L	ND	0.05	0.025	0	4
Dissolved Oxygen	mg/L	4.46	12.6	7.54	4	4
Flow Rate	mgd	0.68	10.7	4.29	4	4
Hardness - Total as CaCO3	mg/L	40	63	52.2	4	4
Iron	mg/L	ND	1.09	0.455	3	4
Lead	mg/L	ND	0.005	0.0025	0	4
Magnesium	mg/L	2.47	6.35	4.16	4	4
Manganese	mg/L	0.0529	0.174	0.0869	4	4
Mercury	mg/L	ND	0.0002	0.0001	0	4
Nickel	mg/L	ND	0.005	0.0025	0	4
Nitrate/Nitrite as Nitrogen	mg/L	ND	1.8	0.695	2	4
PCB-1016	ug/L	ND	0.17	0.0838	0	4
PCB-1221	ug/L	ND	0.18	0.0887	0	4
PCB-1232	ug/L	ND	0.14	0.07	0	4
PCB-1242	ug/L	ND	0.1	0.05	0	4
PCB-1248	ug/L	ND	0.12	0.06	0	4
PCB-1254	ug/L	ND	0.07	0.035	0	4
PCB-1260	ug/L	ND	0.05	0.025	0	4
PCB-1268	ug/L	ND	0.09	0.045	0	4
pH	Std Unit	7.05	7.39	7.26	4	4
Phosphorous	mg/L	0.08	0.2	0.12	4	4
Polychlorinated biphenyl	ug/L	ND	0.18	0.0887	0	4
Potassium	mg/L	2.31	5.97	3.57	4	4
Selenium	mg/L	ND	0.005	0.0025	0	4
Silver	mg/L	ND	0.001	0.0005	0	4
Sodium	mg/L	5.87	36.7	21.1	4	4
Suspended Solids	mg/L	ND	14	5.87	0	4
Temperature	deg F	43.3	74.3	58.4	4	4
Thallium	mg/L	ND	0.01	0.005	0	4
Trichloroethene	ug/L	ND	1.1	0.65	1	4
Turbidity	NTU	21.5	79	50.2	2	2
Uranium	mg/L	ND	0.005	0.0015	0	8

Surface Water Non-Radiological Data

Table 4.8 Non-Radiological Monitoring Data for Surface Water Location L291

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Vanadium	mg/L	ND	0.02	0.01	0	4
Zinc	mg/L	ND	0.02	0.01	0	4

Surface Water Non-Radiological Data

Table 4.9 Non-Radiological Monitoring Data for Surface Water Location L10

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Alkalinity	mg/L	19	25	23.2	4	4
Aluminum	mg/L	ND	2.73	1.02	3	4
Ammonia	mg/L	ND	0.2	0.1	0	3
Ammonia as Nitrogen	mg/L	ND	0.2	0.1	0	1
Antimony	mg/L	ND	0.005	0.0025	0	4
Arsenic	mg/L	ND	0.01	0.005	0	4
Barium	mg/L	0.0429	0.0883	0.0632	4	4
Beryllium	mg/L	ND	0.001	0.0005	0	4
Cadmium	mg/L	ND	0.001	0.0005	0	4
Calcium	mg/L	18.3	39.6	26.9	4	4
Chloride	mg/L	17	44	29.7	4	4
Chromium	mg/L	ND	0.02	0.01	0	4
Cobalt	mg/L	ND	0.001	0.0005	0	4
Conductivity	umho/cm	254	433	356	4	4
Copper	mg/L	ND	0.0111	0.00472	1	4
Cyanide	mg/L	ND	0.05	0.025	0	4
Dissolved Oxygen	mg/L	3.18	10.2	6.02	4	4
Flow Rate	mgd	0.16	2.54	0.995	4	4
Hardness - Total as CaCO3	mg/L	68	92	78.7	4	4
Iron	mg/L	0.262	7.26	2.57	4	4
Lead	mg/L	ND	0.141	0.0371	1	4
Magnesium	mg/L	4.47	10.6	7.54	4	4
Manganese	mg/L	0.0738	0.155	0.115	4	4
Mercury	mg/L	ND	0.0002	0.0001	0	4
Nickel	mg/L	ND	0.005	0.0025	0	4
Nitrate/Nitrite as Nitrogen	mg/L	ND	0.62	0.36	2	4
PCB-1016	ug/L	ND	0.17	0.0838	0	4
PCB-1221	ug/L	ND	0.18	0.0887	0	4
PCB-1232	ug/L	ND	0.14	0.0688	0	4
PCB-1242	ug/L	ND	0.1	0.05	0	4
PCB-1248	ug/L	ND	0.12	0.0587	0	4
PCB-1254	ug/L	ND	0.07	0.035	0	4
PCB-1260	ug/L	ND	0.05	0.025	0	4
PCB-1268	ug/L	ND	0.09	0.045	0	4
pH	Std Unit	6.77	7.38	7.09	4	4
Phosphorous	mg/L	0.2	0.38	0.28	4	4
Polychlorinated biphenyl	ug/L	ND	0.18	0.0887	0	4
Potassium	mg/L	2.23	15.1	6.11	4	4
Selenium	mg/L	ND	0.005	0.0025	0	4
Silver	mg/L	ND	0.001	0.0005	0	4
Sodium	mg/L	23	73.8	52.5	4	4
Suspended Solids	mg/L	ND	25	10.9	1	4
Temperature	deg F	44.6	78.5	63.5	4	4
Thallium	mg/L	ND	0.01	0.005	0	4
Trichloroethene	ug/L	ND	1	0.5	0	4
Turbidity	NTU	18	49	37	3	3
Uranium	mg/L	ND	0.0242	0.0116	4	8

Surface Water Non-Radiological Data

Table 4.9 Non-Radiological Monitoring Data for Surface Water Location L10

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Vanadium	mg/L	ND	0.02	0.01	0	4
Zinc	mg/L	ND	0.02	0.01	0	4

Surface Water Non-Radiological Data

Table 4.10 Non-Radiological Monitoring Data for Surface Water Location L194

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Alkalinity	mg/L	18	23	20.7	4	4
Aluminum	mg/L	ND	1.02	0.428	2	4
Ammonia	mg/L	ND	0.2	0.1	0	3
Ammonia as Nitrogen	mg/L	ND	0.2	0.1	0	1
Antimony	mg/L	ND	0.005	0.0025	0	4
Arsenic	mg/L	ND	0.01	0.005	0	4
Barium	mg/L	0.0261	0.0436	0.0366	4	4
Beryllium	mg/L	ND	0.001	0.0005	0	4
Cadmium	mg/L	ND	0.001	0.0005	0	4
Calcium	mg/L	15.2	27.6	21.6	4	4
Chloride	mg/L	21	44	30.5	4	4
Chromium	mg/L	ND	0.02	0.01	0	4
Cobalt	mg/L	ND	0.001	0.0005	0	4
Conductivity	umho/cm	306	438	386	4	4
Copper	mg/L	ND	0.0052	0.0026	0	4
Cyanide	mg/L	ND	0.05	0.025	0	4
Dissolved Oxygen	mg/L	4.95	10.3	6.9	4	4
Flow Rate	mgd	0.37	2.67	1.65	4	4
Hardness - Total as CaCO3	mg/L	66	90	82	4	4
Iron	mg/L	0.282	0.886	0.506	4	4
Lead	mg/L	ND	0.005	0.0025	0	4
Magnesium	mg/L	6.87	10.6	7.98	4	4
Manganese	mg/L	0.0277	0.0752	0.0462	4	4
Mercury	mg/L	ND	0.0002	0.0001	0	4
Nickel	mg/L	ND	0.005	0.0025	0	4
Nitrate/Nitrite as Nitrogen	mg/L	ND	0.5	0.372	2	4
PCB-1016	ug/L	ND	0.17	0.0838	0	4
PCB-1221	ug/L	ND	0.18	0.0887	0	4
PCB-1232	ug/L	ND	0.14	0.0688	0	4
PCB-1242	ug/L	ND	0.1	0.05	0	4
PCB-1248	ug/L	ND	0.12	0.0587	0	4
PCB-1254	ug/L	ND	0.07	0.035	0	4
PCB-1260	ug/L	ND	0.05	0.025	0	4
PCB-1268	ug/L	ND	0.09	0.045	0	4
pH	Std Unit	7.05	7.44	7.18	4	4
Phosphorous	mg/L	0.24	0.4	0.305	4	4
Polychlorinated biphenyl	ug/L	ND	0.18	0.0887	0	4
Potassium	mg/L	2.29	4.4	3.13	4	4
Selenium	mg/L	ND	0.005	0.0025	0	4
Silver	mg/L	ND	0.001	0.0005	0	4
Sodium	mg/L	33.9	60.3	44.8	4	4
Suspended Solids	mg/L	ND	15	9.12	2	4
Temperature	deg F	49	81.8	67.7	4	4
Thallium	mg/L	ND	0.01	0.005	0	4
Trichloroethene	ug/L	ND	1	0.5	0	4
Turbidity	NTU	22.1	75.1	42.5	3	3
Uranium	mg/L	ND	0.014	0.00722	4	8

Surface Water Non-Radiological Data

Table 4.10 Non-Radiological Monitoring Data for Surface Water Location L194

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Vanadium	mg/L	ND	0.02	0.01	0	4
Zinc	mg/L	ND	0.0451	0.0188	1	4

Surface Water Non-Radiological Data

Table 4.11 Non-Radiological Monitoring Data for Surface Water Location L11

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Alkalinity	mg/L	21	40	29.8	5	5
Aluminum	mg/L	ND	4.63	1.9	3	5
Ammonia	mg/L	ND	0.2	0.1	0	4
Ammonia as Nitrogen	mg/L	ND	0.2	0.1	0	1
Antimony	mg/L	ND	0.005	0.0025	0	5
Arsenic	mg/L	ND	0.01	0.005	0	5
Barium	mg/L	0.0509	0.0713	0.0602	5	5
Beryllium	mg/L	ND	0.001	0.0005	0	5
Cadmium	mg/L	ND	0.001	0.0005	0	5
Calcium	mg/L	10.8	22.4	16	5	5
Chloride	mg/L	7.9	36	21	5	5
Chromium	mg/L	ND	0.02	0.01	0	5
Cobalt	mg/L	ND	0.001	0.0005	0	5
Conductivity	umho/cm	153	437	290	5	5
Copper	mg/L	ND	0.0052	0.0026	0	5
Cyanide	mg/L	ND	0.05	0.025	0	5
Dissolved Oxygen	mg/L	4.73	11.3	8.33	5	5
Flow Rate	mgd	1.02	2.57	1.65	5	5
Hardness - Total as CaCO3	mg/L	47	99	68.8	5	5
Iron	mg/L	0.222	2.86	1.36	5	5
Lead	mg/L	ND	0.005	0.0025	0	5
Magnesium	mg/L	2.8	8.83	5.11	5	5
Manganese	mg/L	0.068	0.169	0.0957	5	5
Mercury	mg/L	ND	0.0002	0.0001	0	5
Nickel	mg/L	ND	0.005	0.0025	0	5
Nitrate/Nitrite as Nitrogen	mg/L	ND	0.6	0.336	4	5
PCB-1016	ug/L	ND	0.17	0.083	0	5
PCB-1221	ug/L	ND	0.18	0.088	0	5
PCB-1232	ug/L	ND	0.14	0.069	0	5
PCB-1242	ug/L	ND	0.12	0.064	1	5
PCB-1248	ug/L	ND	0.12	0.059	0	5
PCB-1254	ug/L	ND	0.07	0.035	0	5
PCB-1260	ug/L	ND	0.05	0.025	0	5
PCB-1268	ug/L	ND	0.09	0.045	0	5
pH	Std Unit	6.81	7.44	7.05	5	5
Phosphorous	mg/L	0.11	0.31	0.188	5	5
Polychlorinated biphenyl	ug/L	ND	0.18	0.094	1	5
Potassium	mg/L	2.11	5.37	3.08	5	5
Selenium	mg/L	ND	0.005	0.0025	0	5
Silver	mg/L	ND	0.001	0.0005	0	5
Sodium	mg/L	9.53	46.1	29.1	5	5
Suspended Solids	mg/L	ND	20	7.3	0	5
Temperature	deg F	43.2	76	57.6	5	5
Thallium	mg/L	ND	0.01	0.005	0	5
Trichloroethene	ug/L	ND	1	0.5	0	5
Turbidity	NTU	15.3	119	85.6	4	4
Uranium	mg/L	ND	0.012	0.00421	4	10

Surface Water Non-Radiological Data

Table 4.11 Non-Radiological Monitoring Data for Surface Water Location L11

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Vanadium	mg/L	ND	0.02	0.01	0	5
Zinc	mg/L	ND	0.02	0.01	0	5

Surface Water Non-Radiological Data

Table 4.12 Non-Radiological Monitoring Data for Surface Water Location L12

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Alkalinity	mg/L	22	27	25	5	5
Aluminum	mg/L	ND	0.311	0.142	1	5
Ammonia	mg/L	ND	0.2	0.1	0	3
Ammonia as Nitrogen	mg/L	ND	0.2	0.1	0	2
Antimony	mg/L	ND	0.005	0.0025	0	5
Arsenic	mg/L	ND	0.01	0.005	0	5
Barium	mg/L	0.0348	0.0741	0.0561	5	5
Beryllium	mg/L	ND	0.001	0.0005	0	5
Cadmium	mg/L	ND	0.001	0.0005	0	5
Calcium	mg/L	15.1	39.2	33.3	5	5
Chloride	mg/L	20	28	25	5	5
Chromium	mg/L	ND	0.02	0.01	0	5
Cobalt	mg/L	ND	0.00167	0.000836	2	5
Conductivity	umho/cm	315	430	389	5	5
Copper	mg/L	ND	0.0052	0.0026	0	5
Cyanide	mg/L	ND	0.05	0.025	0	5
Dissolved Oxygen	mg/L	6.47	12.6	8.57	5	5
Flow Rate	mgd	0.67	4.77	2.86	5	5
Hardness - Total as CaCO3	mg/L	93	129	119	5	5
Iron	mg/L	ND	0.454	0.281	3	5
Lead	mg/L	ND	0.005	0.0025	0	5
Magnesium	mg/L	5.72	7.28	6.63	5	5
Manganese	mg/L	0.0551	0.425	0.198	5	5
Mercury	mg/L	ND	0.0002	0.0001	0	5
Nickel	mg/L	ND	0.005	0.0025	0	5
Nitrate/Nitrite as Nitrogen	mg/L	0.32	1.3	0.818	5	5
PCB-1016	ug/L	ND	0.17	0.083	0	5
PCB-1221	ug/L	ND	0.18	0.088	0	5
PCB-1232	ug/L	ND	0.14	0.069	0	5
PCB-1242	ug/L	ND	0.1	0.05	0	5
PCB-1248	ug/L	ND	0.12	0.059	0	5
PCB-1254	ug/L	ND	0.07	0.035	0	5
PCB-1260	ug/L	ND	0.05	0.025	0	5
PCB-1268	ug/L	ND	0.09	0.045	0	5
pH	Std Unit	6.7	7.02	6.82	5	5
Phosphorous	mg/L	0.05	0.17	0.1	5	5
Polychlorinated biphenyl	ug/L	ND	0.18	0.088	0	5
Potassium	mg/L	2.43	4.75	3.4	5	5
Selenium	mg/L	ND	0.005	0.0025	0	5
Silver	mg/L	ND	0.001	0.0005	0	5
Sodium	mg/L	22.9	34	28.5	5	5
Suspended Solids	mg/L	ND	14	7	1	5
Temperature	deg F	52.4	72.9	65.3	5	5
Thallium	mg/L	ND	0.01	0.005	0	5
Trichloroethene	ug/L	ND	6.5	3.14	4	5
Turbidity	NTU	63.1	155	109	2	2
Uranium	mg/L	ND	0.028	0.00517	5	10

Surface Water Non-Radiological Data

Table 4.12 Non-Radiological Monitoring Data for Surface Water Location L12

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Vanadium	mg/L	ND	0.02	0.01	0	5
Zinc	mg/L	ND	0.02	0.01	0	5

Surface Water Non-Radiological Data

Table 4.13 Non-Radiological Monitoring Data for Surface Water Location L241

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Alkalinity	mg/L	22	35	27.7	4	4
Aluminum	mg/L	ND	5.86	1.6	2	4
Ammonia	mg/L	ND	0.2	0.1	0	3
Ammonia as Nitrogen	mg/L	ND	0.2	0.1	0	1
Antimony	mg/L	ND	0.005	0.0025	0	4
Arsenic	mg/L	ND	0.01	0.005	0	4
Barium	mg/L	0.066	0.0929	0.0781	4	4
Beryllium	mg/L	ND	0.001	0.0005	0	4
Cadmium	mg/L	ND	0.001	0.0005	0	4
Calcium	mg/L	11.5	22.6	17.2	4	4
Chloride	mg/L	7.4	39	25.4	4	4
Chromium	mg/L	ND	0.02	0.01	0	4
Cobalt	mg/L	ND	0.001	0.0005	0	4
Conductivity	umho/cm	148	391	303	4	4
Copper	mg/L	ND	0.0052	0.0026	0	4
Cyanide	mg/L	ND	0.05	0.025	0	4
Dissolved Oxygen	mg/L	5.82	8.8	7.82	4	4
Flow Rate	mgd	0.64	8.52	4.06	4	4
Hardness - Total as CaCO3	mg/L	50	96	79.7	4	4
Iron	mg/L	0.229	3.44	1.15	4	4
Lead	mg/L	ND	0.005	0.0025	0	4
Magnesium	mg/L	2.94	9.75	6.73	4	4
Manganese	mg/L	0.023	0.0638	0.0444	4	4
Mercury	mg/L	ND	0.0002	0.0001	0	4
Nickel	mg/L	ND	0.005	0.0025	0	4
Nitrate/Nitrite as Nitrogen	mg/L	0.39	1.1	0.63	4	4
PCB-1016	ug/L	ND	0.17	0.0825	0	4
PCB-1221	ug/L	ND	0.18	0.0875	0	4
PCB-1232	ug/L	ND	0.14	0.0688	0	4
PCB-1242	ug/L	ND	0.1	0.05	0	4
PCB-1248	ug/L	ND	0.12	0.0587	0	4
PCB-1254	ug/L	ND	0.07	0.035	0	4
PCB-1260	ug/L	ND	0.05	0.025	0	4
PCB-1268	ug/L	ND	0.09	0.045	0	4
pH	Std Unit	6.35	6.89	6.63	4	4
Phosphorous	mg/L	0.08	0.25	0.18	4	4
Polychlorinated biphenyl	ug/L	ND	0.18	0.0875	0	4
Potassium	mg/L	2.05	5.1	3.12	4	4
Selenium	mg/L	ND	0.005	0.0025	0	4
Silver	mg/L	ND	0.001	0.0005	0	4
Sodium	mg/L	6.48	47.7	28.9	4	4
Suspended Solids	mg/L	ND	39	14.4	1	4
Temperature	deg F	44.9	76.5	61.8	4	4
Thallium	mg/L	ND	0.01	0.005	0	4
Trichloroethene	ug/L	15	39	23.5	4	4
Turbidity	NTU	23.5	79.7	51.2	3	3
Uranium	mg/L	ND	0.006	0.00316	4	8

Surface Water Non-Radiological Data

Table 4.13 Non-Radiological Monitoring Data for Surface Water Location L241

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Vanadium	mg/L	ND	0.02	0.01	0	4
Zinc	mg/L	ND	0.02	0.01	0	4

Surface Water Non-Radiological Data

Table 4.14 Non-Radiological Monitoring Data for Surface Water Location C746K-5

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Alkalinity	mg/L	25	35	29	5	5
Aluminum	mg/L	ND	1.42	0.393	2	5
Ammonia	mg/L	ND	0.2	0.1	0	4
Ammonia as Nitrogen	mg/L	ND	0.2	0.1	0	1
Antimony	mg/L	ND	0.005	0.0025	0	5
Arsenic	mg/L	ND	0.01	0.005	0	5
Barium	mg/L	0.0339	0.0502	0.0393	5	5
Beryllium	mg/L	ND	0.001	0.0005	0	5
Cadmium	mg/L	ND	0.001	0.0005	0	5
Calcium	mg/L	17.4	22.5	18.6	5	5
Chloride	mg/L	9.7	25	14.7	5	5
Chromium	mg/L	ND	0.02	0.01	0	5
Cobalt	mg/L	ND	0.001	0.0005	0	5
Conductivity	umho/cm	175	318	239	5	5
Copper	mg/L	ND	0.0052	0.0026	0	5
Cyanide	mg/L	ND	0.05	0.025	0	5
Dissolved Oxygen	mg/L	5.46	11.9	7.44	5	5
Flow Rate	mgd	0.43	4.31	1.95	5	5
Hardness - Total as CaCO3	mg/L	54	78	66.4	5	5
Iron	mg/L	0.321	1.13	0.6	5	5
Lead	mg/L	ND	0.005	0.0025	0	5
Magnesium	mg/L	3.2	9.16	5.39	5	5
Manganese	mg/L	0.061	0.19	0.0899	5	5
Mercury	mg/L	ND	0.0002	0.0001	0	5
Nickel	mg/L	ND	0.005	0.0025	0	5
Nitrate/Nitrite as Nitrogen	mg/L	ND	0.9	0.384	2	5
PCB-1016	ug/L	ND	0.17	0.084	0	5
PCB-1221	ug/L	ND	0.18	0.089	0	5
PCB-1232	ug/L	ND	0.14	0.07	0	5
PCB-1242	ug/L	ND	0.1	0.05	0	5
PCB-1248	ug/L	ND	0.12	0.06	0	5
PCB-1254	ug/L	ND	0.16	0.06	1	5
PCB-1260	ug/L	ND	0.05	0.025	0	5
PCB-1268	ug/L	ND	0.09	0.045	0	5
pH	Std Unit	6.89	7.31	7.19	5	5
Phosphorous	mg/L	0.07	0.16	0.112	5	5
Polychlorinated biphenyl	ug/L	ND	0.18	0.103	1	5
Potassium	mg/L	2.34	3.85	3.05	5	5
Selenium	mg/L	ND	0.005	0.0025	0	5
Silver	mg/L	ND	0.001	0.0005	0	5
Sodium	mg/L	9.42	33.1	19.9	5	5
Suspended Solids	mg/L	ND	17	5.7	0	5
Temperature	deg F	48.8	77.4	63.6	5	5
Thallium	mg/L	ND	0.01	0.005	0	5
Trichloroethene	ug/L	ND	1	0.5	0	5
Turbidity	NTU	3.3	11.6	6.07	3	3
Uranium	mg/L	ND	0.005	0.0015	0	10

Surface Water Non-Radiological Data

Table 4.14 Non-Radiological Monitoring Data for Surface Water Location C746K-5

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Vanadium	mg/L	ND	0.02	0.01	0	5
Zinc	mg/L	ND	0.02	0.01	0	5

Surface Water Non-Radiological Data

Table 4.15 Non-Radiological Monitoring Data for Surface Water Location S31

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Alkalinity	mg/L	15	35	23.5	4	4
Aluminum	mg/L	ND	0.226	0.132	1	4
Ammonia	mg/L	ND	0.44	0.31	2	3
Ammonia as Nitrogen	mg/L	ND	0.2	0.1	0	1
Antimony	mg/L	ND	0.005	0.0025	0	4
Arsenic	mg/L	ND	0.01	0.005	0	4
Barium	mg/L	0.0114	0.016	0.0131	4	4
Beryllium	mg/L	ND	0.001	0.0005	0	4
Cadmium	mg/L	ND	0.001	0.0005	0	4
Calcium	mg/L	12.3	19.9	16.7	4	4
Chloride	mg/L	21	34	26	4	4
Chromium	mg/L	ND	0.02	0.01	0	4
Cobalt	mg/L	ND	0.001	0.0005	0	4
Conductivity	umho/cm	236	374	312	4	4
Copper	mg/L	ND	0.00798	0.0047	2	4
Cyanide	mg/L	ND	0.05	0.025	0	4
Dissolved Oxygen	mg/L	4.33	10.5	6.76	4	4
Flow Rate	mgd	0.7	1.1	0.85	4	4
Hardness - Total as CaCO3	mg/L	53	78	66.2	4	4
Iron	mg/L	ND	0.571	0.248	2	4
Lead	mg/L	ND	0.005	0.0025	0	4
Magnesium	mg/L	4.95	9.83	6.8	4	4
Manganese	mg/L	0.0102	0.0556	0.0232	4	4
Mercury	mg/L	ND	0.0002	0.0001	0	4
Nickel	mg/L	ND	0.005	0.0025	0	4
Nitrate/Nitrite as Nitrogen	mg/L	0.77	1.2	1.03	4	4
PCB-1016	ug/L	ND	0.17	0.0825	0	4
PCB-1221	ug/L	ND	0.18	0.0875	0	4
PCB-1232	ug/L	ND	0.14	0.07	0	4
PCB-1242	ug/L	ND	0.1	0.05	0	4
PCB-1248	ug/L	ND	0.12	0.06	0	4
PCB-1254	ug/L	ND	0.32	0.106	1	4
PCB-1260	ug/L	ND	0.05	0.025	0	4
PCB-1268	ug/L	ND	0.09	0.045	0	4
pH	Std Unit	6.57	7.23	7	4	4
Phosphorous	mg/L	0.44	0.47	0.45	4	4
Polychlorinated biphenyl	ug/L	ND	0.32	0.145	1	4
Potassium	mg/L	2.46	3.26	2.78	4	4
Selenium	mg/L	ND	0.005	0.0025	0	4
Silver	mg/L	ND	0.001	0.0005	0	4
Sodium	mg/L	29.6	47.3	38.9	4	4
Suspended Solids	mg/L	ND	17	5.87	0	4
Temperature	deg F	53.8	86.4	72.4	4	4
Thallium	mg/L	ND	0.01	0.005	0	4
Trichloroethene	ug/L	ND	1	0.5	0	4
Turbidity	NTU	10.9	190	100	2	2
Uranium	mg/L	ND	0.0122	0.00536	4	8

Surface Water Non-Radiological Data

Table 4.15 Non-Radiological Monitoring Data for Surface Water Location S31

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Vanadium	mg/L	ND	0.02	0.01	0	4
Zinc	mg/L	ND	0.02	0.01	0	4

Surface Water Non-Radiological Data

Table 4.16 Non-Radiological Monitoring Data for Surface Water Location C746KTB1

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Alkalinity	mg/L	17	38	26.5	4	4
Aluminum	mg/L	ND	1.5	0.529	2	4
Ammonia	mg/L	ND	0.2	0.1	0	3
Ammonia as Nitrogen	mg/L	ND	0.2	0.1	0	1
Antimony	mg/L	ND	0.005	0.0025	0	4
Arsenic	mg/L	ND	0.01	0.005	0	4
Barium	mg/L	0.0246	0.0676	0.0482	4	4
Beryllium	mg/L	ND	0.001	0.0005	0	4
Cadmium	mg/L	ND	0.001	0.0005	0	4
Calcium	mg/L	10.8	18.9	13.8	4	4
Chloride	mg/L	7.5	31	18.4	4	4
Chromium	mg/L	ND	0.02	0.01	0	4
Cobalt	mg/L	ND	0.001	0.0005	0	4
Conductivity	umho/cm	147	346	237	4	4
Copper	mg/L	ND	0.0052	0.0026	0	4
Cyanide	mg/L	ND	0.05	0.025	0	4
Dissolved Oxygen	mg/L	2.89	11.2	8.21	4	4
Flow Rate	mgd	0.1	1.87	0.715	4	4
Hardness - Total as CaCO3	mg/L	42	70	55.7	4	4
Iron	mg/L	ND	0.994	0.454	3	4
Lead	mg/L	ND	0.005	0.0025	0	4
Magnesium	mg/L	2.6	7.18	4.7	4	4
Manganese	mg/L	0.0194	0.42	0.129	4	4
Mercury	mg/L	ND	0.0002	0.0001	0	4
Nickel	mg/L	ND	0.005	0.0025	0	4
Nitrate/Nitrite as Nitrogen	mg/L	ND	0.9	0.45	2	4
PCB-1016	ug/L	ND	0.17	0.0838	0	4
PCB-1221	ug/L	ND	0.18	0.0887	0	4
PCB-1232	ug/L	ND	0.14	0.0688	0	4
PCB-1242	ug/L	ND	0.1	0.05	0	4
PCB-1248	ug/L	ND	0.12	0.0587	0	4
PCB-1254	ug/L	ND	0.07	0.035	0	4
PCB-1260	ug/L	ND	0.05	0.025	0	4
PCB-1268	ug/L	ND	0.09	0.045	0	4
pH	Std Unit	6.94	7.08	6.98	4	4
Phosphorous	mg/L	0.06	0.09	0.075	4	4
Polychlorinated biphenyl	ug/L	ND	0.18	0.0887	0	4
Potassium	mg/L	2	4.27	2.87	4	4
Selenium	mg/L	ND	0.005	0.0025	0	4
Silver	mg/L	ND	0.001	0.0005	0	4
Sodium	mg/L	9	49.6	26.3	4	4
Suspended Solids	mg/L	ND	13	8.87	2	4
Temperature	deg F	48.3	74.4	61.3	4	4
Thallium	mg/L	ND	0.01	0.005	0	4
Trichloroethene	ug/L	ND	1	0.5	0	4
Turbidity	NTU	80.8	87	83.9	2	2
Uranium	mg/L	ND	0.005	0.0019	1	8

Surface Water Non-Radiological Data

Table 4.16 Non-Radiological Monitoring Data for Surface Water Location C746KTB1

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Vanadium	mg/L	ND	0.02	0.01	0	4
Zinc	mg/L	ND	0.02	0.01	0	4

Surface Water Non-Radiological Data

Table 4.17 Non-Radiological Monitoring Data for Surface Water Location L8

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Alkalinity	mg/L	22	30	24.2	4	4
Aluminum	mg/L	ND	0.601	0.381	3	4
Ammonia	mg/L	ND	0.2	0.1	0	3
Ammonia as Nitrogen	mg/L	ND	0.2	0.1	0	1
Antimony	mg/L	ND	0.005	0.0025	0	4
Arsenic	mg/L	ND	0.01	0.005	0	4
Barium	mg/L	0.0374	0.0658	0.0515	4	4
Beryllium	mg/L	ND	0.001	0.0005	0	4
Cadmium	mg/L	ND	0.001	0.0005	0	4
Calcium	mg/L	22.3	38.1	31.6	4	4
Chloride	mg/L	21	58	35	4	4
Chromium	mg/L	ND	0.02	0.01	0	4
Cobalt	mg/L	ND	0.001	0.0005	0	4
Conductivity	umho/cm	301	644	463	4	4
Copper	mg/L	ND	0.0052	0.0026	0	4
Cyanide	mg/L	ND	0.05	0.025	0	4
Dissolved Oxygen	mg/L	7.85	9.69	8.45	4	4
Hardness - Total as CaCO3	mg/L	86	148	116	4	4
Iron	mg/L	0.314	0.81	0.613	4	4
Lead	mg/L	ND	0.005	0.0025	0	4
Magnesium	mg/L	6.43	14.1	9.26	4	4
Manganese	mg/L	0.113	0.262	0.187	4	4
Mercury	mg/L	ND	0.0002	0.0001	0	4
Nickel	mg/L	ND	0.005	0.0025	0	4
Nitrate/Nitrite as Nitrogen	mg/L	0.76	1.2	0.98	4	4
PCB-1016	ug/L	ND	0.17	0.0838	0	4
PCB-1221	ug/L	ND	0.18	0.0887	0	4
PCB-1232	ug/L	ND	0.14	0.07	0	4
PCB-1242	ug/L	ND	0.1	0.05	0	4
PCB-1248	ug/L	ND	0.12	0.06	0	4
PCB-1254	ug/L	ND	0.07	0.035	0	4
PCB-1260	ug/L	ND	0.05	0.025	0	4
PCB-1268	ug/L	ND	0.09	0.045	0	4
pH	Std Unit	6.8	7.13	6.95	4	4
Phosphorous	mg/L	0.07	0.13	0.0925	4	4
Polychlorinated biphenyl	ug/L	ND	0.18	0.0887	0	4
Potassium	mg/L	2.87	6.93	4.86	4	4
Selenium	mg/L	ND	0.005	0.0025	0	4
Silver	mg/L	ND	0.001	0.0005	0	4
Sodium	mg/L	25.9	63.9	42.2	4	4
Suspended Solids	mg/L	ND	21	9.12	1	4
Temperature	deg F	56	80.1	64.9	4	4
Thallium	mg/L	ND	0.01	0.005	0	4
Trichloroethene	ug/L	ND	2.9	1.1	1	4
Turbidity	NTU	6.8	40	19	3	3
Uranium	mg/L	ND	0.007	0.00293	3	8
Vanadium	mg/L	ND	0.02	0.01	0	4

Surface Water Non-Radiological Data

Table 4.17 Non-Radiological Monitoring Data for Surface Water Location L8

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Zinc	mg/L	ND	0.02	0.01	0	4

Surface Water Non-Radiological Data

Table 4.18 Non-Radiological Monitoring Data for Surface Water Location L29

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Alkalinity	mg/L	24	50	34	4	4
Aluminum	mg/L	ND	1.88	0.932	2	4
Ammonia	mg/L	ND	0.2	0.1	0	3
Ammonia as Nitrogen	mg/L	ND	0.2	0.1	0	1
Antimony	mg/L	ND	0.005	0.0025	0	4
Arsenic	mg/L	ND	0.01	0.005	0	4
Barium	mg/L	0.0278	0.0447	0.036	4	4
Beryllium	mg/L	ND	0.001	0.0005	0	4
Cadmium	mg/L	ND	0.001	0.0005	0	4
Calcium	mg/L	19.1	38.7	31.2	4	4
Chloride	mg/L	12	24	16	4	4
Chromium	mg/L	ND	0.02	0.01	0	4
Cobalt	mg/L	ND	0.00124	0.000685	1	4
Conductivity	umho/cm	222	341	285	4	4
Copper	mg/L	ND	0.0052	0.0026	0	4
Cyanide	mg/L	ND	0.05	0.025	0	4
Dissolved Oxygen	mg/L	7.33	9.75	8.86	4	4
Hardness - Total as CaCO3	mg/L	78	122	108	4	4
Iron	mg/L	ND	1.84	0.907	2	4
Lead	mg/L	ND	0.005	0.0025	0	4
Magnesium	mg/L	6.73	11.1	8.8	4	4
Manganese	mg/L	0.0364	0.124	0.074	4	4
Mercury	mg/L	ND	0.0002	0.0001	0	4
Nickel	mg/L	ND	0.005	0.0025	0	4
Nitrate/Nitrite as Nitrogen	mg/L	ND	0.7	0.495	3	4
PCB-1016	ug/L	ND	0.17	0.0838	0	4
PCB-1221	ug/L	ND	0.18	0.0887	0	4
PCB-1232	ug/L	ND	0.14	0.07	0	4
PCB-1242	ug/L	ND	0.1	0.05	0	4
PCB-1248	ug/L	ND	0.12	0.06	0	4
PCB-1254	ug/L	ND	0.07	0.035	0	4
PCB-1260	ug/L	ND	0.05	0.025	0	4
PCB-1268	ug/L	ND	0.09	0.045	0	4
pH	Std Unit	7.81	8.2	7.99	4	4
Phosphorous	mg/L	ND	0.12	0.0787	3	4
Polychlorinated biphenyl	ug/L	ND	0.18	0.0887	0	4
Potassium	mg/L	1.99	2.62	2.23	4	4
Selenium	mg/L	ND	0.005	0.0025	0	4
Silver	mg/L	ND	0.001	0.0005	0	4
Sodium	mg/L	9.06	22.7	13.3	4	4
Suspended Solids	mg/L	ND	50	26.5	2	4
Temperature	deg F	60.8	86.5	69.5	4	4
Thallium	mg/L	ND	0.01	0.005	0	4
Trichloroethene	ug/L	ND	1	0.5	0	4
Turbidity	NTU	11.2	77	43	3	3
Uranium	mg/L	ND	0.005	0.0015	0	8
Vanadium	mg/L	ND	0.02	0.01	0	4

Surface Water Non-Radiological Data

Table 4.18 Non-Radiological Monitoring Data for Surface Water Location L29

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Zinc	mg/L	ND	0.02	0.01	0	4

Surface Water Non-Radiological Data

Table 4.19 Non-Radiological Monitoring Data for Surface Water Location L30

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Alkalinity	mg/L	16	50	30	4	4
Aluminum	mg/L	0.21	2.36	1.04	4	4
Ammonia	mg/L	ND	0.2	0.1	0	3
Ammonia as Nitrogen	mg/L	ND	0.2	0.1	0	1
Antimony	mg/L	ND	0.005	0.0025	0	4
Arsenic	mg/L	ND	0.01	0.005	0	4
Barium	mg/L	0.0277	0.0499	0.0372	4	4
Beryllium	mg/L	ND	0.001	0.0005	0	4
Cadmium	mg/L	ND	0.001	0.0005	0	4
Calcium	mg/L	21.1	36.2	29.6	4	4
Chloride	mg/L	8.2	27	16	4	4
Chromium	mg/L	ND	0.02	0.01	0	4
Cobalt	mg/L	ND	0.00149	0.000748	1	4
Conductivity	umho/cm	192	381	276	4	4
Copper	mg/L	ND	0.0052	0.0026	0	4
Cyanide	mg/L	ND	0.05	0.025	0	4
Dissolved Oxygen	mg/L	6.7	9.63	8.74	4	4
Hardness - Total as CaCO3	mg/L	78	125	102	4	4
Iron	mg/L	0.262	2.34	1.07	4	4
Lead	mg/L	ND	0.005	0.0025	0	4
Magnesium	mg/L	4.71	11.2	8.12	4	4
Manganese	mg/L	0.0421	0.147	0.0809	4	4
Mercury	mg/L	ND	0.0002	0.0001	0	4
Nickel	mg/L	ND	0.005	0.0025	0	4
Nitrate/Nitrite as Nitrogen	mg/L	ND	0.88	0.465	3	4
PCB-1016	ug/L	ND	0.17	0.085	0	4
PCB-1221	ug/L	ND	0.18	0.09	0	4
PCB-1232	ug/L	ND	0.14	0.07	0	4
PCB-1242	ug/L	ND	0.1	0.05	0	4
PCB-1248	ug/L	ND	0.12	0.06	0	4
PCB-1254	ug/L	ND	0.07	0.035	0	4
PCB-1260	ug/L	ND	0.05	0.025	0	4
PCB-1268	ug/L	ND	0.09	0.045	0	4
pH	Std Unit	7.48	8.25	7.96	4	4
Phosphorous	mg/L	ND	0.13	0.0862	3	4
Polychlorinated biphenyl	ug/L	ND	0.18	0.09	0	4
Potassium	mg/L	1.81	2.85	2.23	4	4
Selenium	mg/L	ND	0.005	0.0025	0	4
Silver	mg/L	ND	0.001	0.0005	0	4
Sodium	mg/L	6.53	22.2	12.8	4	4
Suspended Solids	mg/L	ND	39	22	2	4
Temperature	deg F	61.9	87.3	70.5	4	4
Thallium	mg/L	ND	0.01	0.005	0	4
Trichloroethene	ug/L	ND	1	0.5	0	4
Turbidity	NTU	56.7	95	70.3	3	3
Uranium	mg/L	ND	0.005	0.0015	0	8
Vanadium	mg/L	ND	0.02	0.01	0	4

Surface Water Non-Radiological Data

Table 4.19 Non-Radiological Monitoring Data for Surface Water Location L30

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Zinc	mg/L	ND	0.02	0.01	0	4

Surface Water Non-Radiological Data

Table 4.20 Non-Radiological Monitoring Data for Surface Water Location L306

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Alkalinity	mg/L	25	70	42.5	4	4
Aluminum	mg/L	0.295	1.04	0.586	4	4
Ammonia	mg/L	ND	0.2	0.1	0	3
Ammonia as Nitrogen	mg/L	ND	0.2	0.1	0	1
Antimony	mg/L	ND	0.005	0.0025	0	4
Arsenic	mg/L	ND	0.01	0.005	0	4
Barium	mg/L	0.0357	0.0458	0.0411	4	4
Beryllium	mg/L	ND	0.001	0.0005	0	4
Cadmium	mg/L	ND	0.001	0.0005	0	4
Calcium	mg/L	25	52.5	38.8	4	4
Chloride	mg/L	17	33	22.2	4	4
Chromium	mg/L	ND	0.02	0.01	0	4
Cobalt	mg/L	ND	0.001	0.0005	0	4
Conductivity	umho/cm	280	443	360	4	4
Copper	mg/L	ND	0.0052	0.0026	0	4
Cyanide	mg/L	ND	0.05	0.025	0	4
Dissolved Oxygen	mg/L	6.91	10.6	9.09	4	4
Hardness - Total as CaCO3	mg/L	107	152	137	4	4
Iron	mg/L	0.305	1.07	0.646	4	4
Lead	mg/L	ND	0.005	0.0025	0	4
Magnesium	mg/L	9.98	16.4	12.3	4	4
Manganese	mg/L	0.0323	0.0763	0.0499	4	4
Mercury	mg/L	ND	0.0002	0.0001	0	4
Nickel	mg/L	ND	0.005	0.0025	0	4
Nitrate/Nitrite as Nitrogen	mg/L	0.26	1.2	0.835	4	4
PCB-1016	ug/L	ND	0.17	0.0838	0	4
PCB-1221	ug/L	ND	0.18	0.0887	0	4
PCB-1232	ug/L	ND	0.14	0.07	0	4
PCB-1242	ug/L	ND	0.1	0.05	0	4
PCB-1248	ug/L	ND	0.12	0.06	0	4
PCB-1254	ug/L	ND	0.07	0.035	0	4
PCB-1260	ug/L	ND	0.05	0.025	0	4
PCB-1268	ug/L	ND	0.09	0.045	0	4
pH	Std Unit	7.7	7.98	7.85	4	4
Phosphorous	mg/L	ND	0.13	0.0762	3	4
Polychlorinated biphenyl	ug/L	ND	0.18	0.0887	0	4
Potassium	mg/L	2.15	3.27	2.62	4	4
Selenium	mg/L	ND	0.005	0.0025	0	4
Silver	mg/L	ND	0.001	0.0005	0	4
Sodium	mg/L	10.7	33.9	18.5	4	4
Suspended Solids	mg/L	ND	36	23.1	3	4
Temperature	deg F	61	86.6	69.5	4	4
Thallium	mg/L	ND	0.01	0.005	0	4
Trichloroethene	ug/L	ND	1	0.5	0	4
Turbidity	NTU	12	56.4	35	3	3
Uranium	mg/L	ND	0.005	0.0015	0	8
Vanadium	mg/L	ND	0.02	0.01	0	4

Surface Water Non-Radiological Data

Table 4.20 Non-Radiological Monitoring Data for Surface Water Location L306

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Zinc	mg/L	ND	0.02	0.01	0	4

Surface Water Non-Radiological Data

Table 4.21 Non-Radiological Monitoring Data for Surface Water Location L64

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Alkalinity	mg/L	18	29	25.2	4	4
Aluminum	mg/L	ND	1.35	0.412	1	4
Ammonia	mg/L	ND	0.2	0.1	0	3
Ammonia as Nitrogen	mg/L	ND	0.2	0.1	0	1
Antimony	mg/L	ND	0.005	0.0025	0	4
Arsenic	mg/L	ND	0.01	0.005	0	4
Barium	mg/L	0.0345	0.0545	0.044	4	4
Beryllium	mg/L	ND	0.001	0.0005	0	4
Cadmium	mg/L	ND	0.001	0.0005	0	4
Calcium	mg/L	9.93	11	10.7	4	4
Chloride	mg/L	8.1	18	12.5	4	4
Chromium	mg/L	ND	0.02	0.01	0	4
Cobalt	mg/L	ND	0.001	0.0005	0	4
Conductivity	umho/cm	135	163	146	4	4
Copper	mg/L	ND	0.0052	0.0026	0	4
Cyanide	mg/L	ND	0.05	0.025	0	4
Dissolved Oxygen	mg/L	4.38	11.9	9.09	4	4
Flow Rate	mgd	0.61	17.6	6.83	4	4
Hardness - Total as CaCO3	mg/L	36	49	43.5	4	4
Iron	mg/L	0.6	1.28	0.894	4	4
Lead	mg/L	ND	0.005	0.0025	0	4
Magnesium	mg/L	2.49	3.4	2.79	4	4
Manganese	mg/L	0.141	0.364	0.274	4	4
Mercury	mg/L	ND	0.0002	0.0001	0	4
Nickel	mg/L	ND	0.005	0.0025	0	4
Nitrate/Nitrite as Nitrogen	mg/L	ND	0.89	0.335	2	4
PCB-1016	ug/L	ND	0.17	0.0838	0	4
PCB-1221	ug/L	ND	0.18	0.0887	0	4
PCB-1232	ug/L	ND	0.14	0.0688	0	4
PCB-1242	ug/L	ND	0.1	0.05	0	4
PCB-1248	ug/L	ND	0.12	0.0587	0	4
PCB-1254	ug/L	ND	0.23	0.0838	1	4
PCB-1260	ug/L	ND	0.05	0.025	0	4
PCB-1268	ug/L	ND	0.09	0.045	0	4
pH	Std Unit	6.63	7.29	6.93	4	4
Phosphorous	mg/L	ND	0.09	0.055	2	4
Polychlorinated biphenyl	ug/L	ND	0.23	0.124	1	4
Potassium	mg/L	1.94	2.74	2.32	4	4
Selenium	mg/L	ND	0.005	0.0025	0	4
Silver	mg/L	ND	0.001	0.0005	0	4
Sodium	mg/L	5.74	16	11.3	4	4
Suspended Solids	mg/L	ND	17	6.37	0	4
Temperature	deg F	43.8	81.4	63.9	4	4
Thallium	mg/L	ND	0.01	0.005	0	4
Trichloroethene	ug/L	ND	1	0.5	0	4
Turbidity	NTU	18.2	82	43	3	3
Uranium	mg/L	ND	0.005	0.0015	0	8

Surface Water Non-Radiological Data

Table 4.21 Non-Radiological Monitoring Data for Surface Water Location L64

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Vanadium	mg/L	ND	0.02	0.01	0	4
Zinc	mg/L	ND	0.02	0.01	0	4

Table 4.22 Non-Radiological Monitoring Data for Surface Water Seep Location LBCSP5

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
1,1,1-Trichloroethane	ug/L	ND	25	12.5	0	4
1,1,2-Trichloroethane	ug/L	ND	25	12.5	0	4
1,1-Dichloroethane	ug/L	ND	25	12.5	0	4
1,1-Dichloroethene	ug/L	ND	25	12.5	0	4
1,2-Dichloroethane	ug/L	ND	25	12.5	0	4
1,2-Dimethylbenzene	ug/L	ND	25	12.5	0	4
Alkalinity	mg/L	50	72	57.3	3	3
Benzene	ug/L	ND	25	12.5	0	4
Bromodichloromethane	ug/L	ND	25	12.5	0	4
Calcium	mg/L	23.3	25.3	24.5	4	4
Carbon tetrachloride	ug/L	ND	25	12.5	0	4
Chloride	mg/L	32	34	32.7	4	4
Chloroform	ug/L	ND	25	12.5	0	4
cis-1,2-Dichloroethene	ug/L	ND	25	12.5	0	4
Conductivity	umho/cm	340	348	344	4	4
Dissolved Oxygen	mg/L	3.44	4.45	4.13	4	4
Ethylbenzene	ug/L	ND	25	12.5	0	4
m,p-Xylene	ug/L	ND	75	28.1	0	4
Magnesium	mg/L	6.94	10	8.48	4	4
Manganese	mg/L	ND	0.015	0.00755	2	4
pH	Std Unit	5.9	6.45	6.2	4	4
Potassium	mg/L	1.58	1.88	1.68	4	4
Sodium	mg/L	31.5	36.8	33.9	4	4
Sulfate	mg/L	15	16	15.5	4	4
Temperature	deg F	57.5	59.3	58.1	4	4
Tetrachloroethene	ug/L	ND	25	12.5	0	4
Toluene	ug/L	ND	25	12.5	0	4
trans-1,2-Dichloroethene	ug/L	ND	25	12.5	0	4
Trichloroethene	ug/L	470	510	490	4	4
Turbidity	NTU	2.7	38.5	20.6	2	2
Vinyl chloride	ug/L	ND	10	5	0	4

Surface Water Non-Radiological Data

Table 4.23 Non-Radiological Monitoring Data for Surface Water Seep Location LBCSP6

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
1,1,1-Trichloroethane	ug/L	ND	25	10.6	0	4
1,1,2-Trichloroethane	ug/L	ND	25	10.6	0	4
1,1-Dichloroethane	ug/L	ND	25	10.6	0	4
1,1-Dichloroethene	ug/L	ND	25	10.6	0	4
1,2-Dichloroethane	ug/L	ND	25	10.6	0	4
1,2-Dimethylbenzene	ug/L	ND	25	10.6	0	4
Alkalinity	mg/L	40	50	46.7	3	3
Benzene	ug/L	ND	25	10.6	0	4
Bromodichloromethane	ug/L	ND	25	10.6	0	4
Calcium	mg/L	22.7	30.9	25.1	4	4
Carbon tetrachloride	ug/L	ND	25	10.6	0	4
Chloride	mg/L	34	40	36	4	4
Chloroform	ug/L	ND	25	10.6	0	4
cis-1,2-Dichloroethene	ug/L	ND	25	10.6	0	4
Conductivity	umho/cm	322	332	328	4	4
Dissolved Oxygen	mg/L	3.03	4.82	3.86	4	4
Ethylbenzene	ug/L	ND	25	10.6	0	4
m,p-Xylene	ug/L	ND	75	24.4	0	4
Magnesium	mg/L	6.51	8.88	7.83	4	4
Manganese	mg/L	0.0252	0.12	0.0638	4	4
pH	Std Unit	6	6.26	6.13	4	4
Potassium	mg/L	1.35	2.1	1.62	4	4
Sodium	mg/L	30	34	31.9	4	4
Sulfate	mg/L	13	14	13.5	4	4
Temperature	deg F	54.8	62	58	4	4
Tetrachloroethene	ug/L	ND	25	10.6	0	4
Toluene	ug/L	ND	25	10.6	0	4
trans-1,2-Dichloroethene	ug/L	ND	25	10.6	0	4
Trichloroethene	ug/L	200	330	265	4	4
Turbidity	NTU	63.7	63.7	63.7	1	1
Vinyl chloride	ug/L	ND	10	4.25	0	4

Sediment Non-Radiological Data

Table 4.24 Non-Radiological Data for Sediment Location S20

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Aluminum	mg/kg	1820	2910	2360	2	2
Antimony	mg/kg	ND	9.7	4.81	0	2
Arsenic	mg/kg	ND	19.4	9.62	0	2
Barium	mg/kg	21.8	56	38.9	2	2
Beryllium	mg/kg	ND	0.699	0.469	1	2
Cadmium	mg/kg	ND	1.94	0.963	0	2
Calcium	mg/kg	310	1080	695	2	2
Chromium	mg/kg	8.88	16.5	12.7	2	2
Cobalt	mg/kg	3.03	6.81	4.92	2	2
Copper	mg/kg	3.33	6.24	4.79	2	2
Grain Size Diameter Fines	%	14.9	14.9	14.9	1	1
Iron	mg/kg	6260	14600	10400	2	2
Lead	mg/kg	ND	19.4	9.62	0	2
Magnesium	mg/kg	173	284	228	2	2
Manganese	mg/kg	146	437	292	2	2
Mercury	mg/kg	ND	0.11	0.0492	0	2
Moisture	%	45.4	45.4	45.4	1	1
Nickel	mg/kg	ND	4.85	2.4	0	2
PCB-1016	ug/kg	ND	100	50	0	2
PCB-1221	ug/kg	ND	130	62.5	0	2
PCB-1232	ug/kg	ND	100	50	0	2
PCB-1242	ug/kg	ND	60	30	0	2
PCB-1248	ug/kg	ND	100	50	0	2
PCB-1254	ug/kg	ND	90	45	0	2
PCB-1260	ug/kg	ND	100	50	0	2
PCB-1268	ug/kg	ND	80	40	0	2
Polychlorinated biphenyl	ug/kg	ND	130	62.5	0	2
Potassium	mg/kg	119	156	138	2	2
Selenium	mg/kg	ND	19.4	9.62	0	2
Silver	mg/kg	ND	2.43	1.21	0	2
Sodium	mg/kg	ND	97	48.1	0	2
Thallium	mg/kg	ND	19.4	9.62	0	2
Total Organic Carbon (TOC)	ug/g	6800	6800	6800	1	1
Uranium	mg/kg	ND	158	103	1	2
Vanadium	mg/kg	11.2	26.9	19	2	2
Zinc	mg/kg	ND	19.4	9.62	0	2

Sediment Non-Radiological Data

Table 4.25 Non-Radiological Data for Sediment Location C612

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Aluminum	mg/kg	4490	8420	6460	2	2
Antimony	mg/kg	ND	9.88	4.75	0	2
Arsenic	mg/kg	ND	19.8	9.5	0	2
Barium	mg/kg	35.3	92.5	63.9	2	2
Beryllium	mg/kg	ND	0.619	0.433	1	2
Cadmium	mg/kg	ND	2.2	1.59	1	2
Calcium	mg/kg	1170	2060	1620	2	2
Chromium	mg/kg	12.9	43.8	28.3	2	2
Cobalt	mg/kg	3.19	3.7	3.44	2	2
Copper	mg/kg	9.34	52.2	30.8	2	2
Grain Size Diameter Fines	%	31.9	31.9	31.9	1	1
Iron	mg/kg	8360	9380	8870	2	2
Lead	mg/kg	ND	19.8	9.5	0	2
Magnesium	mg/kg	591	1240	916	2	2
Manganese	mg/kg	61.7	81.5	71.6	2	2
Mercury	mg/kg	ND	0.17	0.0657	0	2
Moisture	%	58.7	58.7	58.7	1	1
Nickel	mg/kg	8.2	13.6	10.9	2	2
PCB-1016	ug/kg	ND	90	45	0	2
PCB-1221	ug/kg	ND	120	60	0	2
PCB-1232	ug/kg	ND	90	45	0	2
PCB-1242	ug/kg	ND	60	30	0	2
PCB-1248	ug/kg	ND	90	45	0	2
PCB-1254	ug/kg	ND	80	40	0	2
PCB-1260	ug/kg	ND	90	45	0	2
PCB-1268	ug/kg	ND	70	35	0	2
Polychlorinated biphenyl	ug/kg	ND	120	60	0	2
Potassium	mg/kg	381	635	508	2	2
Selenium	mg/kg	ND	19.8	9.5	0	2
Silver	mg/kg	ND	2.47	1.19	0	2
Sodium	mg/kg	228	247	238	2	2
Thallium	mg/kg	ND	19.8	9.5	0	2
Total Organic Carbon (TOC)	ug/g	4200	4200	4200	1	1
Uranium	mg/kg	ND	312	181	1	2
Vanadium	mg/kg	15.2	20	17.6	2	2
Zinc	mg/kg	27.2	33.4	30.3	2	2

Sediment Non-Radiological Data

Table 4.26 Non-Radiological Data for Sediment Location C616

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Aluminum	mg/kg	4720	7100	5910	2	2
Antimony	mg/kg	ND	9.15	4.44	0	2
Arsenic	mg/kg	ND	18.3	8.87	0	2
Barium	mg/kg	61.7	86.1	73.9	2	2
Beryllium	mg/kg	0.552	0.796	0.674	2	2
Cadmium	mg/kg	2.02	2.04	2.03	2	2
Calcium	mg/kg	1090	1160	1120	2	2
Chromium	mg/kg	22.3	22.8	22.5	2	2
Cobalt	mg/kg	3.54	6.69	5.12	2	2
Copper	mg/kg	16.9	25.4	21.1	2	2
Grain Size Diameter Fines	%	11.8	11.8	11.8	1	1
Iron	mg/kg	8270	19800	14000	2	2
Lead	mg/kg	ND	18.3	8.87	0	2
Magnesium	mg/kg	701	828	764	2	2
Manganese	mg/kg	55.2	494	275	2	2
Mercury	mg/kg	ND	0.19	0.0717	0	2
Moisture	%	43.8	43.8	43.8	1	1
Nickel	mg/kg	7.37	10.4	8.88	2	2
PCB-1016	ug/kg	ND	100	50	0	2
PCB-1221	ug/kg	ND	130	65	0	2
PCB-1232	ug/kg	ND	100	50	0	2
PCB-1242	ug/kg	ND	60	30	0	2
PCB-1248	ug/kg	ND	100	50	0	2
PCB-1254	ug/kg	ND	90	45	0	2
PCB-1260	ug/kg	ND	100	50	0	2
PCB-1268	ug/kg	ND	80	40	0	2
Polychlorinated biphenyl	ug/kg	ND	130	65	0	2
Potassium	mg/kg	415	451	433	2	2
Selenium	mg/kg	ND	18.3	8.87	0	2
Silver	mg/kg	ND	2.29	1.11	0	2
Sodium	mg/kg	178	282	230	2	2
Thallium	mg/kg	ND	18.3	8.87	0	2
Total Organic Carbon (TOC)	ug/g	3600	3600	3600	1	1
Uranium	mg/kg	ND	225	135	1	2
Vanadium	mg/kg	9.65	35.5	22.6	2	2
Zinc	mg/kg	30.1	30.9	30.5	2	2

Sediment Non-Radiological Data

Table 4.27 Non-Radiological Data for Sediment Location K001

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Aluminum	mg/kg	4690	5470	5080	2	2
Antimony	mg/kg	ND	9.74	4.62	0	2
Arsenic	mg/kg	ND	19.5	9.25	0	2
Barium	mg/kg	44.1	49.5	46.8	2	2
Beryllium	mg/kg	ND	0.487	0.231	0	2
Cadmium	mg/kg	ND	1.95	0.925	0	2
Calcium	mg/kg	884	1820	1350	2	2
Chromium	mg/kg	13	13.4	13.2	2	2
Cobalt	mg/kg	2.63	2.91	2.77	2	2
Copper	mg/kg	20.4	23.8	22.1	2	2
Grain Size Diameter Fines	%	46.6	46.6	46.6	1	1
Iron	mg/kg	5790	6510	6150	2	2
Lead	mg/kg	ND	19.5	9.25	0	2
Magnesium	mg/kg	623	722	672	2	2
Manganese	mg/kg	25.2	47.4	36.3	2	2
Mercury	mg/kg	ND	0.2	0.0727	0	2
Moisture	%	134	134	134	1	1
Nickel	mg/kg	ND	4.87	2.31	0	2
PCB-1016	ug/kg	ND	100	47.5	0	2
PCB-1221	ug/kg	ND	130	62.5	0	2
PCB-1232	ug/kg	ND	100	47.5	0	2
PCB-1242	ug/kg	ND	60	30	0	2
PCB-1248	ug/kg	ND	100	47.5	0	2
PCB-1254	ug/kg	ND	90	42.5	0	2
PCB-1260	ug/kg	ND	100	47.5	0	2
PCB-1268	ug/kg	ND	80	37.5	0	2
Polychlorinated biphenyl	ug/kg	ND	130	62.5	0	2
Potassium	mg/kg	415	425	420	2	2
Selenium	mg/kg	ND	19.5	9.25	0	2
Silver	mg/kg	ND	2.44	1.16	0	2
Sodium	mg/kg	219	260	240	2	2
Thallium	mg/kg	ND	19.5	9.25	0	2
Total Organic Carbon (TOC)	ug/g	4900	4900	4900	1	1
Uranium	mg/kg	ND	163	103	1	2
Vanadium	mg/kg	7.96	9.37	8.66	2	2
Zinc	mg/kg	22.8	34.4	28.6	2	2

Sediment Non-Radiological Data

Table 4.28 Non-Radiological Data for Sediment Location S1

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Aluminum	mg/kg	2480	4010	3240	2	2
Antimony	mg/kg	ND	9.51	4.68	0	2
Arsenic	mg/kg	ND	19	9.35	0	2
Barium	mg/kg	21.7	33.8	27.7	2	2
Beryllium	mg/kg	ND	0.475	0.234	0	2
Cadmium	mg/kg	ND	1.9	0.935	0	2
Calcium	mg/kg	1540	2130	1840	2	2
Chromium	mg/kg	6.65	10.7	8.68	2	2
Cobalt	mg/kg	3.89	4.48	4.18	2	2
Copper	mg/kg	8.61	9.95	9.28	2	2
Grain Size Diameter Fines	%	14.5	14.5	14.5	1	1
Iron	mg/kg	5980	8480	7230	2	2
Lead	mg/kg	ND	19	9.35	0	2
Magnesium	mg/kg	328	489	408	2	2
Manganese	mg/kg	80.2	397	239	2	2
Mercury	mg/kg	ND	0.13	0.0557	0	2
Moisture	%	54.4	54.4	54.4	1	1
Nickel	mg/kg	ND	4.75	2.34	0	2
PCB-1016	ug/kg	ND	100	47.5	0	2
PCB-1221	ug/kg	ND	130	62.5	0	2
PCB-1232	ug/kg	ND	100	47.5	0	2
PCB-1242	ug/kg	ND	60	30	0	2
PCB-1248	ug/kg	ND	100	47.5	0	2
PCB-1254	ug/kg	ND	90	42.5	0	2
PCB-1260	ug/kg	ND	100	47.5	0	2
PCB-1268	ug/kg	ND	80	37.5	0	2
Polychlorinated biphenyl	ug/kg	ND	130	62.5	0	2
Potassium	mg/kg	215	217	216	2	2
Selenium	mg/kg	ND	19	9.35	0	2
Silver	mg/kg	ND	2.38	1.17	0	2
Sodium	mg/kg	115	190	152	2	2
Thallium	mg/kg	ND	19	9.35	0	2
Total Organic Carbon (TOC)	ug/g	6000	6000	6000	1	1
Uranium	mg/kg	ND	159	103	1	2
Vanadium	mg/kg	10.1	12.9	11.5	2	2
Zinc	mg/kg	27.7	28.6	28.1	2	2

Sediment Non-Radiological Data

Table 4.29 Non-Radiological Data for Sediment Location S31

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Aluminum	mg/kg	2500	3390	2940	2	2
Antimony	mg/kg	ND	9.1	4.49	0	2
Arsenic	mg/kg	ND	18.2	8.97	0	2
Barium	mg/kg	33.2	39.8	36.5	2	2
Beryllium	mg/kg	ND	0.455	0.225	0	2
Cadmium	mg/kg	ND	2.32	1.61	1	2
Calcium	mg/kg	2660	16200	9430	2	2
Chromium	mg/kg	16.4	18.5	17.4	2	2
Cobalt	mg/kg	2.35	2.39	2.37	2	2
Copper	mg/kg	41.2	46.4	43.8	2	2
Grain Size Diameter Fines	%	36.6	36.6	36.6	1	1
Iron	mg/kg	5400	5820	5610	2	2
Lead	mg/kg	ND	19.8	14.4	1	2
Magnesium	mg/kg	723	1040	882	2	2
Manganese	mg/kg	40.1	44.7	42.4	2	2
Mercury	mg/kg	0.49	0.49	0.49	2	2
Moisture	%	212	212	212	1	1
Nickel	mg/kg	17.1	22.4	19.7	2	2
PCB-1016	ug/kg	ND	100	47.5	0	2
PCB-1221	ug/kg	ND	130	62.5	0	2
PCB-1232	ug/kg	ND	100	47.5	0	2
PCB-1242	ug/kg	ND	60	27.5	0	2
PCB-1248	ug/kg	ND	100	47.5	0	2
PCB-1254	ug/kg	ND	90	42.5	0	2
PCB-1260	ug/kg	ND	2430	1240	1	2
PCB-1268	ug/kg	ND	80	37.5	0	2
Polychlorinated biphenyl	ug/kg	ND	2430	1250	1	2
Potassium	mg/kg	181	220	200	2	2
Selenium	mg/kg	ND	18.2	8.97	0	2
Silver	mg/kg	ND	2.28	1.12	0	2
Sodium	mg/kg	130	150	140	2	2
Thallium	mg/kg	ND	18.2	8.97	0	2
Total Organic Carbon (TOC)	ug/g	15000	15000	15000	1	1
Uranium	mg/kg	ND	174	110	1	2
Vanadium	mg/kg	6.33	9.88	8.11	2	2
Zinc	mg/kg	98.7	133	116	2	2

Sediment Non-Radiological Data

Table 4.30 Non-Radiological Data for Sediment Location S33

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Aluminum	mg/kg	2510	3230	2870	2	2
Antimony	mg/kg	ND	9.69	4.68	0	2
Arsenic	mg/kg	ND	19.4	9.37	0	2
Barium	mg/kg	26.7	28.6	27.6	2	2
Beryllium	mg/kg	ND	0.484	0.234	0	2
Cadmium	mg/kg	ND	1.94	0.937	0	2
Calcium	mg/kg	358	552	455	2	2
Chromium	mg/kg	7.19	7.27	7.23	2	2
Cobalt	mg/kg	ND	2.87	2.04	1	2
Copper	mg/kg	3.9	5.51	4.7	2	2
Grain Size Diameter Fines	%	29.7	29.7	29.7	1	1
Iron	mg/kg	5020	5830	5420	2	2
Lead	mg/kg	ND	19.4	9.37	0	2
Magnesium	mg/kg	263	329	296	2	2
Manganese	mg/kg	136	230	183	2	2
Mercury	mg/kg	ND	0.2	0.0737	0	2
Moisture	%	32	32	32	1	1
Nickel	mg/kg	ND	4.84	2.34	0	2
PCB-1016	ug/kg	ND	5720	2880	1	2
PCB-1221	ug/kg	ND	130	62.5	0	2
PCB-1232	ug/kg	ND	100	47.5	0	2
PCB-1242	ug/kg	ND	60	30	0	2
PCB-1248	ug/kg	ND	100	47.5	0	2
PCB-1254	ug/kg	ND	90	42.5	0	2
PCB-1260	ug/kg	ND	100	47.5	0	2
PCB-1268	ug/kg	ND	80	37.5	0	2
Polychlorinated biphenyl	ug/kg	ND	5720	2890	1	2
Potassium	mg/kg	182	200	191	2	2
Selenium	mg/kg	ND	19.4	9.37	0	2
Silver	mg/kg	ND	2.42	1.17	0	2
Sodium	mg/kg	ND	96.9	46.8	0	2
Thallium	mg/kg	ND	19.4	9.37	0	2
Total Organic Carbon (TOC)	ug/g	2700	2700	2700	1	1
Uranium	mg/kg	ND	146	97.2	1	2
Vanadium	mg/kg	10.2	11	10.6	2	2
Zinc	mg/kg	ND	19.4	9.37	0	2

Sediment Non-Radiological Data

Table 4.31 Non-Radiological Data for Sediment Location S2

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Aluminum	mg/kg	3830	4280	4060	2	2
Antimony	mg/kg	ND	9.96	4.67	0	2
Arsenic	mg/kg	ND	19.9	9.32	0	2
Barium	mg/kg	31.3	48.9	40.1	2	2
Beryllium	mg/kg	ND	0.498	0.234	0	2
Cadmium	mg/kg	ND	1.99	0.932	0	2
Calcium	mg/kg	897	1530	1210	2	2
Chromium	mg/kg	16.6	25.8	21.2	2	2
Cobalt	mg/kg	3.04	5.88	4.46	2	2
Copper	mg/kg	4.97	5.94	5.45	2	2
Grain Size Diameter Fines	%	37.2	37.2	37.2	1	1
Iron	mg/kg	6040	8520	7280	2	2
Lead	mg/kg	ND	19.9	9.32	0	2
Magnesium	mg/kg	383	399	391	2	2
Manganese	mg/kg	219	510	364	2	2
Mercury	mg/kg	ND	0.14	0.0592	0	2
Moisture	%	42.6	42.6	42.6	1	1
Nickel	mg/kg	ND	4.98	2.33	0	2
PCB-1016	ug/kg	ND	100	47.5	0	2
PCB-1221	ug/kg	ND	130	60	0	2
PCB-1232	ug/kg	ND	100	47.5	0	2
PCB-1242	ug/kg	ND	60	27.5	0	2
PCB-1248	ug/kg	ND	100	47.5	0	2
PCB-1254	ug/kg	ND	90	42.5	0	2
PCB-1260	ug/kg	ND	100	47.5	0	2
PCB-1268	ug/kg	ND	80	37.5	0	2
Polychlorinated biphenyl	ug/kg	ND	130	60	0	2
Potassium	mg/kg	204	208	206	2	2
Selenium	mg/kg	ND	19.9	9.32	0	2
Silver	mg/kg	ND	2.49	1.17	0	2
Sodium	mg/kg	ND	107	78.4	1	2
Thallium	mg/kg	ND	19.9	9.32	0	2
Total Organic Carbon (TOC)	ug/g	6900	6900	6900	1	1
Uranium	mg/kg	ND	179	114	1	2
Vanadium	mg/kg	11.5	16.3	13.9	2	2
Zinc	mg/kg	26.2	29.8	28	2	2

Sediment Non-Radiological Data

Table 4.32 Non-Radiological Data for Sediment Location S27

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Aluminum	mg/kg	3480	4630	4100	3	3
Antimony	mg/kg	ND	9.7	4.72	0	3
Arsenic	mg/kg	ND	19.4	9.43	0	3
Barium	mg/kg	32.3	42.8	36.5	3	3
Beryllium	mg/kg	ND	0.485	0.236	0	3
Cadmium	mg/kg	ND	1.94	0.943	0	3
Calcium	mg/kg	433	533	483	3	3
Chromium	mg/kg	7.95	26.5	20	3	3
Cobalt	mg/kg	ND	2.5	1.61	1	3
Copper	mg/kg	3.83	6.75	5.73	3	3
Grain Size Diameter Fines	%	38.4	38.4	38.4	1	1
Iron	mg/kg	3950	5950	4760	3	3
Lead	mg/kg	ND	19.4	9.43	0	3
Magnesium	mg/kg	344	434	394	3	3
Manganese	mg/kg	83.5	103	90.6	3	3
Mercury	mg/kg	ND	0.19	0.0632	0	3
Moisture	%	27.6	27.6	27.6	1	1
Nickel	mg/kg	ND	4.85	2.36	0	3
PCB-1016	ug/kg	ND	100	46.7	0	3
PCB-1221	ug/kg	ND	130	61.7	0	3
PCB-1232	ug/kg	ND	100	46.7	0	3
PCB-1242	ug/kg	ND	60	30	0	3
PCB-1248	ug/kg	ND	100	46.7	0	3
PCB-1254	ug/kg	ND	90	41.7	0	3
PCB-1260	ug/kg	ND	100	46.7	0	3
PCB-1268	ug/kg	ND	80	36.7	0	3
Polychlorinated biphenyl	ug/kg	ND	130	61.7	0	3
Potassium	mg/kg	222	311	260	3	3
Selenium	mg/kg	ND	19.4	9.43	0	3
Silver	mg/kg	ND	2.43	1.18	0	3
Sodium	mg/kg	ND	122	94.6	2	3
Thallium	mg/kg	ND	19.4	9.43	0	3
Total Organic Carbon (TOC)	ug/g	1800	1800	1800	1	1
Uranium	mg/kg	ND	116	88.6	2	3
Vanadium	mg/kg	9.02	10.8	10.1	3	3
Zinc	mg/kg	ND	20.9	16.7	2	3

Sediment Non-Radiological Data

Table 4.33 Non-Radiological Data for Sediment Location S34

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Aluminum	mg/kg	3030	11000	6180	3	3
Antimony	mg/kg	ND	9.32	4.58	0	3
Arsenic	mg/kg	ND	18.6	9.15	0	3
Barium	mg/kg	28.5	98.9	55.1	3	3
Beryllium	mg/kg	ND	0.587	0.348	1	3
Cadmium	mg/kg	ND	1.86	0.915	0	3
Calcium	mg/kg	493	1230	744	3	3
Chromium	mg/kg	11.5	34.5	24	3	3
Cobalt	mg/kg	3.99	5.86	5	3	3
Copper	mg/kg	4.68	11.3	7.81	3	3
Grain Size Diameter Fines	%	31	35.4	33.2	2	2
Iron	mg/kg	4450	10500	6660	3	3
Lead	mg/kg	ND	18.6	9.15	0	3
Magnesium	mg/kg	265	878	494	3	3
Manganese	mg/kg	48.3	146	100	3	3
Mercury	mg/kg	ND	0.2	0.079	0	3
Moisture	%	31.7	33.8	32.7	2	2
Nickel	mg/kg	ND	5.96	3.51	1	3
PCB-1016	ug/kg	ND	100	46.7	0	3
PCB-1221	ug/kg	ND	120	60	0	3
PCB-1232	ug/kg	ND	100	46.7	0	3
PCB-1242	ug/kg	ND	60	28.3	0	3
PCB-1248	ug/kg	ND	100	46.7	0	3
PCB-1254	ug/kg	ND	90	43.3	0	3
PCB-1260	ug/kg	ND	100	46.7	0	3
PCB-1268	ug/kg	ND	80	38.3	0	3
Polychlorinated biphenyl	ug/kg	ND	120	60	0	3
Potassium	mg/kg	167	540	344	3	3
Selenium	mg/kg	ND	18.6	9.15	0	3
Silver	mg/kg	ND	2.33	1.14	0	3
Sodium	mg/kg	ND	113	68.2	1	3
Thallium	mg/kg	ND	18.6	9.15	0	3
Total Organic Carbon (TOC)	ug/g	2100	2100	2100	2	2
Uranium	mg/kg	ND	117	69.8	1	3
Vanadium	mg/kg	6.33	20.1	12.1	3	3
Zinc	mg/kg	ND	40.4	19.5	1	3

Sediment Non-Radiological Data

Table 4.34 Non-Radiological Data for Sediment Location C746KTB2

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Aluminum	mg/kg	3010	5720	4360	2	2
Antimony	mg/kg	ND	9.3	4.54	0	2
Arsenic	mg/kg	ND	18.6	9.07	0	2
Barium	mg/kg	23.3	44.1	33.7	2	2
Beryllium	mg/kg	ND	0.465	0.227	0	2
Cadmium	mg/kg	ND	1.86	0.907	0	2
Calcium	mg/kg	418	861	640	2	2
Chromium	mg/kg	7.19	9.92	8.55	2	2
Cobalt	mg/kg	2.73	4.69	3.71	2	2
Copper	mg/kg	4.37	4.87	4.62	2	2
Grain Size Diameter Fines	%	31.4	31.4	31.4	1	1
Iron	mg/kg	5550	8460	7000	2	2
Lead	mg/kg	ND	18.6	9.07	0	2
Magnesium	mg/kg	265	477	371	2	2
Manganese	mg/kg	168	403	286	2	2
Mercury	mg/kg	ND	0.18	0.0668	0	2
Moisture	%	52	52	52	1	1
Nickel	mg/kg	ND	4.65	2.27	0	2
PCB-1016	ug/kg	ND	100	47.5	0	2
PCB-1221	ug/kg	ND	130	62.5	0	2
PCB-1232	ug/kg	ND	100	47.5	0	2
PCB-1242	ug/kg	ND	60	30	0	2
PCB-1248	ug/kg	ND	100	47.5	0	2
PCB-1254	ug/kg	ND	90	42.5	0	2
PCB-1260	ug/kg	ND	100	47.5	0	2
PCB-1268	ug/kg	ND	80	40	0	2
Polychlorinated biphenyl	ug/kg	ND	130	62.5	0	2
Potassium	mg/kg	192	318	255	2	2
Selenium	mg/kg	ND	18.6	9.07	0	2
Silver	mg/kg	ND	2.32	1.13	0	2
Sodium	mg/kg	ND	93	45.4	0	2
Thallium	mg/kg	ND	18.6	9.07	0	2
Total Organic Carbon (TOC)	ug/g	5400	5400	5400	1	1
Uranium	mg/kg	ND	137	91.7	1	2
Vanadium	mg/kg	11.1	15.9	13.5	2	2
Zinc	mg/kg	ND	21.6	15.2	1	2

Sediment Non-Radiological Data

Table 4.35 Non-Radiological Data for Sediment Location L194

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Aluminum	mg/kg	4270	6560	5420	2	2
Antimony	mg/kg	ND	9.47	4.67	0	2
Arsenic	mg/kg	ND	18.9	9.32	0	2
Barium	mg/kg	31.1	54.4	42.7	2	2
Beryllium	mg/kg	ND	0.473	0.234	0	2
Cadmium	mg/kg	ND	1.89	0.932	0	2
Calcium	mg/kg	1030	1040	1040	2	2
Chromium	mg/kg	11.3	14.8	13	2	2
Cobalt	mg/kg	3	4.76	3.88	2	2
Copper	mg/kg	3.84	8.08	5.96	2	2
Grain Size Diameter Fines	%	44	44	44	1	1
Iron	mg/kg	5110	7450	6280	2	2
Lead	mg/kg	ND	18.9	9.32	0	2
Magnesium	mg/kg	421	563	492	2	2
Manganese	mg/kg	119	268	194	2	2
Mercury	mg/kg	ND	0.12	0.0542	0	2
Moisture	%	40.3	40.3	40.3	1	1
Nickel	mg/kg	ND	4.73	2.33	0	2
PCB-1016	ug/kg	ND	100	47.5	0	2
PCB-1221	ug/kg	ND	130	62.5	0	2
PCB-1232	ug/kg	ND	100	47.5	0	2
PCB-1242	ug/kg	ND	60	30	0	2
PCB-1248	ug/kg	ND	100	47.5	0	2
PCB-1254	ug/kg	ND	90	42.5	0	2
PCB-1260	ug/kg	ND	100	47.5	0	2
PCB-1268	ug/kg	ND	80	37.5	0	2
Polychlorinated biphenyl	ug/kg	ND	130	62.5	0	2
Potassium	mg/kg	228	241	234	2	2
Selenium	mg/kg	ND	18.9	9.32	0	2
Silver	mg/kg	ND	2.37	1.17	0	2
Sodium	mg/kg	ND	102	74.7	1	2
Thallium	mg/kg	ND	18.9	9.32	0	2
Total Organic Carbon (TOC)	ug/g	3100	3100	3100	1	1
Uranium	mg/kg	ND	152	99.7	1	2
Vanadium	mg/kg	9.64	12.9	11.3	2	2
Zinc	mg/kg	20	38.7	29.3	2	2

Sediment Non-Radiological Data

Table 4.36 Non-Radiological Data for Sediment Location S32

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Aluminum	mg/kg	5070	7070	6070	2	2
Antimony	mg/kg	ND	9.94	4.87	0	2
Arsenic	mg/kg	ND	19.9	9.75	0	2
Barium	mg/kg	38.5	52.5	45.5	2	2
Beryllium	mg/kg	ND	0.497	0.244	0	2
Cadmium	mg/kg	ND	1.99	0.975	0	2
Calcium	mg/kg	1230	2490	1860	2	2
Chromium	mg/kg	22.5	30.9	26.7	2	2
Cobalt	mg/kg	3.11	4.37	3.74	2	2
Copper	mg/kg	18.8	36.9	27.8	2	2
Grain Size Diameter Fines	%	30.3	30.3	30.3	1	1
Iron	mg/kg	6370	9820	8100	2	2
Lead	mg/kg	ND	19.9	9.75	0	2
Magnesium	mg/kg	522	809	666	2	2
Manganese	mg/kg	122	302	212	2	2
Mercury	mg/kg	ND	0.2	0.145	1	2
Moisture	%	77.9	77.9	77.9	1	1
Nickel	mg/kg	16	17.5	16.7	2	2
PCB-1016	ug/kg	ND	90	42.5	0	2
PCB-1221	ug/kg	ND	120	57.5	0	2
PCB-1232	ug/kg	ND	90	42.5	0	2
PCB-1242	ug/kg	ND	60	27.5	0	2
PCB-1248	ug/kg	ND	90	42.5	0	2
PCB-1254	ug/kg	390	830	610	2	2
PCB-1260	ug/kg	380	580	480	2	2
PCB-1268	ug/kg	ND	70	35	0	2
Polychlorinated biphenyl	ug/kg	770	1410	1090	2	2
Potassium	mg/kg	318	523	420	2	2
Selenium	mg/kg	ND	19.9	9.75	0	2
Silver	mg/kg	ND	2.51	1.85	1	2
Sodium	mg/kg	ND	110	79.8	1	2
Thallium	mg/kg	ND	19.9	9.75	0	2
Total Organic Carbon (TOC)	ug/g	15000	15000	15000	1	1
Uranium	mg/kg	ND	211	129	1	2
Vanadium	mg/kg	9.46	13.2	11.3	2	2
Zinc	mg/kg	70.4	88.2	79.3	2	2

Sediment Non-Radiological Data

Table 4.37 Non-Radiological Data for Sediment Location S28

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Aluminum	mg/kg	1390	2490	1940	2	2
Antimony	mg/kg	ND	9.69	4.74	0	2
Arsenic	mg/kg	ND	19.4	9.47	0	2
Barium	mg/kg	15.3	30	22.6	2	2
Beryllium	mg/kg	ND	0.485	0.237	0	2
Cadmium	mg/kg	ND	1.94	0.947	0	2
Calcium	mg/kg	136	368	252	2	2
Chromium	mg/kg	3.72	4.58	4.15	2	2
Cobalt	mg/kg	ND	7.06	4.13	1	2
Copper	mg/kg	3.1	3.95	3.52	2	2
Grain Size Diameter Fines	%	15.5	15.5	15.5	1	1
Iron	mg/kg	2850	5360	4100	2	2
Lead	mg/kg	ND	19.4	9.47	0	2
Magnesium	mg/kg	115	261	188	2	2
Manganese	mg/kg	51.8	464	258	2	2
Mercury	mg/kg	ND	0.1	0.0482	0	2
Moisture	%	32.1	32.1	32.1	1	1
Nickel	mg/kg	ND	5.97	4.2	1	2
PCB-1016	ug/kg	ND	100	47.5	0	2
PCB-1221	ug/kg	ND	130	62.5	0	2
PCB-1232	ug/kg	ND	100	47.5	0	2
PCB-1242	ug/kg	ND	60	30	0	2
PCB-1248	ug/kg	ND	100	47.5	0	2
PCB-1254	ug/kg	ND	90	42.5	0	2
PCB-1260	ug/kg	ND	100	47.5	0	2
PCB-1268	ug/kg	ND	80	37.5	0	2
Polychlorinated biphenyl	ug/kg	ND	130	62.5	0	2
Potassium	mg/kg	113	164	138	2	2
Selenium	mg/kg	ND	19.4	9.47	0	2
Silver	mg/kg	ND	2.42	1.18	0	2
Sodium	mg/kg	ND	96.9	47.3	0	2
Thallium	mg/kg	ND	19.4	9.47	0	2
Total Organic Carbon (TOC)	ug/g	2400	2400	2400	1	1
Uranium	mg/kg	ND	96.9	47.3	0	2
Vanadium	mg/kg	5.5	8.76	7.13	2	2
Zinc	mg/kg	ND	20.8	15.2	1	2

Deer Non-Radiological Data

Table 4.38 Non-Radiological Analysis of Deer Liver Tissue for 2005

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Aluminum	mg/kg	ND	3.21	2.32	4	6
Antimony	mg/kg	ND	1.51	0.882	3	6
Arsenic	mg/kg	ND	0.15	0.0717	0	6
Barium	mg/kg	0.0866	0.223	0.163	6	6
Beryllium	mg/kg	ND	0.0139	0.00723	1	6
Cadmium	mg/kg	ND	0.307	0.161	3	6
Chromium	mg/kg	0.135	0.273	0.185	6	6
Cobalt	mg/kg	ND	0.158	0.0769	0	6
Copper	mg/kg	18.8	65	39.6	6	6
Iron	mg/kg	86.2	111	101	6	6
Lead	mg/kg	ND	1.25	0.608	0	6
Lipids	%	5.49	7.54	6.16	6	6
Manganese	mg/kg	2.85	5.56	4.29	6	6
Mercury	mg/kg	ND	0.05	0.0247	0	6
Nickel	mg/kg	ND	0.421	0.205	0	6
PCB-1016	ug/kg	ND	9.66	4.63	0	6
PCB-1221	ug/kg	ND	9.66	4.63	0	6
PCB-1232	ug/kg	ND	9.66	4.63	0	6
PCB-1242	ug/kg	ND	9.66	4.63	0	6
PCB-1248	ug/kg	ND	9.66	4.63	0	6
PCB-1254	ug/kg	ND	9.66	4.63	0	6
PCB-1260	ug/kg	ND	9.66	4.63	0	6
PCB-1268	ug/kg	ND	10.7	5.62	1	6
Polychlorinated biphenyl	ug/kg	ND	10.7	5.62	1	6
Selenium	mg/kg	ND	0.527	0.308	4	6
Silver	mg/kg	ND	0.184	0.0896	0	6
Thallium	mg/kg	ND	1.41	1	5	6
Vanadium	mg/kg	ND	0.29	0.168	3	6
Zinc	mg/kg	29.6	39.5	34.8	6	6

Deer Non-Radiological Data

Table 4.39 Non-Radiological Analysis of Deer Muscle Tissue for 2005

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Aluminum	mg/kg	ND	2.53	1.78	4	6
Antimony	mg/kg	ND	1.47	0.631	1	6
Arsenic	mg/kg	ND	0.15	0.0725	0	6
Barium	mg/kg	0.0562	0.119	0.0923	6	6
Beryllium	mg/kg	ND	0.0121	0.00592	0	6
Cadmium	mg/kg	ND	0.185	0.0877	1	6
Chromium	mg/kg	0.138	0.861	0.405	6	6
Cobalt	mg/kg	ND	0.157	0.0768	0	6
Copper	mg/kg	1.27	1.64	1.46	6	6
Iron	mg/kg	41	160	66.3	6	6
Lead	mg/kg	ND	1.24	0.607	0	6
Manganese	mg/kg	0.303	1.04	0.479	6	6
Mercury	mg/kg	ND	0.05	0.0245	0	6
Nickel	mg/kg	ND	0.418	0.204	0	6
Selenium	mg/kg	ND	0.247	0.121	0	6
Silver	mg/kg	ND	0.183	0.0893	0	6
Thallium	mg/kg	ND	2.8	1.14	3	6
Vanadium	mg/kg	ND	0.337	0.129	1	6
Zinc	mg/kg	11.1	17.6	13.8	6	6

Table 4.40 Non-Radiological Analysis of Deer Kidney Tissue for 2005

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Aluminum	mg/kg	ND	1.54	0.756	0	6
Antimony	mg/kg	ND	0.951	0.468	0	6
Arsenic	mg/kg	ND	0.15	0.0742	0	6
Barium	mg/kg	0.355	0.603	0.466	6	6
Beryllium	mg/kg	ND	0.0121	0.00597	0	6
Cadmium	mg/kg	0.264	3.34	1.61	6	6
Chromium	mg/kg	ND	0.27	0.144	3	6
Cobalt	mg/kg	ND	0.158	0.0775	0	6
Copper	mg/kg	3.6	4.73	4	6	6
Iron	mg/kg	50.5	98.6	82.6	6	6
Lead	mg/kg	ND	1.24	0.612	0	6
Manganese	mg/kg	1.53	1.92	1.77	6	6
Mercury	mg/kg	ND	0.05	0.0242	0	6
Nickel	mg/kg	ND	0.42	0.206	0	6
Selenium	mg/kg	1	1.33	1.19	6	6
Silver	mg/kg	ND	0.183	0.0902	0	6
Thallium	mg/kg	ND	1.52	0.549	1	6
Vanadium	mg/kg	ND	0.222	0.111	1	6
Zinc	mg/kg	17.6	23.9	21	6	6

Deer Non-Radiological Data

Table 4.41 Non-Radiological Analysis of Deer Fat Tissue for 2005

Analysis	Units	Minimum	Maximum	Average	Count Detects	Count Samples
Lipids	%	26.1	89.6	58.1	10	10
PCB-1016	ug/kg	ND	9.75	4.68	0	10
PCB-1221	ug/kg	ND	9.75	4.68	0	10
PCB-1232	ug/kg	ND	9.75	4.68	0	10
PCB-1242	ug/kg	ND	9.75	4.68	0	10
PCB-1248	ug/kg	ND	9.75	4.68	0	10
PCB-1254	ug/kg	ND	9.75	4.68	0	10
PCB-1260	ug/kg	ND	9.75	4.68	0	10
PCB-1268	ug/kg	ND	112	34.6	4	10
Polychlorinated biphenyl	ug/kg	ND	112	34.6	4	10

Paducah Annual Site Environmental Report 2005
Data Summary