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Portsmouth Annual Environmental Report for 2001

Canadian geese at the Portsmouth Gaseous Diffusion Plant

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Portsmouth Annual Environmental Report
for 2001
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for release to the public.

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ACRONYMS

CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
Ci	curie
DOE	U.S. Department of Energy
DOE/PORTS	facilities operated by DOE (not leased to USEC) at the Portsmouth Gaseous Diffusion Plant
EPA	Environmental Protection Agency
HF	hydrogen fluoride
kg	kilogram
LLW	low-level radioactive waste
mg/L	milligram per liter (equivalent to part per million)
Fg/L	microgram per liter (equivalent to part per billion)
Fg/m^3	microgram per cubic meter
mrem	millirem
NPDES	National Pollutant Discharge Elimination System
PCB	polychlorinated biphenyl
pCi/g	picocurie per gram
pCi/L	picocurie per liter
PK	Peter Kiewit
PORTS	Portsmouth Gaseous Diffusion Plant
RCRA	Resource Conservation and Recovery Act
SODI	Southern Ohio Diversification Initiative
TLD	thermoluminescent dosimeter
USEC	United States Enrichment Corporation

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DEFINITIONS

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

activity – See "radioactivity."

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

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

analyte – A constituent or parameter being analyzed.

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

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

background radiation – Radiation that occurs naturally in the surrounding environment.

beta particle – A negatively charged particle emitted from the nucleus of an atom during radioactive decay. 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.

categorical exclusion – A class of actions that either individually or cumulatively would not have a significant effect on the human environment and therefore would not require preparation of an environmental assessment or environmental impact statement under the National Environmental Policy Act.

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

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

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

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

contamination – Deposition of unwanted material on the surfaces of 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.

critical habitat – Specific areas that may require special management considerations or protection and on which physical or biological features essential to the conservation of a species are found.

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 commonly used:

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 (FCi) – 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; 0.037 disintegration per second.

decontamination and decommissioning – The cleanup and removal of buildings, structures, or objects contaminated with hazardous substances during past production or disposal activities.

derived concentration guide – 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 or a dose equivalent of 5 rem to any tissue, including skin and the lens of the eye. The guidelines for radionuclides in air and water are provided in DOE Order 5400.5, *Radiation Protection of the Public and the Environment.*

dissolved solids – Organic or inorganic material dissolved in water. Excessive amounts of dissolved solids make water unfit to drink or to use in industrial processes.

downgradient – In the direction of groundwater flow.

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

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

effluent monitoring – The collection and analysis of samples or measurement of liquid and gaseous effluents to characterize and quantify the release of contaminants, assess radiation exposures to the public, and demonstrate 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 incident of radiation on living or inanimate material by accident or intent. Background exposure is the exposure to natural background ionizing radiation. Occupational exposure is exposure to ionizing radiation that takes place at a person's workplace. Population exposure is the exposure to the total number of persons who inhabit an area.

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

formation – In geologic terms, a unit of rock or a unit of material that could form a rock such as sand.

friable – The ability of a material to be pulverized, crumbled, or reduced to powder by hand pressure when dry.

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

glove box – An enclosure with built-in sleeves and gloves used by a person to manipulate hazardous materials such as highly enriched uranium without directly exposing the person to the material.

groundwater – Water below the land surface in a zone where all void space between rocks, soil, etc., is filled with water.

hexavalent – A compound that has six valence electrons.

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.

industrial solid waste landfill – A type of landfill that exclusively disposes of solid waste generated by manufacturing or industrial operations.

in situ – In its original place; field measurements taken without removing the sample from its origin; remediation performed while the contaminated media (e.g., groundwater) remains below the surface.

interim remedial measure – Cleanup activities initiated after it has been determined that contamination or waste disposal practices pose an immediate threat to human health and/or the environment. These measures are implemented until a more permanent solution can be made.

internal radiation – Occurs when natural radionuclides enter the body by ingestion of food or water 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.

jurisdictional wetland – An area that is periodically or permanently inundated by surface or ground water, supports plants adapted to wetlands, and has soil typically found in wetlands, but is not associated with an active holding pond.

leachate – A liquid that results from water collecting contaminants as it trickles through wastes, agricultural pesticides, or fertilizers. Leachate may occur in farming areas, feed lots, and landfills and may result in hazardous substances entering surface water, groundwater, or soil.

manifest – A form required by RCRA that is used to document and track waste during transportation and disposal.

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.

maximum contaminant level – The maximum permissible level of a contaminant in drinking water provided by a public water system.

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

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 – Millirem: the dose equivalent that is one-thousandth of a rem.

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

non-jurisdictional wetland – An area that is periodically or permanently inundated by surface or ground water, supports plants adapted to wetlands, and has soil typically found in wetlands, and is associated with an active holding pond.

nuclide – An atom specified by 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.

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 7, neutral solutions have a pH equal to 7, and basic solutions have a pH from 7 to 14.

polychlorinated biphenyl (PCB) –An industrial compound, used primarily as a lubricant, which is produced by adding chlorine to biphenyl, a colorless, crystalline compound.

preliminary remediation goal – The concentration of a constituent in environmental media (soil, groundwater, etc.) that is considered protective of human health and the environment.

quality assurance – Any action in environmental monitoring to demonstrate the reliability of monitoring and measurement data.

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

rad – The unit of absorbed dose deposited in a volume of material.

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 – A radioactive nuclide capable of spontaneous transformation into other nuclides by changing its nuclear configuration or energy level. This transformation is accomplished by the emission of photons or particles.

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 or cleanup of a site contaminated with waste. See "Environmental Restoration."

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

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

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

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

Superfund – The program operated under the legislative authority of the Comprehensive Environmental Response, Compensation, and Liability Act and Superfund Amendments and Reauthorization Act that funds and conducts EPA emergency and long-term removal and remedial actions.

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 in the earth's soils such as potassium-40, thorium, and uranium. Terrestrial radiation contributes to natural background radiation.

transuranics – Elements such as plutonium and neptunium that have atomic numbers (the number of protons in the nucleus) greater than 92. All transuranics are radioactive.

trichloroethene – A colorless liquid used in many industrial applications as a cleaner and/or solvent. One of many chemicals that is classified as a volatile organic compound.

trip blank – A quality control sample of water that accompanies sample containers from the analytical laboratory, to the field sampling location where environmental samples are collected, back to the analytical laboratory to determine whether environmental samples have been contaminated during shipment.

troughing system – A system designed to collect leaking PCBs in the PORTS process buildings.

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

upgradient – In the opposite direction of groundwater flow.

upgradient well – A well installed hydraulically upgradient of a site to provide data to compare to a downgradient well to determine whether the site is affecting groundwater quality.

volatile organic compounds – Chemicals composed primarily of hydrogen, oxygen, and carbon that readily volatilize into the air. They include light alcohols, acetone, trichloroethene, dichloroethene, benzene, vinyl chloride, toluene, methylene chloride, and many other compounds.

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

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EXECUTIVE SUMMARY

SITE AND OPERATIONS OVERVIEW

The Portsmouth Gaseous Diffusion Plant (PORTS), which began operation in 1954, is one of two uranium enrichment facilities in the United States (see Fig. 1). In 1993, the U.S. Department of Energy (DOE) leased the uranium enrichment production and operations facilities at PORTS to the United States Enrichment Corporation (USEC). USEC enriched uranium at PORTS for use in commercial nuclear power reactors until May 11, 2001 when production was ceased based on a USEC business decision. USEC currently continues its uranium enrichment shipping and transfer operations at PORTS and has placed the production facilities at PORTS into a cold standby mode, under a contract with DOE. The cold standby mode allows the plant to be maintained in a condition so that uranium enrichment production could restart within 18-24 months, if necessary.

Responsibility for implementing environmental compliance at PORTS is split between DOE, as site owner, and USEC. DOE is responsible for environmental restoration, waste management, uranium programs, and long term stewardship of nonleased facilities at PORTS. USEC is responsible for cold standby operations, removal of uranium deposits from process equipment, and winterization of the process buildings (which were formerly heated by the uranium enrichment process). With the exception of Chap. 2, Compliance Summary, Chap. 4, Environmental Radiological Program Information, and Chap. 5, Environmental Non-Radiological Program Information, this report does not cover USEC operations

Fig. 1. The Portsmouth Gaseous Diffusion Plant.

at PORTS. USEC data are included in these chapters to provide a more complete picture of the programs in place at PORTS to detect and assess potential impacts to human health and the environment resulting from PORTS activities.

PORTS is located on 5.8 square miles in Pike County, Ohio. The county has approximately 27,700 residents.

ENVIRONMENTAL COMPLIANCE

Responsibility for implementing environmental compliance at PORTS is divided between DOE (as the site owner) and USEC. USEC is responsible for compliance activities directly associated with the operations that are leased from DOE, including air emission permits for uranium enrichment facilities, water discharge permits for several holding ponds and water treatment facilities, and management of wastes generated by USEC operations.

DOE/PORTS has been issued a permit for discharge of water to surface streams, several air emission permits, and a permit for the storage of hazardous wastes. DOE is also responsible for preparing a number of reports for compliance with environmental regulations. These reports include an annual groundwater monitoring report, an annual hazardous waste report, an annual polychlorinated biphenyl (PCB) document log, an annual summary of radionuclide air emissions and the associated dose to the public from these emissions, a monthly summary of National Pollutant Discharge Elimination System (NPDES) monitoring, an annual hazardous chemical inventory, and an annual toxic chemical release inventory.

An inspection completed by the U.S. Environmental Protection Agency (EPA) and Ohio EPA on August 6-7, 2001, resulted in a Notice of Violation based on two cases of workers who had not received refresher training required by the DOE/PORTS permit to store hazardous waste. The Notice of Violation letter received by DOE on August 22, 2001, noted that the violation had been abated (the individuals had received the refresher training) due to DOE's quick response to the violation.

On November 13, 2001, DOE/PORTS received a Notice of Violation from Ohio EPA pertaining to construction of the barrier wall at the X-749 Landfill (part of the Corrective Measures Implementation for Quadrant I). Ohio EPA felt that deviations were being made to the approved design specifications for construction of the wall without prior written approval from Ohio EPA, which is a violation of the 1989 Ohio Consent Decree. DOE/PORTS has responded to Ohio EPA's concerns and continues to work closely with Ohio EPA to resolve issues pertaining to this complex construction project.

ENVIRONMENTAL PROGRAMS

Environmental Restoration, Waste Management, and Public Awareness Programs are conducted at PORTS to protect and inform the local population, improve the quality of the environment, and comply with federal and state regulations.

Environmental Restoration Program

Environmental restoration is the process of cleaning up inactive waste sites and facilities to demonstrate that risks to human health and the environment are either eliminated or reduced to safe levels. DOE established the Environmental Restoration Program to find, analyze, and correct site contamination problems as quickly and inexpensively as possible. This task may be accomplished by

removing, stabilizing, or treating hazardous substances. The Environmental Restoration budget for fiscal year 2001 was $23.5 million.

The Ohio Consent Decree and the U.S. EPA Administrative Consent Order require investigation and cleanup of PORTS in accordance with the Resource Conservation and Recovery Act (RCRA) Corrective Action Program. The site is divided into four quadrants to facilitate the investigation and cleanup. In March 2001, Ohio EPA issued the Decision Document for Quadrant I, which identified the selected remedies for the areas that require remediation. DOE received approval from Ohio EPA for the *Quadrant II Cleanup Alternative Study/Corrective Measures Study* on March 26, 2001.

Remediation activities took place at several units in 2001. Two of the remedial actions required for Quadrant I, construction of a barrier wall on the eastern and southern portion of the X-749 Landfill and installation of 11 additional groundwater extraction wells in the Quadrant I Groundwater Investigative Area, were begun in 2001. Remedial actions for two units in Quadrant II, removal of the X-701C Neutralization Pit/X-701A Lime House, and removal of contaminated soils near the X-720 Neutralization Pit, were completed in 2001. Maintenance and monitoring of the phytoremediation system for the groundwater plume near the X-740 Waste Oil Handling Facility continued in 2001.

Waste Management Program

The DOE/PORTS Waste Management Program directs the safe storage, treatment, and disposal of waste generated from past plant operations, plant maintenance, and environmental restoration projects.

Waste management activities must comply with DOE Orders, Ohio EPA regulations, and U.S. EPA regulations. Waste management requirements are varied and often complex because of the variety of wastes generated by DOE/PORTS activities. The types of waste managed by DOE/PORTS include:

- *Low-level radioactive waste (LLW)* – radioactive waste not classified as high level or transuranic and that does not contain any components regulated by RCRA or the Toxic Substances Control Act.

- *Hazardous (RCRA) waste* – waste that contains one or more of the wastes listed under RCRA or that exhibits one or more of the four RCRA hazardous characteristics: ignitability, corrosivity, reactivity, and toxicity.

- *RCRA/LLW mixed waste* – waste containing both hazardous and radioactive components. The waste is subject to RCRA, which governs the hazardous components, and to additional regulations that govern the radioactive components.

- *PCB wastes* – waste containing PCBs, a class of synthetic organic chemicals. Under Toxic Substances Control Act regulations, PCB manufacturing was prohibited after 1978. However, continued use of PCBs is allowed, provided that the use does not pose a risk to human health or the environment. Disposal of all PCB materials is regulated under the Toxic Substances Control Act.

- *PCB/LLW mixed waste* – waste containing both PCB and radioactive components. The waste is subject to the Toxic Substances Control Act that governs PCB components, and to additional regulations that govern radioactive components.

- *Industrial sanitary waste* – waste generated by commercial operations, such as office waste.

Supplemental policies also have been implemented for waste management including minimizing waste generation; characterizing and certifying wastes before they are stored, processed, treated, or

disposed; pursuing volume reduction (such as blending and bulking) as well as on-site storage in preparation for safe and compliant final treatment and/or disposal; and recycling.

Public Awareness Program

DOE provides a public Environmental Information Center to allow access to all documents used to make decisions on remedial actions being taken at PORTS. The information center is located on the plant site just outside the E-Vehicle portal and is open 9 a.m. to 12 p.m. Monday and Tuesday, 12 p.m. to 4 p.m. Wednesday and Thursday, or by appointment (740-289-3317). Due to additional security measures in place at the plant post-September 11, 2001, members of the public must call the Information Center in advance at the number listed above to be placed on the visitor list prior to visiting the Information Center. Additional information is provided by the DOE Site Office (740-897-2003) and the Bechtel Jacobs Company Public Affairs Manager (740-897-2336).

Semiannual public update meetings and public workshops on specific topics are also held to keep the public informed and to receive their comments and questions. Periodically, fact sheets about major projects are written for the public. Semiannual environmental bulletins are printed and distributed to more than 4,000 recipients, including those on the community relations mailing list, neighbors within 2 miles of the plant, and plant employees and retirees.

ENVIRONMENTAL MONITORING

Environmental monitoring at PORTS includes air, water, soil, and biota (animals, vegetation, and crops) and includes measurement of both radiological and chemical parameters. Environmental monitoring programs may be required by regulations, permit requirements, and DOE Orders, but also may be developed to reduce public concerns about plant operations. In 2001, environmental monitoring information was collected by both DOE and USEC for the following programs:

- Airborne discharges,
- Ambient air,
- Direct radiation,
- Discharges to surface water,
- Surface water,
- Sediment,
- Soil,
- Vegetation, and
- Biota.

DOE also collects extensive environmental monitoring information on groundwater at PORTS. Groundwater monitoring is discussed in the Groundwater Programs chapter.

DOSE

Potential impacts on human health from radionuclides released by PORTS operations are calculated based on environmental monitoring data. This impact, called a dose, can be caused by radionuclides released to air and/or water, or radiation emanating directly from buildings or other objects at PORTS. The U.S. EPA sets a 10 millirem (mrem)/year limit for dose from radionuclides released to the air and the DOE sets a 100 mrem/year limit for dose from radionuclides from all potential pathways (air, water, and direct radiation). A person living in southern Ohio receives a dose of approximately 300 mrem/year from

natural sources of radiation (National Council on Radiation Protection 1987). Figure 2 provides a comparison of the doses from various common radiation sources.

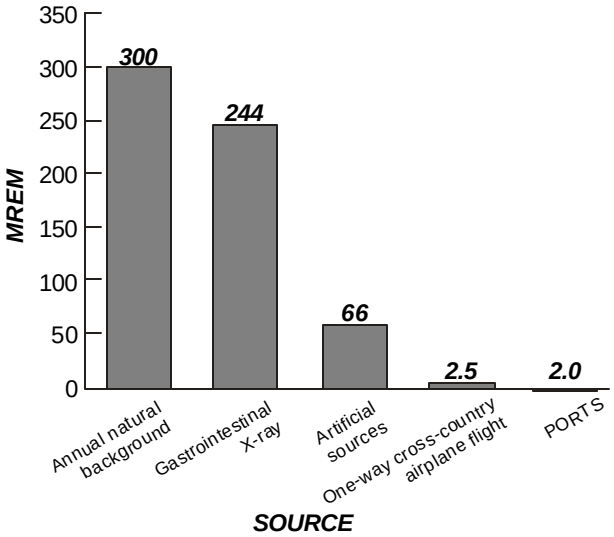

Fig. 2. Comparison of dose from various common radiation sources.

This report includes radiological dose calculations for the dose to the public from radionuclides released to the air and surface water, and from direct radiation based on environmental monitoring data collected by both DOE and USEC. The maximum dose a member of the public could receive from radiation released by PORTS in 2001 is 2.0 mrem, based on a maximum dose of 0.060 mrem from airborne radionuclides, 0.040 mrem from radionuclides released to the Scioto River, 0.98 mrem from direct radiation from the PORTS depleted uranium cylinder storage yards, and 0.88 mrem based on exposure to radionuclides detected by DOE and USEC environmental monitoring programs at off-site sampling locations in 2001.

GROUNDWATER PROGRAMS

Groundwater monitoring at DOE/PORTS includes RCRA hazardous waste units, solid waste disposal units, and RCRA Corrective Action Program units. The *Integrated Groundwater Monitoring Plan* establishes the groundwater monitoring requirements for PORTS and has been reviewed and approved by Ohio EPA. In general, samples are collected from wells at 11 groundwater monitoring areas and surface water locations that are part of the groundwater monitoring program. Samples are analyzed for metals, volatile organic compounds, and radiological constituents. DOE/PORTS then compares constituents detected in the groundwater to standards called preliminary remediation goals to assess the potential for each constituent to affect human health and the environment.

Additional groundwater monitoring is completed to meet DOE Order requirements. Exit pathway monitoring assesses the effect of DOE/PORTS on regional groundwater quality and quantity. Baseline monitoring is conducted to establish background data for use in assessing the effect of DOE/PORTS operations on the groundwater. DOE Orders are also the basis for the radiological monitoring of groundwater at PORTS.

Five groundwater contamination plumes have been identified on site at PORTS. The primary groundwater contaminant is trichloroethene. Remediation of groundwater is being addressed under Ohio EPA's RCRA Corrective Action Program. No significant changes in the groundwater plumes were noted in 2001.

The *Integrated Groundwater Monitoring Plan* also addresses monitoring of residential water supplies near PORTS to verify that site contaminants have not migrated off site. Technetium-99 was detected in some of the residential drinking water samples collected in 2001. These detections could not result from groundwater migration off site due to the location of the water supplies and groundwater flow patterns, but could result from the inherent level of error associated with laboratory analytical capabilities. The concentration of technetium-99 in the samples collected by DOE was near the laboratory detection

limit (or minimum detectable activity). Ohio EPA also collected samples of the residential water supplies when the DOE samples were collected. Technetium-99 was not detected in any of the Ohio EPA samples. The maximum dose that a person could receive from PORTS operations in 2001 (2.0 mrem) includes the dose to a person who drank water contaminated with these low levels of technetium-99.

QUALITY ASSURANCE AND QUALITY CONTROL

Data reliability is of the utmost importance for monitoring releases and measuring radiation in the environment. To demonstrate that the monitoring and measurement results are accurate, DOE/PORTS has implemented a quality assurance and quality control program based on guidelines from the U.S. EPA, the American Society for Testing and Materials, and other federal and state agencies. The DOE/PORTS staff administers numerous quality control activities to verify reliability of the data on a day-to-day basis. DOE/PORTS also participates actively in quality control programs administered by agencies outside the site such as the U.S. EPA.

1. INTRODUCTION

1.1 SUMMARY

The Portsmouth Gaseous Diffusion Plant (PORTS) is located on a 5.8-square-mile site in a rural area of Pike County, Ohio. U.S. Department of Energy (DOE) activities at PORTS include environmental restoration, waste management, and long term stewardship of nonleased facilities. Production facilities for the separation of uranium isotopes are leased to the United States Enrichment Corporation (USEC), but most activities associated with the uranium enrichment process ceased in 2001. USEC activities are not covered by this document, with the exception of some environmental compliance information provided in Chap. 2 and radiological and non-radiological environmental monitoring program information discussed in Chaps. 4 and 5.

1.2 INTRODUCTION

PORTS, which began operation in 1954, is owned by DOE. Effective July 1, 1993, DOE leased the production facilities at the site to USEC, which was established by the Energy Policy Act of 1992. USEC became a publicly-held corporation in 1998. USEC enriched uranium at PORTS for use in commercial nuclear power reactors until May 11, 2001 when production was ceased based on a USEC business decision. USEC currently continues to conduct its uranium enrichment shipping and transfer operations at PORTS and has placed the production facilities at PORTS into a cold standby mode, under a contract with DOE. Bechtel Jacobs Company LLC has managed the DOE programs at PORTS since April 1, 1998.

This report is intended to fulfill the substantive requirements of DOE Order 5400.1, *General Environmental Protection Program.* This DOE Order requires development of an Annual Site Environmental Report that includes information on regulatory compliance, environmental programs, radiological and non-radiological monitoring programs, groundwater programs, and quality assurance. This report is not intended to present all of the monitoring data at PORTS. Additional data collected for other site purposes, such as environmental restoration and waste management, are presented in other documents that have been prepared in accordance with applicable laws. These data are available through other mechanisms.

1.3 DESCRIPTION OF SITE LOCALE

DOE/PORTS is located in a rural area of Pike County, Ohio, on a 5.8-square-mile site (see Fig. 1.1). The site is 2 miles east of the Scioto River in a small valley running parallel to and approximately 120 feet above the Scioto River floodplain. Figure 1.2 depicts the plant site and its immediate environs.

Pike County has approximately 27,700 residents. Scattered rural development is

Fig. 1.1. Location of PORTS within the State of Ohio.

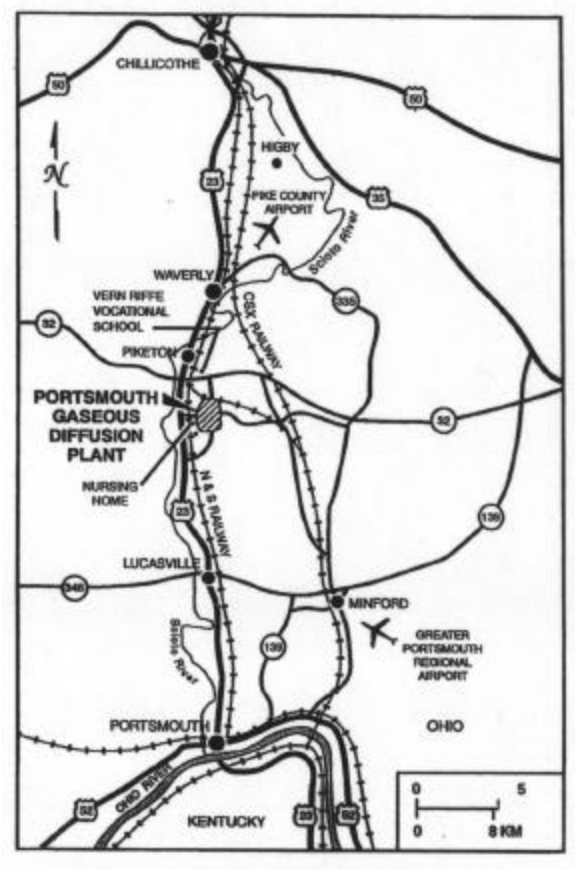

Fig. 1.2. Location of PORTS in relation to the geographic region.

typical; however, the county contains numerous small villages such as Piketon, Wakefield, and Jasper that lie within a few miles of the plant. The county's largest community, Waverly, is about 10 miles north of the plant and has a population of about 4,400 residents. The nearest residential center in this area is Piketon, which is about 5 miles north of the plant on U.S. Route 23; its population is about 1,900. Several residences are adjacent to the southern half of the eastern boundary and along Wakefield Mound Road (old U.S. 23), directly west of the plant. One nursing home, with a capacity of 36 persons, is located along Wakefield Mound Road.

Additional population centers within 50 miles of the plant are Portsmouth (population 20,909), 27 miles south; Chillicothe (population 21,796), 27 miles north; and Jackson (population 6,184), 18 miles east (2000 U.S. Census). The total population within 50 miles of the plant is approximately 600,000 persons.

1.4 DESCRIPTION OF SITE OPERATIONS

DOE, through its managing contractor Bechtel Jacobs Company LLC, is responsible for the Environmental Restoration, Waste Management, and Uranium Programs at the plant, as well as other nonleased DOE property. The Environmental Restoration Program performs remedial investigations to define the nature and extent of contamination, evaluate the risk to public health and the environment, and determine the available alternatives from feasibility studies of potential remedial actions for sites under investigation. The goal of the Environmental Restoration Program is to verify that releases from past operations at DOE/PORTS are thoroughly investigated and that remedial action is taken to protect human health and the environment.

The Waste Management Program is responsible for managing wastes generated at the site. Wastes must be identified and stored in accordance with all environmental regulations. The Waste Management Program also arranges transportation and off-site disposal of wastes. The goal of the Waste Management Program is to manage waste from the time it is generated to its ultimate treatment, recycling, or disposal in accordance with all applicable regulations.

The Uranium Program is responsible for the cost-effective management of PORTS facilities and real property retained by DOE. Responsibilities include managing contracts between DOE/PORTS and other subcontractors for such services as maintenance, utilities, chemical operations, uranium material handling, and laboratory analysis. The Uranium Program also oversees the management and coordination of the PORTS Depleted Uranium Hexafluoride and Lithium Management and Storage Programs and warehousing of uranium materials.

2. COMPLIANCE SUMMARY

2.1 SUMMARY

Responsibility for implementing environmental compliance at PORTS is divided between DOE (as the site owner) and USEC. USEC is responsible for compliance activities directly associated with the operations that are leased from DOE, including air emission permits for uranium enrichment facilities, water discharge permits for several holding ponds and water treatment facilities, and management of wastes generated by current enrichment operations.

DOE/PORTS has been issued a permit for discharge of water to surface streams, several air emission permits, and a permit for the storage of hazardous wastes. DOE is also responsible for preparing a number of reports for compliance with environmental regulations. These reports include an annual groundwater monitoring report, an annual hazardous waste report, an annual polychlorinated biphenyl (PCB) document log, an annual summary of radionuclide air emissions and the associated dose to the public from these emissions, a monthly summary of National Pollutant Discharge Elimination System (NPDES) monitoring, an annual hazardous chemical inventory, and an annual toxic chemical release inventory. Additional information on each of these reports is provided within this chapter.

DOE/PORTS is inspected regularly by the federal, state, and local agencies responsible for enforcing environmental regulations at PORTS. DOE/PORTS received two Notices of Violation from the Ohio Environmental Protection Agency (EPA) in 2001: one regarding two workers who had not received annual refresher training and the second involving failure to receive written approval from Ohio EPA for deviations from approved design specifications for a construction project at the X-749 Landfill. Other noncompliances reported by DOE/PORTS in 2001 include one exceedence of an NPDES permit limitation, one unpermitted discharge from a DOE NPDES outfall, and improper labeling and/or storage of 174 containers of hazardous waste.

2.2 INTRODUCTION

Responsibility for implementing environmental compliance at PORTS is divided between DOE (as the site owner) and USEC. USEC is responsible for compliance activities directly associated with the operations that are leased from DOE, including air emission permits for uranium enrichment facilities and water discharge permits for several holding ponds and water treatment facilities. USEC is also responsible for the management of wastes generated by current enrichment operations. DOE retains responsibility for "legacy" wastes, which contain constituents such as asbestos and PCBs that were used in DOE operations prior to the lease agreement. DOE is also responsible for the Environmental Restoration Program, Waste Management Program, and operation of all nonleased facilities.

DOE/PORTS has been issued an NPDES permit for discharge of water to surface streams, several air emission permits, and a Resource Conservation and Recovery Act (RCRA) Part B permit for the storage of hazardous wastes. Appendix B lists the active DOE/PORTS environmental permits for 2001.

Several federal, state, and local agencies are responsible for enforcing environmental regulations at DOE/PORTS. Primary regulatory agencies are U.S. EPA, Ohio EPA, Ohio Department of Health, and Ohio State Fire Marshal's Office. These agencies issue permits, review compliance reports, conduct joint monitoring programs, inspect facilities and operations, and oversee compliance with applicable regulations.

DOE/PORTS conducts self-assessments to identify environmental issues and consults the regulatory agencies to identify the appropriate actions necessary to achieve and maintain compliance.

2.3 COMPLIANCE STATUS

2.3.1 Environmental Restoration and Waste Management

2.3.1.1 Comprehensive Environmental Response, Compensation, and Liability Act

DOE/PORTS is not on the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) National Priorities List of sites requiring cleanup, but is regulated under the provisions of CERCLA by the U.S. EPA Administrative Consent Order. The U.S. EPA Administrative Consent Order, issued on September 29, 1989 (amended in 1994 and 1997), and Consent Decree with the State of Ohio, issued on August 29, 1989, require the investigation and cleanup of surface water and air releases, groundwater contamination plumes, and solid waste management units at PORTS. U.S. EPA and Ohio EPA have chosen to oversee environmental remediation activities at DOE/PORTS under the RCRA Corrective Action Program instead of the CERCLA program.

PORTS was divided into four quadrants based on groundwater flow patterns to facilitate the expedient cleanup of contaminated sites in accordance with RCRA corrective action and closure requirements. The Environmental Restoration Program at PORTS addresses requirements of the Ohio Consent Decree and U.S. EPA Administrative Consent Order. Chapter 3, Sect. 3.2, provides additional information on the Environmental Restoration Program.

Section 103 of CERCLA requires notification to the National Response Center if hazardous substances are released to the environment in amounts greater than or equal to the reportable quantity. Reportable quantities are listed in the Act and vary depending on the type of hazardous substance released. During 2001, DOE/PORTS had no reportable quantity releases of hazardous substances subject to Section 103 notification requirements.

2.3.1.2 Emergency Planning and Community Right-To-Know Act

The Emergency Planning and Community Right-To-Know Act of 1986, also referred to as the Superfund Amendments and Reauthorization Act Title III, requires reporting of emergency planning information, hazardous chemical inventories, and releases to the environment. Emergency Planning and Community Right-To-Know Act reports are submitted to federal, state, and local authorities.

Section 304 of the Emergency Planning and Community Right-To-Know Act requires reporting of off-site reportable quantity releases to state and local authorities**.** During 2001, DOE/PORTS had no reportable quantity releases.

The Hazardous Chemical Inventory Report, which includes the identity, location, storage information, and hazards of the chemicals that exceeded threshold planning quantities, is submitted annually to state and local authorities. Twenty-five materials stored by DOE/PORTS exceeded the threshold planning quantities for the entire site (including USEC) in 2001: 1,1,1-trichloroethane, aluminum oxide, argon, asbestos, asphalt, carbon dioxide, diesel fuel, ethylene glycol, gasoline, kerosene, lithium hydroxide monohydrate, lubricating oil, fuel oil, methanol, oxygen, PCBs, sodium chloride, sodium fluoride, sulfuric acid, triuranium octaoxide, uranium dioxide, uranium hexafluoride, uranium metal, uranium tetrafluoride, and uranium trioxide. The lithium hydroxide monohydrate was removed from PORTS in May 2001.

The Toxic Chemical Release Inventory is sent annually to U.S. EPA and Ohio EPA. This report details releases to the environment of specified chemicals when they are manufactured, processed, or otherwise used by the entire site (including USEC) in amounts that exceed threshold quantities specified by U.S. EPA. In 2001, DOE/PORTS was required to report the off-site transfer of approximately 246 lbs of lead compounds to permitted treatment/disposal facilities. USEC reported the release and/or on-site treatment of six chemicals: chlorine, dichlorotetrafluoroethane, methanol, nitrate compounds, sulfuric acid, and lead compounds.

2.3.1.3 Resource Conservation and Recovery Act

RCRA regulates the generation, accumulation, storage, transportation, and disposal of wastes. Wastes are designated as hazardous by the EPA because of various chemical properties, including ignitibility, corrosivity, reactivity, and toxicity.

Hazardous waste. DOE/PORTS is permitted by Ohio EPA to store hazardous waste in the X-7725 and X-326 facilities. The permit, often called a Part B Permit, was issued to DOE/PORTS in 1995. A permit renewal application was submitted to Ohio EPA in 2000 and the permit was renewed by Ohio EPA on March 15, 2001. The permit governs the storage of hazardous waste and includes requirements for waste identification, inspections of storage areas and emergency equipment, emergency procedures, training requirements, and other information required by Ohio EPA.

In June 2001, DOE reported a permit non-compliance in accordance with the conditions of the RCRA Part B Permit. When preparing for off-site disposal of waste that was previously determined to be non-hazardous, DOE/PORTS discovered 111 containers of this waste that should have been designated as hazardous waste. None of the containers were labeled hazardous waste and 12 containers were not stored in a permitted storage area. After these containers were discovered, all containers of this type of waste were reviewed, and an additional 63 containers were also determined to be hazardous waste. Immediately upon discovery, the containers were labeled hazardous waste and moved to permitted storage area (those containers that were not in a permitted storage area). A review of inspection checklists indicated that no spills or releases had occurred from the containers that were not properly labeled or stored.

Facilities such as PORTS that generate or store hazardous waste are required to submit an annual report to Ohio EPA. This annual report contains the name and address of each facility that waste was shipped to during the previous calendar year, the name and address of the transporter for each waste shipment, the description and quantity of each waste shipped off site, and a description of waste minimization efforts. PORTS submitted the report for calendar year 2001 to Ohio EPA in February 2002. Chapter 3, Sect. 3.3, Waste Management Program, provides additional information on wastes from PORTS that were recycled, treated, or disposed in 2001.

RCRA also requires closure of areas formerly used to store hazardous waste. Of the 19 areas at PORTS that were formerly used to store hazardous waste, 14 have been closed in accordance with Ohio EPA requirements. The five remaining areas are being remediated as part of the RCRA Corrective Action Program at PORTS.

RCRA may also require groundwater monitoring at hazardous waste units. As discussed in Chap. 6, groundwater monitoring requirements at PORTS have been integrated into one document, the *Integrated Groundwater Monitoring Plan*. Hazardous waste units included in the *Integrated Groundwater Monitoring Plan* are the X-231B Southwest Oil Biodegradation Plot, X-616 Chromium Sludge Surface Impoundments, X-701B Holding Pond, X-701C Neutralization Pit, X-735 RCRA Landfill (northern portion), and X-749 Contaminated Materials Storage Yard (northern portion). Chapter 6 discusses the groundwater monitoring requirements for these units.

Solid waste. Groundwater monitoring may be required at closed solid waste facilities. Groundwater monitoring requirements for the closed X-734 Landfills, X-735 Industrial Solid Waste Landfill, and X-749A Classified Materials Disposal Facility are included in the *Integrated Groundwater Monitoring Plan.* Chapter 6 discusses the groundwater monitoring programs for these units.

2.3.1.4 Federal Facility Compliance Act

DOE/PORTS currently stores waste that is a mixture of RCRA hazardous waste and low-level radioactive waste. RCRA hazardous waste is subject to Land Disposal Restrictions, which do not allow the storage of hazardous waste for longer than one year. The Federal Facility Compliance Act, enacted by Congress in October 1992, allows for the storage of mixed hazardous/low-level radioactive waste for longer than one year because treatment for this type of waste is not readily available. The Act also requires federal facilities to develop and submit site treatment plans for treatment of mixed wastes. On October 4, 1995, Ohio EPA issued Director's Final Findings and Orders to implement the Federal Facility Compliance Act. This Order allows the storage of mixed waste beyond one year and gave approval of the DOE/PORTS Proposed Site Treatment Plan. An annual update to the Site Treatment Plan is required by these Director's Final Findings and Orders. This annual update for fiscal year 2001 was submitted to Ohio EPA in December 2001.

2.3.1.5 Toxic Substances Control Act

The Toxic Substances Control Act regulates the use, storage, and disposal of PCBs. The electrical power system at PORTS, which is leased by USEC, uses oil-based circuit breaker transformers and large high-voltage capacitors, both containing PCB oil, to supply electricity to the enrichment cascade. The *2001 PCB Document Log for the Portsmouth Gaseous Diffusion Plant* identifies 147 PCB transformers and 11,099 large PCB capacitors either in service or stored for reuse at PORTS.

In February 1992, a Federal Facilities Compliance Agreement between DOE and U.S. EPA addressing PCB issues became effective and resolved several compliance issues. These issues included the use of PCBs in systems that are not totally enclosed, storage of wastes containing both PCBs and radionuclides in accordance with nuclear criticality safety requirements, and storage of wastes containing both PCBs and radionuclides for longer than one year. The agreement required installation of troughs under motor exhaust duct gaskets located in production facilities to collect PCB oil leaks. When leaks or spills of PCBs occur, they are managed in accordance with the Federal Facilities Compliance Agreement. Annual and quarterly reports of progress made toward milestones specified in the Federal Facilities Compliance Agreement are submitted to the U.S. EPA. In addition, DOE and U.S. EPA representatives meet to resolve any unanticipated issues or uncertainties regarding the terms of the agreement. As of the end of 2001, DOE/PORTS was in compliance with the requirements and milestones of this Federal Facilities Compliance Agreement.

DOE/PORTS operates a number of storage areas for PCB wastes. The storage areas meet all applicable requirements of the federal regulations and the DOE Federal Facilities Compliance Agreement. Much of PORTS PCB waste is in long-term storage because of the lack of commercial disposal facilities authorized to dispose of wastes containing both PCBs and radionuclides.

An annual document log is prepared to meet regulatory requirements. The document log provides an inventory of PCB items in use, in storage as waste, and shipping/disposal information for PCB items disposed in 2001. The *2001 PCB Document Log for the Portsmouth Gaseous Diffusion Plant* was prepared in June 2002. Chapter 3, Sect. 3.3, Waste Management Program, provides additional information on PORTS PCB wastes treated or disposed in 2001.

Other sections of the Toxic Substances Control Act have little or no impact on DOE/PORTS. Although friable asbestos, which deteriorates into airborne fibers, is regulated under the Act, the specific regulations applicable to PORTS are similar to other state and federal regulations such as the National Emission Standards for Hazardous Air Pollutants. DOE/PORTS also responds to U.S. EPA requests for health and safety data, but such responses indicate that DOE/PORTS does not import chemicals or manufacture, process, or distribute chemical substances for commercial purposes.

2.3.1.6 Federal Insecticide, Fungicide, and Rodenticide Act

Plant personnel apply general-use pesticides according to product labeling, and all product warnings and cautions are strictly obeyed. When application of a restricted-use pesticide is required, a certified contractor is employed. No restricted-use pesticides were applied at DOE/PORTS in 2001.

2.3.2 Radiation Protection

2.3.2.1 DOE Order 5400.5, Radiation Protection of the Public and the Environment

DOE Order 5400.5 provides guidance and establishes radiation protection standards and control practices designed to protect the public and the environment from undue radiological risk from operations of DOE and DOE contractors. The order requires that off-site radiation doses do not exceed 100 millirem/year above background for all exposure pathways. Chapter 4 provides the dose calculations for compliance with this DOE Order.

2.3.3 Air Quality and Protection

2.3.3.1 Clean Air Act

In 2001, DOE/PORTS applied for and received air emission permits for two boilers and two aboveground storage tanks associated with the X-6002 Recirculating Hot Water Plant. The plant was built to provide hot water to heat DOE buildings that were formerly heated by hot water produced from the heat given off by the gaseous diffusion process. Because the gaseous diffusion process is no longer operating at PORTS, an alternative source of heat for the recirculating hot water system was needed. The Recirculating Hot Water Plant began operation in November 2001. Air emissions from the X-6002 Recirculating Hot Water Plant are discussed in Chap. 5, Sect. 5.3.1.

In addition to the air permits associated with the Hot Water Plant, DOE/PORTS had four permitted and nine registered air emission sources at the end of 2001 (see Appendix B).

2.3.3.2 Clean Air Act, Title VI, Stratospheric Ozone Protection

As part of the Stratospheric Ozone Protection Plan, DOE has instituted a record-keeping system consisting of forms and labels to comply with the Title VI record-keeping and labeling requirements. These requirements affect all areas that use ozone-depleting substances in units or devices. The appliance service record and retrofit or retirement plan forms apply to units with a capacity of more than 50 pounds. The refrigeration equipment disposal log and associated appliance disposal label are used by all units regardless of capacity. Maintenance and service of air conditioning/refrigeration units under DOE control are conducted under contract with USEC. The contractor technicians who service the equipment have been trained in accordance with U.S. EPA requirements.

USEC uses an ozone-depleting substance, specifically dichlorotetrafluoroethane, as a coolant in the cascade system used to produce enriched uranium. In 2001, USEC estimated that 420,000 pounds of dichlorotetrafluoroethane were released to the air.

2.3.3.3 National Emission Standards for Hazardous Air Pollutants

The National Emission Standards for Hazardous Air Pollutants require PORTS to submit an annual estimate of radiological emissions from DOE/PORTS sources. In the first quarter 2001, air emissions testing at two of the DOE/PORTS groundwater treatment facilities indicated that these facilities emit small quantities of radionuclides to the air. Based on these results, DOE is responsible for four sources of radionuclide emissions: X-623 Groundwater Treatment Facility, X-624 Groundwater Treatment Facility, X-326 L-cage Glove Box, and X-744G Glove Box. A glove box is an enclosure with built-in sleeves and gloves that is used by a person to repackage or transfer hazardous material without directly exposing the person to the material.

In 2001, the X-326 L-cage Glove Box and X-744G Glove Box were not used; therefore, radiological emissions from DOE/PORTS in 2001 are based on emissions from the X-623 Groundwater Treatment Facility and the X-624 Groundwater Treatment Facility. Emissions from the groundwater treatment facilities were conservatively estimated based on the assumption that the highest emissions recorded during the first quarter 2001 testing were emitted continuously throughout 2001. Based on this assumption, radiological air emissions from the X-623 Groundwater Treatment Facility and the X-624 Groundwater Treatment Facility in 2001 were 0.00063 curie (Ci). Chapter 4, Sect. 4.3.3, provides the radiological dose calculations to members of the public from these emissions.

2.3.4 Water Quality and Protection

2.3.4.1 Clean Water Act

The DOE/PORTS NPDES permit, issued in 1995 and modified in 1996 and 1997, encompasses six monitored outfalls. Three of the outfalls are classified as point-source discharges to waters of the state, and the other three outfalls are internal outfalls classified as effluents. Water from these three internal outfalls is treated in the USEC Sewage Treatment Plant before reaching waters of the state. Chapter 4, Sect. 4.3.5.1, and Chap. 5, Sect. 5.4.1.1 provide additional information on the DOE/PORTS NPDES outfalls.

The DOE/PORTS NPDES permit expired on March 31, 1999. DOE submitted a permit renewal application to Ohio EPA in September 1998 in accordance with Ohio EPA requirements. The expired permit will remain in effect until Ohio EPA issues a new permit. This expired permit was in effect throughout 2001.

One of the NPDES permit limitations was exceeded during 2001. The sample collected from Outfall 015 (X-624 Groundwater Treatment Facility) on October 16, 2001 exceeded the permit limitation for trichloroethene. The permit limitation was 10 micrograms per liter (Fg/L) and the sample result was 11 Fg/L. Ohio EPA was notified of the permit exceedence. No other NPDES permit limitations were exceeded during 2001. The overall DOE NPDES compliance rate for 2001 was 99.8%. The compliance rate is calculated by dividing the number of measurements that did not exceed the applicable permit limits by the total number of measurements made.

In addition, an unpermitted discharge occurred on October 13, 2001 when a recirculating heating water pipe ruptured and approximately 20,000 gallons of make-up feed water was discharged through a storm sewer to the X-2230N Holding Pond (DOE NPDES Outfall 013). The NPDES permit for this outfall does not list make-up water as a permitted discharge. A sample of the pond discharge was analyzed for pH, which was within the permit limitation for this outfall. Ohio EPA was notified of this discharge.

2.3.5 Other Environmental Statutes

2.3.5.1 Underground storage tank regulations

The Underground Storage Tank Program is managed in accordance with the Ohio State Fire Marshal's Bureau of Underground Storage Tank Regulations. DOE/PORTS renewed the registration of eight tanks in June 2001. DOE leased these eight underground storage tanks to USEC. However, in October 2001, one of the tanks was transferred back to DOE when USEC transferred control of the X-334 facility, where the tank is located, back to DOE.

In October 2001, the Ohio Department of Commerce, Division of State Fire Marshall, awarded DOE the "Green Buckeye Award$_{SM}$" in recognition of the time, money, and energy invested to ensure that the site's underground storage tanks are in compliance with state regulations.

2.3.5.2 National Environmental Policy Act

The National Environmental Policy Act requires evaluation of the environmental impacts of activities at federal facilities and of activities funded with federal dollars. Reviews are required for all projects to determine the potential for environmental impacts to the following:

- property (e.g., sites, buildings, structures, and objects) of historical, archaeological, or architectural significance, as officially designated by federal, state, or local governments, including properties eligible for listing on the *National Register of Historic Places*;
- potential habitat (including critical habitat) of federally listed endangered, threatened, proposed, or candidate species or of state-listed endangered and threatened species;
- floodplains and wetlands;
- natural areas such as federally and state-designed wilderness areas, national parks, national natural landmarks, wild and scenic rivers, coastal zones, state and federal wildlife refuges, and marine sanctuaries;
- prime agricultural lands; and
- special sources of water (such as sole-source aquifers, wellhead protection areas, and other water sources that are vital to a region).

Reviews also consider impacts to air, surface water, groundwater, biota, socioeconomics, environmental justice, and worker safety and health.

DOE/PORTS has a formal program dedicated to compliance pursuant to DOE Order 451.1, *National Environmental Policy Act Compliance Program.* Restoration actions, waste management, enrichment facilities maintenance, and other activities are evaluated to determine the appropriate level of evaluation

and documentation. Documents are evaluated and approved internally. Environmental impact statements, however, must be produced by an independent organization. Routine operation and maintenance activities are also evaluated to assess potential environmental impacts. Most activities at PORTS qualified for a categorical exclusion as defined in the regulations. These activities were considered routine and had no significant individual or cumulative environmental impacts.

In 2001, 34 record reports and 6 categorical exclusions were generated for DOE/PORTS project activities. These projects were part of the Waste Management, Environmental Restoration, and Uranium Programs. Examples of projects addressed by the record reports include groundwater monitoring well installation, waste disposal projects, road repaving, and building repair. Categorical exclusions were prepared for projects such as the demolition and removal of the X-701C Neutralization Pit and X-701A Lime House; transportation of uranium dioxide from the Hanford, Washington, DOE site; and corrective actions in Quadrant II.

In addition, an Environmental Assessment was completed for winterization activities in preparation for cold standby at PORTS, which included construction of the X-6002 Recirculating Hot Water Plant. A finding of no significant impact was approved for this assessment.

2.3.5.3 Endangered Species Act

The Endangered Species Act of 1973, as amended, provides for the designation and protection of endangered and threatened wildlife and plants, and the habitat on which such species depend. When appropriate, formal consultations are made with the U.S. Fish and Wildlife Service and the Ohio Department of Natural Resources. A sitewide threatened and endangered species habitat survey and an Indiana bat (*Byosis sodalis*) survey were completed in August 1996. No Indiana bats were found at PORTS. Few potential critical habitats were identified, and a report of the survey activities and results was provided to the Ohio Department of Natural Resources as required by the Federal Fish and Wildlife permit obtained to conduct the survey. No additional activities were completed in 2001.

2.3.5.4 National Historic Preservation Act

The National Historic Preservation Act of 1966 is the primary law governing the protection of cultural resources (archaeological and historical properties). Cultural resource reviews are conducted on a case-by-case basis, and consultations with the Ohio State Historic Preservation Officer are made as required by Section 106 of the Act. A draft programmatic agreement among DOE, the Ohio State Historic Preservation Officer, and the Advisory Council on Historic Preservation concerning the management of historical and cultural properties at DOE/PORTS was submitted to the State Historic Preservation Officer for review and comment in 1997.

Phase I of the historical/archaeological survey was completed in September 1996. Fieldwork for Phase II of the project was completed in May 1997. Artifacts from the 1940s and 1950s were uncovered as well as remains from former dwellings that were present prior to construction of PORTS. Results from the survey will be coordinated with the State of Ohio Historic Preservation Office, and a Cultural Resources Management Plan will be developed.

In 2001, the State Historical Preservation Office was notified of a number of site activities including construction of the new Recirculating Hot Water Plant, groundwater sampling and investigation in the southern portion of the X-749 groundwater monitoring area, and the proposed DOE property transfer to the Southern Ohio Diversification Initiative (SODI) for possible reindustrialization. The office provided comments on the proposed property transfer to DOE in December 2001. The State Historical Preservation Office notified DOE that there were no adverse effects on historic properties from

construction of the Recirculating Hot Water Plant and upgrade of the X-622 Groundwater Treatment Facility.

2.3.5.5 Archaeological and Historic Preservation Act and Archaeological Resources Protection Act

The Archaeological and Historic Preservation Act and the Archaeological Resources Protection Act require the Secretary of the Department of Interior to report to Congress on various federal archaeological activities. The Archaeological Resources Protection Act requires federal land managers to provide archaeology program information to the Secretary of the Interior for this report. *The Department of the Interior Questionnaire on Fiscal Year 2001 Federal Archaeological Activities at the Portsmouth Gaseous Diffusion Plant* was completed and submitted to DOE Headquarters in December 2001 to satisfy this requirement.

2.3.5.6 Farmland Protection Policy Act

The Farmland Protection Policy Act of 1981 requires federal agencies to consider the effects of their proposed actions on prime farmland. Prime farmland is generally defined as land that has the best combination of physical and chemical characteristics for producing crops of statewide or local importance. When required, prime farmland surveys are conducted, and consultations with the U.S. Department of Agriculture's Natural Resources Conservation Service are made. No prime farmland surveys have been conducted at DOE/PORTS.

2.3.5.7 Title 10 Code of Federal Regulations Part 1022, "Compliance with Floodplain/Wetlands Environmental Review Requirements"

Part 1022 of Title 10 of the Code of Federal Regulations establishes policy and procedures for compliance with Executive Order 11988, Floodplain Management, and Executive Order 11990, Protection of Wetlands. The regulatory authority for wetlands is the United States Army Corps of Engineers. Activities (other than routine maintenance) proposed within 100-year and 500-year floodplains or in wetlands require publication of a notice of involvement in the Federal Register. For floodplains, a floodplain statement of findings summarizing the floodplain assessment is also required by DOE and must be published in the Federal Register for public comment at least 15 days prior to the start of the project. An assessment is also required for activity in a wetland prior to authorization to determine all effects of the proposed project. Many activities have been previously authorized by nationwide or regional permits and only require notification. Other activities qualify for abbreviated permit processing, whereby permission is granted via correspondence from the Corps of Engineers.

The sitewide wetland survey report was completed and submitted to the Corps of Engineers in 1996. There are 41 jurisdictional wetlands and four non-jurisdictional wetlands totaling 34.361 acres at PORTS. Activities in jurisdictional wetlands require a Clean Water Act Section 404 permit from the Corps of Engineers. No DOE activities required a Clean Water Act Section 404 permit during 2001.

2.4 OTHER MAJOR ENVIRONMENTAL ISSUES AND ACTIONS

2.4.1 Environmental Program Inspections

During 2001, three inspections of the DOE/PORTS programs were conducted by federal, state, or local agencies. Table 2.1 lists these inspections.

Table 2.1. Environmental inspections at DOE/PORTS for 2001

Date	Agency	Type	Findings
January 29-30	Ohio EPA	RCRA	None
April 10	Pike County Health Department and Ohio EPA	Inspection of closed solid waste landfills: X-749A, X-749, and X-735 (solid waste portion)	None
August 6-7	U.S. EPA and Ohio EPA	RCRA	See Sect. 2.4.2

2.4.2 Inspection Findings

The RCRA inspection completed by U.S. EPA and Ohio EPA on August 6-7, 2001, resulted in a Notice of Violation based on two cases of workers who had not received refresher training required by the RCRA Part B Permit. The Notice of Violation letter received by DOE on August 22, 2001, noted that the violation had been abated (the individuals had received the refresher training) due to DOE's quick response to the violation.

2.4.3 Other Notices of Violation

On November 13, 2001, DOE/PORTS received a Notice of Violation from Ohio EPA pertaining to construction of the barrier wall at the X-749 Landfill (part of the Corrective Measures Implementation for Quadrant I, see Chap. 3, Sect. 3.2.2.1). Ohio EPA felt that deviations were being made to the approved design specifications for construction of the wall without prior written approval from Ohio EPA, which is a violation of the 1989 Ohio Consent Decree. DOE/PORTS has responded to Ohio EPA's concerns and continues to work closely with Ohio EPA to resolve issues pertaining to this complex construction project.

2.5 UNPLANNED RELEASES

One unplanned release from DOE/PORTS was reported in 2001 as an off-normal occurrence that required reporting under DOE Order 232.1, *Occurrence Reporting and Processing of Operations Information*. The release was an unpermitted discharge from DOE NPDES Outfall 013 (the X-2230N Holding Pond) that occurred on October 13, 2001 when a recirculating heating water pipe ruptured and approximately 20,000 gallons of make-up feed water was discharged through a storm sewer to the pond. Section 2.3.4.1 provides additional information concerning this release.

2.6 SUMMARY OF PERMITS

Appendix B lists the permits held by DOE/PORTS in 2001.

3. ENVIRONMENTAL PROGRAM INFORMATION

3.1 SUMMARY

Environmental Restoration activities in 2001 included initiation of construction of a barrier wall at the X-749 landfill and groundwater extraction wells in Quadrant I, demolition and removal of the X-701A Lime House and X-701C Neutralization Pit, removal of contaminated soils near the former X-720 Neutralization Pit, and development of various work plans, sampling plans, and other documents required by Ohio EPA. An investigation was also begun to determine whether a groundwater plume located near the southern boundary of PORTS has moved beyond a barrier designed to assist with other remedial actions to contain the plume on DOE property.

In 2001, approximately 7.8 million lbs of waste from DOE/PORTS were recycled, treated, or disposed. Activities undertaken by the Waste Minimization, Pollution Prevention, Training, Information Exchanges, and Public Awareness programs are also discussed in this chapter.

3.2 ENVIRONMENTAL RESTORATION PROGRAM

DOE established the Environmental Restoration Program in 1989 to identify and correct site contamination areas as quickly and cost-effectively as possible. The Environmental Restoration Program was granted an initial budget of $13.8 million. The Environmental Restoration Program budget for fiscal year 2001 was $23.5 million.

The Environmental Restoration Program addresses inactive sites through remedial action and deals with active facilities through eventual decontamination and decommissioning. Options for correcting or mitigating the contaminated sites and facilities include removal, containment, and treatment of contaminants. Because PORTS is a large facility, it is divided into four quadrants (Quadrant I, II, III, and IV) to facilitate the cleanup process.

The Environmental Restoration Program was established to fulfill the cleanup requirements of the Ohio Consent Decree and U.S. EPA Administrative Consent Order, both issued in 1989. As required by these enforcement actions, DOE/PORTS Environmental Restoration Program activities are conducted in accordance with the RCRA corrective action process, which consists of the following:

- *Description of current conditions* – to provide knowledge of the groundwater, surface water, soil, and air.
- *RCRA facility assessment* – to identify releases of contaminants and determine the need for further investigation.
- *RCRA facility investigation* – to determine the nature and extent of any contamination.
- *Cleanup alternatives study/corrective measures study* – to evaluate and select a remediation alternative.
- *Corrective measures implementation* – to implement the selected remediation measure.

- *Interim remedial measures* – to implement quick remediation or mitigation measures prior to permanent action.

DOE/PORTS has completed the description of current conditions, RCRA facility assessment, and RCRA facility investigation. No interim remedial measures were undertaken in 2001. Cleanup alternatives study/corrective measures study activities, corrective measures implementations, and technology applications are described in the following sections.

3.2.1 Cleanup Alternatives Study/Corrective Measures Study

As required by the Consent Decree and the Administrative Consent Order, the cleanup alternatives studies/corrective measures studies identify the solid waste management units and explore the remedial alternatives within Quadrants I through IV. Following the approval of the final cleanup alternative studies/corrective measure studies, Ohio EPA selects the remedial alternatives that will undergo further review for determining the final remedial actions (the Preferred Plan). Upon concurrence from the U.S. EPA and completion of the public review and comment period, the U.S. EPA and Ohio EPA select the final remedial actions for each quadrant. Ohio EPA issues a decision document to notify DOE/PORTS of the final remedial actions chosen for the site. DOE/PORTS is required to submit a corrective measures implementation plan that details the implementation of the final remedial actions listed in the decision document.

The *Quadrant I Cleanup Alternative Study/Corrective Measures Study* was approved by Ohio EPA in 2000. In March 2001, Ohio EPA issued the decision document for Quadrant I, which identified the selected remedies for the areas that require remediation. The remedial actions identified for Quadrant I are (1) installation of multimedia caps over the X-231A and X-231B Biodegradation Plots, (2) installation of 11 additional groundwater extraction wells in the Quadrant I Groundwater Investigative Area to extract contaminated groundwater for treatment in the X-622 Groundwater Treatment Facility, and (3) for the X-749/X-120/PK Landfill Area, phytoremediation of 27.5 acres of the groundwater plume, installation of a barrier wall around the eastern and southern portion of the X-749 Landfill, and continued operation of the groundwater collection trenches installed at the PK Landfill and X-749 Landfill. Installation of multimedia caps over the X-231A and X-231B Biodegradation Plots was completed in 2000. Installation of the extraction wells and construction of the barrier wall at the X-749 Landfill began in 2001 (see Sect. 3.2.2).

The *Quadrant II Cleanup Alternative Study/Corrective Measures Study* was approved by Ohio EPA on March 26, 2001. In September 2001, however, DOE received a request from Ohio EPA to provide an amendment to the approved study to address additional alternatives to remediate soil at the X-701B area. This amendment was submitted to Ohio EPA in December 2001.

The *Quadrant III Cleanup Alternative Study/Corrective Measures Study* was approved by Ohio EPA in 1998. The Decision Document for Quadrant III required remediation of the groundwater plume near the X-740 Waste Oil Handling Facility. Section 3.2.2.5 provides information on the corrective measures implementation for this area.

The *Quadrant IV Cleanup Alternative Study/Corrective Measures Study* was approved by Ohio EPA in 1998. DOE received the Decision Document for Quadrant IV in 2000. No new remedial actions were required in Quadrant IV (remedial actions have already taken place at the X-344D Hydrogen Fluoride Neutralization Pit, X-735 Landfills, X-611A Former Lime Sludge Lagoons, and X-734 Landfill Area). The Corrective Measures Implementation Final Progress Report was submitted to Ohio EPA in May 2001.

3.2.2 Corrective Measures Implementation

In Quadrant I, corrective measures begun in 2001 include installation of a barrier wall around the eastern and southern portion of the X-749 Landfill and installation of additional groundwater extraction wells in the Quadrant I Groundwater Investigative Area. Remedial actions for two units in Quadrant II, removal of the X-701C Neutralization Pit/X-701A Lime House, and removal of contaminated soils near the X-720 Neutralization Pit were completed in 2001. Maintenance and monitoring of the phytoremediation system for the groundwater plume near the X-740 Waste Oil Handling Facility continued in 2001. The following subsections summarize each of these projects.

3.2.2.1 Barrier wall installation at the X-749 Landfill

Planning for installation of a barrier wall on the south and east sides of the X-749 Landfill took place through the first three quarters of 2001, and installation of the wall began in October 2001. As of December 31, 2001, the total length of the barrier wall had been excavated and approximately 75% of the trench associated with the wall had been backfilled. Construction of the wall will continue in 2002.

DOE received a Notice of Violation from Ohio EPA concerning this project in November 2001. Chapter 2, Sect. 2.4.3, provides additional information regarding this Notice of Violation.

3.2.2.2 Installation of groundwater extraction wells in the Quadrant I Groundwater Investigative Area

The corrective measures selected for the Quadrant I Groundwater Investigative Area (Five-Unit Area) include installation of 11 new groundwater extraction wells and treatment of the extracted groundwater in the X-622 Groundwater Treatment Facility. Planning for installation of the extraction wells and an upgrade of the X-622 Groundwater Treatment Facility (to treat the additional volume of extracted groundwater) began in 2000 and continued in the beginning of 2001. Construction for installation of the extraction wells began in August 2001 and will continue in 2002. Construction for the upgrade of the X-622 Groundwater Treatment Facility began in July 2001 and will be completed in 2002.

3.2.2.3 X-701C Neutralization Pit/X-701A Lime House removal

In Quadrant II, removal of the X-701C Neutralization Pit, X-701A Lime House, and associated facilities was completed in accordance with a work plan approved by Ohio EPA. The X-701C Neutralization Pit received process water and wastewater from the basement sump in the X-700 Chemical Cleaning Facility for over 30 years and was one of the sources of groundwater contamination in the Quadrant II Groundwater Investigative Area (see Chap. 6).

The X-701A Lime House was demolished in May 2001. Excavation of process lines at these facilities began in May and was completed in June 2001. Excavation of the neutralization pit, including adding hydrogen peroxide to the excavation to degrade volatile organic compounds in the soil and groundwater, took place in June and July 2001. All project activities were completed by the end of September 2001.

3.2.2.4 Removal of contaminated soils near the X-720 Neutralization Pit

Soil contaminated with chemicals at concentrations exceeding preliminary remediation goals was excavated in Quadrant II in the area of the former X-720 Neutralization Pit. Soil was removed from four locations and samples were collected to ensure that the contaminated soils had been removed. Based on the analytical results for these soil samples, additional soil was excavated in two locations and additional

soil samples were collected. A single detection of nickel was above the preliminary remediation goal, but Ohio EPA determined that no additional soil should be excavated. The excavations were filled and seeded with grass by the end of 2001.

3.2.2.5 Groundwater plume near the X-740 Waste Oil Handling Facility

Phytoremediation, a process that uses plants to remove, degrade, or contain contaminants in soil and/or groundwater, is being used to remediate contaminated groundwater near the X-740 Waste Oil Handling Facility. Over 700 hybrid poplar trees were planted on a 2.6-acre area above the X-740 groundwater plume in 1999. Groundwater monitoring of both the elevation of groundwater in the aquifer and the concentration of contaminants in the groundwater plume are used to monitor the system. Chapter 6 provides information about the groundwater monitoring completed for this area in 2001.

3.2.3 Additional Investigations

3.2.3.1 X-749 investigation

In 1995, a slurry wall was installed at the southern edge of the groundwater plume emanating from the X-749 landfill to assist in preventing the plume from moving off DOE property. Groundwater wells have been in place just upgradient of the slurry wall to monitor the groundwater plume; however, six new groundwater wells were installed in 2000 downgradient from the slurry wall near the DOE property line to confirm that the slurry wall is preventing the groundwater plume from moving off site.

A groundwater sample collected in the second quarter of 2001 at one of the new wells downgradient of the slurry wall contained trichloroethene at 2 Fg/L, which could indicate that the groundwater plume is moving beyond the slurry wall. Two samples were collected from the well in the third quarter; one of these samples also contained trichloroethene at 2 Fg/L. Trichloroethene was not detected in the second sample collected in the third quarter or in a sample collected in the fourth quarter. A sampling plan for an assessment of the X-749 groundwater plume in this area was implemented in 2002.

3.2.4 Technology Applications

The DOE/PORTS Technology Applications Program was established in 1993 to facilitate the introduction of innovative or experimental environmental technology into the DOE/PORTS Environmental Restoration Program. The primary function of the technology program is to identify, evaluate, and test/demonstrate innovative advancements in environmental characterization and cleanup. The goal is to incorporate the most practical, cost-effective cleanup approaches as they are evolving for full-scale application at the plant. By combining conventional research and development with cleanup efforts, technology demonstrations enable the site to solve real problems using innovative methods. The Technology Applications Program utilizes a team of DOE contractors, national laboratory scientists, university researchers, private industry representatives, site engineers, and technical staff.

3.2.4.1 X-701B *in situ c*hemical oxidation

In 2001, the Technology Applications Program evaluated *in situ* chemical oxidation at the X-701B Holding Pond. Oxidation is a type of chemical reaction. *In situ* (in place) chemical oxidation is used to remediate volatile organic compounds such as trichloroethene in groundwater. With this technique, chemical oxidants are injected into the ground, a chemical reaction takes place, and the trichloroethene is changed into nontoxic chemical compounds. Laboratory experiments have demonstrated that potassium permanganate, sodium permanganate, and hydrogen peroxide can effectively oxidize trichloroethene.

The X-701B Holding Pond area was chosen for this technology demonstration because of the existing horizontal and vertical groundwater wells and the extensive site characterization data for the area. In 1998-2000, sodium permanganate and/or potassium permanganate were introduced into the soil and/or groundwater at this area to oxidize trichloroethene. The results of these technology demonstrations indicated that *in situ* chemical oxidation through recirculation could effectively oxidize trichloroethene in groundwater in the area affected by the wells.

In 2001, a different chemical, hydrogen peroxide, was used in this technology demonstration. Approximately 2800 gallons of a 5% hydrogen peroxide solution were injected into eight existing groundwater wells in the western portion of the X-701B groundwater plume in November 2001. After the injection process was completed, the project was shut down for the winter. Continued use of this technology is pending further evaluation by DOE and Ohio EPA.

3.3 WASTE MANAGEMENT PROGRAM

The DOE/PORTS Waste Management Program directs the safe storage, treatment, and disposal of waste generated by past and present operations and from current Environmental Restoration projects. DOE/PORTS also stores USEC-generated waste in the RCRA Part B permitted storage areas. Waste managed under the program is divided into the following six categories, which are defined below:

- *Low-level radioactive waste (LLW)* – radioactive waste not classified as high level or transuranic and that does not contain any components regulated by RCRA or the Toxic Substances Control Act.

- *Hazardous (RCRA) waste* – waste that contains one or more of the wastes listed under RCRA or that exhibits one or more of the four RCRA hazardous characteristics: ignitability, corrosivity, reactivity, and toxicity.

- *RCRA/LLW mixed waste* – waste containing both hazardous and radioactive components. The waste is subject to RCRA, which governs the hazardous components, and to additional regulations that govern the radioactive components.

- *PCB wastes* – waste containing PCBs, a class of synthetic organic chemicals. Under Toxic Substances Control Act regulations, PCB manufacturing was prohibited after 1978. However, continued use of PCBs is allowed, provided that the use does not pose a risk to human health or the environment. Disposal of all PCB materials is regulated under the Toxic Substances Control Act.

- *PCB/LLW mixed waste* – waste containing both PCB and radioactive components. The waste is subject to the Toxic Substances Control Act that governs PCB components, and to additional regulations that govern radioactive components.

- *Industrial sanitary waste* – waste generated by commercial operations, such as office waste.

During 2001, approximately 7.8 million lbs of waste from PORTS were recycled, treated, or disposed (Table 3.1). Future waste management projects include continuing shipments for disposal of low-level radioactive waste and mixed waste, and the treatment of mixed and PCB/mixed waste at off-site commercial facilities.

Waste management requirements are varied and are sometimes complex because of the variety of waste streams generated by DOE/PORTS activities. DOE Orders, Ohio EPA regulations, and U.S. EPA regulations must be satisfied to demonstrate compliance for waste management activities. Additional

Table 3.1. Waste Management Program treatment, disposal, and recycling accomplishments for 2001

Waste stream	Quantity	Treated, disposed, or recycled	Treatment, disposal, or recycling facility
P-101, soft combustible debris	5773 drums / 646,818 lbs	Disposed	Envirocare
P-450, floor sweepings	1745 drums / 499,645 lbs	Disposed	Envirocare
X-701B steam strip sludge	331 drums / 135,104 lbs	Disposed	Envirocare
X-720 Neutralization Pit soils	33 B-25 boxes / 1,523,135 lbs	Disposed	Envirocare
X-747H scrap metal	449 containers / 2,864,726 lbs	Disposed	Envirocare
X-701C demolition debris	110 B-25 boxes / 910,831 lbs	Disposed	Envirocare
X-701C asbestos debris	3 B-25 boxes / 19,918 lbs	Disposed	Envirocare
X-744Y debris	698 BOBs and B-25 boxes / 1,127,730 lbs	Disposed	Envirocare
Quadrant I soil, personal protective equipment, debris	45 drums / 25,208 lbs	Disposed	Envirocare
Quadrant I soil, personal protective equipment, debris	43 drums / 30,521 lbs	Treated	Materials &Energy Corporation
Heavy metal sludge	1 5-gallon bucket 26 lbs	Treated	Waste Control Specialist
Cooling tower curtains	21 drums / 7541 lbs	Disposed	Envirocare
Waste oil and solvent	1 tanker / 13,023 lbs	Treated	TSCA incinerator
Compressed gas cylinder	1 cylinder / 16 lbs	Treated and disposed	Safety Kleen
Aluminum cans	1592 lbs	Recycled	Star, Inc.
Cardboard	10,612 lbs	Recycled	Star, Inc.

policies have been implemented for management of radioactive, hazardous, and mixed wastes. These policies include the following:

- minimizing waste generation;
- characterizing and certifying wastes before they are stored, processed, treated, or disposed;
- pursuing volume reduction (such as blending and bulking) as well as on-site storage in preparation for safe and compliant final treatment and/or disposal; and
- recycling.

3.4 WASTE MINIMIZATION AND POLLUTION PREVENTION PROGRAM

DOE/PORTS has combined its waste minimization and pollution prevention efforts to consolidate related activities. The objectives of the DOE/PORTS Waste Minimization and Pollution Prevention Program include the following:

- fostering a philosophy to conserve resources and create a minimum of waste and pollution;
- promoting the use of nonhazardous materials in DOE/PORTS operations to minimize potential risks to human health and the environment;
- reducing or eliminating the generation of wastes through material substitution, product reformulation, process modification, improved housekeeping, and on-site recycling; and
- complying with federal and state regulations and DOE policies and requirements for waste minimization.

The DOE/PORTS Waste Minimization and Pollution Prevention Program continues activities to achieve the waste minimization objectives. Typical projects include the following:

- maintaining a comprehensive waste tracking and reporting system;
- evaluating DOE/PORTS processes and activities to identify waste minimization opportunities;
- maintaining an effective DOE/PORTS waste minimization training program;
- maintaining a waste minimization and pollution prevention awareness promotional campaign; and
- providing a waste minimization and pollution prevention information exchange network.

The Pollution Prevention Awareness Program consists of (1) pollution prevention awareness through newsletters, bulletins, and memoranda; (2) awards, recognition for employees, and performance indicators; (3) information exchange; and (4) training. Anther recognized pollution prevention measure is the *Portsmouth Spill Prevention, Control, and Countermeasures Plan.*

Highlights of the Waste Minimization and Pollution Prevention Program in 2001 include the following:

- sponsored a science-related field trip for approximately 1000 students from southern Ohio and northern Kentucky to the Center of Science and Industry in Columbus, Ohio;
- recharacterized (through sampling and analysis) two waste streams as LLW versus RCRA/LLW mixed waste totaling approximately 80,000 lbs of waste resulting in reduced hazards and disposal costs associated with the waste;
- recycled more than 12,000 lbs of sanitary waste including office paper, corrugated cardboard, and aluminum cans;
- maintained 100% procurement of post-consumer recycled office paper and significantly increased the purchase of other products containing recycled material; and
- conducted a Pollution Prevention Opportunity Assessment on volume reduction of wood products (pallets) contaminated with radioactivity.

Activities planned for 2002 include initiating a comprehensive training program for Environmental Restoration activities to support the goals established in Executive Order 13101, continuing the scrap metal recycling program, and enhancing support of the Pollution Prevention Program through additional funding to increase the infrastructure and perform the necessary assessments to fully implement a Pollution Prevention Program that crosses all department and subcontractor boundaries.

3.5 ENVIRONMENTAL TRAINING PROGRAM

DOE/PORTS provides environmental training to increase employee awareness of environmental activities and to enhance the knowledge and qualifications of personnel performing tasks associated with environmental assessment, planning, and restoration. The program includes on- and off-site classroom instruction, on-the-job training, seminars, and specialized workshops and courses. Environmental training conducted or prepared by DOE/PORTS includes hazardous waste training required by RCRA and numerous Occupational Safety and Health Administration training requirements.

3.6 INFORMATION EXCHANGE PROGRAM

To improve and update its environmental monitoring and research programs, DOE/PORTS exchanges information within the site and with other DOE facilities and other sources of information. DOE/PORTS representatives attend both DOE-sponsored and independent technical information exchange workshops, such as the annual DOE Model Conference and other professional conferences.

3.7 PUBLIC AWARENESS PROGRAM

A comprehensive community relations and public participation program has been in place since early 1990. The purpose of the program is to foster a spirit of openness and credibility between PORTS officials and local citizens, elected officials, business, media, and various segments of the public. The program also provides the public with opportunities to become involved in the decisions affecting environmental issues at the plant.

DOE/PORTS opened a public Environmental Information Center in February 1993 to provide public access to all documents used to make decisions on remedial actions being taken at the plant. The Information Center is on the west side of the plant site in a modular unit outside the E-Vehicle portal. The mailing address for the Information Center is U.S. DOE Environmental Information Center, P.O. Box 693, Piketon, Ohio 45661. The street address is 3930 U.S. Route 23 South, Perimeter Road West, Piketon, Ohio 45661. Hours for the Information Center are 9 a.m. to 12 p.m. Monday and Tuesday, 12 p.m. to 4 p.m. Wednesday and Thursday, or by appointment (740-289-3317). Due to additional security measures in place at the plant post-September 11, 2001, members of the public must call the Information Center in advance at the number listed above to be placed on the visitor list prior to visiting the Information Center.

Semiannual public update meetings and public workshops on specific topics are also held to keep the public informed and to receive their comments and questions. Periodically, fact sheets about major projects are written for the public. Semiannual environmental bulletins are printed and distributed to more than 4,000 recipients, including those on the community relations mailing list, neighbors within 2 miles of the plant, and plant employees and retirees.

Points of contact have been established for the public to obtain information or direct questions regarding the Environmental Management Program. The DOE Site Office may be contacted at 740-897-2003. The Bechtel Jacobs Company Public Affairs Manager (740-897-2336) also provides information on the program.

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4. ENVIRONMENTAL RADIOLOGICAL PROGRAM INFORMATION

4.1 SUMMARY

Environmental monitoring at PORTS includes air, water, soil, sediment, and biota (animals, vegetation, and crops) as well as measurement of both radiological and chemical parameters. This chapter discusses the radiological component of environmental monitoring programs at PORTS; Chap. 5 discusses the non-radiological parameters for the monitoring programs.

Environmental monitoring programs are required by state and federal regulations, permit requirements, and DOE Orders, but also are developed to reduce public concerns about plant operations. In 2001, environmental monitoring information was collected by both DOE and USEC. Unlike other chapters of this report that focus on DOE activities at PORTS, this chapter includes monitoring information collected by USEC.

Environmental monitoring data collected at PORTS are used to assess potential impacts to human health and the environment from radionuclides released by PORTS operations. This impact, called a dose, can be caused by radionuclides released to air and/or water, or radiation emanating directly from buildings or other objects at PORTS. The U.S. EPA sets a 10 millirem (mrem)/year limit for dose from radionuclides released to the air, and the DOE sets a 100 mrem/year limit for dose from radionuclides from all potential pathways. A person living in southern Ohio receives a dose of approximately 300 mrem/year from natural sources of radiation. This chapter includes radiological dose calculations for the dose to the public from radionuclides released to the air and surface water, from direct radiation, and from radionuclides detected by environmental monitoring programs for residential drinking water, sediment, soil, vegetation, and biota (deer, crops, and fish). The maximum dose a member of the public could receive from radiation released by PORTS in 2001 or detected by environmental monitoring programs in 2001 is 2.0 mrem. Table 4.1 summarizes this dose information.

Table 4.1. Summary of potential doses to the public from PORTS in 2001

Source of dose	Dose (mrem)
Airborne radionuclides	0.060
Radionuclides released to the Scioto River	0.039
Direct radiation from depleted uranium cylinder storage yards	0.98
Radionuclides detected by environmental monitoring programs [drinking water, sediment, soil, vegetation, and biota (deer, fish, and crops)]	0.88
Total	2.0

4.2 INTRODUCTION

Environmental monitoring programs at PORTS are designed to detect the effects (if any) of PORTS operations on human health and the environment. Multiple samples are collected throughout the year and are analyzed for radionuclides that could be present from PORTS activities. The results of these monitoring programs are used to gauge the environmental impacts of PORTS operations and to set priorities for environmental improvements.

Environmental regulations, permit requirements, DOE Orders, and public concerns are all considered in developing environmental monitoring programs. State and federal regulations drive some of the monitoring conducted at DOE/PORTS such as limitations on discharges to air and water. DOE Orders

5400.1, *General Environmental Protection Program*, and 5400.5, *Radiation Protection of the Public and the Environment*, also address environmental monitoring requirements. Specific radionuclides monitored at PORTS are selected based on the materials handled at PORTS and on historic sampling data.

Environmental monitoring data are collected by both DOE and USEC. Because USEC data are important in developing a complete picture of environmental monitoring at PORTS, these data are included in this report. USEC information is provided for informational purposes only; DOE cannot certify the accuracy of USEC data.

Data from the following environmental monitoring programs are included in this chapter:

- Airborne discharges,
- Ambient air,
- Radiation,
- Discharges to surface water,
- Surface water,
- Sediment,
- Soil,
- Vegetation, and
- Biota.

DOE also conducts an extensive groundwater monitoring program at PORTS. Chapter 6 provides information on the groundwater monitoring program, associated surface water monitoring, and water supply monitoring.

As discussed in this chapter, dose is a measure of the potential biological damage that could be caused by exposure to and subsequent absorption of radiation to the body. Because there are many natural sources of radiation, a person living in the Portsmouth area receives a dose of approximately 300 mrem/year from sources of natural radiation. Appendix A provides additional information on radiation and dose.

Releases of radionuclides such as technetium-99 from PORTS activities can cause a dose to a member of the public in addition to the dose received from natural sources of radiation. PORTS activities that release radionuclides are regulated by the U.S. EPA and DOE. Airborne releases of radionuclides from DOE facilities are regulated by the U.S. EPA under the Clean Air Act and the National Emission Standards for Hazardous Air Pollutants. These regulations set an annual dose limit of 10 mrem/year to any member of the public as a result of airborne radiological releases. Airborne radionuclide discharges may also be regulated, along with all other atmospheric pollutants, under the State of Ohio Permit to Operate requirements for sources of air emissions.

DOE also regulates radionuclide emissions to all environmental media through DOE Orders 5400.1, *General Environmental Protection Program*, and 5400.5, *Radiation Protection of the Public and the Environment.* DOE Order 5400.5 sets an annual dose limit of 100 mrem/year to any member of the public from all radionuclide releases from a facility, unlike the National Emission Standards for Hazardous Air Pollutants, which apply to only airborne radiological releases.

Small quantities of radionuclides were released to the environment from DOE/PORTS operations during 2001. This chapter describes the methods used to estimate the potential doses that could result from radionuclides released from PORTS operations. In addition, this chapter assesses the potential doses that could result from radionuclides historically released by PORTS and detected in 2001 by USEC or DOE environmental monitoring programs.

4.3 RADIOLOGICAL EMISSIONS AND DOSES

Exposure to radioactive materials can occur from releases to the atmosphere, surface water, or groundwater. In addition, a dose could be received through direct external irradiation by radiation emanating from buildings and other objects located within PORTS boundaries. For 2001, doses are estimated for exposure to atmospheric releases, releases to surface water, and direct radiation. Doses are also estimated for exposure to radionuclides from PORTS operations that were detected in 2001 as part of the USEC monitoring programs for sediment, soil, vegetation, and biota (deer, crops, and fish) and the DOE monitoring program for residential drinking water supplies. Exposure to radionuclides detected in groundwater at PORTS is not included because contaminated groundwater at PORTS is contained on site and is not a source of drinking water.

In addition, DOE Order 5400.5 sets an absorbed dose rate of 1 rad per day to native aquatic organisms. This chapter contains the dose calculations required to demonstrate compliance with this requirement.

DOE/PORTS workers and visitors who may be exposed to radiation are also monitored. These results are also provided in this chapter.

4.3.1 Dose Terminology

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, possibly resulting in tissue damage. Radiation may come from radionuclides outside the body (in or on environmental media or objects) 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, and 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.

The three natural uranium isotopes (uranium-234, uranium-235, and uranium-238) and technetium-99 are the most commonly detected radionuclides in environmental media samples collected around PORTS. Other radioactive isotopes are also part of the radioactive dose received from PORTS operations.

A number of specialized measurement units have been defined for characterizing exposures to ionizing radiation. Because the damage associated with exposure to radiation results primarily from the deposition of radiant energy in tissue, the units are defined in terms of the amount of radiant energy absorbed by human (or animal) tissue and in terms of the biological consequences of the absorbed energy. These units include the following:

- *Absorbed dose* – a physical quantity that defines the amount of incident radiant energy absorbed per unit mass of an irradiated material; its unit of measure is the rad. The absorbed dose depends on the type and energy of the incident radiation and on the atomic number of the absorbing material.

- *Dose equivalent* – a quantity that expresses the biological effectiveness of an absorbed dose in a specified human organ or tissue; its unit of measure is the rem. The dose equivalent is numerically equal to the absorbed dose multiplied by modifying factors that relate the absorbed dose to biological effects.

- *Effective dose equivalent* – a weighted sum of dose equivalents to specified organs that can be used to estimate health-effect risk to exposed persons. In this report, the term "effective dose equivalent" is often shortened to "dose."

- *Collective dose equivalent* – the sum of committed (effective) dose equivalents to all individuals in an exposed population. The unit of measure is the person-rem. The collective dose is also frequently called the "population dose."

4.3.2 Airborne Emissions

Airborne discharges of radionuclides from PORTS are regulated under the Clean Air Act National Emission Standards for Hazardous Air Pollutants. Releases of radionuclides are used to calculate a dose to members of the public. Section 4.3.3 discusses the results of this dose calculation.

Because USEC operates the uranium enrichment process at PORTS, USEC is responsible for most of the sources that emit radionuclides. In 2001, USEC reported emissions of 0.2 curie (a measure of radioactivity) from its radionuclide emission sources.

DOE/PORTS is responsible for four radiological emission sources: the X-326 L-cage Glove Box, X-744G Glove Box, X-623 Groundwater Treatment Facility, and X-624 Groundwater Treatment Facility. The glove boxes are used to repackage wastes or other materials that contain radionuclides, and the groundwater treatment facilities treat groundwater contaminated with radionuclides. The glove boxes were not used in 2001. Emissions from the groundwater treatment facilities are based on emission tests completed in the first quarter 2001 and are estimated at 0.00063 curie.

4.3.3 Dose Calculation Based on Airborne Emissions

A dose calculation for atmospheric, or airborne, radionuclides is required by the U.S. EPA under the program called the National Emission Standards for Hazardous Air Pollutants. The effect of radionuclides released to the atmosphere by DOE/PORTS during 2001 was characterized by calculating effective dose equivalents to the maximally exposed person (the individual who resides at the most exposed point near the plant) and to the entire population (approximately 600,000 residents) within 50 miles of the plant. Dose calculations were made using a computer program called CAP88 (Beres 1990), which was developed under sponsorship of the U.S. EPA for use in demonstrating compliance with the National Emission Standards for Hazardous Air Pollutants for radionuclides. The program uses models to calculate concentrations of radionuclides in the air and on the ground and in foodstuffs (e.g., vegetables, meat, and milk) and subsequent intakes by individuals. The program also uses meteorological data collected at PORTS such as wind direction, wind speed, atmospheric stability, rainfall, and average air temperature.

Radionuclide emissions were modeled for the two DOE/PORTS groundwater treatment facilities identified in Sect. 4.3.2. The dose calculations assumed that each person remained unprotected, resided at home (actually outside the house) during the entire year, and obtained food according to the rural pattern defined in the National Emission Standards for Hazardous Air Pollutants background documents. This pattern specifies that 70% of the vegetables and produce, 44% of the meat, and 40% of the milk consumed by each person are produced in the local area (e.g., in a home garden). The remaining portion of each food is assumed to be produced within 50 miles of DOE/PORTS. These assumptions most likely result in an overestimate of the dose received by a member of the public, since it is unlikely that a person spends the entire year outside at home and consumes food from the local area as described above.

The maximum potential dose to an off-site individual from radiological releases from DOE air emission sources at PORTS in 2001 was 0.014 mrem/year. This dose has increased slightly from the dose calculated by DOE in 2000 (0.01 mrem/year) because of differences in wind speed and/or wind direction in 2001.

USEC also completes the dose calculations described above for the air emission sources leased to USEC (e.g., the uranium enrichment facilities and other sources). The combined dose from USEC and DOE sources is 0.060 mrem/year, well below the 10-mrem/year limit applicable to PORTS and the approximate 300-mrem/year dose that the average individual in the United States receives from natural sources of radiation.

The collective dose equivalent (or population dose) to the entire population within 50 miles of PORTS was 0.198 person-rem/year, based on USEC calculations of 0.18 person-rem/year from USEC sources and 0.018 person-rem/year from DOE sources. The population dose to the nearest community, Piketon, was calculated to be 0.04 person-rem/year, based on USEC calculations of 0.039 person-rem/year from USEC sources and 0.0013 person-rem/year from DOE sources.

4.3.4 Dose Calculation Based on Ambient Air Monitoring

DOE collects samples from 14 ambient air monitoring stations (see Fig. 4.1) and analyzes them for the radionuclides that could be present in ambient air due to PORTS activities. These radionuclides are isotopic uranium (uranium-233/234, uranium-235, uranium-236, and uranium-238), technetium-99, and selected transuranic radionuclides (americium-241, neptunium-237, plutonium-238, and plutonium-239/240). The ambient air monitoring stations measure radionuclides released from the DOE and USEC point sources (the sources described in Sect. 4.3.2), fugitive air emissions (emission that are not associated with a specific release point, such as a stack), and background concentrations of radionuclides (radionuclides that occur naturally in the environment and are not associated with PORTS operations).

The CAP88 model generates a dose conversion factor that was used to calculate a dose for a given concentration of each radionuclide in air. The following assumptions were made to calculate the dose at each station: (1) the highest concentration of each radionuclide detected in 2001 was assumed to be present for the entire year; or (2) if a radionuclide was not detected, the radionuclide was assumed to be present at half the detection limit for the analytical method.

The dose associated with each radionuclide at each ambient air monitoring station was added to obtain the gross dose for each station. The net dose for each station was obtained by subtracting the dose measured at the background station (A37). The net dose ranged from zero (at stations with a gross dose less than the background station) to 0.00019 mrem/year at station A10.

The highest net dose measured at the ambient air monitoring stations is approximately 0.3% of the dose calculated from the combined DOE and USEC point source emissions (0.060 mrem/year).

4.3.5 Discharges of Radionuclides from NPDES Outfalls

4.3.5.1 DOE outfalls

DOE/PORTS has six discharge points, or outfalls, through which water is discharged from the site (see Fig. 4.2). Three outfalls discharge directly to surface water, and three discharge to the USEC X-6619 Sewage Treatment Plant before leaving the site through USEC NPDES Outfall 003 to the Scioto River. A brief description of each DOE outfall at PORTS follows.

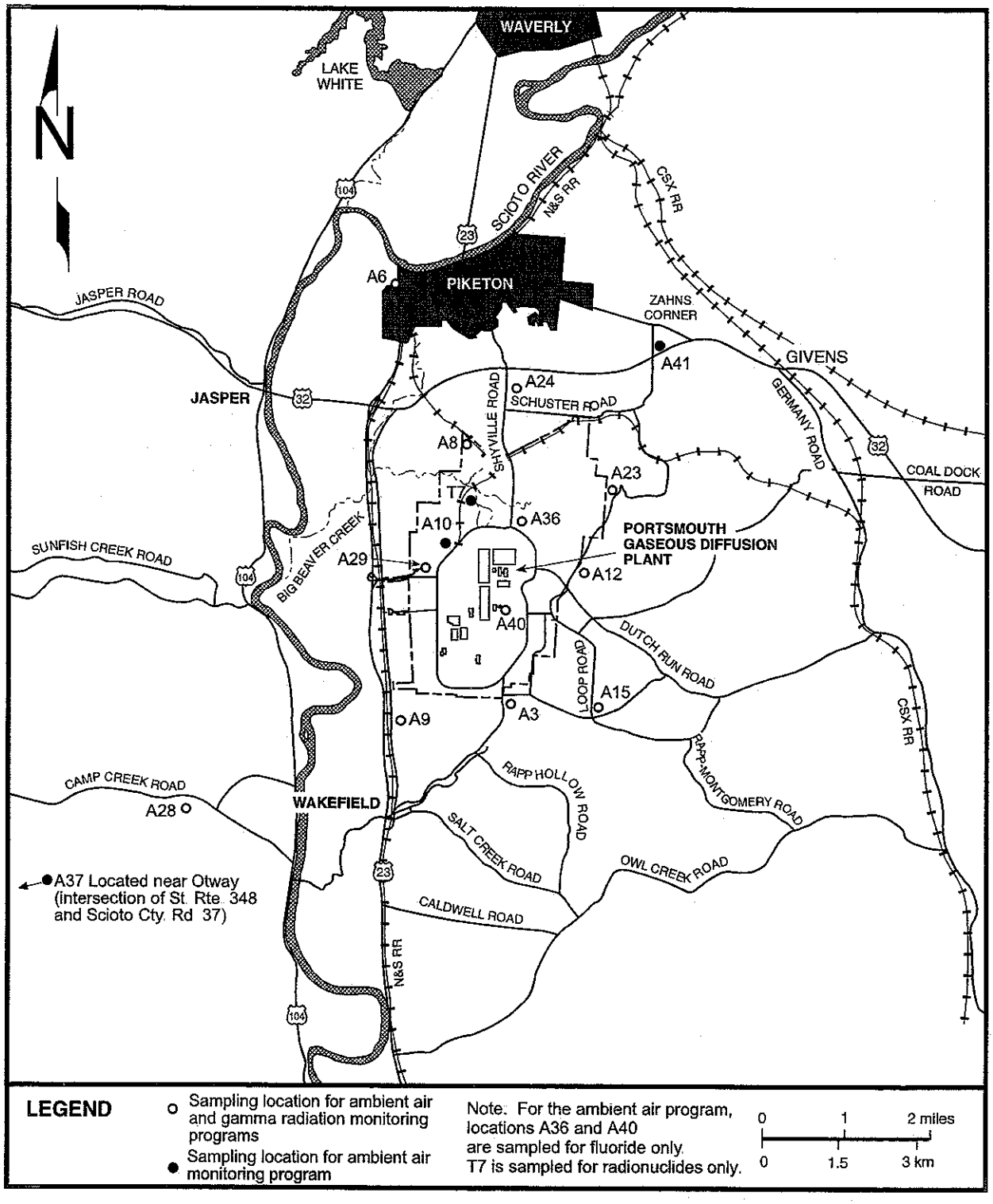

Fig. 4.1. DOE ambient air and gamma radiation monitoring locations.

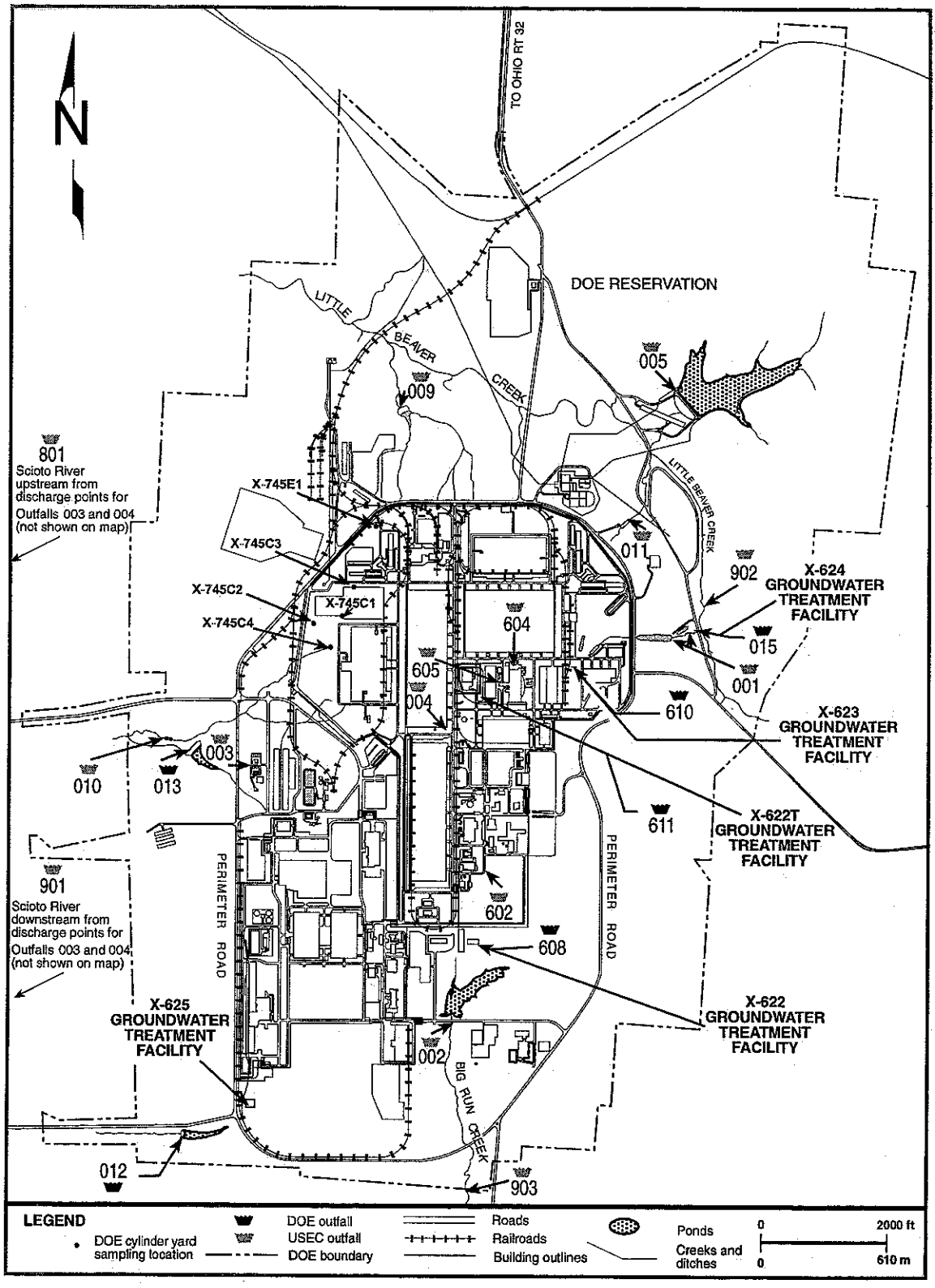

Fig. 4.2. DOE and USEC NPDES outfalls/monitoring points and DOE cylinder storage yard surface water sampling locations.

DOE NPDES Outfall 012 (X-2230M Holding Pond) – The X-2230M Holding Pond accumulates precipitation runoff, non-contact cooling water, and steam condensate from the southern portion of the PORTS reservation. The pond provides an area where solids can settle, chlorine can dissipate, and oil can be separated from the water prior to its release to an unnamed stream that flows to the Scioto River.

DOE NPDES Outfall 013 (X-2230N Holding Pond) – The X-2230N Holding Pond accumulates precipitation runoff, non-contact cooling water, and steam condensate from the southwestern portion of the PORTS reservation. The pond provides an area where solids can settle, chlorine can dissipate, and oil can be separated from the water prior to its release to the West Ditch, which flows to the Scioto River.

DOE NPDES Outfall 015 (X-624 Groundwater Treatment Facility) – This facility removes volatile organic compounds from contaminated groundwater originating from the X-701B plume interceptor trenches. These groundwater interceptor trenches were constructed to control the migration of volatile organic compound-contaminated groundwater toward Little Beaver Creek. Treated water is released to a ditch that flows to Little Beaver Creek.

DOE NPDES Outfall 608 (X-622 Groundwater Treatment Facility) – This facility removes volatile organic compounds from contaminated groundwater originating from site remediation activities in the southern portion of the site. Treated water is discharged to the sanitary sewer and then through USEC NPDES Outfall 003.

DOE NPDES Outfall 610 (X-623 Groundwater Treatment Facility) – This facility removes volatile organic compounds from contaminated groundwater originating from site remediation activities and from miscellaneous well development and purge waters. Treated water is discharged to the sanitary sewer and then through USEC NPDES Outfall 003.

DOE NPDES Outfall 611 (X-622T Groundwater Treatment Facility) – This facility removes volatile organic compounds from groundwater collecting in sumps located in the basements of the X-705 and X-700 buildings. Treated water is discharged to the sanitary sewer and then through USEC NPDES Outfall 003.

DOE monitors NPDES outfalls for radiological discharges by collecting water samples and analyzing the samples for technetium-99, total uranium, uranium isotopes (uranium-233/234, uranium-235, uranium-236, and uranium-238), and transuranic radionuclides (americium-241, neptunium-237, plutonium-238, and plutonium-239/240).

Discharges of radionuclides in liquids through DOE NPDES outfalls have no significant impact on public health and the environment. Uranium discharges in 2001 from external DOE NPDES outfalls (Outfalls 012, 013, and 015) were estimated at 1.2 kilograms. Total radioactivity released from the external outfalls was 1.3 curies of uranium isotopes (uranium-233/234, uranium-235, and uranium-238) and 2.7 curies of technetium-99. These values were calculated using monthly monitoring data from the DOE NPDES outfalls. Analytical results below the detection limit were assigned a value of zero in the calculations to determine the quantities of uranium and radiation discharged through the DOE NPDES outfalls.

Americium-241 was detected at 0.1522 picocurie per liter (pCi/L) in the sample collected from DOE Outfall 013 in the third quarter 2001. Americium-241 was not detected at this outfall in the other three quarterly samples collected in 2001. Neptunium-237 was detected at DOE Outfall 608 in the fourth quarter 2001, but was not detected in the fourth quarter sample collected by USEC NPDES Outfall 003 (Outfall 608 discharges to Outfall 003). Plutonium-238 and plutonium-239/240 were not detected in samples collected from any of the DOE outfalls in 2001.

4.3.5.2 USEC outfalls

USEC is responsible for 11 NPDES outfalls through which water is discharged from the site (see Fig. 4.2). Eight outfalls discharge directly to surface water, and three discharge to another USEC NPDES outfall before leaving the site. A brief description of each USEC NPDES outfall follows.

USEC NPDES Outfall 001 (X-230J7 East Holding Pond) – The X-230J7 East Holding Pond receives non-contact cooling water, steam condensate, foundation drainage, storm runoff, hydro-testing water from cylinders, and sanitary water for eyewash/shower station testing and flushing. The pond provides an area where materials suspended in the influent can settle, chlorine can dissipate, and oil can be diverted and contained. Water from this holding pond is discharged to a ditch that flows to Little Beaver Creek.

USEC NPDES Outfall 002 (X-230K South Holding Pond) – The X-230K South Holding Pond receives non-contact cooling water, steam condensate, foundation drainage, treated coal pile runoff, storm runoff, fire-fighting training and fire suppression system water, and sanitary water for eyewash/shower station testing and flushing. The pond provides an area where materials suspended in the influent can settle, chlorine can dissipate, oil can be contained, and pH can be adjusted. Water from this holding pond is discharged to Big Run Creek.

USEC NPDES Outfall 003 (X-6619 Sewage Treatment Plant) – The X-6619 Sewage Treatment Plant treats PORTS sewage as well as water discharged from DOE groundwater treatment facilities, the X-700 Biodenitrification Facility, the X-705 Decontamination Microfiltration System, and miscellaneous waste streams. The X-6619 Sewage Treatment Plant uses screening, aeration, clarification, and filtering followed by chlorination to treat wastewater prior to release to the Scioto River.

USEC NPDES Outfall 004 (Cooling Tower Blowdown) – This outfall was relocated in 2000 to the junction of Pike Avenue and 15th Avenue at PORTS. It monitors blowdown water from various cooling towers on site prior to discharge to the Scioto River.

USEC NPDES Outfall 005 (X-611B Lime Sludge Lagoon) – The X-611B Lime Sludge Lagoon is used to settle lime sludge used in a water-softening process. The X-611B also receives rainwater runoff. Water from this facility is generally returned to the X-611 Water Treatment Plant for treatment. Direct discharges from this facility occur only during periods of excessive rainfall. During such rare events, the lagoon discharges to Little Beaver Creek.

USEC NPDES Outfall 009 (X-230L North Holding Pond) – The X-230L North Holding Pond receives non-contact cooling water, steam condensate, storm runoff, fire suppression system water, and sanitary water for eyewash/shower station testing and flushing. The pond provides an area where materials suspended in the influent can settle, chlorine can dissipate, and oil can be contained. Water from this holding pond is discharged to an unnamed stream that flows to Little Beaver Creek.

USEC NPDES Outfall 010 (X-230J5 Northwest Holding Pond) – The X-230J5 Northwest Holding Pond receives non-contact cooling water, steam condensate, storm runoff, fire-fighting training and fire suppression system water, and sanitary water for eyewash/shower station testing and flushing. The pond provides an area where materials suspended in the influent can settle, chlorine can dissipate, and oil can be diverted and contained. Water from this holding pond is discharged to the West Ditch, which flows to the Scioto River.

USEC NPDES Outfall 011 (X-230J6 Northeast Holding Pond) – The X-230J6 Northeast Holding Pond receives non-contact cooling water, steam condensate, storm runoff, fire suppression system water, and sanitary water for eyewash/shower station testing and flushing. The pond provides an area where

materials suspended in the influent can settle, chlorine can dissipate, and oil can be diverted and contained. Water from this holding pond is discharged to an unnamed stream that flows to Little Beaver Creek.

USEC NPDES Outfall 602 (X-621 Coal Pile Runoff Treatment Facility) – The X-621 Coal Pile Runoff Treatment Facility treats storm water runoff from the coal pile at the X-600 Steam Plant. The treated water is discharged to the X-230K South Holding Pond (USEC NPDES Outfall 002).

USEC NPDES Outfall 604 (X-700 Biodenitrification Facility) – The X-700 Biodenitrification Facility receives solutions from plant operations that are high in nitrate. At the X-700, these solutions are diluted and treated biologically using bacteria prior to being discharged to the X-6619 Sewage Treatment Plant (USEC NPDES Outfall 003).

USEC NPDES Outfall 605 (X-705 Decontamination Microfiltration System) – The X-705 Decontamination Microfiltration System treats process wastewater using microfiltration and pressure filtration technology. The treated water is discharged to the X-6619 Sewage Treatment Plant (USEC NPDES Outfall 003).

The USEC NPDES Permit also identifies four additional monitoring points that are not discharge points as described in the previous paragraphs. USEC NPDES Station Number 801 is a background monitoring location on the Scioto River upstream from USEC NPDES Outfalls 003 and 004. USEC NPDES Station Number 901 is a monitoring location on the Scioto River downstream from Outfall 003 and 004 and located in the discharge plume from these two outfalls. USEC NPDES Station Number 902 is a monitoring location on Little Beaver Creek downstream from USEC NPDES Outfall 001, and USEC NPDES Station Number 903 is a monitoring location on Big Run Creek downstream from USEC NPDES Outfall 002.

Data collected by USEC and provided to DOE showed that USEC released 16.2 kilograms of uranium through its external NPDES outfalls (Outfalls 001 through 011) in 2001. Total radioactivity released was 0.0259 curie of uranium and 0.0522 curie of technetium-99. Transuranic radionuclides (americium-241, neptunium-237, plutonium-238, and plutonium-239/240) were not detected in any of the samples collected from USEC NPDES outfalls in 2001.

4.3.6 Dose Calculation for Releases to Surface Water

Radionuclides are measured at the DOE and USEC NPDES external outfalls (three DOE outfalls and eight USEC outfalls). Water from these external outfalls is either directly discharged to the Scioto River or eventually flows into the Scioto River from the Little Beaver Creek, Big Run Creek, or unnamed tributaries to these water bodies. A hypothetical dose to a member of the public was calculated using the measured radiological discharges and the average annual flow rate of the Scioto River.

Total uranium mass (in Fg/L) and activity (in pCi/L) for americium-241, neptunium-237, plutonium-238, plutonium-239/240, and technetium-99 were measured in the water discharged from the DOE or USEC outfalls. Total uranium was assumed to be 5.2% uranium-235, 94% uranium-238, and 0.8% uranium-234. The maximum individual dose was calculated using the above-mentioned measured radionuclide discharges from the plant outfalls and the average annual flow rate of the Scioto River. All discharge radioactivity levels were expressed in total activity per year (Ci/year) and used along with the average river flow to calculate radioactivity per volume.

The dose calculations were derived from the procedures developed for a similar DOE facility: *LADTAPXL: An Improved Electronic Spreadsheet Version of LADTAP II* (Hamby 1991). Environmental

pathways considered were ingestion of water, ingestion of fish, swimming, boating, and shoreline activities. The assumption was made that a person eats 21 kilograms (46 lbs) of fish caught in the Scioto River, drinks 730 liters (190 gal) of river water, swims for 27 hours, boats for 105 hours, and occupies the shoreline for 69 hours during the year. Based on the calculations across all isotopes found in the outfalls, this individual could receive an annual dose of about 0.039 mrem. This is a very conservative exposure scenario because the Scioto River is not used for drinking water downstream of PORTS (about 90% of the hypothetical dose from liquid effluents is from drinking water) and it is unlikely that a person would eat 46 lbs of fish from the river. This dose is similar to the dose calculated in 2000 (0.042 mrem).

4.3.7 Radiological Dose Calculation for Direct Radiation

The DOE/PORTS Radiological Protection Organization monitors direct radiation levels in active DOE/PORTS facilities on a continual basis. This radiation monitoring assists in determining the radiation levels that workers are exposed to and in identifying changes in radiation levels. These measurements provide (1) information for worker protection, (2) a means to trend radiological exposure data for specified facilities, and (3) a means to estimate potential public exposure to radiation from DOE/PORTS activities.

Thermoluminescent dosimeters (TLDs) are used to measure beta, gamma, and neutron radiation. The TLD consists of four crystals that store radiation as potential energy. When the TLD crystals are heated, this stored energy is released as light. This light is quantifiable and correlates directly to the amount of ionizing radiation to which the TLD was exposed. The TLD can differentiate exposure to beta, gamma, and neutron radiation as well as shallow and deep radiation. Shallow radiation penetrates only the outer portion of the skin. Deep radiation penetrates the entire body (similar to an x-ray).

Five major DOE/PORTS facilities are monitored for direct radiation exposure levels: the X-7725 Waste Storage Facility, X-326 Process Building, X-345 SNM Storage Building, X-744G Bulk Storage Building, and the X-745C and X-745E Depleted Uranium Hexafluoride Cylinder Storage Yards.

The Perimeter Road passes close to the edge of the cylinder yards. Therefore, data from direct radiation monitoring at the cylinder yards are used to assess potential exposure to the public from passing traffic on Perimeter Road.

The radiological exposure data provided from the TLDs at each facility are based on exposure to ionizing radiation for an entire year (i.e., 24 hours/day, 7 days/week, 52 weeks/year - 8,736 hours/year). The radiological exposure to members of the general public is estimated as the time that a person drives on Perimeter Road past the cylinder yards. Tests estimate that a car traveling slightly under the posted speed limit passes by the cylinder yards in 20 to 30 seconds. Potential public exposure to radiation from the cylinder yards is calculated as follows:

Assumptions:

- A person driving to and from work (2 exposures/day) is the most conservative plausible scenario.
- The driver will pass by the cylinder yards within 1 minute.

Calculation:

1. Subtract natural background radiation – 78 mrem/year from the total effective dose equivalent. Natural background radiation consists of 50 mrem/year cosmic radiation and 28 mrem/year terrestrial radiation (see Appendix A).

2. Divide this dose measurement by 8736 hours to determine the exposure per hour.

3. Multiply this exposure by 6.2 hours/year (1 minute/trip x 2 trips/day x 5 work-days/week x 37 weeks/year x 1 hour/60 minutes). Please note that Perimeter Road was closed to public access following September 11, 2001; therefore, the dose was calculated for 37 weeks instead of the entire year (52 weeks).

The total effective dose equivalent reported in Table 4.2 represents the gross exposure levels at each facility. These levels include ionizing radiation from PORTS activities in those areas and natural background radiation (i.e., terrestrial and cosmic radiation). The final column provides the potential dose to the public from each area.

Table 4.2. Direct radiation doses at DOE/PORTS facilities – 2001

Facility	Total effective dose equivalent (deep dose) (mrem/year)[a]	Estimated public dose (mrem/year) 6.2 hours exposure
X-7725	101	NA[b]
X-326	0	NA[b]
X-345	0	NA[b]
X-744G	4592	NA[b]
X-745C	619	0.44
X-745E	761	0.54

[a]Area TLDs were averaged for each building and the TLDs closest to Perimeter Road were used for the cylinder storage yards.
[b]Not applicable - no public exposure to radiation from these buildings.

Based on the assumptions and calculations provided, exposure to the public from radiation from the cylinder yards is approximately 0.98 mrem/year. This dose has decreased from the dose reported in 2000 (1.15 mrem/year) due to the closure of Perimeter Road to the public following September 11, 2001. The average yearly dose to a person in the United States is approximately 366 mrem: 300 mrem from natural radiation sources and 66 mrem from manmade radiation sources (see Appendix A). The potential estimated dose from the cylinder yards to a member of the public is less than 0.3 percent of the average yearly radiation exposure for a person in the United States.

4.3.8 Radiological Dose Calculations for Environmental Monitoring Data

Environmental monitoring at PORTS includes collecting samples at off-site locations around the PORTS reservation and analyzing the samples for radionuclides that could be present due to PORTS operations. Samples are analyzed for uranium, uranium isotopes, technetium-99, and/or selected transuranics (americium-241, neptunium-237, plutonium-238, and plutonium-239/240). Uranium occurs naturally in the environment; therefore, detections of uranium cannot necessarily be attributed to PORTS operations. Detections of technetium-99 and transuranics most likely result from activities at PORTS.

DOE sets a limit of 100 mrem/year for a potential dose to a member of the public via exposure to all radionuclide releases from a DOE facility. To ensure that PORTS meets this standard, dose calculations were completed for detections of radionuclides in residential drinking water, sediment, soil, vegetation, and biota (deer, fish, and crops) at off-site sampling locations. Detections of radionuclides on the DOE reservation were not used to assess risk because the public does not have access to the facility.

The following sections provide brief descriptions of the dose calculations for each monitoring program. Methodologies used to complete each risk calculation are based on information developed and

approved by U.S. EPA including the *Exposure Factors Handbook* (U.S. EPA 1997) and *Internal Dose Conversion Factors for Calculation of Dose to the Public* (DOE 1988). Table 4.3 summarizes the results of each dose calculation.

Table 4.3. Summary of potential doses to the public from radionuclides detected by PORTS environmental monitoring programs in 2001

Source of dose	Dose (mrem/year)
Drinking water	0.015
Sediment	0.049
Soil	0.024
Vegetation	0.000027
Biota (deer)	0.76
Biota (fish)	0.033
Biota (crops)	0.00025
Total	0.88

4.3.8.1 Dose calculation for technetium-99 in residential drinking water

In the third quarter 2001, technetium-99 was detected at low concentrations (14 and 12 pCi/L) in both samples collected from a residential drinking water well located northwest of PORTS near the intersection of Routes 23 and 32. These detections are below drinking water standards for public water supplies, which are called maximum contaminant levels. The maximum contaminant level applicable to technetium-99 is 4 mrem/year for all man-made radionuclides that emit beta particles (technetium-99 emits beta particles). The concentration of technetium-99 in drinking water that results in a dose of 4 mrem/year is 900 pCi/L, as provided in the National Bureau of Standards Handbook 69 (U.S. Department of Commerce 1963), which is referenced by Ohio EPA drinking water regulations.

A dose calculation was also completed based on the assumption that a person drank water contaminated with technetium-99 at 13 pCi/L (the average of 14 and 12 pCi/L) throughout the year. Based on exposure factors from U.S. EPA's *Exposure Factors Handbook* (U.S. EPA 1997), the dose that could be received by an individual from water contaminated at this level is 0.015 mrem/year. Chapter 6, Sect. 6.4.13 provides additional information about the water supply monitoring program and a map of water supply monitoring locations.

4.3.8.2 Dose calculation for sediment

The dose calculation for sediment is based on the detection of 16 picocuries per gram (pCi/g) of technetium-99, 4.054 pCi/g of uranium-233/234, 0.1546 pCi/g of uranium-235, 0.04165 pCi/g of uranium 236, and 1.359 pCi/g of uranium-238 in the sediment sample collected in spring 2001 from monitoring location RM-7, an off-site sampling location on Little Beaver Creek just before it flows into Big Beaver Creek. Based on exposure factors from U.S. EPA's *Exposure Factors Handbook* (U.S. EPA 1997), the dose that could be received by an individual from sediment contaminated at these levels is 0.049 mrem/year. Section 4.6.5 provides additional information on the sediment monitoring program as well as a map of sediment sampling locations.

4.3.8.3 Dose calculation for soil

The dose calculation for soil is based on the detection of 0.3604 pCi/g of uranium-233/234 and 0.3149 pCi/g of uranium-238 at an off-site sampling location near Zahns Corner (SAS-22). Based on

exposure factors from U.S. EPA's *Exposure Factors Handbook* (U.S. EPA 1997), the dose that could be received by an individual from soil contaminated at these levels is 0.024 mrem/year. Section 4.6.7 provides additional information on the soil monitoring program as well as a map of soil monitoring locations.

4.3.8.4 Dose calculation for vegetation

The dose calculation for vegetation is based on the detection of 1.09 pCi/g of technetium-99 at sampling location SAV-12, which is on the eastern property line of the DOE reservation. The dose calculation of 0.000027 mrem/year is based on human consumption of beef cattle that ate this vegetation. Section 4.6.8.3 provides additional information on the vegetation monitoring program and maps of the sampling locations.

4.3.8.5 Dose calculation for deer and fish

The dose calculation for consumption of deer is based on the detection of radionuclides in two of the five deer livers collected at PORTS during the 2000-2001 hunting season and assumes a limit of two deer per hunter for the hunting season. If the hunter ate both of these deer livers - one liver containing americium-241 at 0.0458 pCi/g, and the second liver containing plutonium-239 at 0.0567 pCi/g, uranium-233/234 at 0.034 pCi/g, uranium-235/236 at 0.0512 pCi/g, and uranium-238 at 0.0255 pCi/g - the hunter would receive a dose of 0.757 mrem. This dose is the same as the dose reported last year because it is based on the same data. Section 4.6.8.1 provides additional information on the deer sampling program at PORTS.

The dose calculation for fish is based on the detection of 0.06639 pCi/g of uranium-238 in a bass caught in Little Beaver Creek near the property line. Based on exposure factors from U.S. EPA's *Exposure Factors Handbook* (U.S. EPA 1997), the dose that could be received by an individual from fish contaminated at this level is 0.033 mrem/year. Section 4.6.8.2 provides additional information on this monitoring program.

4.3.8.6 Dose calculation for crops

The dose calculation for crops is based on detections of technetium-99 in crops at two off-site locations in 2001. Technetium-99 was detected in beans (0.209 pCi/g), broccoli (0.326 pCi/g), and tomatoes (0.193 and 0.187 pCi/g) at off-site location #2 and in green beans (0.861 pCi/g) and tomatoes (0.136 pCi/g) at off-site location #3. Based on exposure factors from U.S. EPA's *Exposure Factors Handbook* (U.S. EPA 1997), the dose that could be received by a person consuming these crops is 0.00019 mrem/year at off-site location #2 and 0.00025 mrem/year at off-site location #3. The dose at off-site location #3 is used to assess compliance with the DOE standard of 100 mrem/year because it is the larger of the two doses that could be received from eating these crops. Section 4.6.8.4 provides additional information on this monitoring program.

4.3.9 Radiological Dose Results for DOE/PORTS Workers and Visitors

The Radiation Exposure Information Reporting System report is an electronic file created annually to comply with DOE Order 231.1. This report contains exposure results for all monitored individuals at DOE/PORTS, including visitors, with a positive exposure during the previous calendar year. The 2001 Radiation Exposure Information Reporting System report indicated that there were no visitors with a positive exposure.

The average total effective dose in 2001 for all monitored DOE/PORTS employees and subcontractors was 1.85 mrem. This dose includes cylinder lot workers, who received an average total effective dose of 64 mrem, and all other monitored workers, who received an average total effective dose of 0.84 mrem. These doses are consistent with the doses received by workers in 2000 (42 mrem for cylinder lot workers and 0.82 mrem for all other workers).

4.4 PROTECTION OF BIOTA

DOE Order 5400.5 sets an absorbed dose rate of 1 rad/day to native aquatic organisms. DOE Technical Standard ENVR-0011, *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota* (DOE 2000), was used to demonstrate compliance with this limit. The methodology for evaluating compliance with this dose limit has changed from the method used in the *Annual Environmental Report for 2000* because DOE recommends usage of Technical Standard ENVR-0011 in its guidance for preparation of the Annual Site Environmental Report.

Analytical data for radionuclides detected in sediment and water collected at approximately the same location are used to assess compliance with the 1 rad/day limit for aquatic organisms. Data collected at sampling location RW/RM-7, an off-site surface water and sediment sampling location on Little Beaver Creek just before it flows into Big Beaver Creek, were used for this evaluation because the highest levels of uranium isotopes and technetium-99 in sediment and some of the highest levels in surface water were detected at this location.

The maximum values of technetium-99, uranium-233/234, uranium-235, and uranium-238 detected in sediment or surface water at this location were entered into the spreadsheet that is part of DOE Technical Standard ENVR-0011. The assessment indicates that the concentrations of radionuclides detected in water and sediment at this location do not result in a dose of more than 1 rad/day to aquatic organisms.

Although there are no formal DOE limits for the dose rate to terrestrial biota, it is recommended that DOE sites meet international limits for terrestrial biota that are 1 rad/day for terrestrial plants and 0.1 rad/day for terrestrial animals. Analytical data for surface water and soil collected south of the plant on Big Run Creek (surface water sampling location RW-3 and soil sampling location SAS-3) were used to assess the dose recommendations for terrestrial plants and animals. This location was selected because it is accessible to the public, water and soil samples are collected at approximately the same location, and both samples were analyzed for uranium isotopes.

Uranium-233/234 and uranium-238 were detected in both the surface water and soil samples collected at the sampling locations (RW-3 and SAS-3) in 2001. These data were entered into the spreadsheet that is part of DOE Technical Standard ENVR-0011. The assessment indicates that the concentrations of radionuclides detected in water and sediment at this location do not result in a dose of more than 1 rad/day to terrestrial biota (plants or animals).

4.5 UNPLANNED RADIOLOGICAL RELEASES

No unplanned releases of radionuclides took place at DOE/PORTS in 2001.

4.6 ENVIRONMENTAL RADIOLOGICAL MONITORING

4.6.1 Ambient Air Monitoring

The ambient air monitoring stations measure radionuclides released from (1) DOE and USEC point sources (the sources discussed in Sect. 4.3.2), (2) fugitive air emissions (emissions from PORTS that are not associated with a stack or pipe such as remediation sites or normal building ventilation), and (3) background concentrations of radionuclides (radionuclides that occur naturally, such as uranium). These radionuclides are isotopic uranium (uranium-233/234, uranium-235, uranium-236, and uranium-238), technetium-99, and selected transuranic radionuclides (americium-241, neptunium-237, plutonium-238, and plutonium-239/240).

In 2001, samples were collected from 14 ambient air monitoring stations in and around PORTS (see Sect. 4.3.4, Fig. 4.1). A background ambient air monitoring station (A37) is located approximately 13 miles southwest of the plant. The analytical results from air sampling stations closer to the plant are compared to these background measurements.

Uranium-233/234, uranium-235, and uranium-238 were routinely detected at the stations and in most of the samples collected from each station. Uranium-236 was detected in one or two samples at 6 of the 14 stations (A3, A8, A10, A12, A23, and T7). Americium-241 was detected at least once at 10 stations (A6, A9, A10, A12, A15, A23, A24, A29, A41, and T7). Neptunium-237 was detected in one sample at station A12, and plutonium-238 or plutonium-239/240 was detected in one of the samples collected at stations A9, A10, and A15 during 2001. Technetium-99 was not detected at any of the sampling stations in 2001. Detections of the transuranic radionuclides and uranium-236 were usually near the detection limit for the analytical method.

To confirm that air emissions from PORTS are within regulatory requirements and are not harmful to human health, the ambient air monitoring data were used to calculate a dose to a hypothetical person living at the monitoring station. The net dose calculation for station A10 is 0.00019 mrem/year, which is well below the 10 mrem/year limit applicable to PORTS. Section 4.3.4 provides additional information about this dose calculation.

4.6.2 Radiation

Gamma radiation is measured by DOE at 19 locations that include most of the ambient air monitoring locations (see Sect. 4.3.4, Fig. 4.1) and other locations within the plant (see Fig. 4.3). Two locations detected elevated levels of gamma radiation in 2001: location #874, which monitors the X-745C Depleted Uranium Cylinder Storage Yard and location #933, which is west of the X-744G building in the X-701B Holding Pond groundwater monitoring area.

The dose resulting from radiation emanating from the DOE cylinder storage yards is measured at five locations around the northwest corner of the plant just inside Perimeter Road (see Fig. 4.3). TLDs are placed at the monitoring locations at the beginning of each quarter, remain at the monitoring location throughout the quarter, and are removed from the monitoring location at the end of the quarter and sent to the laboratory for processing.

A dose was not detected at monitoring location #41 in any quarter in 2001. A dose was detected at location #890 only in the second quarter of 2001. Doses were detected at each of the other monitoring locations (#868, #874, and #882) in each quarter, except for location #874 where the TLD was missing from the monitoring location at the end of the second quarter. Section 4.3.7 provides a dose calculation to a member of the public based on radiation detected at the cylinder storage yards. The total potential dose

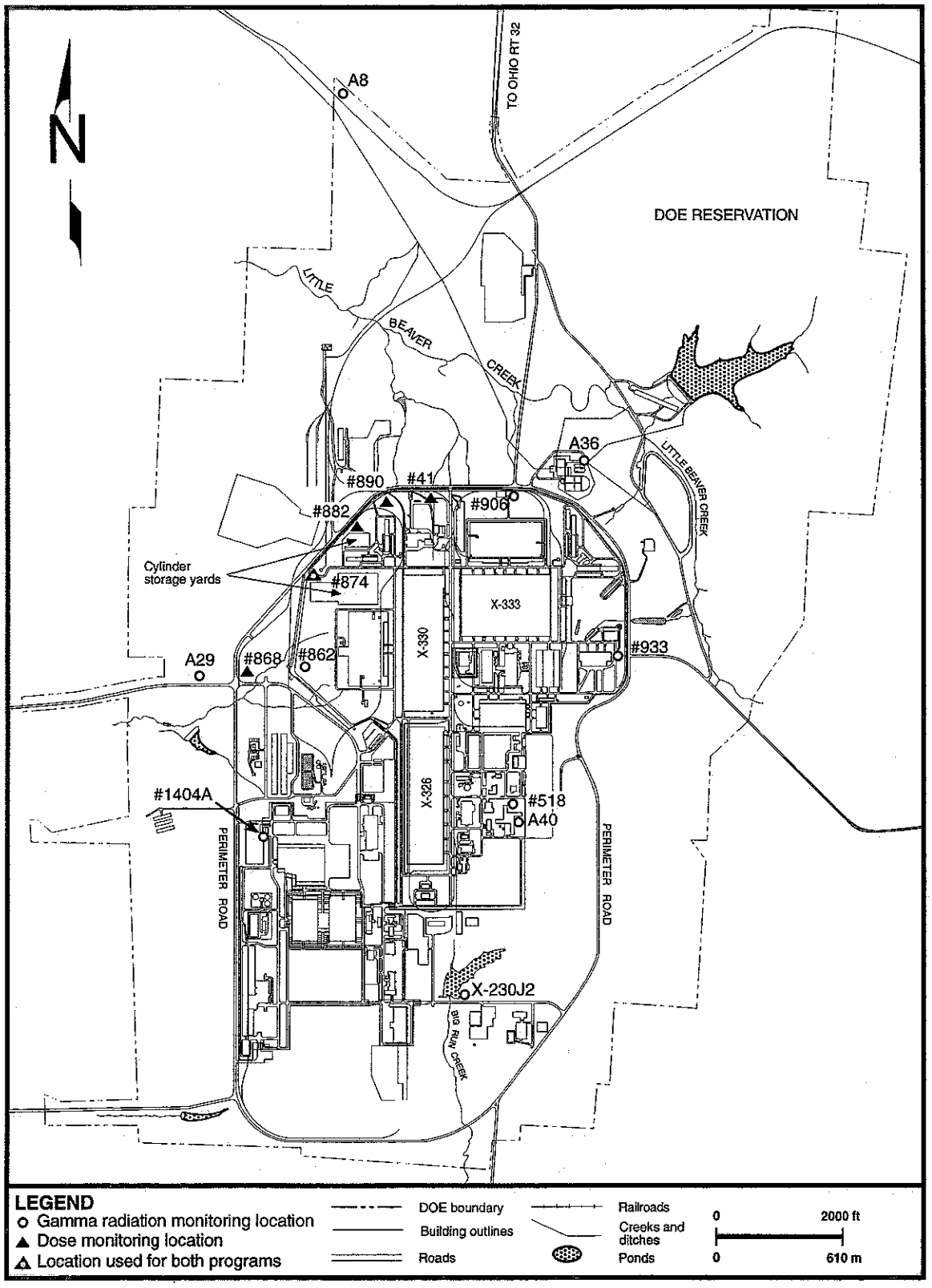

Fig. 4.3. On-site gamma radiation and dose monitoring locations.

to a member of the public resulting from PORTS operations, which includes this dose calculation, is well below the DOE standard of 100 mrem/year.

4.6.3 Surface Water from DOE Cylinder Storage Yards

Ohio EPA requires monthly collection of surface water samples from two locations (X-745C1 and X-745E1) at the X-745C and X-745E Depleted Uranium Hexafluoride Cylinder Storage Yards, and DOE voluntarily collects samples at three additional locations (X-745C2, X-745C3, and X-745C4). Figure 4.2 shows the sampling locations. Samples collected during 2001 were analyzed for total uranium, uranium isotopes (uranium-233/234, uranium-235, uranium-236, and uranium-238), and transuranic radionuclides (americium-241, neptunium-237, plutonium-238, and plutonium-239/240).

During 2001, maximum detections of uranium and uranium isotopes are as follows: uranium at 14 Fg/L, uranium-233/234 at 5.2 pCi/L, uranium-235 at 0.21 pCi/L, and uranium-238 at 4.7 pCi/L. Uranium-236, americium-241, neptunium-237, plutonium-238, and plutonium-239/240 were not detected in any of the samples collected in 2001. Technetium-99 was detected in three samples at a maximum concentration of 10 pCi/L.

4.6.4 Surface Water

In 2001, USEC collected water samples at 14 locations upstream and downstream from the PORTS reservation. These samples were taken from the Scioto River, Little Beaver Creek, Big Beaver Creek, and Big Run Creek (see Fig. 4.4). As background measurements, samples were also collected from local streams approximately 10 miles north, south, east, and west of PORTS. Samples were collected weekly from the Scioto River and monthly from the other streams, with the exception of one of the downstream locations on Little Beaver Creek (RW-8), which was sampled weekly.

Each sample was analyzed for alpha activity, beta activity, total uranium, and technetium-99. Each of these measurements, with the exception of technetium-99, will detect naturally-occurring radionuclides in the environment; therefore, measurements from upstream locations are compared to downstream locations to assess whether PORTS activities have affected the river or stream. Natural variation and manmade activities not related to PORTS can also cause sample variation.

Concentrations of radionuclides detected at upstream and downstream locations on the Scioto River and Big Beaver Creek were similar. Beta activity, technetium-99, and uranium were detected more frequently and at higher concentrations at the downstream sampling locations on Little Beaver Creek (RW-7 and RW-8) than at the upstream sampling location (RW-12). Uranium was detected more frequently at one of the downstream sampling locations on Big Run Creek (RW-3) than at the upstream sampling location (RW-33). The maximum detection of technetium-99 at any surface water sampling location in 2001 (43 pCi/L at RW-8) is well below the DOE derived concentration guide of 100,000 pCi/L for technetium-99 in ingested water. Detections of uranium at the downstream sampling locations, while different from concentrations detected upstream, are similar to detections of naturally-occurring uranium at the upstream Scioto River sampling location and may be attributable to natural variation.

Samples collected at the surface water monitoring points in November or December 2001 were also analyzed for isotopic uranium (uranium-233/234, uranium-235, uranium-236, and uranium-238) and selected transuranic radionuclides (americium-241, neptunium-237, plutonium-238, and plutonium-239/240). None of the transuranics or uranium-236 were detected in the samples. Uranium 233/234 was detected in 11 of the 14 samples at a maximum concentration of 2.14 pCi/L in the sample collected from RW-8. Uranium-235 was detected only in the sample collected from RW-7 at 0.1594 pCi/L. Uranium-238 was detected in 5 of the 14 samples at a maximum concentration of 0.8681 pCi/L in the sample

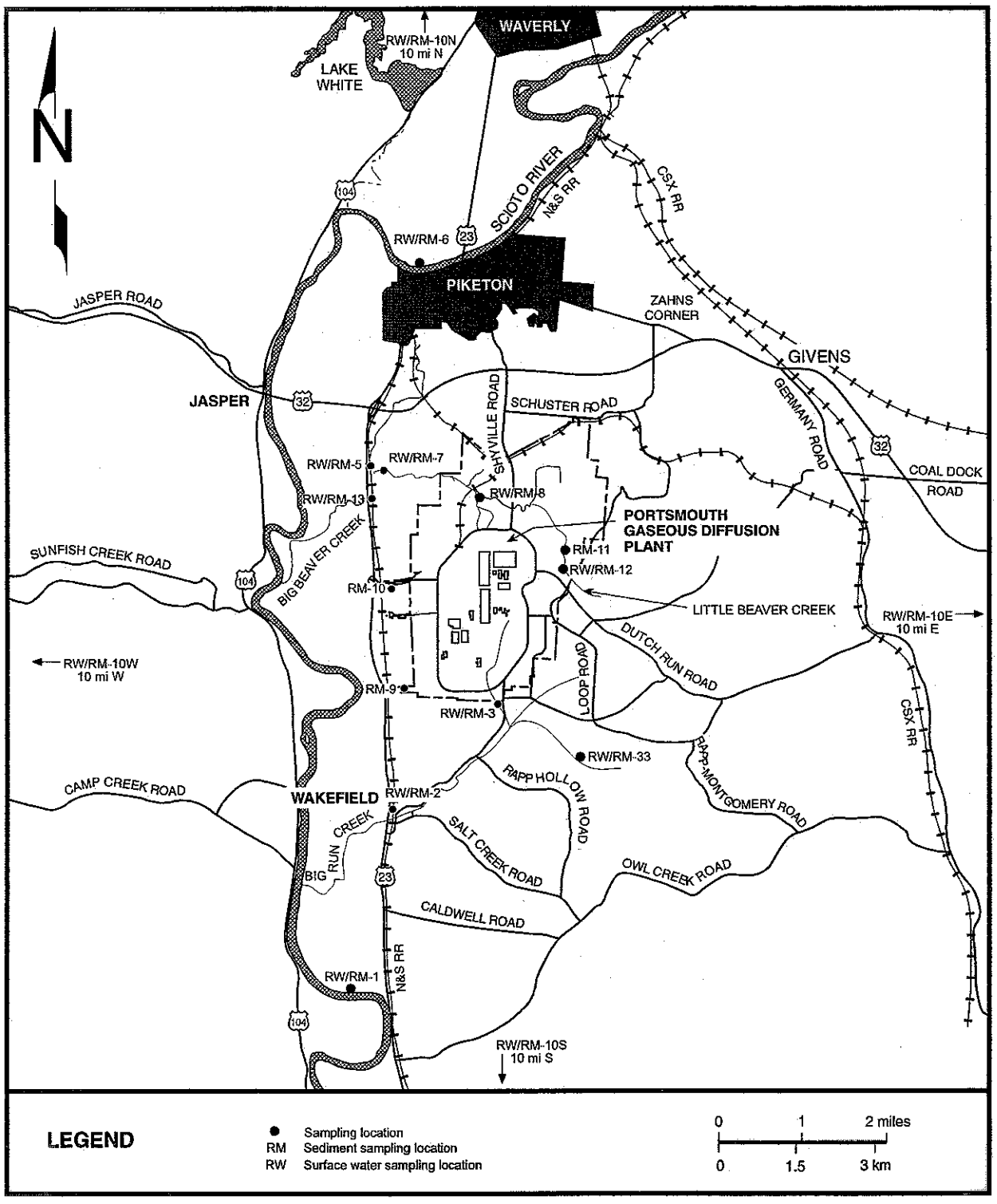

Fig. 4.4. USEC surface water and sediment monitoring locations.

collected from RW-1. Each of these detections is well below the DOE derived concentration guide for the respective uranium isotope in drinking water (500 pCi/L for uranium-233/234 and 600 pCi/L for uranium-235 and uranium-238).

4.6.5 Sediment

In 2001, USEC collected sediment samples at the same locations upstream and downstream from the PORTS reservation where surface water samples are collected and at the NPDES outfalls on the east and west sides of the reservation (see Fig. 4.4). Samples were collected in the spring and fall and were analyzed for alpha activity, beta activity, total uranium, and technetium-99. Uranium, alpha activity, and beta activity occur naturally in the environment; therefore, these constituents detected in the samples may not result from activities at PORTS. The results of sampling conducted in 2001 appear to indicate that there are no appreciable differences in the levels of these constituents found in the samples taken upstream and downstream from PORTS.

Technetium-99 is usually detected in sediment samples collected in locations downstream from PORTS. In 2001, technetium-99 was detected in one or both of the samples collected from downstream sampling locations on Little Beaver Creek (RM-7 and RM-8). Technetium-99 was detected in both the upstream and downstream samples collected on Big Beaver Creek (RM-5 and RM-13) and Big Run Creek (RM-33, RM-2, and RM-3). Technetium-99 was also detected in the sediment samples collected at USEC NPDES Outfall 001, USEC Outfall 010/DOE Outfall 013, and DOE Outfall 012 (RM-9, RM-10, and RM-11, respectively) and at two of the background sampling locations (RM-10S and RM-10W).

Many of the detections of technetium-99 were at or close to the detection limit for the analytical method. In general, levels of technetium-99 detected in sediment are consistent with results from 1999 and 2000. Concentrations of technetium-99 detected at some locations (RM-7 and RM-8 on Little Beaver Creek) increased in 2001 compared to 2000 data, but are similar to or less than the concentration of technetium-99 detected at these locations in 1999.

In 2001, at least one sediment sample from each sampling location except RM-1 (downstream Scioto River) was analyzed for uranium isotopes (uranium-233/234, uranium-235, uranium-236, and uranium-238) and transuranic radionuclides (americium-241, neptunium-237, plutonium-238, and plutonium-239/240). The highest concentrations of total uranium were detected at the west background sampling location (RM-10W); however, the highest concentrations of uranium isotopes were usually detected at one of the downstream sampling locations on Little Beaver Creek (RM-7 or RM-8). These results are consistent with the low levels of technetium-99 contamination also detected at these two sampling locations. Section 4.3.8.2 provides a dose assessment based on the highest detections of technetium-99 and uranium isotopes at sediment sampling location RM-7. The total potential dose to a member of the public resulting from PORTS operations, which includes this dose calculation, is well below the DOE standard of 100 mrem/year.

Americium-241 was detected in samples collected at three locations: upstream Big Beaver Creek (RM-5), downstream Big Run Creek at Wakefield (RM-2), and at USEC Outfall 010/DOE Outfall 013 (RM-10). These detections were near the detection limit for the analytical method. None of the other transuranic radionuclides were detected in the samples.

4.6.6 Site Effluent

DOE collects water samples from 11 locations (see Fig. 4.5) to determine the concentration of radioactive material that is present in the sediment suspended in the water sample. The data are used to determine compliance with DOE Order 5400.5, *Radiation Protection of the Public and the Environment*,

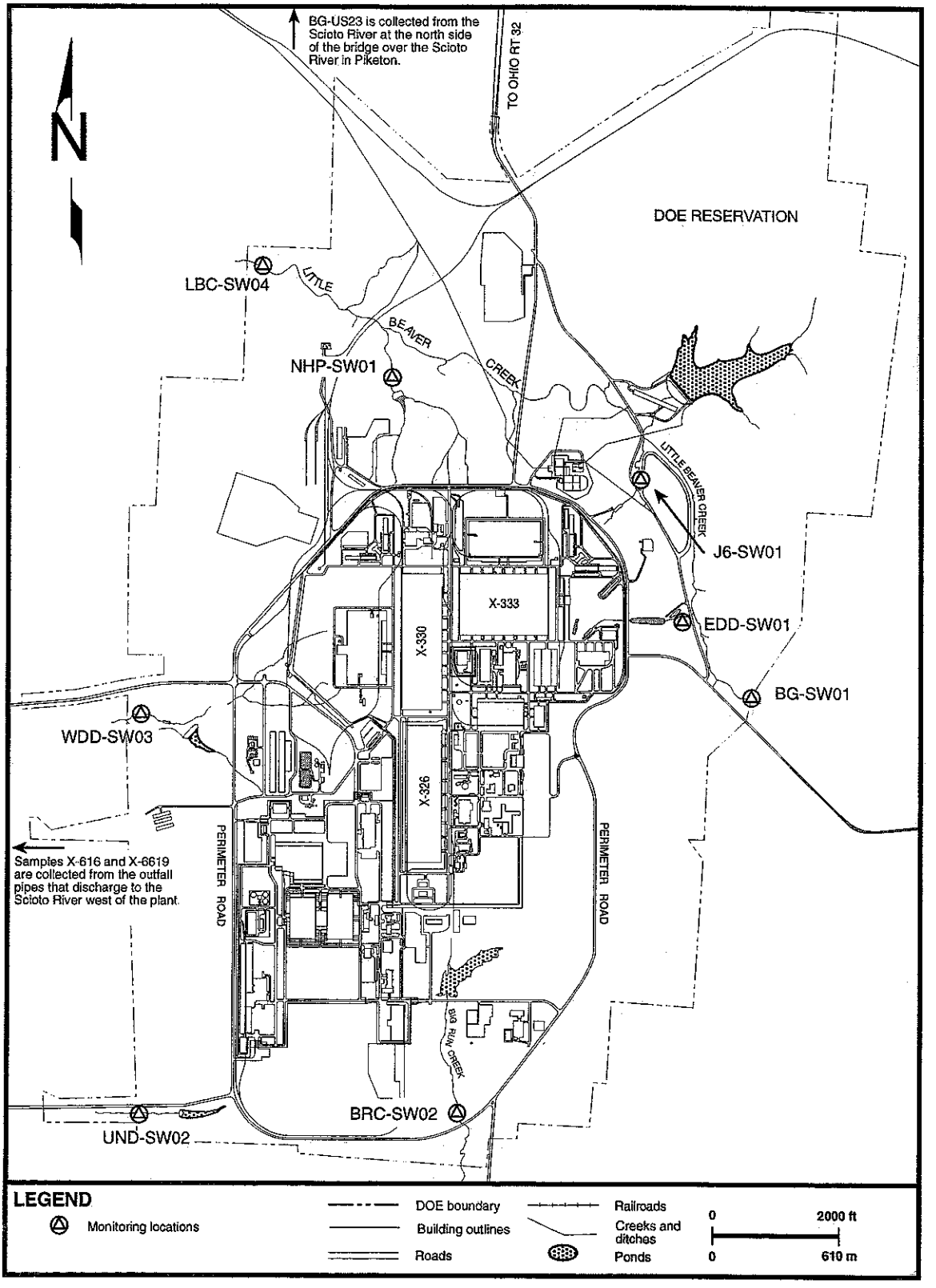

Fig. 4.5. DOE site effluent monitoring locations.

Chapter II, paragraph 3a(4). This paragraph states:

> *To prevent the buildup of radionuclide concentrations in sediments, liquid process waste streams containing radioactive material in the form of settleable solids may be released to natural waterways if the concentration of radioactive material in the solids present in the waste stream does not exceed 5 pCi (0.2 becquerel) per gram above background level, of settleable solids for alpha-emitting radionuclides or 50 pCi (2 becquerels) per gram above background level, of settleable solids for beta-gamma-emitting radionuclides.*

The sampling locations consist of two background surface water locations (BG-SW01 and BG-US23), six surface water sampling locations (BRC-SW02, EDD-SW01, LBC-SW04, NHP-SW01, UND-SW02, and WDD-SW03), and three NPDES effluent locations (J6-SW01, X-616, and X-6619). In 2001, two samples were collected semiannually (June and December) from each monitoring location. One sample was analyzed for total suspended solids, total alpha activity, and total beta activity. The other sample was analyzed for non-settleable solids, total alpha activity, and total beta activity.

In 2001, the alpha and beta activities calculated for the settleable solids portion of each sample were below the DOE standard cited above with the exception of the sample collected at BRC-SW02 in December 2001. The alpha activity in the settleable solids portion of the sample was calculated to be 39 pCi/g and the beta activity was 71 pCi/g. The sample had an elevated total suspended solids concentration of 3188 milligrams per liter (mg/L). It should be noted, however, that the sample collected at BRC-SW02 is not a process waste stream. The sample is surface water from Big Run Creek downstream of the X-230K South Holding Pond and includes discharges from USEC Outfall 002, storm water runoff from the southern portion of PORTS, and groundwater discharge from the Quadrant I Groundwater Investigative Area and X-749/X-120/PK Landfill Area.

4.6.7 Soil

USEC collects soil samples in the process area of the PORTS reservation, on unused land on the PORTS reservation, and in off-site locations up to 10 miles from PORTS (see Figs. 4.6 and 4.7). Samples are analyzed for alpha activity, beta activity, total uranium, and technetium-99. Analytical results from the external samples (samples not collected in the process area of PORTS) represent natural background radionuclides and deposition of airborne radionuclides from PORTS. Analytical results from samples collected in the process area of PORTS also represent background radionuclides and airborne deposition, but can also include radionuclides deposited from spills or other plant operations.

Both the historical and 2001 sampling programs have identified areas of soil contamination within the process area of PORTS. Analytical results for alpha activity, beta activity and total uranium from the external samples collected near PORTS are not appreciably different from results of samples collected 10 miles from PORTS. Technetium-99 was detected at less than 0.5 pCi/g at several off-site soil sampling locations (SAS-13, SAS-14, SAS-16, SAS-6, and SAS-17) and at three of the four background sampling locations (RS-10N, RS-10S, and RS-10E).

In 2001, soil samples from five locations near ambient air monitoring stations were also analyzed for selected transuranic radionuclides (americium-241, neptunium-237, plutonium-238, and plutonium-239/240) and isotopic uranium (uranium-233/234, uranium-235, uranium-236, and uranium-238). One location is within the process area of PORTS (RIS-1), three locations are on the DOE reservation but not in the process area (SAS-3, SAS-10, and SAS-23), and one location is about 3 miles from the plant near Zahns Corner (SAS-22).

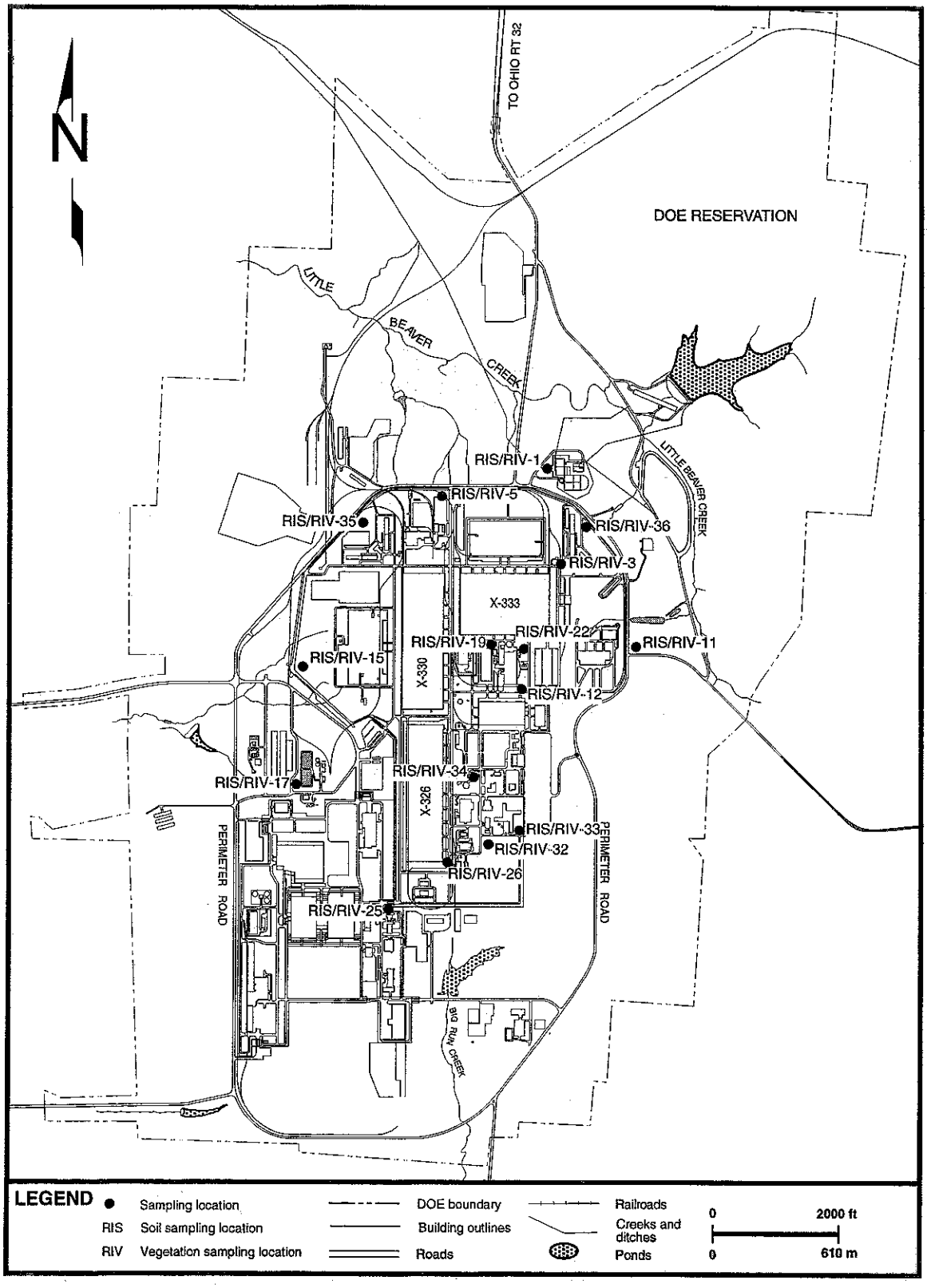

Fig. 4.6. Internal monitoring locations for USEC soil and vegetation monitoring programs.

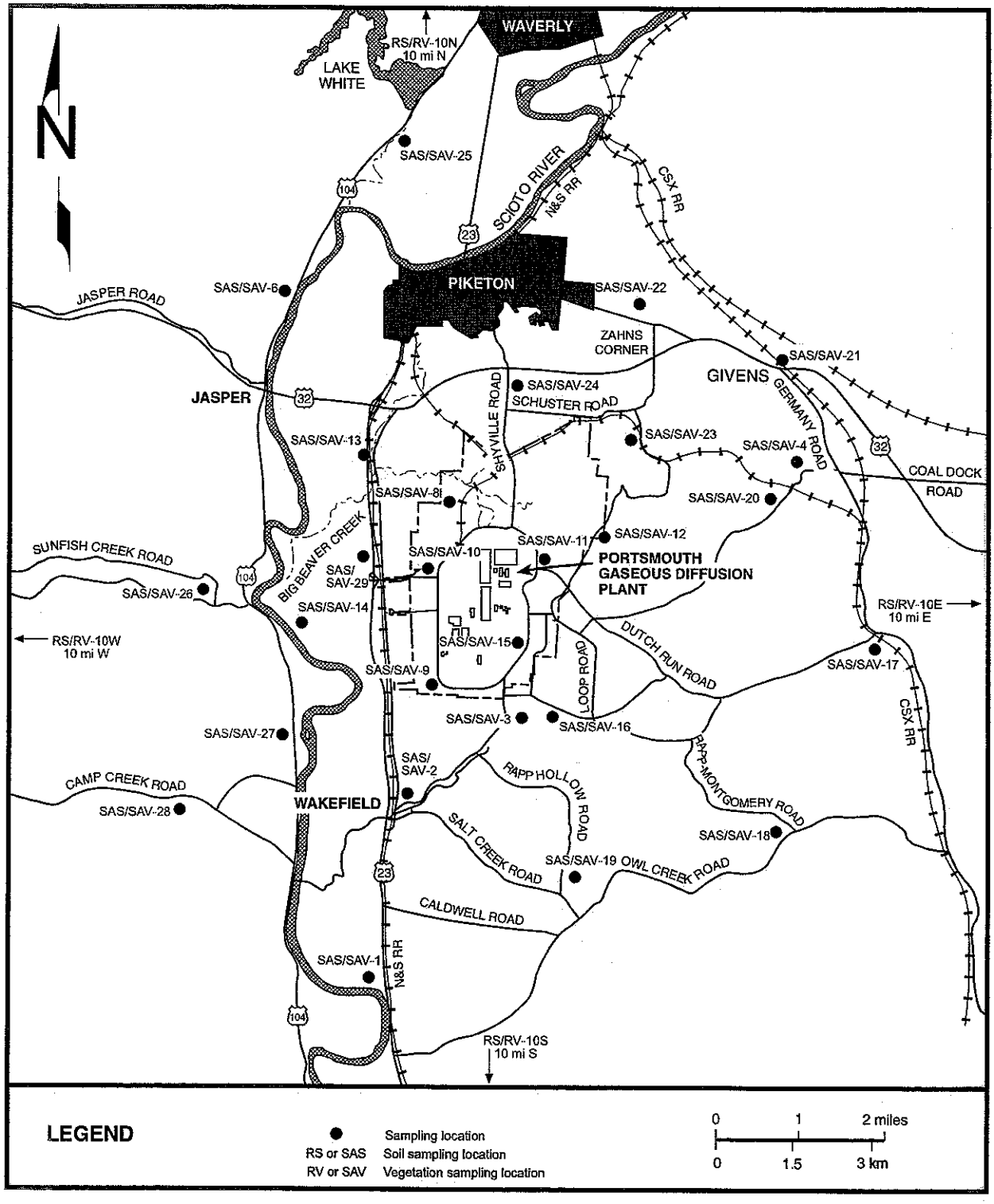

Fig. 4.7. External monitoring locations for USEC soil and vegetation monitoring programs.

None of the transuranics or uranium-236 was detected in the samples. Uranium-233/234 and uranium-238 were detected in all of the samples at concentrations less than 1 pCi/g. Uranium-235 was detected in two of the samples (both collected on DOE property) at less than 0.05 pCi/g.

Section 4.3.8.3 provides a dose assessment based on the highest detections of uranium-233/234 and uranium-238 at the off-site soil sampling location near Zahns Corner (SAS-22). Data from this location were used for the dose calculation because these data resulted in a higher dose than the highest detection of technetium-99 at an off-site location and are therefore a more conservative estimate of the dose that a member of the public could receive from PORTS operations. The total potential dose to a member of the public resulting from PORTS operations, which includes this dose calculation, is well below the DOE standard of 100 mrem/year.

4.6.8 Biological Monitoring

Biological monitoring at PORTS is used to assess the uptake of radionuclides and other constituents into local biota (deer, fish, vegetation, and crops). DOE collects samples of deer harvested during the hunting season. USEC collects data to assess potential impacts to vegetation, crops, and fish at or near PORTS.

4.6.8.1 Deer

Due to increased security at PORTS after September 11, 2001, the annual deer hunt that was scheduled to take place during the 2001-2002 hunting season was cancelled. The data included in this section were collected during the PORTS deer hunt in 2000-2001 and were also provided in the *Portsmouth Annual Environmental Report for 2000*. This data and the resulting dose calculation are included in this report so that the dose estimate to a member of the public from PORTS operations is as complete as possible.

Kidney and liver samples were collected from five deer harvested at PORTS during the 2000-2001 hunting season (December 2000 through January 2001). The kidneys and liver were collected from each deer for analysis because these organs concentrate any radiological constituents ingested by the deer. Each kidney and liver sample was analyzed for americium-241, neptunium-237, plutonium-238, plutonium-239/240, technetium-99, total uranium, uranium-233/234, uranium-235/236, and uranium-238.

The kidney sample from one deer contained americium-241 at 0.0405 pCi/g and the liver from the same deer contained plutonium-238 at 0.0567 pCi/g, uranium isotopes at concentrations ranging from 0.0255 to 0.0512 pCi/g, and total uranium at 0.0667 pCi/g. The liver from another deer contained americium-241 at 0.0458 pCi/g. Uranium and uranium isotopes occur naturally and may be present due to exposure to naturally-occurring uranium. The detections of americium-241 and plutonium-238 are considered suspect because of the very low detection limits for these samples. Section 4.3.8.5 provides a dose assessment based on a member of the public consuming two deer livers containing radionuclides. The total potential dose to a member of the public resulting from PORTS operations, which includes this dose calculation, is well below the DOE standard of 100 mrem/year. None of the other radionuclides listed above were present above detection limits in any of the other samples.

In December 2001, liver, kidney, and muscle samples were collected from two deer harvested at a background sampling location approximately 15 miles west-northwest of PORTS in Bainbridge, Ohio. Samples were analyzed for transuranic radionuclides (americium-241, neptunium-237, plutonium-238, and plutonium-239/240), technetium-99, total uranium, and uranium isotopes (uranium-233/234, uranium-235, uranium-236, and uranium-238). Transuranics and technetium-99 were not detected in any of the samples. Uranium was detected in one of the deer kidneys at 0.2052 micrograms per gram (Fg/g),

and uranium isotopes were detected in all three types of tissue samples at concentrations less than 0.1 pCi/g. These detections are most likely due to exposure to naturally occurring uranium.

4.6.8.2 Fish

In 2001, USEC collected 12 fish from the Scioto River, Little Beaver Creek, and Big Beaver Creek. Fish samples were analyzed for alpha activity, beta activity, technetium-99, total uranium, transuranic radionuclides (americium-241, neptunium-237, plutonium-238, and plutonium-239/240), and uranium isotopes (uranium-233/234, uranium-235, uranium-236, and uranium-238).

The only parameters detected in the fish samples were beta activity (detected in three fish caught in the Scioto River at a maximum concentration of 4.34 pCi/g), total uranium (detected in a catfish caught in the Scioto River at 0.076 Fg/g), and uranium-238 (detected in a bass caught in Little Beaver Creek at 0.06639 pCi/g and a drum caught in the Scioto River at 0.03588 pCi/g). None of the other parameters were detected in any of the samples. Each of the detected parameters occurs naturally in the environment and are most likely indicative of background levels.

A dose assessment based on a member of the public consuming fish containing the highest concentration of uranium-238 detected in the fish samples is provided in Sect. 4.3.8.5. The total potential dose to a member of the public resulting from PORTS operations, which includes this dose calculation, is well below the DOE standard of 100 mrem/year.

4.6.8.3 Vegetation

To assess the uptake of radionuclides into plant material, USEC collects vegetation samples in the same areas where soil samples are collected (see Figs. 4.6 and 4.7). Vegetation is analyzed for technetium-99 and total uranium. Some vegetation samples collected in 2001 within the process area of PORTS contained detectable concentrations of technetium-99 that are higher than the concentrations present in samples collected off site. Uranium was detected at 2.8 Fg/g in one of the vegetation samples collected in 2001 within the process area southwest of the X-326 process building (RIV-25).

In 2000, technetium-99 was detected at concentrations less than 0.5 pCi/g in samples collected at off-site locations, including background locations, and continued to be detected at similar concentrations at off-site locations in 2001. Uranium was also detected in vegetation collected at the east background location (RV-10E) at 0.28 Fg/g. Uranium was not detected in any of the other samples collected in 2001.

Technetium-99 was detected at 1.09 pCi/g in the vegetation sample collected at the DOE property line on the east side of the reservation (SAV-12). Section 4.3.8.4 provides a dose assessment based on a member of the public consuming beef cattle that have grazed on vegetation containing this concentration of technetium-99. The total potential dose to a member of the public resulting from PORTS operations, which includes this dose calculation, is well below the DOE standard of 100 mrem/year.

4.6.8.4 Crops

In addition to vegetation samples, USEC also collects crop samples to assess the uptake of radionuclides into crops. In 2001, 19 samples were collected from three residential locations near PORTS. Crops collected from locations near PORTS included beans, bitter melon, blackberries, eggplant, green peppers, squash, tomatoes, green beans, cucumbers, corn, and broccoli.

Each sample was analyzed for technetium-99 and total uranium. Uranium was not detected in any of the samples. Technetium-99 was detected in beans (0.209 pCi/g), broccoli (0.326 pCi/g), and tomatoes (0.193 and 0.187 pCi/g) at off-site location #2 and in green beans (0.861 pCi/g) and tomatoes (0.136 pCi/g) at off-site location #3. Section 4.3.8.6 provides a dose assessment to a member of the public based on consumption of these crops. The total potential dose to a member of the public resulting from PORTS operations, which includes this dose calculation, is well below the DOE standard of 100 mrem/year.

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5. ENVIRONMENTAL NON-RADIOLOGICAL PROGRAM INFORMATION

5.1 SUMMARY

Non-radiological environmental monitoring at PORTS includes air, water, sediment, and biota (fish and vegetation). Monitoring of non-radiological parameters is required by state and federal regulations and/or permits, but is also completed to reduce public concerns about plant operations. In 2001, non-radiological environmental monitoring information was collected by both DOE and USEC.

5.2 INTRODUCTION

Environmental monitoring programs at PORTS usually monitor both radiological and non-radiological constituents that could be released to the environment as a result of PORTS activities. The radiological components of each monitoring program were discussed in the previous chapter. Environmental monitoring data are collected by both DOE and USEC. Because USEC data are important in developing a complete picture of environmental monitoring at PORTS, these data are included in this report. USEC information is provided for informational purposes only; DOE cannot certify the accuracy of USEC data.

Environmental regulations, permit requirements, and public concerns are all considered in developing the non-radiological component of environmental monitoring programs. State and federal regulations drive some of the monitoring conducted at DOE/PORTS such as limitations on discharges to air and water. Non-radiological data are not collected for some sampling locations and some monitoring programs. Data from the following environmental monitoring programs are included in this chapter:

- Airborne discharges,
- Ambient air,
- Discharges to surface water,
- Surface water,
- Sediment, and
- Biota.

DOE also conducts an extensive groundwater monitoring program at PORTS that includes both radiological and non-radiological constituents. Chapter 6 provides information on the groundwater monitoring program, associated surface water monitoring, and water supply monitoring.

5.3 AIR

Permitted air emission sources at PORTS emit non-radiological air pollutants. In addition, the DOE ambient air monitoring program measures fluoride at monitoring stations within the DOE reservation and in the surrounding area.

5.3.1 Airborne Discharges

DOE/PORTS operates numerous small sources of conventional air pollutants such as nitrogen oxides, sulfur dioxide, and particulate matter. In the past, these emissions were estimated every two years for the Ohio EPA's biennial emission fee statement.

In 2001, DOE constructed and began operation of two boilers to provide heat for DOE facilities. Heat was formerly provided by the gaseous diffusion process, but this process was shut down in May 2001. The boilers, which are fired by #2 fuel oil, began operation in November 2001. DOE reported the following emissions from these units for the Ohio EPA Fee Emissions Report: 5.14 tons of sulfur dioxide, 2.03 tons of nitrogen oxides, 0.41 ton of carbon monoxide, 0.2 ton of particulate matter, and 0.10 ton of volatile organic compounds.

Other emissions sources at DOE/PORTS, which include two landfill venting systems, two glove boxes (not used in 2001), two aboveground storage tanks in the X-6002A Fuel Oil Storage Facility, and two groundwater treatment facilities, emit less than 1 ton per year of conventional air pollutants (on an individual basis), and therefore do not require reporting in the Ohio EPA Fee Emissions Report. Worst-case air emissions from all of these sources (excluding the boilers discussed above), total no more than 1.5 tons per year, assuming that each source emits the maximum allowable amount of each pollutant as provided in the permit or registration for each source.

Another potential air pollutant present at DOE/PORTS is asbestos released by renovation or demolition of plant facilities. Asbestos emissions are controlled by a system of work practices. The amount of asbestos removed and disposed is reported to the Ohio EPA. In 2001, demolition of the X-701A Lime House, which was one of the corrective measures completed in Quadrant II (see Chap. 3, Sect. 3.2.2.3), generated 10 tons of asbestos-contaminated demolition debris. Asbestos was identified in the roofing material from this facility.

In 2001, USEC reported the following emissions of non-radiological air pollutants for the Ohio EPA Fee Assessment of Air Pollution Emissions: 59.86 tons of particulate matter, 1.42 tons of organic compounds, 2627.64 tons of sulfur dioxide, and 362.05 tons of nitrogen oxides. These emissions are associated with the boilers at the X-600 Steam Plant, which provide steam for the PORTS reservation, a boiler at the X-611 Water Treatment Plant, an emergency generator, and a pump powered by diesel fuel.

5.3.2 Ambient Air Monitoring

In addition to the radionuclides discussed in Chap. 4, DOE ambient air monitoring stations also measure fluoride. Fluoride detected at the ambient air monitoring stations could be present due to background concentrations (fluoride occurs naturally in the environment) or from the gaseous diffusion process.

In 2001, samples for fluoride were collected weekly from 15 ambient air monitoring stations in and around PORTS (see Chap. 4, Figs. 4.1 and 4.2). A background ambient air monitoring station (A37) is located approximately 13 miles southwest of the plant. The analytical results from air sampling stations closer to the plant are compared to this background station. In 2001, the average ambient concentration of fluoride measured in samples collected at the background station was 0.063 microgram per cubic meter ($\mu g/m^3$). With the exception of ambient air monitoring station A40, which is within the process area of PORTS immediately east of the X-326 building, ambient concentrations of fluoride measured at the other stations are similar to or less than the average ambient concentration measured at the background station (averages range from 0.045 $\mu g/m^3$ to 0.066 $\mu g/m^3$). The average ambient concentration of fluoride measured at station A40 was 0.094 $\mu g/m^3$.

5.4 WATER

Surface water and groundwater are monitored at PORTS. Groundwater monitoring is discussed in Chap. 6, along with surface water monitoring conducted as part of the groundwater monitoring program. Non-radiological surface water monitoring primarily consists of sampling water discharges associated with both DOE and USEC NPDES-permitted outfalls. In addition, non-radiological parameters are monitored in the Scioto River upstream and downstream of PORTS to determine whether discharges from PORTS affect water quality in the river.

5.4.1 Water Discharges (NPDES Outfalls)

5.4.1.1 DOE NPDES outfalls

Non-radiological discharges from DOE NPDES outfalls are regulated by the DOE NPDES permit. DOE/PORTS has six discharge points, or outfalls, through which water is discharged from the site (see Chap. 4, Fig. 4.3). Three outfalls discharge directly to surface water, and three discharge to the USEC X-6619 Sewage Treatment Plant before leaving the site through USEC NPDES Outfall 003 to the Scioto River. Chapter 4, Sect. 4.3.5.1, provides a brief description of each DOE outfall.

Ohio EPA selects the chemical parameters that must be monitored at each outfall based on the chemical characteristics of the water that flows into the outfall. For example, the DOE outfalls that discharge water from the groundwater treatment facilities (Outfalls 015, 608, 610, and 611) are monitored for trichloroethene because the groundwater treatment facilities treat water that is contaminated with this chemical. The following chemicals are monitored at each DOE outfall.

- DOE NPDES Outfall 012 (X-2230M Holding Pond) – chlorine, chromium, hexavalent chromium, oil and grease, suspended solids, total PCBs, total phosphate as phosphorus, and trichloroethene

- DOE NPDES Outfall 013 (X-2230N Holding Pond) – chlorine, chromium, hexavalent chromium, oil and grease, suspended solids, total PCBs, and total phosphate as phosphorus

- DOE NPDES Outfall 015 (X-624 Groundwater Treatment Facility) – total PCBs and trichloroethene

- DOE NPDES Outfall 608 (X-622 Groundwater Treatment Facility) – *trans*-1,2-dichloroethene, trichloroethene, and zinc

- DOE NPDES Outfall 610 (X-623 Groundwater Treatment Facility) – *trans*-1,2-dichloroethene, trichloroethene, and zinc

- DOE NPDES Outfall 611 (X-622T Groundwater Treatment Facility) – trichloroethene

In 2001, the overall DOE NPDES compliance rate with the NPDES permit was 99.8%. Compliance rates for individual parameters at each outfall were 100%, with the exception of trichloroethene at DOE NPDES Outfall 015 (95.8%). The daily concentration discharge limitation for trichloroethene (10 Fg/L) was exceeded at this outfall in October 2001; the sample result was 11 Fg/L. Trichloroethene was not detected in any other sample collected at this outfall in 2001 (detection limit of 1 Fg/L).

5.4.1.2 USEC NPDES outfalls

Non-radiological discharges from USEC NPDES outfalls are regulated by the USEC NPDES permit that became effective on March 1, 2000. USEC is responsible for 11 NPDES outfalls through which water is discharged from the site (see Chap. 4, Fig. 4.3). Eight outfalls discharge directly to surface water, and three discharge to another USEC NPDES outfall before leaving the site. Chapter 4, Sect. 4.3.5.2, provides a brief description of each USEC NPDES outfall. The following chemicals are monitored at each USEC outfall.

- USEC NPDES Outfall 001 (X-230J7 East Holding Pond) – arsenic, copper, fluoride, manganese, nickel, oil and grease, suspended solids, zinc

- USEC NPDES Outfall 002 (X-230K South Holding Pond) – fluoride, manganese, mercury, oil and grease, silver, suspended solids, thallium

- USEC NPDES Outfall 003 (X-6619 Sewage Treatment Plant) – ammonia-nitrogen, biochemical oxygen demand, chlorine, copper, fecal coliform (May-October only), mercury, nitrate-nitrogen, oil and grease, silver, suspended solids, zinc

- USEC NPDES Outfall 004 (Cooling Tower Blowdown) – copper, dissolved solids, oil and grease, suspended solids, zinc

- USEC NPDES Outfall 005 (X-611B Lime Sludge Lagoon) – suspended solids, PCBs

- USEC NPDES Outfall 009 (X-230L North Holding Pond) – fluoride, manganese, oil and grease, suspended solids, zinc

- USEC NPDES Outfall 010 (X-230J5 Northwest Holding Pond) – manganese, oil and grease, suspended solids, zinc

- USEC NPDES Outfall 011 (X-230J6 Northeast Holding Pond) – copper, fluoride, oil and grease, suspended solids, zinc

- USEC NPDES Outfall 602 (X-621 Coal Pile Runoff Treatment Facility) – iron, manganese, settleable solids, suspended solids

- USEC NPDES Outfall 604 (X-700 Biodenitrification Facility) – copper, iron, nickel, nitrate-nitrogen, zinc

- USEC NPDES Outfall 605 (X-705 Decontamination Microfiltration System) – ammonia-nitrogen, chromium, hexavalent chromium, copper, iron, Kjeldahl nitrogen, nickel, nitrate-nitrogen, nitrite-nitrogen, oil and grease, sulfate, suspended solids, trichloroethene, zinc

The USEC NPDES Permit also identifies four additional monitoring points that are not discharge points as described in the previous paragraphs. USEC NPDES Station Number 801 is a background monitoring location on the Scioto River upstream from USEC NPDES Outfalls 003 and 004. USEC NPDES Station Number 901 is a monitoring location on the Scioto River downstream from Outfall 003 and 004 and located in the discharge plume from these two outfalls. Samples are collected from both of these monitoring points to measure toxicity to minnows and another aquatic organism (Ceriodaphnia).

USEC NPDES Station Number 902 is a monitoring location on Little Beaver Creek downstream from USEC NPDES Outfall 001, and USEC NPDES Station Number 903 is a monitoring location on Big Run Creek downstream from USEC NPDES Outfall 002. Water temperature is the only parameter measured at each of these monitoring points.

In 2001, the overall USEC NPDES compliance rate was 99.8%. During 2001, USEC experienced five exceedences of its NPDES permit limits:

- The daily concentration discharge limitation for total suspended solids at USEC NPDES Outfall 009 (45 mg/L) was exceeded in November 2001; the sample result was 49.8 mg/L.

- The daily loading limitation for total suspended solids at USEC NPDES Outfall 002 [96 kilograms (kg) per day] was exceeded in November 2001; the calculated daily loading was 335 kg/day.

- The daily concentration discharge limitation for total suspended solids at USEC NPDES Outfall 002 (45 mg/L) was exceeded in December 2001; the sample result was 54 mg/L.

- The monthly average concentration discharge limitation for total suspended solids at USEC NPDES Outfall 002 (20 mg/L) was exceeded in December 2001; the monthly average concentration was 24.2 mg/L.

- The daily concentration discharge limitation for manganese at USEC NPDES Outfall 002 (980 Fg/L) was exceeded in December 2001; the sample result was 1280 Fg/L.

In addition, USEC experienced three bypasses of the X-621 Coal Pile Runoff Treatment Facility (USEC NPDES Outfall 602) in 2001, which allowed untreated coal pile runoff to flow to the X-230K Holding Pond (USEC NPDES Outfall 002). The first two bypasses occurred in May 2001 when untreated water from the X-621 lagoon overflowed the emergency spillway due to excessive rainfall. The third bypass occurred in September 2001 when a pumping operation in a manhole south of the X-600 Steam Plant revealed a connection to the X-621 lagoon and resulted in the discharge of untreated water to the X-230K Holding Pond. No exceedences of any NPDES permit limitations for USEC NPDES Outfall 002 occurred in the months that these bypasses occurred.

5.4.2 Surface Water Monitoring

Non-radiological monitoring of surface water locations was conducted at the Scioto River upstream and downstream of PORTS (sampling locations RW-6 and RW-1 – see Chap. 4, Fig. 4.4). Samples from the Scioto River are analyzed for total phosphate as phosphorus, fluoride, 29 metals, and PCBs. Each of these measurements, with the exception of PCBs, will detect naturally-occurring constituents; therefore, measurements from upstream location are compared to the downstream location to assess whether PORTS activities have affected the river. Natural variation and manmade activities not related to PORTS can also cause sample variation.

Weekly samples were collected for fluoride and total phosphate as phosphorus, and the average concentration of each parameter was the same at the upstream and downstream sampling locations. PCBs were not detected in either of the two samples collected for this parameter at each location in 2001. Samples collected during November and December 2001 were analyzed for metals; no significant differences were noted at the upstream and downstream Scioto River sampling locations. Discharges of non-radiological constituents from PORTS do not appear to affect surface water quality in the Scioto River downstream from PORTS.

5.5 SEDIMENT

In 2001, USEC collected sediment samples at the same locations upstream and downstream from the PORTS reservation where surface water samples are collected and at the NPDES outfalls on the east and west sides of the reservation (see Chap. 4, Fig. 4.4). Samples were collected in the spring and fall and were analyzed for 21 metals and PCBs, in addition to the radiological parameters discussed in Chap. 4.

Because metals occur naturally in the environment, the metals detected in the samples most likely did not result from activities at PORTS. In fall 2001, analytical results for several metals (antimony, arsenic, copper, selenium, and thallium) were higher than previous years for virtually all sampling locations, including three of the four background sampling locations. The laboratory that analyzed the samples determined that the results were affected by other metals present in the samples; therefore, the higher concentrations of these metals do not appear to result from PORTS activities. The results of sampling conducted in 2001 appear to indicate that there are no appreciable differences in the concentrations of metals present in sediment samples taken upstream and downstream from PORTS.

Historically, PORTS sediment sampling has detected low levels of PCB contamination in the Little Beaver Creek east of PORTS. This contamination was caused by discharges of treated process water before 1988. PCBs were not detected in the sediment samples collected in 2001.

5.6 BIOLOGICAL MONITORING

Biological monitoring at PORTS is used to assess the uptake of selected metals and/or PCBs into local biota (fish and vegetation).

5.6.1 Fish

In 2001, USEC collected fish from the Little Beaver Creek, Big Beaver Creek, and Scioto River. Fish samples were analyzed for chromium and PCBs, in addition to the radiological parameters discussed in Chap. 4. PCBs were detected in 3 of 12 fish samples: a white bass caught at the upstream surface water monitoring location on the Scioto River (RW-6) and two bass caught in Little Beaver Creek. PCBs, a widespread environmental contaminant, are often detected in fish and may or may not be present as a result of PORTS activities. Chromium was detected in 4 of 12 fish samples. Chromium occurs naturally in soil and is often present in surface water. For example, chromium was detected in six of eight samples of surface water collected at the upstream Scioto River sampling location (RW-6) at a maximum concentration of 12.4 Fg/L. The chromium detected in these fish is most likely due to naturally-occurring chromium.

5.6.2 Vegetation

USEC collects vegetation samples in the same areas where soil samples are collected (see Chap. 4, Figs. 4.5 and 4.6) and analyzes the samples for fluoride, in addition to the radiological parameters discussed in Chap. 4. Fluoride occurs naturally in the environment, but also could be present due to airborne emissions of gaseous fluoride from the uranium enrichment process at PORTS. Some vegetation samples collected in 2001 within the process area of PORTS contained detectable concentrations of fluoride that are higher than the concentrations present in samples collected off site. Fluorides were present in samples collected at off-site sampling locations at concentrations that are most likely indicative of background levels.

6. GROUNDWATER PROGRAMS

6.1 SUMMARY

Groundwater monitoring at DOE/PORTS is required by legal agreements with Ohio EPA and U.S. EPA and also by DOE Orders. More than 400 monitoring wells are used to track the flow of groundwater and to identify and measure groundwater contaminants. Groundwater programs also include on-site surface water monitoring and water supply monitoring. The contaminated groundwater plumes present at PORTS did not change significantly in 2001.

6.2 INTRODUCTION

The PORTS reservation is the largest industrial user of water in the vicinity and obtains its water from three water supply well fields that are next to the Scioto River south of Piketon. The wells tap the Scioto River Valley buried aquifer. In 2001, total groundwater production from the water supply well fields averaged 6.6 million gallons per day for the entire site, including USEC activities. Groundwater directly beneath PORTS is not used as a domestic, municipal, or industrial water supply, and contaminants in the groundwater beneath PORTS do not affect the quality of the water in the Scioto River Valley buried aquifer.

Groundwater monitoring at PORTS includes several activities. Monitoring wells are used to obtain information about groundwater. When the level of water, or groundwater elevation, is measured in a number of wells over a short period of time, the groundwater elevations, combined with information about the subsurface soil, can be used to estimate the rate and direction of groundwater flow. The rate and direction of groundwater flow can be used to predict the movement of contaminants in the groundwater and to develop ways to control or remediate groundwater contamination. Samples of water are also collected from groundwater monitoring wells and analyzed to obtain information about contaminants and naturally-occurring compounds in the groundwater.

6.3 GROUNDWATER MONITORING AT DOE/PORTS

Groundwater monitoring at PORTS was initiated in the 1980s. Groundwater monitoring has been conducted in response to state and/or federal regulations, regulatory documents prepared by DOE/PORTS, legal agreements between DOE and Ohio EPA or U.S. EPA, and DOE Orders.

Because of the numerous regulatory programs applicable to groundwater monitoring at PORTS, an *Integrated Groundwater Monitoring Plan* was developed to establish all groundwater monitoring requirements for PORTS. The initial plan, dated November 1998, was reviewed and approved by Ohio EPA and implemented at PORTS starting on April 1, 1999. A revised plan, dated January 2001, was implemented at PORTS beginning April 1, 2001. Therefore, groundwater monitoring at PORTS in 2001 was performed under both the November 1998 IGWMP (first quarter 2001) and the January 2001 IGWMP (second through fourth quarters of 2001). Changes in the January 2001 IGWMP include the addition of three new monitoring areas: the X-633 Pumphouse/Cooling Towers Area, X-533 Switchyard Area, and X-734 Landfills. Monitoring parameters were also added to wells in some of the existing monitoring areas.

Groundwater monitoring is also conducted to meet DOE Order requirements. Exit pathway monitoring assesses the effect of PORTS on off-site groundwater quality. Baseline monitoring is conducted to establish background data for use in assessing the effect of PORTS operations on the groundwater. DOE Orders are also the basis for the radiological monitoring of groundwater at PORTS.

Two water-bearing zones are present beneath PORTS: the Gallia and Berea formations. The Gallia is the uppermost water-bearing zone and contains most of the groundwater contamination at PORTS. The Berea is deeper than the Gallia and is usually separated from the Gallia by the Sunbury shale, which is a barrier to groundwater flow between the Gallia and Berea formations. Additional information about site hydrogeology is available in the PORTS Environmental Information Center. Chapter 3, Sect. 3.7, provides access requirements for the Information Center.

Several areas of groundwater contamination have been identified at PORTS. Groundwater contamination consists of volatile organic compounds (primarily trichloroethene) and radionuclides such as uranium and technetium-99. Groundwater monitoring results for 2001 generally indicate that:

- Groundwater flow directions and rates of flow were similar to those recorded in 2000.
- Groundwater contamination is contained within the reservation's boundaries.
- The concentration of contaminants and the lateral extent of plume boundaries did not significantly increase in 2001.

The *2001 Groundwater Monitoring Report for the Portsmouth Gaseous Diffusion Plant* provides further details on the groundwater plumes at PORTS, specific monitoring well identifications, and analytical results for monitoring wells. This document and other documents referenced in this chapter are available in the PORTS Environmental Information Center.

This chapter also includes information on the groundwater treatment facilities at PORTS. These facilities receive contaminated groundwater from the groundwater monitoring areas and treat the water prior to discharge through the DOE/PORTS permitted NPDES outfalls.

6.4 GROUNDWATER MONITORING AREAS

The *Integrated Groundwater Monitoring Plan* requires groundwater monitoring of 11 areas within the four quadrants of the site designated by the RCRA Corrective Action Program. These areas (see Fig. 6.1) are:

- X-749/X-120/Peter Kiewit (PK) Landfill,
- Quadrant I Groundwater Investigative Area/X-749A Classified Materials Disposal Facility,
- Quadrant II Groundwater Investigative Area,
- X-701B Holding Pond,
- X-633 Pumphouse/Cooling Towers Area,
- X-616 Chromium Sludge Surface Impoundments,
- X-740 Waste Oil Handling Facility,
- X-611A Former Lime Sludge Lagoons,
- X-735 Landfills,
- X-734 Landfills, and
- X-533 Switchyard Area.

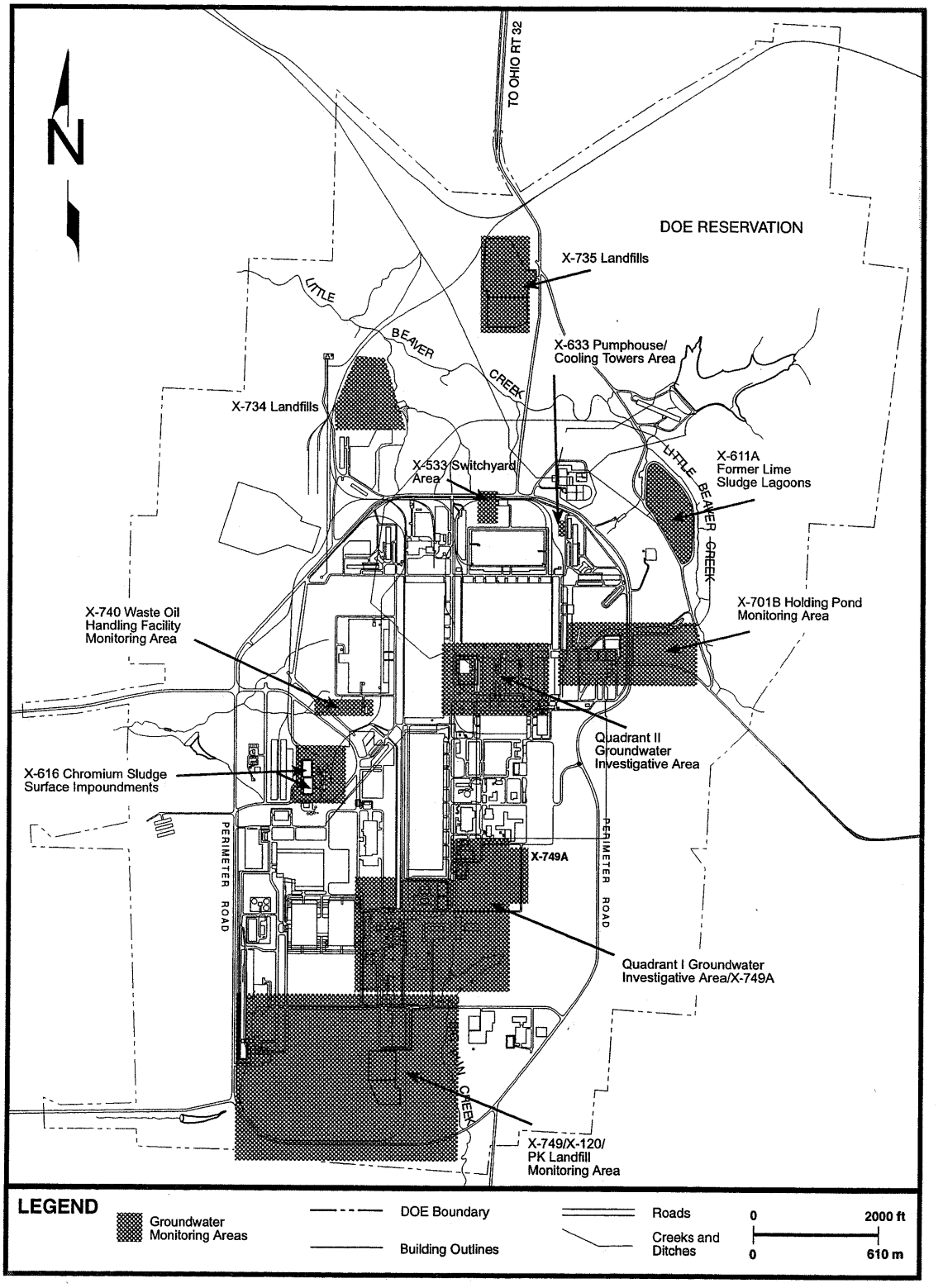


Fig. 6.1. Groundwater monitoring areas at PORTS.

The *Integrated Groundwater Monitoring Plan* also contains requirements for (1) surface water monitoring in creeks and drainage ditches at PORTS that receive groundwater discharge, and (2) water supply monitoring.

In general, samples are collected from wells (or surface water locations) at each area listed above and are analyzed for metals, volatile organic compounds, and radiological constituents. Table 6.1 lists the analytical requirements for each groundwater monitoring area and other monitoring programs described in this chapter. DOE/PORTS then compares constituents detected in the groundwater to standards called preliminary remediation goals to assess the potential for each constituent to affect human health and the environment. The preliminary remediation goals have been determined as part of the RCRA Corrective Action Program at PORTS. Preliminary remediation goals are based on naturally occurring concentrations of some constituents or on risk-based numbers calculated by the EPA, or are determined through a site-specific risk assessment.

6.4.1 X-749 Contaminated Materials Storage Facility/X-120 Old Training Facility/PK Landfill

In the southernmost portion of PORTS, groundwater concerns focus on three contaminant sources: X-749 Contaminated Materials Disposal Facility, X-120 Old Training Facility, and PK Landfill.

6.4.1.1 X-749 Contaminated Materials Disposal Facility

The X-749 Contaminated Materials Disposal Facility is a landfill located in the south-central section of the facility. The landfill covers approximately 7.5 acres and was built in an area of highest elevation within the southern half of PORTS. The landfill operated from 1955 to 1990, during which time buried wastes were generally contained in metal drums or other containers compatible with the waste.

The northern portion (approximately 200,000 square ft) contains waste contaminated with industrial solvents, waste oils from plant compressors and pumps, sludges classified as hazardous, and low-level radioactive materials. The southern portion (approximately 130,000 square ft) contains non-hazardous, low-level radioactive scrap materials.

The initial closure of the X-749 landfill included installation of (1) a multimedia cap, (2) a slurry wall along the north side and northwest corner of X-749, and (3) subsurface groundwater drains on the northern half of the east side and the southwest corner, including one sump within each of the groundwater drains. The slurry wall and subsurface drains extend down to bedrock. Groundwater from the subsurface drains is treated at the X-622 Groundwater Treatment Facility and then discharged in accordance with the DOE/PORTS NPDES permit. In 2000, one of the remedial actions selected by Ohio EPA for the X-749/X-120 groundwater plume was construction of a barrier wall on the south and east sides of the X-749 landfill in order to control migration of contaminants from the landfill. Construction of this wall began in September 2001 (see Chap. 3, Sect. 3.2.2.1).

The leading edge of the contaminated groundwater plume emanating from the X-749 landfill has been approaching the southern boundary of the PORTS reservation. In 1995, a subsurface slurry wall was completed across a portion of this southern boundary. The slurry wall is designed to inhibit migration of the plume off plant property prior to the implementation of a final remedial measure.

Three wells monitor the subsurface slurry wall at the leading edge of the groundwater plume and are sampled quarterly. In 2000, six new wells were installed to monitor the area between the slurry wall and the DOE property boundary; these wells are sampled semiannually. Twenty-one other wells (19 monitoring wells and 2 extraction wells) are sampled semiannually to monitor the X-749 plume. Twenty

Table 6.1. Analytical parameters for monitoring areas and programs at PORTS[a]

Monitoring Area or Program	Analytes	
X-749/X-120/PK Landfill[b]		
X-749/X-120 plume	volatile organic compounds[c] technetium-99 total U, $^{233/234}U$, ^{235}U, ^{236}U, ^{238}U[d] alkalinity	chloride sulfate total metals[d]: Ca, Fe, Mg, K, Na transuranics[d]: ^{241}Am, ^{237}Np, ^{238}Pu, $^{239/240}Pu$
PK Landfill	volatile organic compounds[c] technetium-99 total U, $^{233/234}U$, ^{235}U, ^{236}U, ^{238}U[d] alkalinity chloride sulfate fluoride	total metals[d]: As, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Ni, K, Se, Na, V, Zn mercury transuranics[d]: ^{241}Am, ^{237}Np, ^{238}Pu, $^{239/240}Pu$ Arochlor-1260
Quadrant I Groundwater Investigative Area[b]		
X-231B plume	volatile organic compounds[c, e] technetium-99 total U, $^{233/234}U$, ^{235}U, ^{236}U, ^{238}U[d] alkalinity chloride	sulfate total metals[d, e]: Ca, Fe, Mg, Mn, K, Na transuranics[d]: ^{241}Am, ^{237}Np, ^{238}Pu, $^{239/240}Pu$
X-749A Classified Materials Disposal Facility	volatile organic compounds[f] technetium-99 total U, $^{233/234}U$, ^{235}U, ^{236}U, ^{238}U[d] alkalinity chloride sulfate nitrite nitrate ammonia	total metals[d]: Sb, As, Ba, Be, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Ni, K, Se, Ag, Na, Tl, V, Zn transuranics[d]: ^{241}Am, ^{237}Np, ^{238}Pu, $^{239/240}Pu$ chemical oxygen demand total dissolved solids
Quadrant II Groundwater Investigative Area[b]	volatile organic compounds[c] technetium-99 total U, $^{233/234}U$, ^{235}U, ^{236}U, ^{238}U[d] alkalinity	chloride sulfate total metals[d]: Ca, Fe, Mg, K, Na transuranics[d]: ^{241}Am, ^{237}Np, ^{238}Pu, $^{239/240}Pu$
X-701B Holding Pond[b]	volatile organic compounds[c, e] technetium-99 total U, $^{233/234}U$, ^{235}U, ^{236}U, ^{238}U[d] alkalinity chloride	sulfate total metals[d, e]: Ca, Cd, Co, Cr, Fe, Mg, Mn, K, Pb, Na, Ni, Tl transuranics[d]: ^{241}Am, ^{237}Np, ^{238}Pu, $^{239/240}Pu$
X-633 Pumphouse/Cooling Towers Area	total metals[d]: Cr	

Table 6.1. Analytical parameters for monitoring areas and programs at PORTS[a] (continued)

Monitoring Area or Program	Analytes	
X-616 Chromium Sludge Surface Impoundments	volatile organic compounds[c] alpha, beta activity technetium-99 total U, $^{233/234}U$, ^{235}U, ^{236}U, ^{238}U[d] alkalinity	chloride sulfate total metals[d]: Ca, Fe, Mg, K, Na, Ba, Cd, Cr, Pb, Mn, Ni, Sb, Tl
X-740 Waste Oil Handling Facility[b]	volatile organic compounds[c] technetium-99 total U, $^{233/234}U$, ^{235}U, ^{236}U, ^{238}U[d] alkalinity	chloride sulfate total metals[d]: Ca, Fe, Mg, K, Na transuranics[d]: ^{241}Am, ^{237}Np, ^{238}Pu, $^{239/240}Pu$
X-611A Former Lime Sludge Lagoons	total metals[d]: Be, Cr total U, $^{233/234}U$, ^{235}U, ^{236}U, ^{238}U[d]	
X-735 Landfills	volatile organic compounds[f] technetium-99 total U, $^{233/234}U$, ^{235}U, ^{236}U, ^{238}U[d] alkalinity chloride sulfate nitrite nitrate ammonia	total metals[d]: Sb, As, Ba, Be, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Ni, K, Se, Ag, Na, Tl, V, Zn transuranics[d]: ^{241}Am, ^{237}Np, ^{238}Pu, $^{239/240}Pu$ chemical oxygen demand total dissolved solids
X-734 Landfills	volatile organic compounds[f] technetium-99 total U, $^{233/234}U$, ^{235}U, ^{236}U, ^{238}U[d] alkalinity chloride sulfate nitrite nitrate ammonia	total metals[d]: Sb, As, Ba, Be, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Ni, K, Se, Ag, Na, Tl, V, Zn transuranics[d]: ^{241}Am, ^{237}Np, ^{238}Pu, $^{239/240}Pu$ chemical oxygen demand total dissolved solids
X-533 Switchyard Area	total metals[d]: Cd, Co, Ni	
Surface Water	volatile organic compounds[c] technetium-99 total U, $^{233/234}U$, ^{235}U, ^{236}U, ^{238}U[d] alkalinity	chloride sulfate total metals[d]: Ca, Fe, Mg, K, Na transuranics[d]: ^{241}Am, ^{237}Np, ^{238}Pu, $^{239/240}Pu$
Water Supply	volatile organic compounds[c] technetium-99 total U, $^{233/234}U$, ^{235}U, ^{236}U, ^{238}U[d] alkalinity	chloride sulfate total metals[d]: Ca, Fe, Mg, K, Na transuranics[d]: ^{241}Am, ^{237}Np, ^{238}Pu, $^{239/240}Pu$

Table 6.1. Analytical parameters for monitoring areas and programs at PORTS[a] (continued)

Monitoring Area or Program	Analytes		
Exit Pathway and Baseline	volatile organic compounds[c] technetium-99 total U, $^{233/234}U$, ^{235}U, ^{236}U, ^{238}U[d] alkalinity	chloride sulfate total metals[d]: transuranics[d]:	 Ca, Fe, Mg, K, Na ^{241}Am, ^{237}Np, ^{238}Pu, $^{239/240}Pu$

[a]The following changes were made April 1, 2001: 1) transuranic isotopes were added to all wells in the areas where they are listed, 2) gross alpha and gross beta were deleted from the sampling parameters for X-616, 3) total uranium and isotopic uranium were deleted from the sampling parameters for X-611A, and 4) additional metals were added to selected wells at the Quadrant I Groundwater Investigative Area (X-231B plume) and X-701B Holding Pond.

[b]Selected well(s) in this area are sampled once every two years for a comprehensive list of over 200 potential contaminants (Title 40, Code of Federal Regulations, Part 264 Appendix IX – Appendix to Ohio Administrative Code Rule 3745-54-98).

[c]Acetone, benzene, bromodichloromethane, bromoform, carbon disulfide, carbon tetrachloride, chlorobenzene, chloroethane, chloroform, dibromochloromethane, 1,2-dichlorobenzene, 1,4-dichlorobenzene, 1,1-dichloroethane, 1,2-dichloroethane, 1,1-dichloroethene, cis-1,2-dichloroethene, trans-1,2-dichloroethene, ethylbenzene, bromomethane, chloromethane, methylene chloride, 2-butanone (methyl ethyl ketone), 4-methyl-2-pentanone (methyl isobutyl ketone), 1,1,2,2-tetrachloroethane, tetrachloroethene, toluene, 1,1,1-trichloroethane, 1,1,2-trichloroethane, trichloroethene, trichlorofluoromethane (CFC-11), vinyl chloride, xylenes (M+P xylenes).

[d]Appendix C lists the symbols for metals and transuranic radionuclides.

[e]Not all wells at this area are analyzed for all metals listed or for volatile organic compounds.

[f]Volatile organic compounds listed in footnote c plus: acrylonitrile, bromochloromethane, 1,2-dibromo-3-chloropropane, 1,2-dibromoethane, trans-1,4-dichloro-2-butene, 1,2-dichloropropane, cis-1,3-dichloropropene, trans-1,3-dichloropropene, 2-hexanone (methyl butyl ketone), dibromomethane, iodomethane, styrene, 1,1,1,2-tetrachloroethane, 1,2,3-trichloropropane, and vinyl acetate.

additional wells are sampled annually or biennially to monitor both the X-749 and the X-120 plumes. Table 6.1 lists the analytical parameters for the wells in this area.

6.4.1.2 X-120 Old Training Facility

The X-120 Old Training Facility covered an area of approximately 11.5 acres near the present-day XT-847 building. The X-120 facility, which no longer exists, included a machine shop, metal shop, paint shop, and several warehouses used during the construction of PORTS in the 1950s. The shops may have used solvents and various other materials; disposal practices of these solvents are unknown.

Groundwater in the vicinity of this facility contains primarily trichloroethene. The upgradient (northern) portion of the X-120 plume co-mingles with a portion of the X-749 plume; however, downgradient the X-120 plume migrates independently to the southwest. In 1996, a horizontal well was installed along the approximate axis of the X-120 plume. Contaminated groundwater flows from this well to the X-625 Groundwater Treatment Facility.

Three wells are sampled semiannually to monitor the plume associated with the X-120 area. Twenty additional wells are sampled annually or biennially to monitor both the X-749 and the X-120 plumes. Table 6.1 lists the analytical parameters for the wells in this area.

6.4.1.3 PK Landfill

The PK Landfill is located west of Big Run Creek just south of the X-230K Holding Pond. The landfill, which began operations in 1952, was used as a salvage yard, burn pit, and trash area during the construction of PORTS. After the initial construction, the disposal site was operated as a sanitary landfill until 1968, when soil was graded over the site and the area was seeded with native grasses. No records exist that characterize the material in the landfill.

During site investigations, intermittent seeps were observed emanating from the PK Landfill into Big Run Creek. In 1993, sampling was conducted at three of the seeps and at Big Run Creek approximately 40 ft downstream of the seeps. Sample results indicated that the seeps contained vinyl chloride; however, no vinyl chloride was detected in Big Run Creek.

In 1994, a portion of Big Run Creek was relocated approximately 50 ft to the east. A groundwater collection system was installed in the old creek channel to capture the seeps emanating from the landfill. A second collection system was constructed on the southeastern boundary to contain the groundwater plume migrating toward Big Run Creek from the southern portion of the PK landfill in 1997. A cap was constructed over the landfill in 1998.

Ten wells are sampled semiannually and two sumps that collect groundwater from the plume are sampled quarterly. Table 6.1 lists the analytical parameters for the wells and sumps in this area.

6.4.1.4 Monitoring results for the X-749/X-120/PK Landfill in 2001

A contaminated groundwater plume is associated with the X-749/X-120/PK Landfill groundwater monitoring area (see Fig. 6.2). The most extensive and most concentrated constituents associated with the X-749/X-120 plume are volatile organic compounds, particularly trichloroethene. Data collected in 2001 indicate that the southern perimeter of the X-749/X-120 plume (defined as 5 Fg/L of trichloroethene) has expanded slightly.

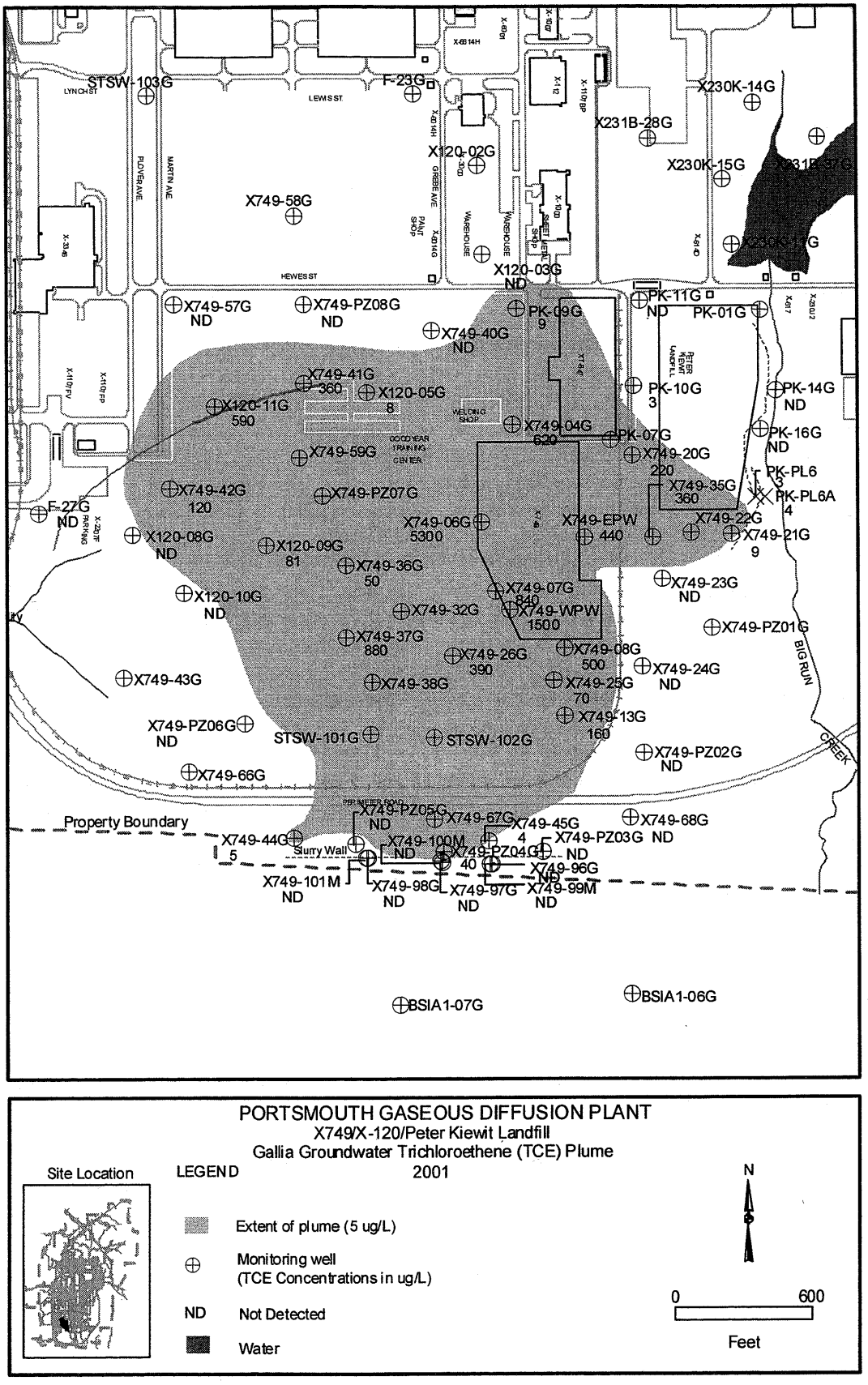


Fig. 6.2. Trichloroethene-contaminated Gallia groundwater plume at the X-749/X-120/PK Landfill.

In 2001, trichloroethene was detected in one of the wells (well X749-97G) installed between the slurry wall and the DOE property boundary. Trichloroethene was detected in the sample collected in the second quarter and in one of two samples collected in the third quarter at concentrations at the detection limit (2 Fg/L); however, trichloroethene was not detected in the second sample collected in the third quarter or the sample collected in the fourth quarter. Xylene was also detected at 4 Fg/L in the sample collected from well X749-96G in the fourth quarter. Activities were begun in 2001 and will continue in 2002 to determine whether the groundwater plume has moved beyond the DOE property boundary.

In addition to volatile organic compounds, inorganics (metals) and radionuclides (uranium, technetium-99, and americium-241) have also been detected in the groundwater beneath the X-749 area. Remediation of groundwater is being accomplished in accordance with the RCRA Corrective Action Program.

Some of the wells associated with the PK Landfill also appear to be contaminated with low levels of volatile organic compounds, but usually at concentrations below preliminary remediation goals. Vinyl chloride, however, was detected in samples collected from wells PK-17B and PK-21B at concentrations ranging from 14 to 34 Fg/L, which is above the preliminary remediation goal of 2 Fg/L.

Under the revised *Integrated Groundwater Monitoring Plan*, which became effective April 1, 2001, cobalt is of special interest in the PK Landfill monitoring area. Cobalt was detected in two wells in 2001 at concentrations above the preliminary remediation goal. Remediation of groundwater is being accomplished in accordance with the RCRA Corrective Action Program.

6.4.2 Quadrant I Groundwater Investigative Area/X-749A Classified Materials Disposal Facility

In the northern portion of Quadrant I, groundwater concerns focus on two areas: the Quadrant I Groundwater Investigative Area and the X-749A Classified Materials Disposal Facility. The X-231B Southwest Oil Biodegradation Plot is a part of the Quadrant I Groundwater Investigative Area and was monitored prior to implementation of the *Integrated Groundwater Monitoring Plan*. The X-749A was also monitored prior to implementation of the *Integrated Groundwater Monitoring Plan* under requirements for solid waste landfills.

6.4.2.1 X-231B Southwest Oil Biodegradation Plot

The X-231B Southwest Oil Biodegradation Plot was used from 1976 to 1983 for land application of contaminated oil/solvent mixtures generated from the enrichment process and maintenance activities. The X-231B area, located west of the X-600 Steam Plant, consisted of two disposal plots, each surrounded by an elevated soil berm, that were periodically fertilized and plowed to enhance aeration and promote biological degradation of waste oil.

Three groundwater extraction wells were installed in the Gallia in 1991 as part of the X-231B interim remedial measure. These wells, which have a cumulative pumping rate of about 9 gal/minute, are located south (downgradient) of the X-231B area. The extracted groundwater is treated at the X-622 Groundwater Treatment Facility. In 2000, a multimedia landfill cap was installed over this area to minimize water infiltration and control the spread of contamination. Construction of 11 new groundwater extraction wells in this area began in 2001. Chapter 3, Sect. 3.2.2.2, provides additional information on this project.

Nineteen wells are sampled semiannually as part of the monitoring program for the Quadrant I Groundwater Investigative Area. An additional 16 wells are sampled annually or biennially. Table 6.1 lists the analytical parameters for the wells in this area.

6.4.2.2 X-749A Classified Materials Disposal Facility

The 6-acre X-749A Classified Materials Disposal Facility operated from 1953 through 1988 for the disposal of wastes classified under the Atomic Energy Act. Potential contaminants include PCBs, asbestos, radionuclides, and industrial waste. Closure of the landfill, completed in 1994, included the construction of a multilayer cap and the installation of a drainage system to collect surface water runoff. The drainage system discharges via a USEC NPDES-permitted outfall.

In August 2000, DOE initiated an assessment monitoring program at this monitoring area because of a statistically significant increase in alkalinity at one of the downgradient X-749A monitoring wells. Therefore, monitoring completed at this area in 2001 includes both routine monitoring required by the *Integrated Groundwater Monitoring Plan* and assessment monitoring.

Eight wells are sampled semiannually as part of the routine monitoring program for the X-749A landfill. Two additional wells were added to the monitoring program for this area in the fourth quarter of 2001 based on the findings of the assessment monitoring program. Table 6.1 lists the analytical parameters for the wells in this area.

6.4.2.3 Monitoring results for the Quadrant I Groundwater Investigative Area/X-749A in 2001

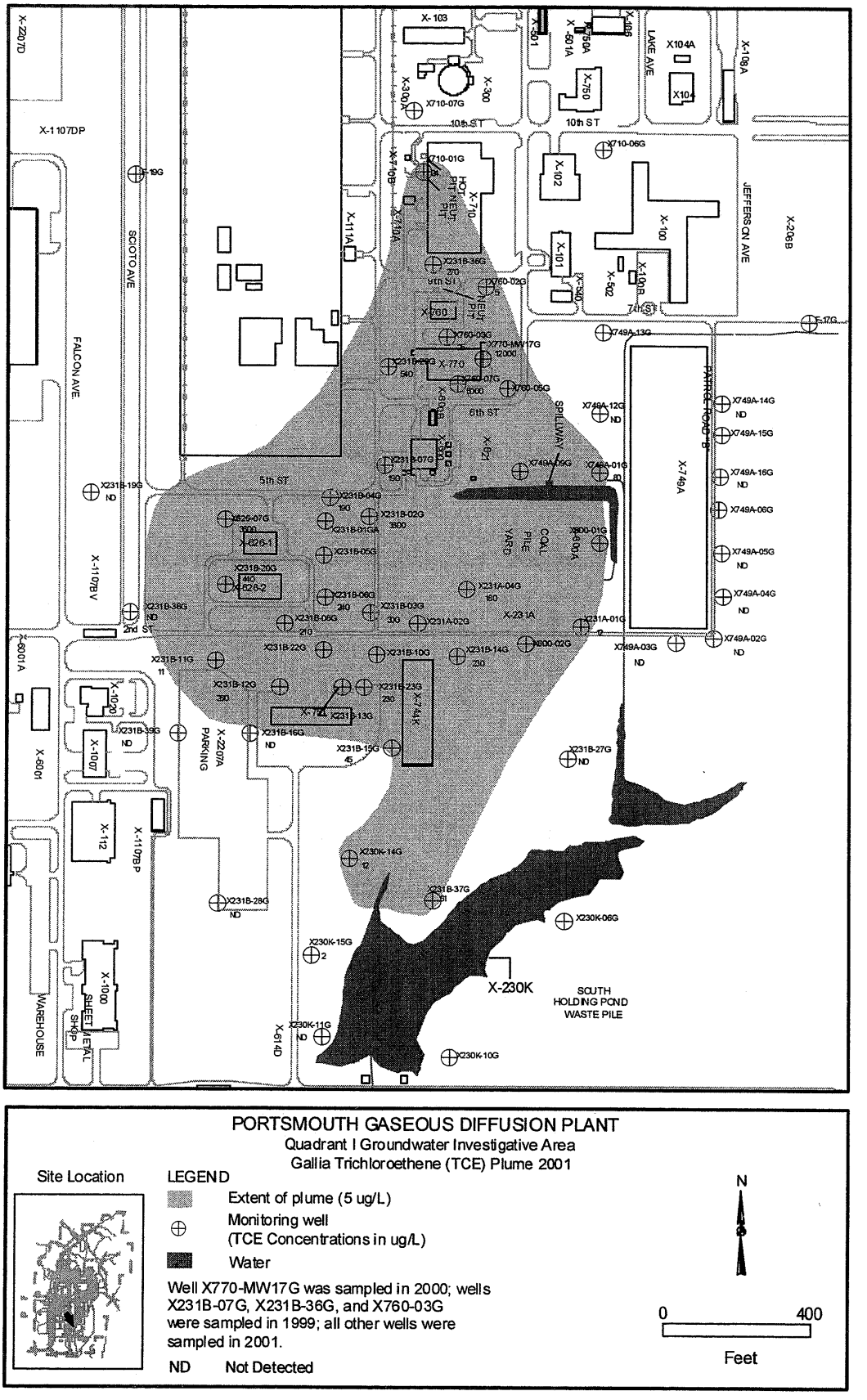
A contaminated groundwater plume consisting primarily of trichloroethene is associated with the Quadrant I Groundwater Investigative Area (see Fig. 6.3). Other volatile organic compounds are also present in the plume. In 2001, no significant changes to the perimeter of the plume (defined as 5 Fg/L of trichloroethene) were noted. Inorganics (metals) and radionuclides (uranium, technetium-99, and americium-241) have also been detected in the groundwater beneath the area. Remediation of groundwater is being accomplished in accordance with the RCRA Corrective Action Program.

Routine monitoring data collected at the X-749A landfill in 2001 were consistent with historical data. Assessment monitoring at the X-749A Landfill was initiated in 2000 and completed in 2001. The *Groundwater Quality Assessment Report for the X-749A Landfill* provides the results of the assessment monitoring program. The report indicates that a release from the landfill has not occurred and recommends a return to detection monitoring at this landfill with a revised statistical approach to minimize false positives in the detection monitoring program.

6.4.3 Quadrant II Groundwater Investigative Area

The Quadrant II Groundwater Investigative Area consists of an area of groundwater contamination with several potential sources. One of these sources, the X-701C Neutralization Pit, was monitored prior to implementation of the *Integrated Groundwater Monitoring Plan*. The X-701C Neutralization Pit was an open-topped neutralization pit that received process effluents and basement sump wastewater such as acid and alkali solutions and rinse water contaminated with trichloroethene and/or trichloroethane from metal cleaning operations. The X-701C Neutralization Pit was located within a trichloroethene plume centered around the X-700 and X-705 buildings. The pit was removed in 2001 (see Chap. 3, Sect. 3.2.2.3).

The natural groundwater flow direction in this area is to the east toward Little Beaver Creek. The groundwater flow pattern has been changed in this area by use of sump pumps in the basement of the X-705 building. Thus, the groundwater plume in this area does not spread but instead flows toward the sumps where it is collected and then treated at the X-622T Groundwater Treatment Facility.


PORTSMOUTH GASEOUS DIFFUSION PLANT
Quadrant I Groundwater Investigative Area
Gallia Trichloroethene (TCE) Plume 2001
Site Location
LEGEND
Extent of plume (5 ug/L)
Monitoring well
(TCE Concentrations in ug/L)
Water
Well X770-MW17G was sampled in 2000; wells X231B-07G, X231B-36G, and X760-03G were sampled in 1999; all other wells were sampled in 2001.
ND Not Detected
N
0
400
Feet
X-230K
SOUTH HOLDING POND WASTE PILE
SCIOTO AVE
FALCON AVE
JEFFERSON AVE
LAKE AVE
10th ST
6th ST
5th ST
SPILLWAY
COAL PILE YARD
PATRICE ROAD B
PARKING
WAREHOUSE
SHEET METAL SHOP
X-749A
X-710
X-760
X-770
X-231A
X-231B
X-230K
X-626-1
X-626-2
X-100
X-102
X-103
X-104A
X-300
X-750
X-1107DP
X-1107BV
X-1107BP
X-2207D
X-2207A
X-6001
X-6001A
X-6101
X-108A
X-206B
X-501A
X-502
X-701A
X-701B
X-111A
X-112
X-1007
X-1008
X-1020
X-1101
X-1102
X-1103
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X-1136
X-1137
X-1138
X-1139
X-1140
X-1141
X-1142
X-1143
X-1144
X-1145
X-1146
X-1147

Nine wells are sampled annually as part of the monitoring program for this area. An additional 15 wells are sampled biennially. One well, X701-01G, is sampled semiannually. Although this well is included in the monitoring program for the Quadrant II Groundwater Investigative Area, it is part of the monitoring program for metals (cadmium and nickel) and volatile organic compounds near the X-744G Bulk Storage Building, which is part of the X-701B monitoring area. Therefore, analytical results for well X701-01G are discussed with results for the X-701B Holding Pond. Table 6.1 lists the analytical parameters for the wells in this area.

6.4.3.1 Monitoring results for the Quadrant II Groundwater Investigative Area in 2001

A contaminated groundwater plume consisting primarily of trichloroethene is associated with the Quadrant II Groundwater Investigative Area (see Fig. 6.4). The extent of this groundwater plume did not change between 2000 and 2001. Numerous other volatile organics were also detected within the plume. Inorganics (metals) and radionuclides (uranium, technetium-99, and americium-241) were also detected in 2001. Remediation of groundwater is being accomplished in accordance with the RCRA Corrective Action Program.

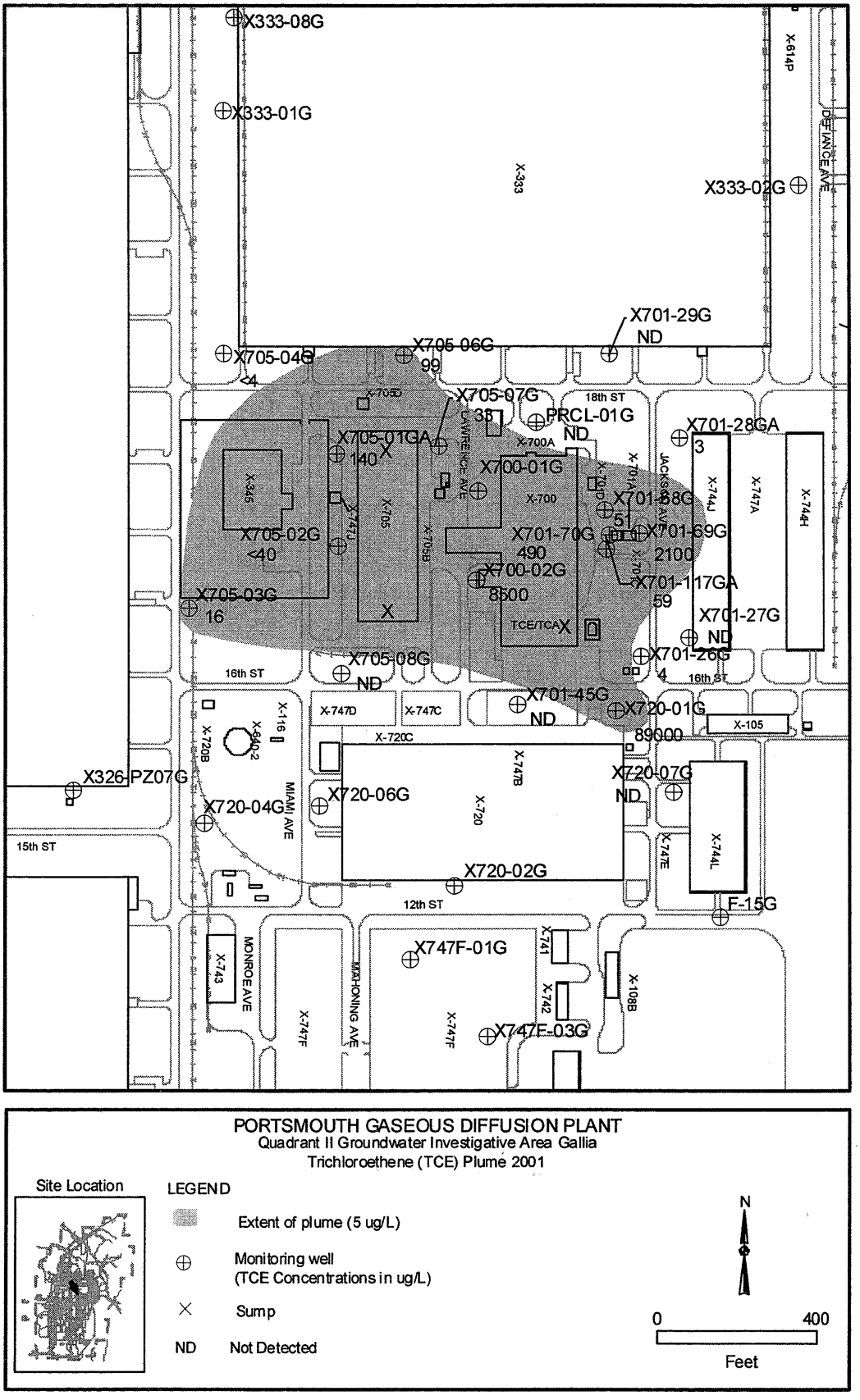
6.4.4 X-701B Holding Pond

In the eastern portion of Quadrant II, groundwater concerns focus on three areas: the X-701B Holding Pond, the X-230J7 Holding Pond, and the X-744Y Waste Storage Yard.

The X-701B Holding Pond was used from the beginning of plant operations in 1954 until November 1988. The pond was designed for neutralization and settlement of acid waste from several sources. Trichloroethane and trichloroethene were also discharged to the pond. Two sludge retention basins were located west of the holding pond. The X-230J7 Holding Ponds received wastewater from the X-701B Holding Pond. The X-744Y Waste Storage Yard is south of the X-701B Holding Pond. The yard is approximately 15 acres and surrounds the X-744G Bulk Storage Building. RCRA hazardous waste was managed in this area.

A contaminated groundwater plume extends from the X-701B Holding Pond to Little Beaver Creek. Three groundwater extraction wells were installed southeast of X-701B as part of the ongoing RCRA closure of the unit. These wells were designed to intercept contaminated groundwater emanating from the holding pond area before it could join the existing groundwater contaminant plume. Extracted groundwater is processed at the X-623 Groundwater Treatment Facility. This facility also processes water recovered from a shallow sump in the bottom of the X-701B Holding Pond. Two groundwater interceptor trenches (French drains) are used to intercept trichloroethene-contaminated groundwater emanating from X-701B. The X-237 Groundwater Collection System has significantly reduced trichloroethene migration into Little Beaver Creek. The 660-foot-long primary trench has two sumps in the backfill, and a 440-foot-long secondary trench intersects the primary trench. The extracted groundwater is treated at the X-624 Groundwater Treatment Facility.

Twenty-six wells are sampled semiannually as part of the monitoring program for this area. An additional 14 wells are sampled annually or biennially. Table 6.1 lists the analytical parameters for the wells in this area.



PORTSMOUTH GASEOUS DIFFUSION PLANT
Quadrant II Groundwater Investigative Area Gallia
Trichloroethene (TCE) Plume 2001

Site Location

LEGEND

Extent of plume (5 ug/L)

Monitoring well
(TCE Concentrations in ug/L)

Sump

ND Not Detected

N

0 400
Feet

Fig. 6.4. Trichloroethene-contaminated Gallia groundwater plume at the Quadrant II Groundwater Investigative Area.

6.4.4.1 Monitoring results for the X-701B Holding Pond in 2001

The trichloroethene plume at this groundwater monitoring area contains the highest concentrations of trichloroethene measured in groundwater at PORTS. Numerous other volatile organics are also detected in samples collected from the monitoring wells in this area. The plume perimeter did not change significantly from 2000 to 2001 (see Fig. 6.5). Additionally, the second trichloroethene plume in the X-701B monitoring area (the plume southwest of the X-744G Bulk Storage Building) did not change significantly in 2001.

An additional detection of trichloroethene is shown at well X701-18G on Fig. 6.5. These data were collected as part of a special study at the X-701B area in 2001; the report entitled *Evaluation of the X-701B In-Situ Chemical Oxidation Injection Site* provides the results and analytical data for this special study.

The revised *Integrated Groundwater Monitoring Plan*, which was implemented on April 1, 2001, added additional parameters to existing monitoring wells and new wells to the monitoring program for the X-701B area. Samples from seven wells in the western portion of the monitoring area were analyzed for selected metals (cadmium, chromium, cobalt, lead, manganese, nickel, and/or thallium). In 2001, one well contained manganese and two wells contained chromium at concentrations above preliminary remediation goals. Samples from five wells near the X-744G Bulk Storage Building were analyzed for cadmium and nickel, which were detected above preliminary remediation goals in three of the five wells.

Radionuclides (uranium, technetium-99, and americium-241) were also detected in the groundwater in this area. Remediation of groundwater is being accomplished in accordance with the RCRA Corrective Action Program.

6.4.5 X-633 Pumphouse/Cooling Towers Area

The X-633 Pumphouse/Cooling Towers Area consists of a recirculating water pumphouse and four cooling towers with associated basins. Chromium-based corrosion inhibitors were added to the cooling water until the early 1990s, when the system was converted to a phosphate-based inhibitor.

In December 1996, the X-633 Pumphouse/Cooling Towers Area was identified as an area of concern for potential metals contamination based on historical analytical data for groundwater wells in this area. Samples from wells in this area were collected in 1998 and 1999 to assess the area for metals contamination. Based on the results of this study, this area was added to the PORTS groundwater monitoring program. Sampling began in the second quarter of 2001, and two wells (see Fig. 6.6) are sampled semiannually for chromium as part of the monitoring program for this area.

6.4.5.1 Monitoring results for the X-633 Pumphouse/Cooling Towers Area in 2001

Chromium was detected in both of the X-633 monitoring wells in 2001. Samples collected from well X633-07G contained chromium at concentrations above the preliminary remediation goal of 100 Fg/L: 1730 Fg/L (second quarter) and 503 Fg/L (fourth quarter). Samples collected from well X633-PZ04G also contained chromium but at levels below the preliminary remediation goal.

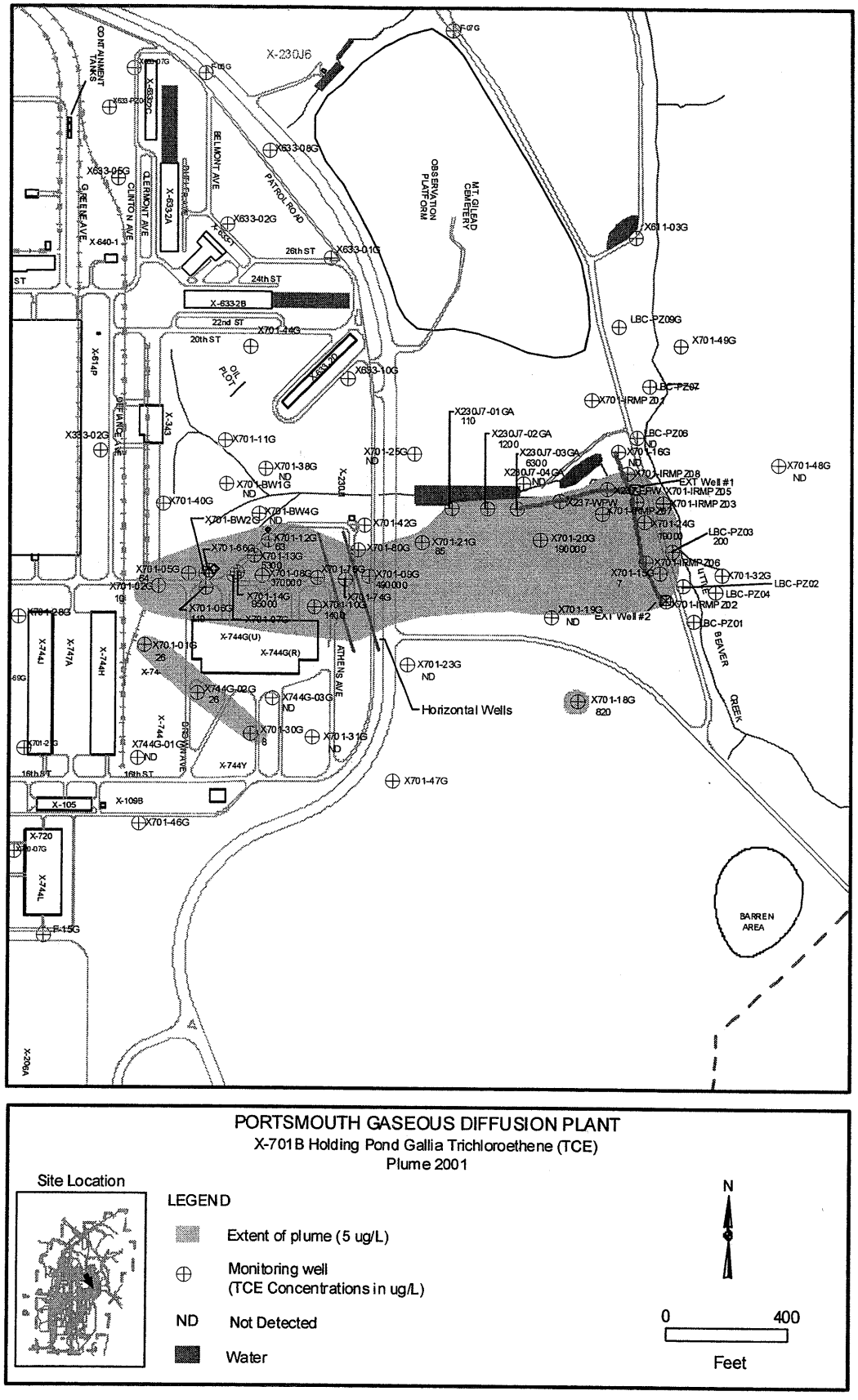


Fig. 6.5. Trichloroethene-contaminated Gallia groundwater plume at the X-701B Holding Pond.

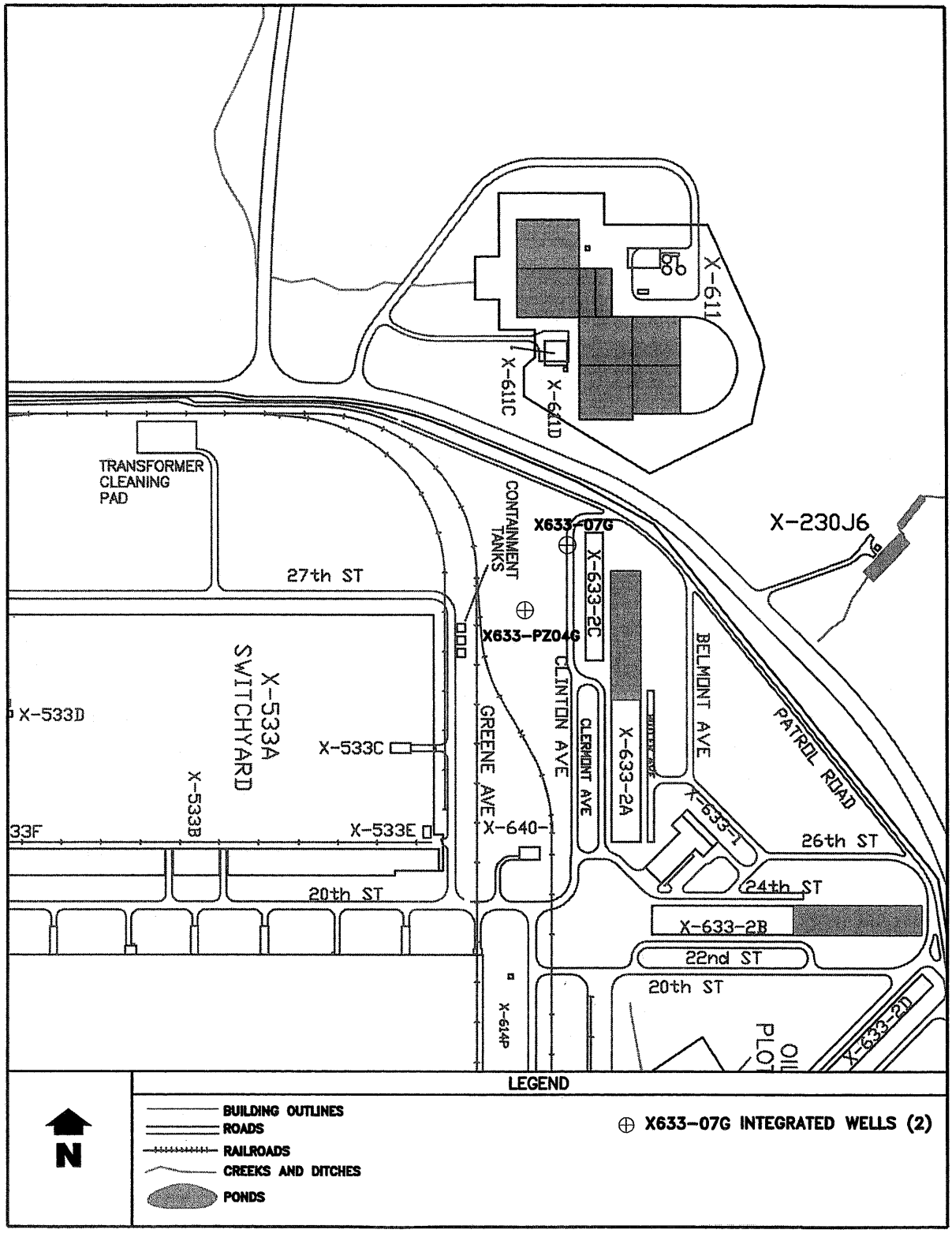


Fig. 6.6. Groundwater monitoring wells at the X-633 Pumphouse/Cooling Towers Area.

6.4.6 X-616 Chromium Sludge Surface Impoundments

The X-616 Chromium Sludge Surface Impoundments were two unlined surface impoundments used from 1976 to 1985 for storage of sludge generated by the treatment of water from the PORTS process cooling system. A corrosion inhibitor containing chromium was used in the cooling water system. Sludge containing chromium was produced by the water treatment system and was pumped into and stored in the X-616 impoundments. The sludge was removed from the impoundments and remediated as an interim action in 1990 and 1991. The unit was certified closed in 1993. Six wells are sampled annually and 10 wells are sampled biennially as part of the monitoring program for this area. Table 6.1 lists the analytical parameters for the wells in this area.

6.4.6.1 Monitoring results for the X-616 Chromium Sludge Surface Impoundments in 2001

Chromium is of special concern at the X-616 because of the previous use of the area. Chromium was detected in 7 of the 16 wells sampled in 2001, but was above the preliminary remediation goal of 100 Fg/L in only one well: X616-05G at 899 Fg/L. Concentrations of chromium detected in this well have exceeded the preliminary remediation goal in previous years as well. Figure 6.7 shows the concentrations of chromium in wells at the X-616.

Volatile organic compounds were detected at low levels in samples collected from three wells at this area. The only volatile organic compound detected above its preliminary remediation goal was trichloroethene. Remediation of groundwater is being accomplished in accordance with the RCRA Corrective Action Program.

6.4.7 X-740 Waste Oil Handling Facility

The X-740 Waste Oil Handling Facility, which is located on the western half of PORTS south of the X-530A Switchyard, consists of two hazardous waste management units: the X-740 Waste Storage Facility and the X-740 Hazardous Waste Storage Tank (sump), which was located within the building. The X-740 facility, which operated from 1983 until 1991, was used as an inventory and staging facility for waste oil and waste solvents that were generated from various plant operational and maintenance activities. The tank/sump, which was only operated until 1990, was used to collect residual waste oil and waste solvents from containers crushed in a hydraulic drum crusher at the facility. The facility and sump were initially identified as hazardous waste management units in 1991. The X-740 Waste Oil Handling Facility (both the facility and sump identified as hazardous waste management units) underwent closure, and closure certification was approved by Ohio EPA in 1998.

In 1999, poplar trees were planted in a 2.6-acre area above the groundwater plume near the X-740 Waste Oil Handling Facility. This remediation technique, called phytoremediation, uses plants to remove or degrade contaminants in soil and groundwater. The monitoring program for the X-740 area includes monitoring of water levels around the trees to evaluate water usage by the trees, in addition to routine monitoring of groundwater wells for contaminants.

Nine wells are sampled semiannually, two wells are sampled annually, and four wells are sampled biennially as part of the monitoring program for this area. Table 6.1 lists the analytical parameters for the wells in this area.

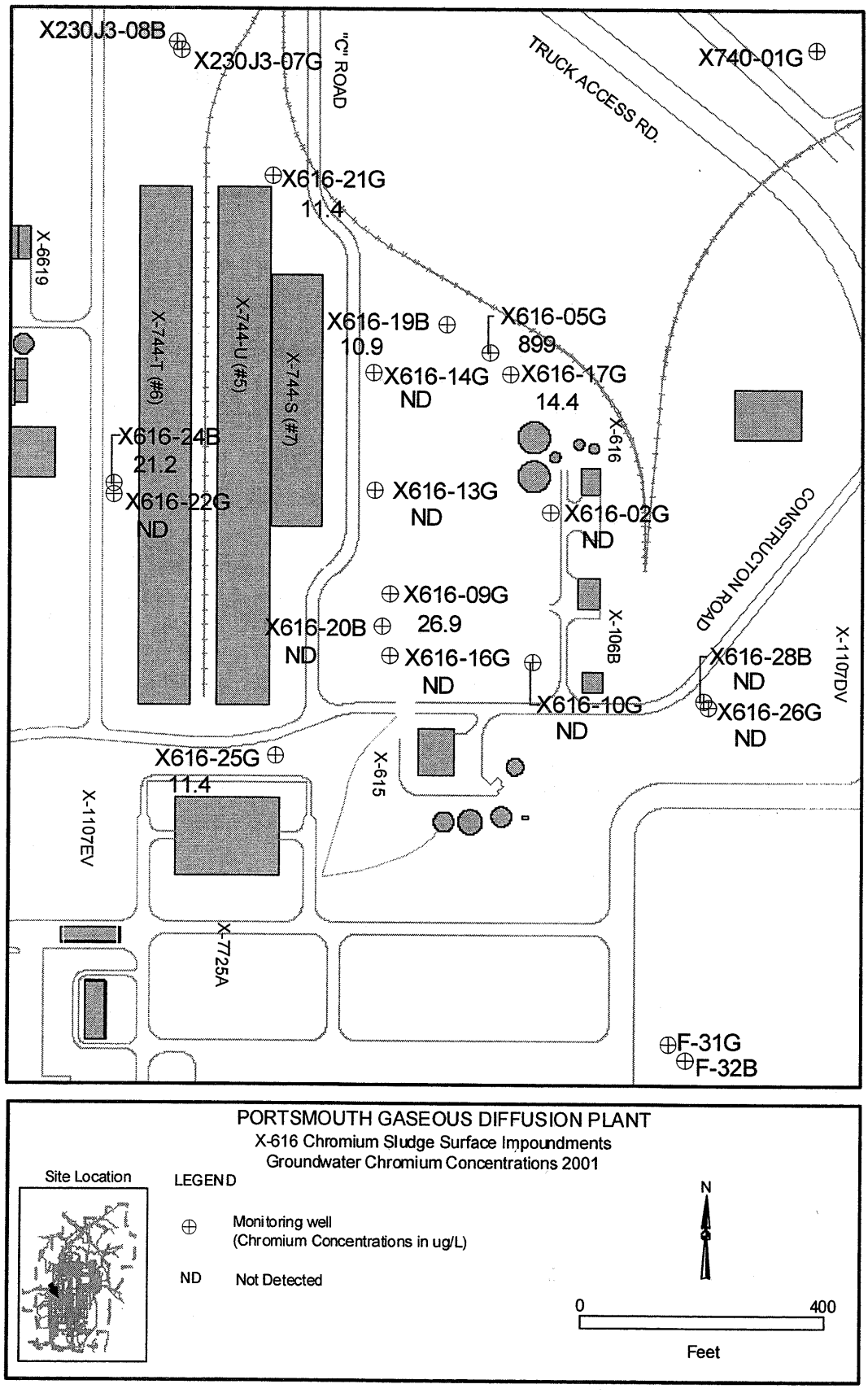


Fig. 6.7. Chromium concentrations in groundwater at the X-616 Chromium Sludge Surface Impoundments.

6.4.7.1 Monitoring results for the X-740 Waste Oil Handling Facility in 2001

Water level measurements are collected on a frequent basis from the X-740 monitoring wells during the growing season to determine whether the poplar trees that are part of the phytoremediation system for this area are using water as intended. Hourly water level measurements collected at two X-740 Gallia wells from July 1 through July 31, 2001, indicated groundwater usage by the trees.

A contaminated groundwater plume consisting primarily of trichloroethene is associated with the X-740 Waste Oil Handling Facility (see Fig. 6.8). The northern perimeter of the plume expanded slightly in 2001 based on the detection of trichloroethene in well X740-PZ17G. Remediation of these constituents is proceeding as part of the RCRA Corrective Action Program.

Inorganics (metals) and radionuclides (uranium, technetium-99, and plutonium-239/240) were also detected in 2001. Remediation of groundwater is being accomplished in accordance with the RCRA Corrective Action Program.

6.4.8 X-611A Former Lime Sludge Lagoons

The X-611A Former Lime Sludge Lagoons were three adjacent unlined sludge retention lagoons constructed in 1954 and used for disposal of lime sludge waste from the site water treatment plant from 1954 to 1960. The lagoons, which had a capacity of approximately 295,000 cubic yards, cover a surface area of approximately 18 acres. The lagoons were constructed in a low-lying area that included Little Beaver Creek. As a result, approximately 1500 ft of Little Beaver Creek was relocated to a channel just east of the lagoons.

As part of the RCRA Corrective Action Program, a prairie habitat has been developed in this area by placing a soil cover over the north, middle, and south lagoons. A soil berm was also constructed outside the northern boundary of the north lagoon to facilitate shallow accumulation of water in this low-lying area. Six wells are sampled semiannually as part of the monitoring program for this area. Table 6.1 lists the analytical parameters for the wells in this area.

6.4.8.1 Monitoring results for the X-611A Former Lime Sludge Lagoons in 2001

The six monitoring wells at X-611A (see Fig. 6.9) are sampled and analyzed for beryllium and chromium. Chromium was detected in two wells (F-07G and X611A-01B) in 2001 at concentrations less than the preliminary remediation goal. Beryllium was detected in samples collected from all of the X-611A monitoring wells in 2001 at concentrations less than the preliminary remediation goal.

Samples collected from the wells in the first quarter of 2001 were also analyzed for total uranium and uranium isotopes (uranium-233/234, uranium-235, uranium-236, and uranium-238).

6.4.9 X-735 Landfills

Several distinct waste management units are contained within the X-735 Landfills area. The main units consist of the hazardous waste landfill, referred to as the X-735 Landfill (Northern Portion), and the X-735 Industrial Solid Waste Landfill. The X-735 Industrial Solid Waste Landfill includes the industrial solid waste cells, asbestos disposal cells, and the closed chromium sludge monocells A and B. The chromium sludge monocells contain a portion of the chromium sludge generated during the closure of the X-616 Chromium Sludge Surface Impoundments.

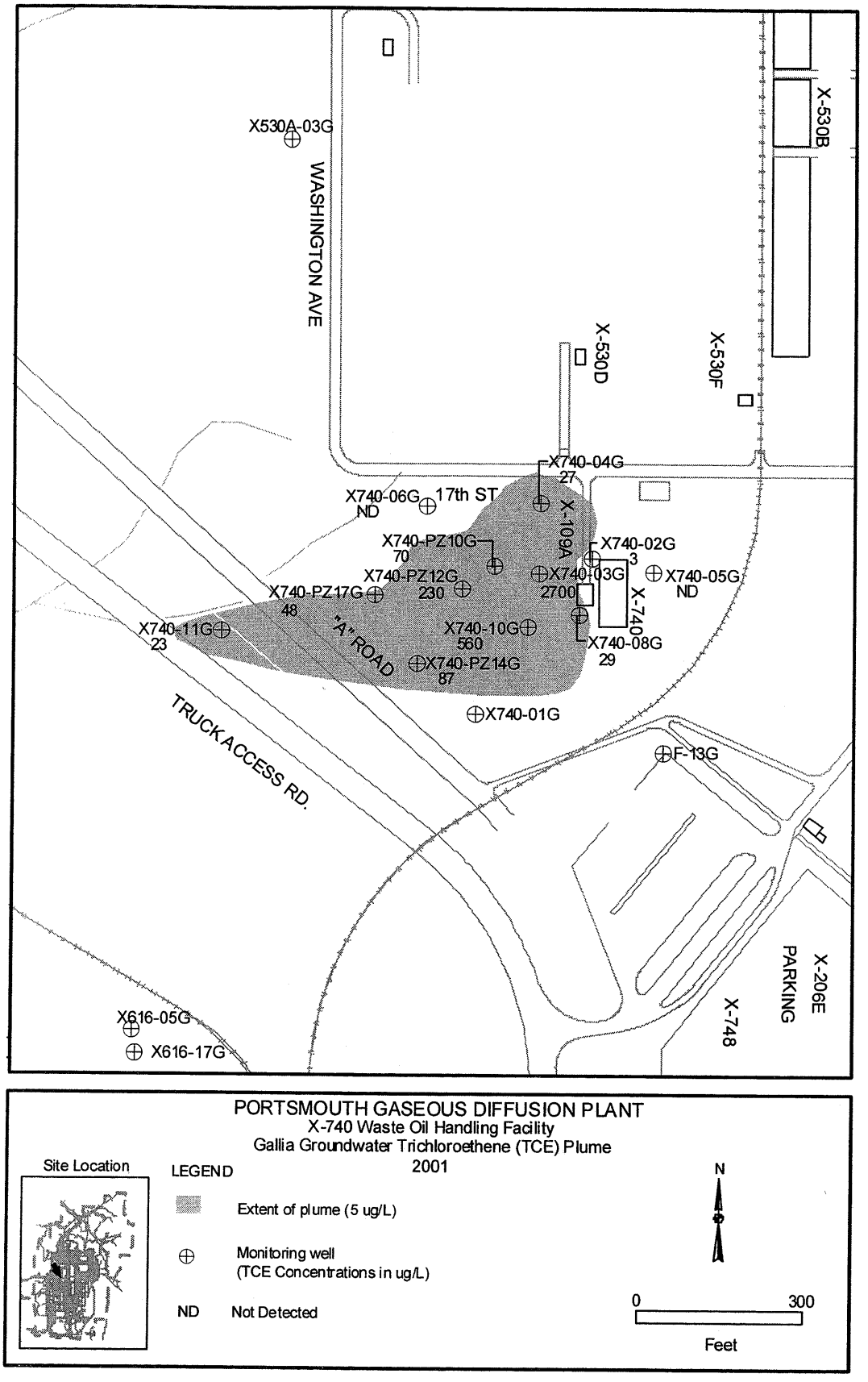


Fig. 6.8. Trichloroethene-contaminated Gallia groundwater plume near the X-740 Waste Oil Handling Facility.

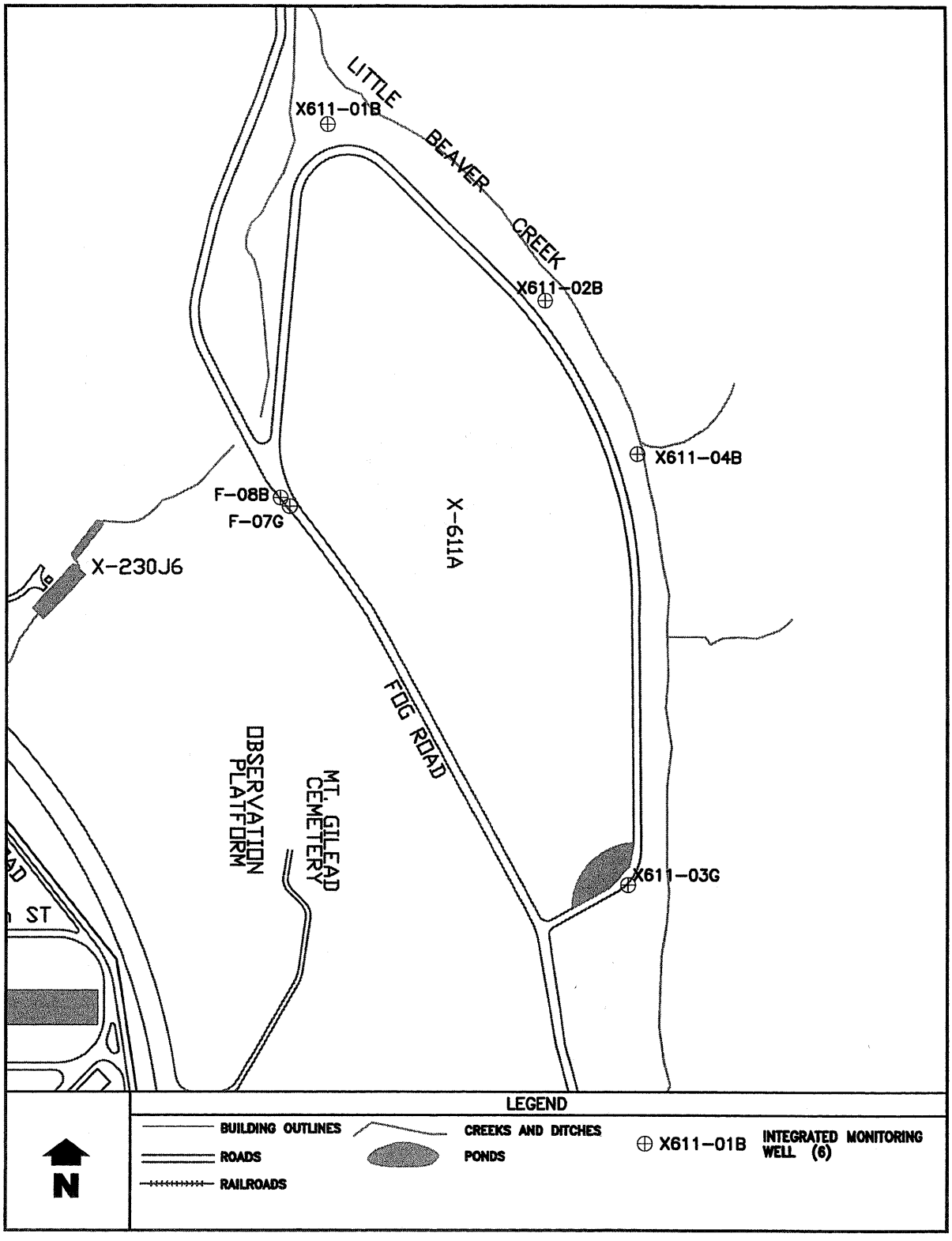


Fig. 6.9. Monitoring wells at the X-611A Former Lime Sludge Lagoons.

Initially, a total of 17.9 acres was approved by the Ohio EPA and Pike County Department of Health for landfill disposal of conventional solid wastes. The landfill began operation in 1981. During operation of the landfill, PORTS investigations indicated that wipe rags contaminated with solvents had inadvertently been disposed in the northern portion of the landfill. Historical data indicated that the wipe rags contaminated with solvents most likely contained methyl ethyl ketone, which was considered a hazardous waste. The contaminated rags were immediately removed from the solid waste stream by instituting new management controls to isolate contaminated rags as hazardous waste.

Waste disposal in the northern area ended in December 1991, and Ohio EPA determined that the area required closure as a RCRA hazardous waste landfill. Consequently, this unit of the sanitary landfill was identified as the X-735 Landfill (Northern Portion). A buffer zone was left unexcavated to provide space for groundwater monitoring wells and a space between the RCRA landfill unit and the remaining southern portion, the X-735 Industrial Solid Waste Landfill. Routine groundwater monitoring has been conducted at the X-735 Landfills since 1991.

The industrial solid waste portion of the X-735 Landfills included a solid waste section and an asbestos waste section. The X-735 Industrial Solid Waste Landfill, not including the chromium sludge monocells, encompasses a total area of approximately 4.1 acres. Operation of the X-735 Industrial Solid Waste Landfill ceased in 1997, and this portion of the landfill was capped in 1998.

In August 2000, DOE initiated an assessment monitoring program at this monitoring area because of a statistically significant increase in several monitoring parameters at three downgradient X-735 monitoring wells. Therefore, monitoring completed at this area in 2001 includes both routine monitoring required by the *Integrated Groundwater Monitoring Plan* and assessment monitoring.

The *Integrated Groundwater Monitoring Plan* incorporates monitoring requirements for the hazardous and solid waste portions of the X-735 Landfills. Thirteen wells are sampled semiannually under the routine monitoring program for this area. Five new background wells were added to the monitoring program for this area in the fourth quarter of 2001 based on the findings of the assessment monitoring program. Table 6.1 lists the analytical parameters and Fig. 6.10 shows the monitoring wells in this area.

6.4.9.1 Monitoring results for the X-735 Landfills in 2001

Routine monitoring data collected at the X-735 Landfills in 2001 were consistent with historical data. Assessment monitoring at the X-735 Landfills was initiated in 2000 and was completed in 2001. The *Groundwater Quality Assessment Report for the X-735 Landfill* provides the results of the assessment monitoring program. The report indicates that a release from the landfills has not occurred and recommends a return to detection monitoring at this landfill with a revised statistical approach to minimize false positives in the detection monitoring program.

6.4.10 X-734 Landfills

The X-734 Landfills consisted of three landfill units that were used until 1985. Detailed records of materials disposed of in the landfills were not kept. However, wastes known to be disposed at the landfills include trash and garbage, construction spoils, wood and other waste from clearing and grubbing, and empty drums. Other materials reportedly disposed of in the landfills may have included waste contaminated with metals, empty paint cans, and uranium-contaminated soil from the X-342 area.

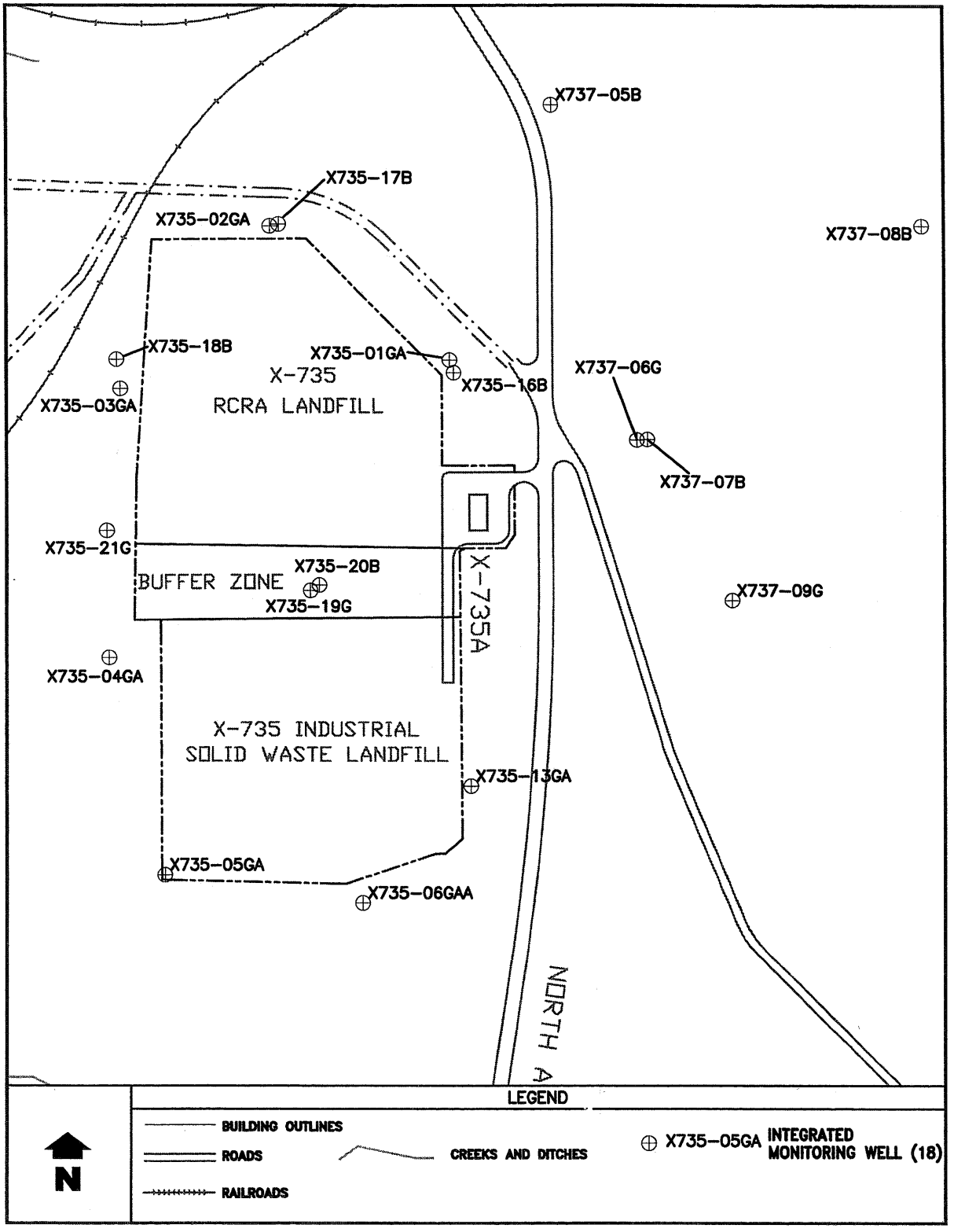


Fig. 6.10. Monitoring wells at the X-735 Landfills.

The X-734 Sanitary Landfill was closed in accordance with the solid waste regulations in effect at that time, and no groundwater monitoring of the unit was required. The X-734 Landfills were capped in 1999-2000 as part of the remedial actions required for Quadrant IV.

Fifteen wells (see Fig. 6.11) are sampled semiannually as part of the monitoring program for this area. Table 6.1 lists the monitoring parameters for the wells in this area.

6.4.10.1 Monitoring results for the X-734 Landfills in 2001

Volatile organic compounds were detected at or above the preliminary remediation goal in the samples from two wells. Trichloroethene was detected in both the second quarter and fourth quarter samples collected from well X734-21B at 160 Fg/L and 130 Fg/L, which is above the preliminary remediation goal of 5 Fg/L. Methylene chloride was detected in the sample collected from well X734-03G in the second quarter at 5 Fg/L (the preliminary remediation goal is 5 Fg/L). No other volatile organic compounds were detected above preliminary remediation goals.

Cobalt is also monitored in the X-734 Landfills area. Cobalt was detected in five wells in 2001 (X734-01G, X734-03G, X734-06G, X734-15G, and X734-16G) at concentrations above the preliminary remediation goal of 13 Fg/L for Gallia wells. Detections of cobalt in these five wells that were above the preliminary remediation goal ranged from 15.7 to 69.8 Fg/L. Additional inorganics (metals) and radionuclides (uranium) were also detected in 2001. Remediation of groundwater is being accomplished in accordance with the RCRA Corrective Action Program.

6.4.11 X-533 Switchyard Area

The X-533 Switchyard Area consists of a switchyard containing electrical transformers and circuit breakers, associated support buildings, and a transformer cleaning pad. The groundwater area of concern is located north of the switchyard and associated support buildings near the transformer cleaning pad.

In December 1996, the X-533 Switchyard Area was identified as an area of concern for potential metals contamination based on historical analytical data for groundwater wells in this area. Samples from wells in this area were collected in 1998 and 1999 to assess the area for metals contamination. The area was added to the PORTS groundwater monitoring program in 2001 because the study identified three metals (cadmium, cobalt, and nickel) that may have contaminated groundwater in this area. Sampling began in the second quarter 2001, and three wells are sampled semiannually for cadmium, cobalt, and nickel.

6.4.11.1 Monitoring results for the X-533 Switchyard Area in 2001

Two Gallia wells that monitor the X-533 Switchyard Area (see Fig. 6.12) were sampled in the second and fourth quarters of 2001 and analyzed for cadmium, cobalt, and nickel. Each of the well samples contained these metals at concentrations above the preliminary remediation goals (6.5 Fg/L for cadmium, 13 Fg/L for cobalt, and 100 Fg/L for nickel). Concentrations of cadmium detected in the wells ranged from 8.82 to 48.6 Fg/L, concentrations of cobalt detected in the wells ranged from 30.4 to 118 Fg/L, and concentrations of nickel detected in the wells ranged from 161 to 722 Fg/L. Remediation of groundwater is being accomplished in accordance with the RCRA Corrective Action Program.

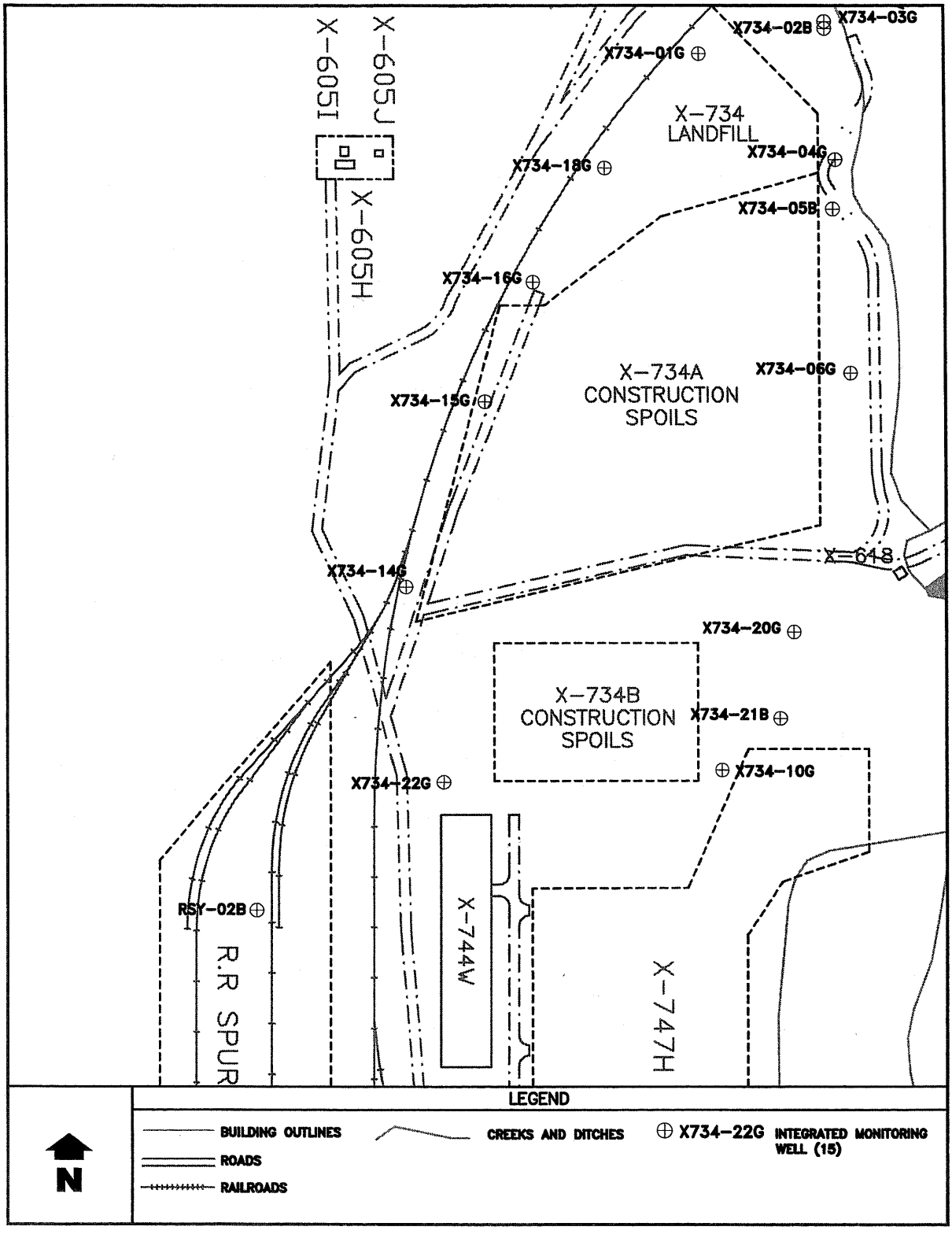


Fig. 6.11. Monitoring wells at the X-734 Landfills.

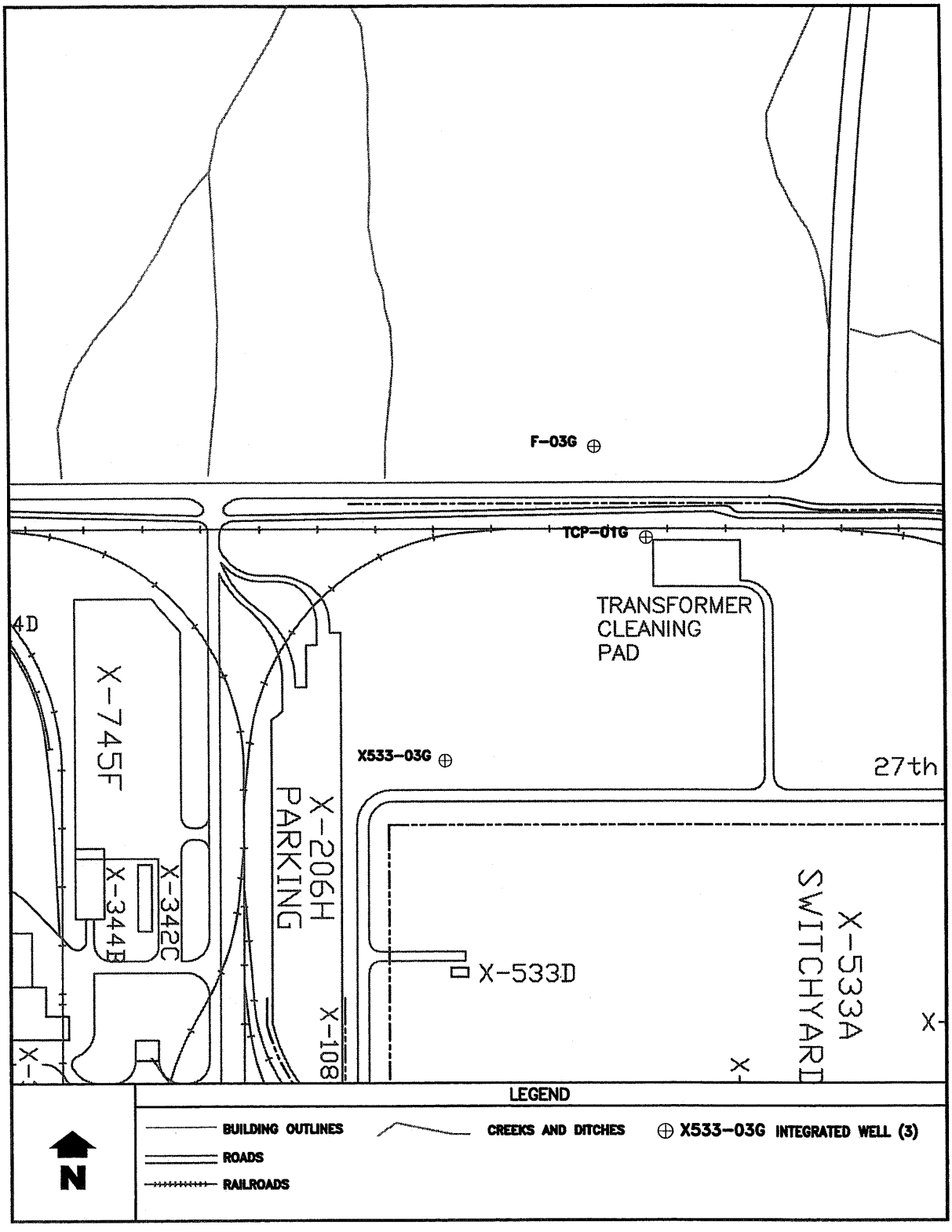


Fig. 6.12. Monitoring wells at the X-533 Switchyard Area.

6.4.12 Surface Water Monitoring

Surface water monitoring is conducted in conjunction with groundwater assessment monitoring to determine if contaminants present in groundwater are detected in surface water samples. Surface water is collected quarterly from 13 locations (see Fig. 6.13). The purpose for each surface water monitoring location is listed below:

- Little Beaver Creek and East Drainage Ditch sample locations LBC-SW01, LBC-SW02, and EDD-SW01 assess possible X-701B area plume groundwater discharges.

- Little Beaver Creek sample location LBC-SW03 assesses potential contamination from the Former X-611A Lime Sludge Lagoons.

- Big Run Creek sample locations BRC-SW01 and BRC-SW02 monitor for potential groundwater discharges related to the X-231B Southwest Oil Biodegradation Plot, the Quadrant I Groundwater Investigative Area plume, and the X-749/X-120/PK Landfill area plume, all of which discharge into the X-230K Holding Pond and Big Run Creek.

- The unnamed Southwestern Drainage Ditch is sampled at two locations, UND-SW01 and UND-SW02, to assess potential groundwater releases to this creek and the X-2230M Holding Pond from the X-749/X-120/PK Landfill area plume.

- The North Holding Pond sample locations NHP-SW01 and LBC-SW04 assess potential groundwater discharges from any unknown Quadrant IV sources.

- The West Drainage Ditch sample locations WDD-SW01, WDD-SW02, and WDD-SW03 assess potential groundwater discharges from the X-616 area to the West Drainage Ditch and the X-2230N Holding Pond.

Table 6.1 lists the analytical parameters for the surface water sampling locations.

6.4.12.1 Monitoring results for surface water in 2001

No volatile organic compounds were detected at the surface water sampling locations in Big Run Creek, Little Beaver Creek, East Drainage Ditch, or West Drainage Ditch during 2001, with the exception of small amounts of chloroform and other trihalomethanes that are common residuals in treated chlorinated drinking water. These streams receive discharges that contain treated drinking water from the PORTS NPDES outfalls. Trichloroethene has been detected regularly in samples collected from the unnamed Southwestern Drainage Ditch (UND-SW01, located inside the perimeter road) at low levels since 1990 and was detected in 2001 at 2 - 3 Fg/L. Trichloroethene was not detected at the sampling location downstream from UND-SW01 (UND-SW02), which indicates that trichloroethene is not present in the surface water exiting the PORTS site.

Uranium occurs naturally in rocks and soil, which may account for the low uranium concentrations that were detected at the surface water sampling locations in 2001. Technetium-99 is occasionally detected at surface water monitoring locations. In the first quarter 2001, technetium-99 was detected at concentrations ranging from 28 to 61 pCi/L at five sampling locations: EDD-SW01, LBC-SW01, LBC-SW02, LBC-SW03, and LBC-SW04. These locations are downstream from the USEC NPDES Outfall 001 and DOE NPDES Outfall 015. The sample collected from USEC NPDES Outfall 001 on the day before the DOE surface water samples were collected contained technetium-99 at 65 pCi/L. Technetium-99 continued to be detected in the samples collected from sampling location LBC-SW03 in

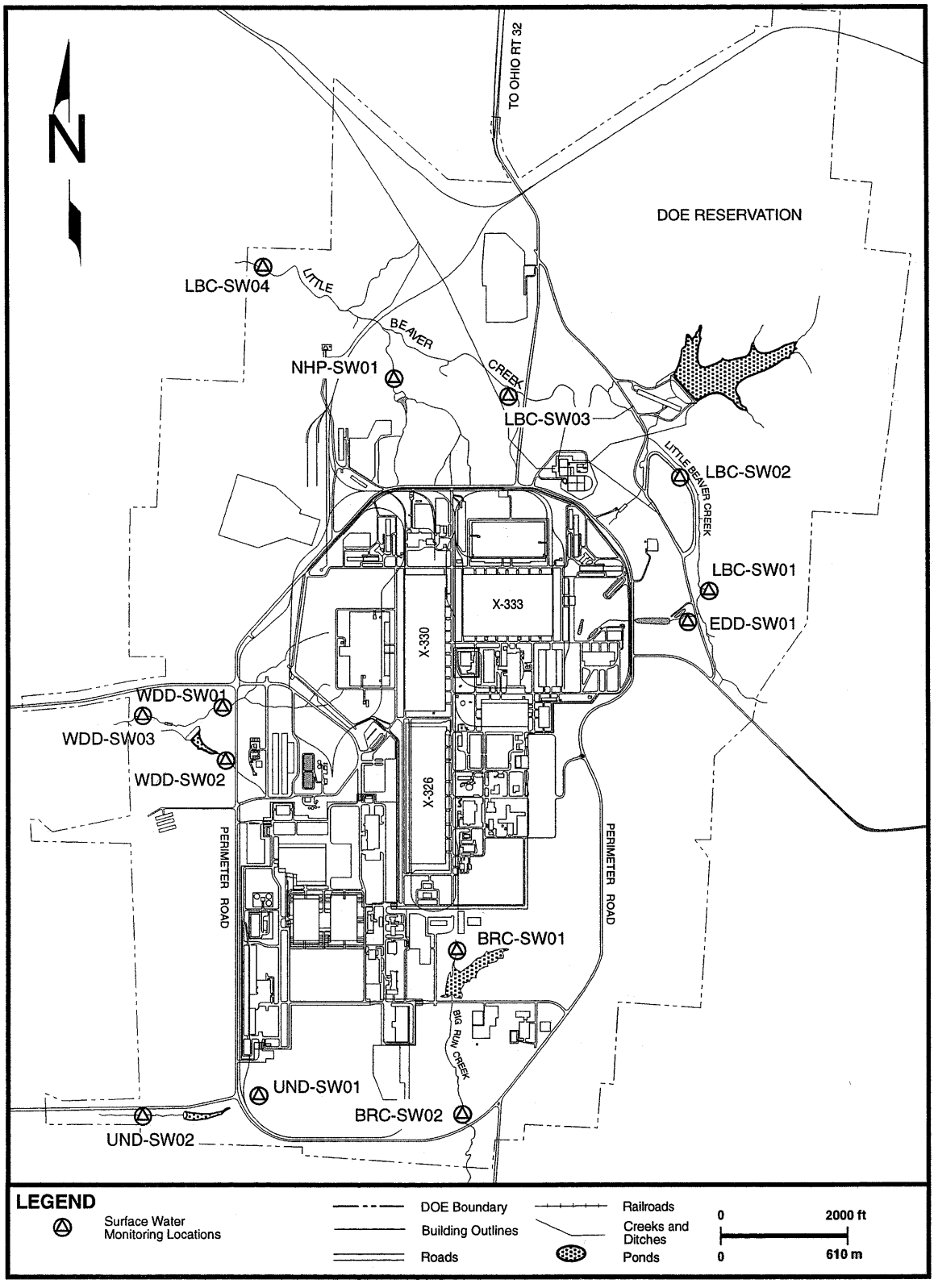


Fig. 6.13. Surface water monitoring locations.

the second quarter (10 pCi/L) and third quarter (12.2 pCi/L). Technetium-99 was also detected in the samples collected from BRC-SW01 in the first quarter (11 pCi/L) and UND-SW01 in the third quarter (8.9 pCi/L).

Each sample collected in the second, third, and fourth quarters was analyzed for selected transuranics (americium-241, neptunium-237, plutonium-238, and plutonium-239/240). Americium-241 was detected in the sample collected at sampling location BRC-SW01 at 0.2361 pCi/L in the third quarter. Americium-241, however, was not detected in the samples collected at this point in the second and fourth quarters of 2001 or in the samples collected at this location in 2000. No other transuranics were detected at any of the sampling locations.

6.4.13 Water Supply Monitoring

Routine monitoring of residential drinking water sources is completed at PORTS in accordance with the requirements of Section VIII of the September 1989 Consent Decree between the State of Ohio and DOE and the Residential Groundwater Monitoring Requirements contained in the *Integrated Groundwater Monitoring Plan.*

The purpose of the program is to determine whether residential drinking water sources have been adversely affected by plant operations. Although this program may provide an indication of contaminant transport off site, it should not be interpreted as an extension of the on-site groundwater monitoring program, which bears the responsibility for detection of contaminants and determining the rate and extent of contaminant movement. Data from this program will not be used in environmental investigations due to the lack of knowledge of how residential wells were constructed and due to the presence of various types of pumps (which may not be ideal equipment for sampling).

Seven residential drinking water sources participated in the program in 2001 (see Fig. 6.14); however, three new residential wells were added to the program in the third quarter and were therefore sampled only once in 2001. Wells are sampled semiannually with two samples collected from each well: a regular sample and a duplicate sample. Each sample is analyzed for the parameters listed in Table 6.1. The PORTS water supply (RES-012 on Fig. 6.14) is also sampled as part of this program. Sampling locations may be added or deleted if requested by a resident and as program requirements dictate. Typically, sampling locations are deleted when a resident obtains a public water supply. Sampling locations are added upon request.

Volatile organic compounds were not detected in any of the water supply samples collected in 2001. Metals detected in the water supply samples were within naturally-occurring concentrations found in the area. Low levels of uranium and uranium isotopes detected in some of the wells are consistent with naturally-occurring concentrations found in common geologic materials.

In the first quarter, no transuranics or technetium-99 were detected in any of the water supply samples. In the third quarter, americium-241 was detected in the regular sample collected at RES-005 at 0.4687 pCi/L, but was not detected in the duplicate sample collected from this location. Neptunium-237 was also detected in the regular sample collected at RES-015 at 0.1644 pCi/L, but was not detected in the duplicate sample collected from this location. No other transuranics were detected in the samples.

In the third quarter, technetium-99 was detected at 15 pCi/L in the regular sample collected from RES-016, but was not detected in the duplicate sample collected from this location. Technetium-99 was detected in both samples (regular and duplicate) collected at RES-015 (14 pCi/L and 12 pCi/L). These detections could not result from groundwater migration off site due to the location of the water supplies and groundwater flow patterns, but could result from the inherent level of error associated with laboratory

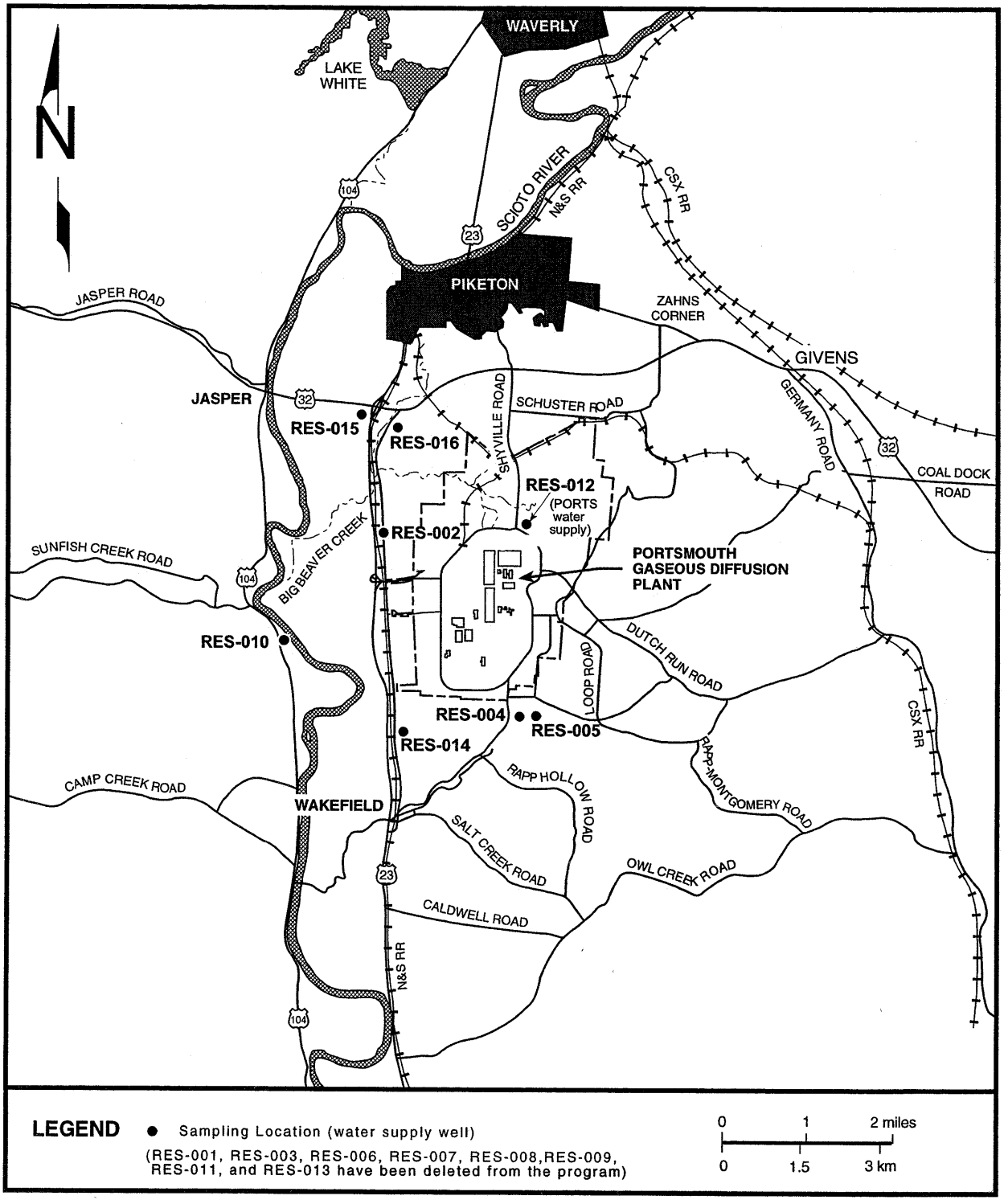


Fig. 6.14. Water supply monitoring locations.

analytical capabilities. The concentration of technetium-99 in the samples collected by DOE was near the laboratory detection limit (or minimum detectable activity). Ohio EPA also collected samples of the residential water supplies when the DOE samples were collected. Technetium-99 was not detected in any of the Ohio EPA samples. The concentrations of technetium-99 detected in the DOE samples are below the Ohio EPA drinking water standard for technetium-99 (900 pCi/L). Chapter 4, Sect. 4.3.8.1 provides additional information about the drinking water standard and a dose calculation based on a member of the public drinking water that contained the average concentration of technetium-99 detected at sampling location RES-015 in the third quarter (13 pCi/L). The total potential dose to a member of the public resulting from PORTS operations, which includes this dose calculation, is well below the DOE standard of 100 mrem/year.

6.5 DOE ORDER MONITORING PROGRAMS

The surveillance monitoring program at DOE/PORTS consists of exit pathway monitoring and baseline monitoring. Exit pathway monitoring assesses the effect of the facility on off-site groundwater quality. Baseline monitoring is conducted to establish baseline data.

6.5.1 Exit Pathway Monitoring

Selected locations on local streams and drainage channels near the reservation boundary are sampling points of the exit pathway monitoring program because groundwater discharges to these surface waters. Monitoring wells near the reservation boundary are also used in the exit pathway monitoring program. Figure 6.15 shows the sampling locations for exit pathway monitoring.

Four surface water sampling points (BRC-SW02, LBC-SW04, UND-SW02, and WDD-SW03) are part of the exit pathway monitoring program. No volatile organic compounds or transuranics were detected in the samples collected from these points. Metals, including uranium, were detected at concentrations consistent with background concentrations for these parameters. Technetium-99 was detected at sampling location LBC-SW04 as discussed in Sect. 6.4.12.1.

In 2001, volatile organic compounds, including trichloroethene, were detected in four of the exit pathway groundwater monitoring wells (X749-44G, X749-45G, X749-96G, and X749-97G) that are also part of the monitoring program for the X-749/X-120/PK Landfill monitoring area (see Fig. 6.2 and Sect. 6.4.1.4). Technetium-99 and transuranics (americium-241, neptunium-237, plutonium-238, and plutonium-239/240) were not detected in any of the exit pathway groundwater monitoring wells.

6.5.2 Baseline Monitoring

Four well clusters, each composed of one well completed in the Gallia and one well completed in the Berea, are sampled annually to determine baseline water quality (Fig. 6.15). Sampling is conducted to provide a comparison between on-site wells and wells that represent background water quality.

6.6 GROUNDWATER TREATMENT FACILITIES

In 2001, a combined total of approximately 21.4 million gallons of water was treated at the X-622, X-622T, X-623, X-624, and X-625 Groundwater Treatment Facilities. Approximately 188 gallons of trichloroethene were removed from the groundwater. All processed water is discharged through NPDES outfalls before exiting PORTS. More water was treated in 2001 than in 2000 (20.7 million gallons) due to variations in groundwater recovery. Facility information is summarized in Table 6.2.

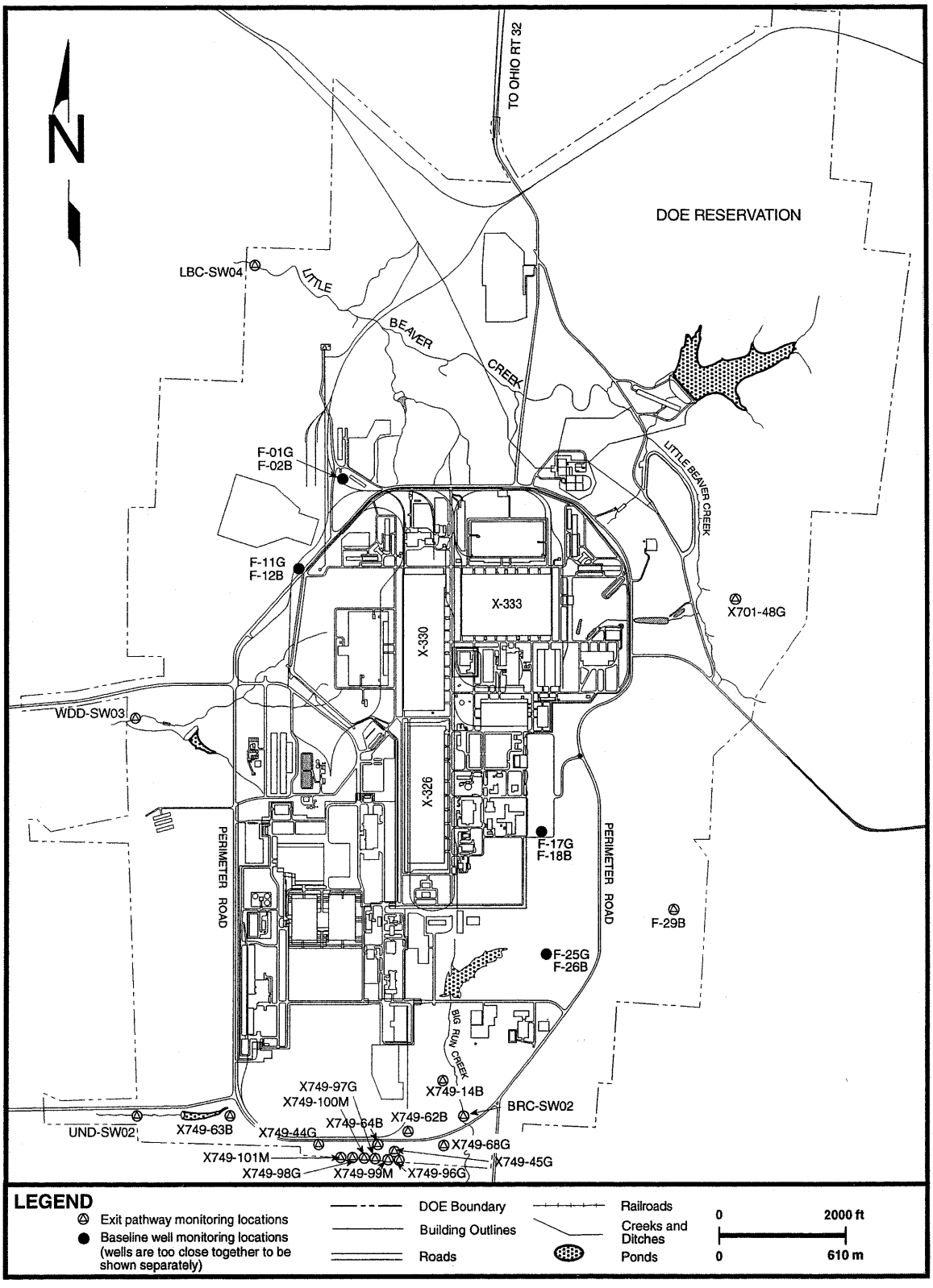


Fig. 6.15. Exit pathway and baseline monitoring locations.

Table 6.2. Summary of trichloroethene removed by DOE/PORTS groundwater treatment facilities in 2001

Facility	Gallons of water treated	Gallons of TCE removed
X-622	6,906,090	1
X-622T	10,103,910	14
X-623	1,757,650	140
X-624	2,394,412	33
X-625	245,449	0.023

6.6.1 X-622 Groundwater Treatment Facility

Activated carbon and green sand filtration are used to treat water at the X-622 Groundwater Treatment Facility. This facility processes groundwater from the Quadrant I Groundwater Investigative Area and the X-749 Contaminated Materials Disposal Facility/X-120 Old Training Facility/PK Landfill groundwater collection systems. In 2001, the facility processed almost 7 million gallons of groundwater, thereby removing 1 gallon of trichloroethene from the water.

6.6.2 X-622T Groundwater Treatment Facility

At the X-622T Groundwater Treatment Facility, activated carbon is used to treat contaminated groundwater from the X-700 Chemical Cleaning Facility and the X-705 Decontamination Building. The X-700 and X-705 buildings are located above the Quadrant II Groundwater Investigative Area plume, and contaminated groundwater is extracted from sumps located in the basement of each building. In 2001, approximately 10.1 million gallons of groundwater were processed, thereby removing 14 gallons of trichloroethene from the water.

6.6.3 X-623 Groundwater Treatment Facility

The X-623 Groundwater Treatment Facility consists of an air stripper with offgas activated carbon filtration and aqueous-phase activated carbon filtration. The X-623 Groundwater Treatment Facility treats trichloroethene-contaminated groundwater from the X-701B Holding Pond and three groundwater extraction wells in the X-701B plume area. The facility treated almost 1.8 million gallons of water in 2001, thereby removing 140 gallons of trichloroethene from the water.

6.6.4 X-624 Groundwater Treatment Facility

At the X-624 Groundwater Treatment Facility, groundwater is treated via an air stripper with offgas activated carbon filtration and aqueous-phase activated carbon filtration. This facility processes trichloroethene-contaminated groundwater from the X-237 interceptor trench associated with the X-701B plume. The facility treated approximately 2.4 million gallons of water in 2001, thereby removing 33 gallons of trichloroethene from the water.

6.6.5 X-625 Groundwater Treatment Facility

Groundwater is gravity-fed from a horizontal well associated with X-749/X-120 groundwater plume to the X-625 Groundwater Treatment Facility. As part of an ongoing technology demonstration, water at this facility has been treated with various passive media such as iron filings. The water is further treated by being passed through activated carbon filtration prior to being discharged. In 2001, approximately 245,000 gallons of groundwater were treated, thereby removing 0.023 gallon of trichloroethene.

7. QUALITY ASSURANCE

7.1 SUMMARY

Quality assurance and quality control are essential components of environmental monitoring at DOE/PORTS. Quality is integrated into sample preservation, field data and sample collection, sample transportation, and sample analysis. Numerous program assessment activities in the field and within the facilities are conducted at regular intervals to demonstrate that quality is built into and maintained in all DOE/PORTS programs.

7.2 INTRODUCTION

Quality assurance, an integral part of environmental monitoring, requires systematic control of the processes involved in sampling the environment and in analyzing the samples. To demonstrate accurate results, DOE/PORTS uses the following planned and systematic controls:

- implementation of standard operating procedures for sample collection and analysis;
- training and qualification of surveyors and analysts;
- implementation of sample tracking and chain-of-custody procedures to demonstrate traceability and integrity of samples and data;
- participation in external quality control programs;
- frequent calibration and routine maintenance of measuring and test equipment;
- maintenance of internal quality control programs;
- implementation of good measurement techniques and good laboratory practices; and
- frequent assessments of field sampling, measurement activities, and laboratory processes.

Environmental sampling is conducted at DOE/PORTS in accordance with state and federal regulations and DOE Orders. Sampling plans and procedures are prepared, and appropriate sampling instruments or devices are selected in accordance with practices recommended by the U.S. EPA, the American Society for Testing and Materials, or other authorities. Chain-of-custody documentation is prepared from the point of sampling. The samples remain in the custody of the sampling group until they are transferred to the sample custodian at the chosen laboratory.

The analytical data are reviewed to determine compliance with applicable regulations and permits. The data are used to identify locations and concentrations of contaminants of concern, to evaluate the rate and extent of contamination at the site, and to help determine the need for remedial action. Adequate and complete documentation generated as a result of these efforts supports the quality standards established at DOE/PORTS.

7.3 FIELD SAMPLING AND MONITORING

Personnel involved in field sampling and monitoring are properly trained. Procedures are developed from guidelines and regulations created by DOE or other regulatory agencies that have authority over DOE/PORTS activities. These procedures specify sampling protocol, sampling devices, and containers and preservatives to be used. Chain-of-custody procedures (used with all samples) are documented, and samples are controlled and protected from the point of collection to the generation of analytical results.

Data generated from field sampling can be greatly influenced by the methods used to collect and transport the samples. A quality assurance program provides the procedures for proper sample collection so that the samples represent the conditions that exist in the environment at the time of sampling. The DOE/PORTS quality assurance program mandates compliance with written sampling procedures, use of clean sampling devices and containers, use of approved sample preservation techniques, and collection of field blanks, trip blanks, and duplicate samples. Chain-of-custody procedures are strictly followed to maintain sample integrity. In order to maintain sample integrity, samples are delivered to the laboratory as soon as practicable after collection.

7.4 ANALYTICAL QUALITY ASSURANCE

DOE/PORTS only uses analytical laboratories that demonstrate compliance in the following areas through participation in independent audits and surveillance programs:

- compliance with federal waste disposal regulations,
- data quality,
- materials management,
- sample control,
- data management,
- electronic data management,
- implementation of a laboratory quality assurance plan, and
- review of external and internal performance evaluation program.

After they are received by DOE/PORTS, analytical laboratory data are independently evaluated using a systematic process that compares the data to established quality assurance/quality control criteria. An independent data validator checks documentation produced by the analytical laboratory to verify that the laboratory has provided data that meet established criteria.

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APPENDIX A

RADIATION

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This appendix presents basic facts concerning radiation. The information is intended as a basis for understanding the dose associated with releases from DOE/PORTS, not as a comprehensive discussion of radiation and its effects on the environment and biological systems. *The McGraw-Hill Dictionary of Scientific and Technical Terms* defines radiation and radioactivity as follows.

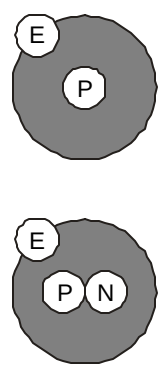
> *radiation* — (1) The emission and propagation of waves transmitting energy through space or through some medium; for example, the emission and propagation of electromagnetic, sound, or elastic waves. (2) The energy transmitted through space or some medium; when unqualified, usually refers to electromagnetic radiation. Also known as radiant energy. (3) A stream of particles, such as electrons, neutrons, protons, alpha particles, or high-energy photons, or a mixture of these (McGraw-Hill 1989).

> *radioactivity*—A particular type of radiation emitted by a radioactive substance, such as alpha radioactivity (McGraw-Hill 1989).

Radiation occurs naturally; it was not invented but discovered. 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.

A.1 ATOMS AND ISOTOPES

All matter is made up of atoms. An atom is "a unit of measure consisting of a single nucleus surrounded by a number of electrons equal to the number of protons in the nucleus" (American Nuclear Society 1986). 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. Atoms of the same element with a different number of neutrons are called isotopes. In other words, isotopes have the same chemical properties but different atomic weights. Figure A.1 depicts isotopes of the element hydrogen. Another example is the element uranium, which has 92 protons; all isotopes of uranium, therefore, have 92 protons. However, each uranium isotope has a different number of neutrons. Uranium-238 (also denoted ^{238}U) has 92 protons and 146 neutrons; uranium-235 has 92 protons and 143 neutrons; uranium-240 has 92 protons and 148 neutrons.



	PROTONS	NEUTRONS
HYDROGEN	1	0
DEUTERIUM	1	1

Fig. A.1. Isotopes of the element hydrogen.

Some isotopes are stable, or nonradioactive; some are radioactive. Radioactive isotopes are called radioisotopes, or radionuclides. In an attempt to become stable, radionuclides "throw away," or emit, rays or particles. This emission of rays and particles is known as radioactive decay.

A.2 RADIATION

Radiation, or radiant energy, is energy in the form of waves or particles moving through space. Visible light, heat, radio waves, and alpha particles are examples of radiation. When people feel warmth from the sunlight, they are actually 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. Radiation also is characterized by the way in which it interacts with matter.

A.2.1 Ionizing Radiation

Normally, an atom has an equal number of protons and electrons; however, atoms can lose or gain electrons in a process known as ionization. Some form of radiation can ionize atoms by "knocking" electrons off atoms. Examples of ionizing radiation include alpha, beta, and gamma radiation. Ionizing radiation is capable of changing the chemical state of matter and subsequently causing biological damage and thus is potentially harmful to human health. Figure A.2 shows the penetrating potential of different types of ionizing radiation.

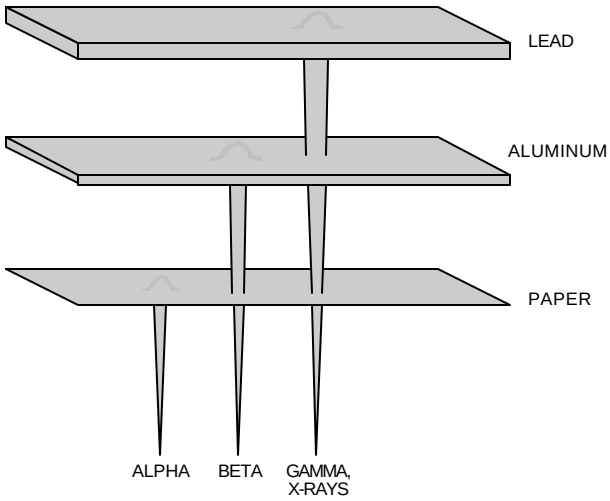


Fig. A.2. Penetrating power of radiation.

A.2.2 Nonionizing Radiation

Nonionizing radiation bounces off or passes through matter without displacing electrons. Examples include visible light and radio waves. Currently, it is unclear whether nonionizing radiation is harmful to human health. In the discussion that follows, the term radiation is used to describe ionizing radiation.

A.3 SOURCES OF RADIATION

Radiation is everywhere. Most occurs naturally, but a small percentage is human-made. Naturally occurring radiation is known as background radiation.

A.3.1 Background Radiation

Many materials are naturally radioactive. In fact, this naturally occurring radiation is the major source of radiation in the environment. Although people have little control over the amount of background radiation to which they are exposed, this exposure must be put into perspective. Background radiation remains relatively constant over time; 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. Background radiation is categorized as cosmic, terrestrial, or internal, depending on its origin.

A.3.1.1 Cosmic radiation

Energetically charged particles from outer space continuously hit the earth's atmosphere. These particles and the secondary particles and photons they create are called cosmic radiation. Because the atmosphere provides some shielding against cosmic radiation, the intensity of this radiation increases with altitude above sea level. For example, a person in Denver, Colorado, is exposed to more cosmic radiation than a person in Death Valley, California.

A.3.1.2 Terrestrial radiation

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.

A.3.1.3 Internal radiation

Radioactive material in the environment enters the body through the air people breathe and the food they eat; it also can enter through an open wound. Natural radionuclides in the body include isotopes of uranium, thorium, radium, radon, polonium, bismuth, and lead in the ^{238}U and ^{232}Th decay series. In addition, the body contains isotopes of potassium (^{40}K), rubidium (^{87}Rb), and carbon (^{14}C).

A.3.2 Human-Made Radiation

Most people are exposed to human-made sources of radiation. Examples include consumer products, medical sources, and fallout from atmospheric atomic bomb tests. (Atmospheric testing of atomic weapons has been suspended in the United States and most parts of the world.) Also, about one-half of 1% of the U.S. population performs work in which radiation in some form is present.

A.3.2.1 Consumer products

Some consumer products are sources of radiation. In some of these products, such as smoke detectors and airport X-ray baggage inspection systems, radiation is essential to the performance of the device. In other products, such as television and tobacco products, the radiation occurs incidentally to the product function.

A.3.2.2 Medical sources

Radiation is an important tool of diagnostic medicine and treatment, and, in this use, is the main source of exposure to human-made radiation. Exposure is deliberate and directly beneficial to the patients exposed. Generally, medical exposures from diagnostic or therapeutic X-rays result from beams directed to specific areas of the body. Thus, all body organs generally are not irradiated uniformly. Radiation and radio-active 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 medicine 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.

A.3.2.3 Other sources

Other sources of radiation include fallout from atmospheric atomic bomb 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 the transportation of radioactive materials.

Transuranic materials are man-made radiological elements. They are created as a reaction in a reactor where uranium fuel is used. These elements are a group of isotopes that are all alpha emitting. They emit alpha particles similar to uranium alpha particles and are monitored by Health Physics at PORTS in the same manner as uranium. Some of the transuranic isotopes that are detectable at PORTS are americium-241, plutonium-238, and plutonium-239/240.

A.4 PATHWAYS OF RADIATION

Radiation and radioactive materials in the environment can reach people through many routes. Potential routes for radiation are referred to as pathways. For example, radioactive material in the air could fall on a pasture. The grass could then be eaten by cows, and the radioactive material on the grass would be present 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 (see Fig. A.3.).

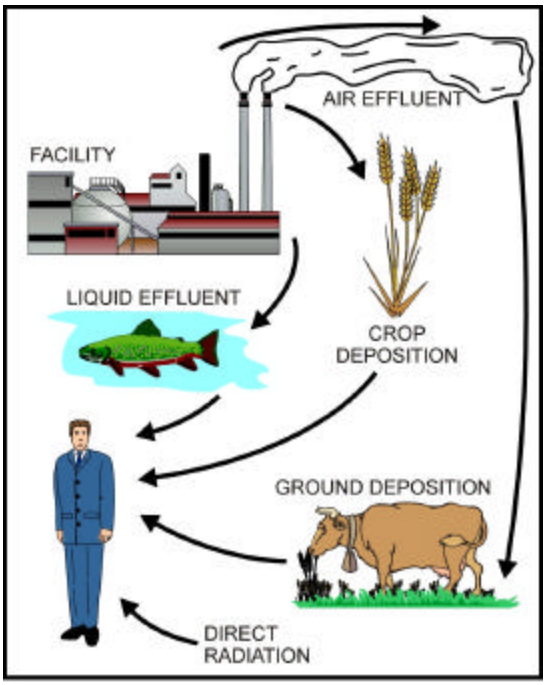


Fig. A.3. Possible radiation pathways.

A.5 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.

A.5.1 Activity

When measuring the amount of radiation in the environment, what is actually being measured is the rate of radioactive decay, or activity. The rate of decay varies widely among the various radioisotopes. For that reason, 1 gram of a radioactive substance may contain the same amount of activity as several tons of another material. This activity is expressed in a unit of measure known as a curie (Ci). More specifically, 1 Ci = 3.75E+10 (37,000,000,000) atom disintegrations per second (dps). In the international system of units, 1 dps = 1 becquerel (Bq). Table A.1 provides units of radiation measure and applicable conversions.

Table A.1. Units of radiation measures

Current System	International System	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

A.5.2 Absorbed Dose

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 rad. In the international system of units, 100 rad equals 1 gray (Gy). In terms of human health, however, it is the effect of the absorbed energy that is important, not the actual amount.

A.5.3 Dose Equivalent

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 rem. One rem of any type of radiation has the same total damaging effect. Because a rem represents a fairly large dose, dose is expressed as a millirem (mrem) or 1/1000 of a rem. In the international system of units, 100 rem equals 1 sievert (Sv); 100 mrem equals 1 millisievert (mSv).

A.6 DOSE

Many terms are used to report dose. 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 and effective dose equivalent 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.6.1 Comparison of Dose Levels

A scale of dose levels is presented in Table A.2. 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 familiarize the reader with the type of doses individuals may receive.

A.6.1.1 Dose from cosmic radiation

The average annual dose received by residents of the United States from cosmic radiation is about 27 mrem (0.27 mSv) (National Council on Radiation Protection 1987). The average annual dose from cosmic radiation received by residents in the Portsmouth area is about 50 mrem (0.50 mSv).

Table A.2. 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 up by the U.S. EPA, for exposures from airborne emissions from operations of nuclear fuel cycle facilities, including power plants and uranium mines and mills
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
50 mrem (0.50 mSv)	Average yearly dose from cosmic radiation received by people in the Portsmouth area
66 mrem (0.66 mSv)	Average yearly dose to people in the United States 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 United States from all sources of natural background radiation
1-5 rem (0.01-0.05 Sv)	U.S. EPA protective action guideline calling for public officials to 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 the Nuclear Regulatory Commission and DOE
10 rem (0.10 Sv)	The Biological Effects of Ionizing Radiations V report estimated that an acute dose at this level would result in a lifetime excess risk of death from cancer of 0.8% (Biological Effects of Ionizing Radiation 1990)
25 rem (0.25 Sv)	U.S. EPA guideline for voluntary maximum dose to emergency workers for non-lifesaving work during an emergency
75 rem (0.75 Sv)	U.S. 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, Summary Pamphlet, WSRC-TR-94-076, Westinghouse Savannah River Company, 1994.

A.6.1.2 Dose from terrestrial radiation

The average annual dose received from terrestrial gamma radiation is about 28 mrem (0.28 mSv) in the United States. This dose varies geographically across the country (National Council on Radiation Protection 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.

A.6.1.3 Dose from internal radiation

Short-lived decay products of radon are the major contributors to the annual dose equivalent for internal radionuclides (mostly ^{222}Rn). 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) (National Council on Radiation Protection 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 (National Council on Radiation Protection 1987).

A.6.1.4 Dose from consumer products

The U.S. average annual dose received by an individual from consumer products is about 10 mrem (0.10 mSv) (National Council on Radiation Protection 1987).

A.6.1.5 Dose from medical sources

Nuclear medicine examinations, which involve the internal administration of radiopharmaceuticals, generally account for the largest portion of the dose received from human-made sources. The radionuclides used in specific tests, however, are not distributed uniformly throughout the body. In these cases, comparisons are made using the concept of effective dose equivalent, which relates exposure of organs or body parts to one effective whole-body dose. The average annual effective dose equivalent from medical examinations is 53 mrem (0.53 mSv), including 39 mrem (0.39 mSv) for diagnostic X-rays and 14 mrem (0.14 mSv) for nuclear medicine procedures (National Council on Radiation Protection 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 (National Council on Radiation Protection 1989).

A.6.1.6 Doses from other sources

Small doses received by individuals occur as a result of radioactive fallout from atmospheric atomic bomb 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 (National Council on Radiation Protection 1987).

A comprehensive U.S. 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 (Kumazawa et al. 1984).

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APPENDIX B

ENVIRONMENTAL PERMITS

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Table B.1. DOE/PORTS environmental permits and registrations

Permit/registered source	Source no.	Issue date	Expiration date	Status
Clean Air Act Permits				
Permit to Install X-6002 Recirculating Hot Water Plant North Boiler, South Boiler, and 2 Oil Storage Tanks	B007, B008, T101, T102	6/14/01	18 months from date of issue	Active
Permit to Operate X-326 L-cage Glove Box	P022	5/5/95	PTO renewal submitted 4/27/98	Active
Permit to Operate X-624 Groundwater Treatment Facility	P019		PTO renewal submitted 11/4/98; PTO under appeal	Active
Permit to Operate X-735 Landfill Cap and Venting System (northern portion)	P023	5/26/95	PTO renewal submitted 4/27/98	Active
Permit to Operate X-744G Glove Box	P007		PTO renewal submitted 11/4/98; PTO under appeal	Active
Registered Source X-345 Emergency Generator	B005		None	Active
Registered Source X-345 Security Fuel Oil Tank	T005		None	Active
Registered Source X-623 Groundwater Treatment Facility	P018		None	Active
Registered Source X-7725 Fluorescent Bulb Crusher	P028		None	Active
Registered Source X-744G Oil-fired Furnace	B006		None	Active
Registered Source X-749 Contaminated Materials Disposal Facility	P027		None	Active
Registered source X-744G Fuel Oil Tank (south)	T008		None	Source no longer operating
Registered Source X-744G Alumina Melter	P020		None	Source no longer operating
Registered Source X-735 Landfill Storage Piles	F006		None	Source no longer operating
Clean Water Act Permits				
NPDES Permit DOE	0IO00000*GD	8/5/95	3/31/99[a]	Active
Permit to Install X-622 Groundwater Treatment Facility	06-2951	11/20/90	None	Active
Permit to Install X-622T Groundwater Treatment Facility	06-3520	11/24/92	None	Active
Permit to Install X-623 Groundwater Treatment Facility	06-3528	1/9/96	None	Active
Permit to Install X-624 Groundwater Treatment Facility	06-3556	10/28/92	None	Active
U.S. Army Corps of Engineers-Section 404, Nationwide Permit No. 6, Radiological Survey		4/30/97		

Table B.1. DOE/PORTS environmental permits and registrations (continued)

Permit/registered source	Source no.	Issue date	Expiration date	Status
	Hazardous Waste Permit			
RCRA Part B Permit	Ohio Permit No. 04-66-0680	3/15/01	3/15/06	Active
	Registrations			
Underground Storage Tank Registration	6651067		Renewed annually	Active

[a]Permit will remain active until renewal application is acted upon by Ohio EPA. The NPDES Permit Renewal Application was submitted to the Ohio EPA on September 23, 1998.

APPENDIX C

RADIONUCLIDE AND CHEMICAL NOMENCLATURE

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Table C.1. Nomenclature and half-life for radionuclides

Radionuclide	Symbol	Half-life
Actinium-228	^{228}Ac	6.2 hours
Americium-241	^{241}Am	458 years
Beryllium-7	^{7}Be	53.3 days
Bismuth-210	^{210}Bi	5.01 days
Bismuth-214	^{214}Bi	19.7 minutes
Lead-206	^{206}Pb	Stable
Lead-210	^{210}Pb	22.3 years
Lead-212	^{212}Pb	10.6 hours
Lead-214	^{214}Pb	26.8 minutes
Neptunium-237	^{237}Np	2,140,000 years
Plutonium-238	^{238}Pu	86.4 years
Plutonium-239	^{239}Pu	24,390 years
Plutonium-240	^{240}Pu	6,580 years
Plutonium-241	^{241}Pu	13.2 years
Plutonium-242	^{242}Pu	379,000 years
Plutonium-244	^{244}Pu	76,000,000 years
Polonium-210	^{210}Po	138.9 days
Polonium-214	^{214}Po	164 microseconds
Polonium-218	^{218}Po	3.05 minutes
Potassium-40	^{40}K	1,260,000,000 years
Protactinium-233	^{233}Pa	27.0 days
Protactinium-234	^{234}Pa	6.7 hours
Protactinium-234m	^{234m}Pa	1.17 minutes
Radium-224	^{224}Ra	3.7 days
Radium-226	^{226}Ra	1,602 years
Radium-228	^{228}Ra	5.8 years
Radon-222	^{222}Rn	3.821 days
Technetium-99	^{99}Tc	212,000 years
Thallium-208	^{208}Tl	3.1 minutes
Thorium-228	^{228}Th	1.9 years
Thorium-230	^{230}Th	75,400 years
Thorium-231	^{231}Th	25.5 hours
Thorium-232	^{232}Th	14,000,000,000 years
Thorium-234	^{234}Th	24.1 days
Uranium-234	^{234}U	247,000 years
Uranium-235	^{235}U	710,000,000 years
Uranium-236	^{236}U	23,900,000 years
Uranium-238	^{238}U	4,510,000,000 years

Table C.2. Nomenclature for elements and chemical constituents

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

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