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; Chapter 5 discusses the non-radiological parameters for the monitoring programs.

Environmental monitoring programs are required by state and federal regulations, permits, and DOE Orders. These programs may also be developed to address public concerns about plant operations. In 2005, environmental monitoring information was collected by both the DOE and USEC. Unlike other chapters of this report that focus on DOE activities at PORTS, this chapter includes monitoring information collected by USEC.

During 2005, the Ohio EPA conducted sampling of surface water, sediment, and fish in areas on-site and around PORTS for a Biological and Water Quality Study. To the extent possible, the Ohio EPA and DOE split the samples collected for this project. Radiological data for samples analyzed by DOE subcontractors are discussed in this section. The Ohio EPA Biological and Water Quality Study for PORTS was prepared by the Ohio EPA and is available through the Ohio EPA Division of Surface Water.

Environmental monitoring data collected at PORTS are used to assess potential impacts to human health and the environment from radionuclides released by current and historical 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 the dose from radionuclides released to the air, and the DOE sets a 100 mrem/year limit for the 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 (the Scioto River), from direct radiation, and from radionuclides detected in 2005 by environmental monitoring programs for sediment, soil, fish, and dairy products (milk). The maximum dose a member of the public could receive from radiation released by PORTS in 2005 (both the DOE and USEC) or detected by environmental monitoring programs in 2005 is 1.67 mrem/year. This dose calculation uses a worst-case approach; that is, the calculation assumes that the same individual is exposed to the most extreme conditions from each pathway. Table 4.1 summarizes this dose information.

Table 4.1. Summary of potential doses to the public from PORTS in 2005

Source of dose	Dose (mrem)/year[a]
Airborne radionuclides	0.012
Radionuclides released to the Scioto River	0.025
Direct radiation from depleted uranium cylinder storage yards	1.1
Radionuclides detected by environmental monitoring programs [sediment, soil, fish, and milk]	0.53
Total	1.67

[a]100 mrem/year is the DOE limit.

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 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, permits, 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 231.1A, *Environment Safety and Health Reporting*, and 5400.5, *Radiation Protection of the Public and the Environment*, also address environmental monitoring requirements.

The DOE *Environmental Monitoring Plan for the Portsmouth Gaseous Diffusion Plant* describes the environmental monitoring programs for DOE PORTS. Specific radionuclides monitored at PORTS are selected based on the materials handled at PORTS and on historic monitoring data. For example, samples are analyzed for total uranium and isotopic uranium because of the uranium enrichment process. Samples are analyzed for transuranic radionuclides (americium-241, neptunium-237, plutonium-238, and plutonium-239/240) and technetium-99 because these radionuclides are produced during the fission process in nuclear reactors and were introduced to PORTS via the use of recycled uranium during the Cold War.

Environmental monitoring data are collected by both the 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. This chapter provides information on the USEC NPDES monitoring program. USEC data are provided for informational purposes only; the 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.

The 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 Chapter 1, LPP replaced Bechtel Jacobs as the DOE PORTS managing contractor for environmental remediation activities on June 27, 2005. The analytical laboratory for radiological analyses of some environmental samples changed due to the new managing contractor. Under Bechtel Jacobs, the USEC Laboratory analyzed radiological samples collected in support of environmental monitoring at PORTS. Beginning in the third quarter of 2005, Severn Trent Laboratories of St. Louis,

Missouri (STL St. Louis) analyzed radiological samples collected by LPP, including groundwater, ambient air, and NPDES samples.

Upon review of the third quarter radiological data, a significant increase was identified in the number of detections of transuranic radionuclides (americium-241, neptunium-237, plutonium-238, and plutonium-239/240). An investigation was initiated immediately to determine the cause of this increase. Until the cause could be established, further shipment of samples to STL St. Louis for radiological analyses was discontinued. LPP contacted personnel with the DOE Consolidation Audit Program, and the personnel recommended that DOE's Radiological and Environmental Sciences Laboratory prepare performance evaluation samples for submittal to STL St. Louis and the USEC Laboratory. The double-blind performance evaluation samples contained low levels of varying combinations of americium-241, neptunium-237, plutonium-238, plutonium-239, technetium-99, uranium-234, and uranium-238.

The USEC Laboratory passed the performance evaluation by reporting activities for all 14 radionuclides within the required acceptance criteria in the three performance evaluation samples submitted to the laboratory; however, STL St. Louis failed the evaluation. Ten of fourteen results reported by STL St. Louis failed to meet required acceptance criteria. STL St. Louis failed the performance acceptance criteria for all reported radionuclides except technetium-99 (passed on 2 of 2 results) and 50% of the reported plutonium results (passed on 2 of 4 results).

Based on the results of the performance evaluation, data provided by STL St. Louis are considered not reliable and therefore are not reported for samples collected in the third and fourth quarters of 2005 and analyzed for transuranic radionuclides and uranium (total uranium and uranium isotopes). Monitoring programs affected by this issue are DOE NPDES monitoring (Section 4.3.5.1), ambient air monitoring (Section 4.6.1), and samples collected in conjunction with the Ohio EPA Biological and Water Quality Study (Sections 4.6.4, 4.6.5, and 4.6.9.2). Technetium-99 data provided by STL St. Louis are included because no issues were identified with technetium-99 results in the performance evaluation.

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 from PORTS activities can result in 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 the 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.

The DOE regulates radionuclide emissions to all environmental media through DOE Orders 450.1, *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. The National Emission Standards for Hazardous Air Pollutants apply only to airborne radiological releases.

Small quantities of radionuclides were released to the environment from DOE PORTS operations during 2005. 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 2005 by environmental monitoring programs.

4.3 RADIOLOGICAL EMISSIONS AND DOSES

Exposure to radioactive materials can occur from releases to the atmosphere, surface water, or groundwater and from exposure to direct external radiation emanating from buildings or other objects. For 2005, doses are estimated for exposure to atmospheric releases, direct radiation, and releases to surface water (the Scioto River).

Doses are also estimated for exposure to radionuclides from PORTS operations that were detected in 2005 as part of the DOE PORTS environmental monitoring programs. Analytical data from the environmental monitoring programs are assessed to determine whether radionuclides were detected at locations accessible to the public. If radionuclides were detected at locations accessible to the public, a dose assessment is usually completed based on the monitoring data. In 2005, doses are estimated for exposure to radionuclides detected by the monitoring programs for sediment, soil, fish, and milk. Exposure to radionuclides detected in groundwater at PORTS is not included because contaminated groundwater at PORTS is not a source of drinking water.

In addition, DOE Order 5400.5 sets an absorbed dose rate limit of 1 rad per day to native aquatic organisms. This chapter discusses the dose calculations completed 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, potentially 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 (americium-241, neptunium-237, plutonium-238, plutonium-239/240, and uranium-236) are rarely detected at PORTS but may be included as a conservative measure in the calculations used to determine the potential 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 exposure of tissue to ionizing radiation, the units are defined in terms of the amount of ionizing radiation

absorbed by human (or animal) tissue and in terms of the biological consequences of the absorbed energy. These units include the following:

- *Absorbed dose* – the quantity of ionizing radiation energy absorbed by an organ divided by the organ's mass. Absorbed dose is measured in units of rad (or gray) (1 rad = 0.01 gray).

- *Dose equivalent* – the product of the absorbed dose (rad) in tissue and a quality factor. Dose equivalent is expressed in units of rem (or sievert) (1 rem = 0.01 sievert).

- *Effective dose equivalent* – the sum of the dose equivalents received by all organs or tissues of the body after each one has been multiplied by an appropriate weighting factor. In this report, the term "effective dose equivalent" is often shortened to "dose."

- *Collective dose equivalent/collective effective dose equivalent* – the sum of the dose equivalents or effective dose equivalents of all individuals in an exposed population expressed in units of person-rem (or person-sievert). The collective effective dose equivalent 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.

USEC is responsible for most of the sources that emit radionuclides, although the uranium enrichment process is not operating. USEC emissions currently result from reprocessing of uranium hexafluoride feedstock and equipment decontamination. In 2005, USEC reported emissions of 0.0154 curie (a measure of radioactivity) from its radionuclide emission sources.

DOE PORTS is responsible for six radiological emission sources.. Two of these sources, X-326 L-cage and X-744G Glove Boxes are used to repackage wastes or other materials that contain radionuclides. The glove boxes were not used in 2005, and the X-744G Glove Box was removed from service. The remaining four sources, the X-622, X-623, X-624, and X-627 Groundwater Treatment Facilities treat groundwater contaminated with radionuclides. Emissions from the groundwater treatment facilities, are based on the maximum concentrations of radionuclides emitted from the facilities during emissions testing and the number of hours each facility operated during the year. For radionuclides that were not detected in emissions testing, half the maximum detection limit for the radionuclide was used to calculate emissions of the radionuclide. Emissions for 2005 were calculated to be 0.000255 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 2005 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 four DOE PORTS groundwater treatment facilities identified in Section 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 a significant 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 2005 was 0.0096 mrem/year. 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 0.012 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 0.043 person-rem/year, based on USEC calculations of 0.013 person-rem/year from USEC sources and 0.030 person-rem/year from DOE sources. The population dose to the nearest community, Piketon, was calculated to be 0.0064 person-rem/year, based on USEC calculations of 0.0002 person-rem/year from USEC sources and 0.0062 person-rem/year from DOE sources.

4.3.4 Dose Calculation Based on Ambient Air Monitoring

The DOE collects samples from 15 ambient air monitoring stations (see Figure 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 Section 4.3.2), fugitive air emissions (emissions that are not associated with a specific release point such as a stack), and background levels of radiation (radiation that occurs naturally in the environment and is 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 2005 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 0 (at stations with a gross dose less than the background station) to 0.00023 mrem/year at station A41, which is northeast of PORTS at Zahns Corner.

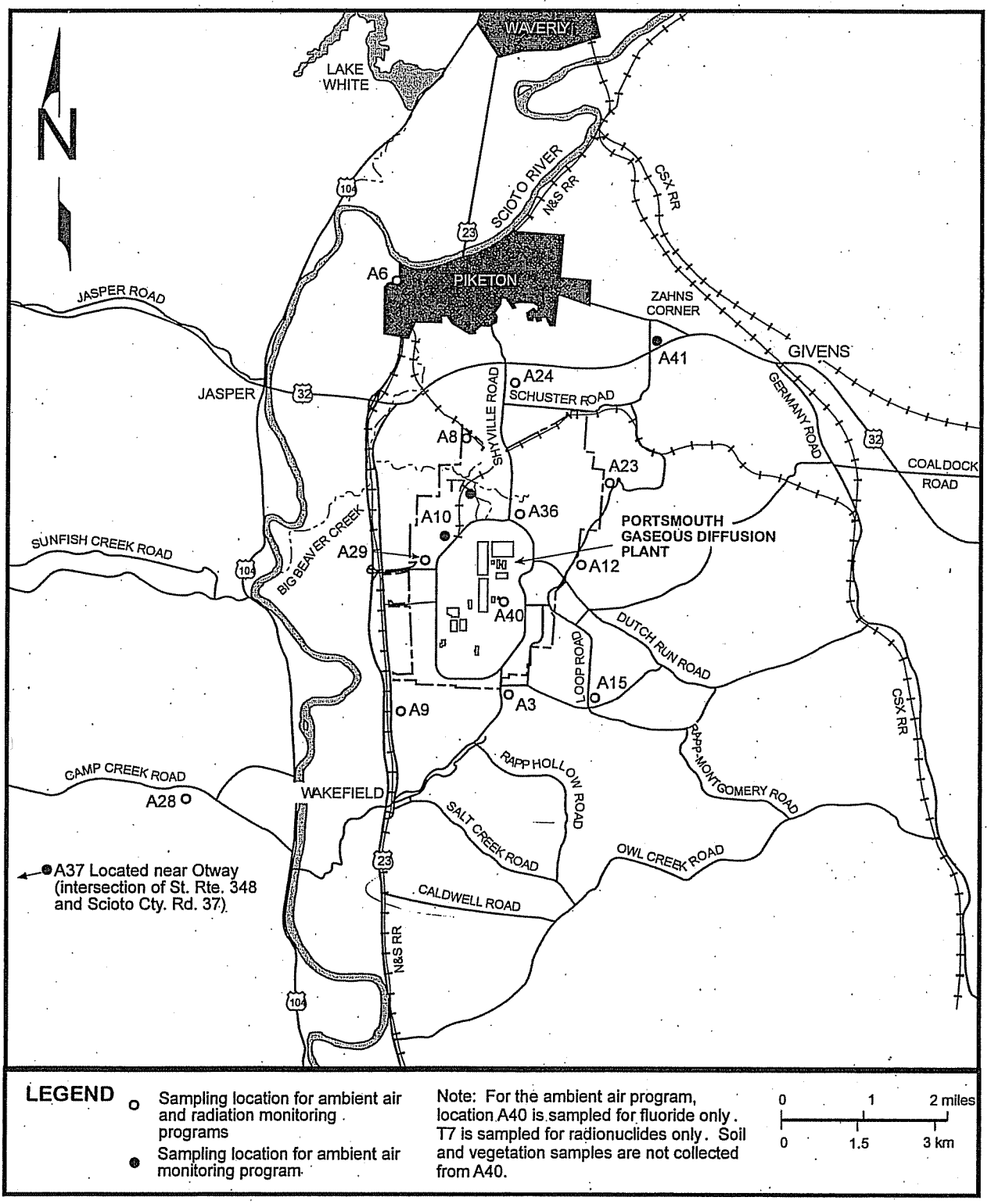

Figure 4.1. DOE ambient air and radiation monitoring locations.

The highest net dose measured at the ambient air monitoring stations (0.00023 mrem/year) is approximately 2% of the dose calculated from the combined DOE and USEC point source emissions (0.012 mrem/year). This dose is significantly less than the 10 mrem/year NESHAP limit for airborne radiological releases and 100 mrem/year DOE limit for all radiological releases from a facility.

4.3.5 Discharges of Radionuclides from NPDES Outfalls

Both the DOE and USEC are responsible for NPDES outfalls at PORTS. This section describes these outfalls and the discharges of radionuclides from these outfalls during 2005.

4.3.5.1 DOE outfalls

DOE PORTS has eight discharge points, or outfalls, through which water is discharged from the site (see Figure 4.2). Three outfalls discharge directly to surface water, four discharge to the USEC X-6619 Sewage Treatment Plant (USEC NPDES Outfall 003), and one discharges to the X-2230M Holding Pond (DOE Outfall 012). Outfall 612 is currently inactive because the X-625 Groundwater Treatment Facility was placed on stand-by with the approval of the Ohio EPA in July 2003. A brief description of each DOE outfall at PORTS follows.

DOE NPDES Outfall 012 (X-2230M Holding Pond) – The X-2230M Holding Pond accumulates treated water from DOE NPDES Outfall 612 and precipitation runoff, non-contact cooling water, and steam condensate from the southern portion of PORTS. 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 PORTS. 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) – The X-624 Groundwater Treatment 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) – The X-622 Groundwater Treatment Facility removes volatile organic compounds from contaminated groundwater originating from site remediation activities in the southern portion of the site, which is Quadrant I in the RCRA Corrective Action Program (see Chapter 3, Section 3.2). Treated water is discharged to the sanitary sewer and then through USEC NPDES Outfall 003.

DOE NPDES Outfall 610 (X-623 Groundwater Treatment Facility) – The X-623 Groundwater Treatment Facility removes volatile organic compounds from contaminated groundwater originating from site remediation activities in the X-701B Holding Pond area in Quadrant II and from miscellaneous well development and purge waters. Treated water is discharged to the sanitary sewer and then through USEC NPDES Outfall 003.

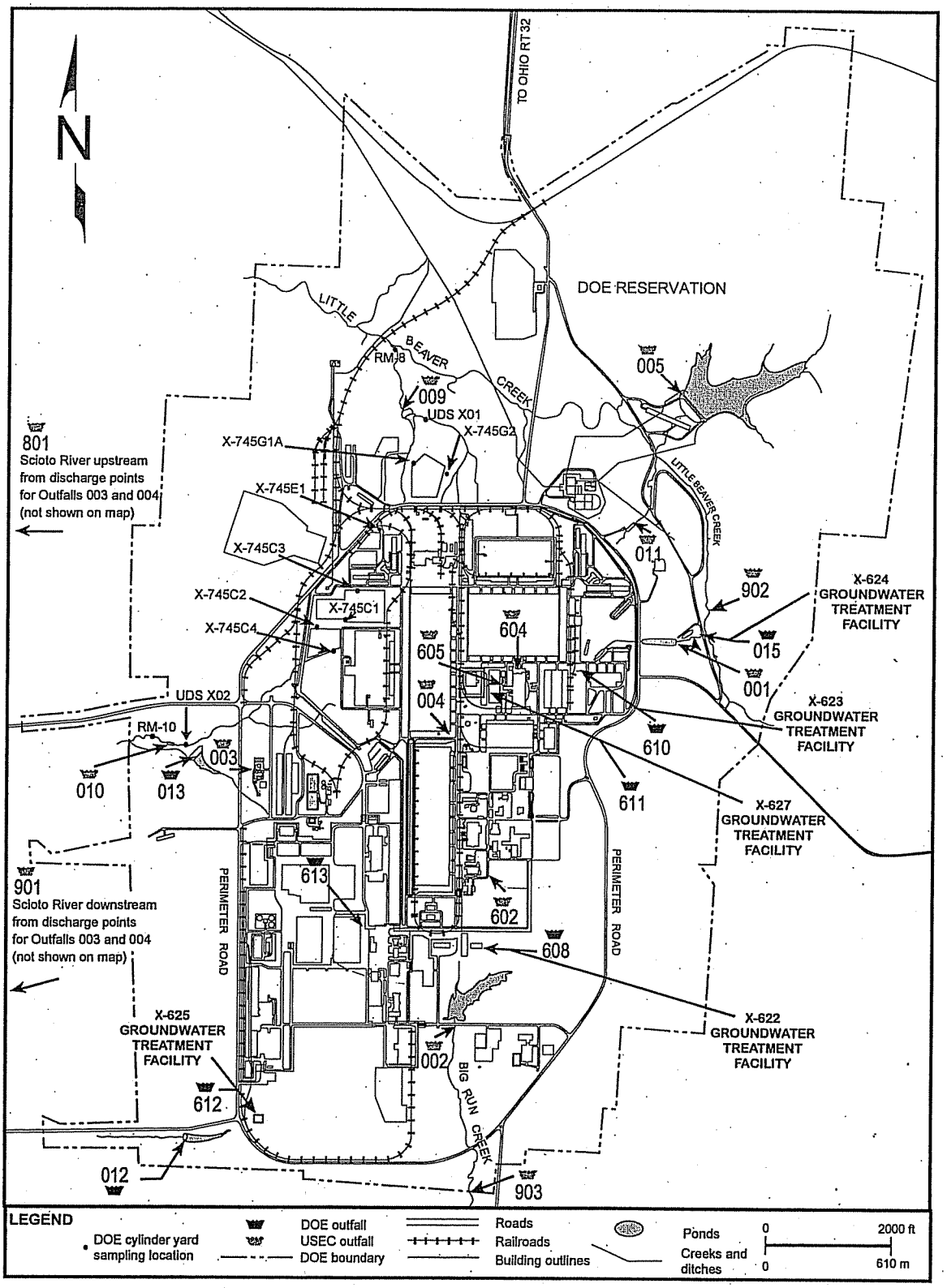

Figure 4.2. DOE and USEC NPDES outfalls/monitoring points and DOE cylinder storage yards sampling locations.

DOE NPDES Outfall 611 (X-627 Groundwater Treatment Facility) – The X-627 Groundwater Treatment Facility removes volatile organic compounds from groundwater collecting in sumps located in the basements of the X-705 and X-700 buildings, which are part of Quadrant II. Treated water is discharged to the sanitary sewer and then through USEC NPDES Outfall 003.

DOE NPDES Outfall 612 (X-625 Groundwater Treatment Facility) – On July 9, 2003, the X-625 Groundwater Treatment Facility was placed on stand-by with approval from the Ohio EPA. This facility removed volatile organic compounds from groundwater collected by the horizontal well in the western portion of the X-749/X-120 groundwater plume. Treated water was discharged to the X-2230M Holding Pond that discharges through DOE NPDES Outfall 012.

DOE NPDES Outfall 613 (X-6002 Particulate Separator) – The X-6002 Particulate Separator removes suspended solids from water used in the X-6002 Recirculating Hot Water Plant, which provides heat to DOE buildings at PORTS. Treated water is discharged to the sanitary sewer and then through USEC NPDES Outfall 003.

When in use, the DOE monitors its NPDES outfalls for radiological discharges by collecting water samples and analyzing the samples for total uranium, uranium isotopes (uranium-233/234, uranium-235, uranium-236, and uranium-238), technetium-99, and transuranic radionuclides (americium-241, neptunium-237, plutonium-238, and plutonium-239/240), with the exception of Outfall 613. Outfall 613 is not monitored for radionuclides because no source exists for radiological contamination of the water discharged from Outfall 613.

Discharges of radionuclides in liquids through DOE NPDES outfalls have no significant impact on public health and the environment. Uranium discharges in 2005 from external DOE NPDES outfalls (Outfalls 012, 013, and 015) were estimated at 1 kilogram. Total radioactivity released from the external outfalls was 0.0008 curie of uranium isotopes and 0.0000027 curie of technetium-99. As discussed in Section 4.2, analytical data for uranium and uranium isotopes from samples collected between July and November are not useable. Therefore, the average concentration of uranium, uranium-233/234, and uranium-238 in 2005 at each outfall was assumed to have been present in discharges for these months. Discharges of uranium-235 and uranium-236 for July through November are assumed to be zero because these radionuclides are rarely detected in samples collected from the external outfalls (Outfalls 012, 013, and 015).

Discharges of radionuclides 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. Discharges of radionuclides from external DOE outfalls are used in the dose calculation for releases to surface water (Section 4.3.6). The dose calculated with these data is significantly less than the 100 mrem/year limit for all radiological releases from a facility.

No transuranics (americium-241, neptunium-237, plutonium-238, and plutonium-239/240) were detected in samples collected from the DOE external NPDES outfalls during 2005.

4.3.5.2 USEC outfalls

USEC is responsible for 11 NPDES outfalls through which water is discharged from the site (see Figure 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) – Outfall 004was 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. Currently the lagoon only discharges during periods of excess rainfall.

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).

In 2005, USEC also monitored 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 Outfalls 003 and 004 and located in the discharge plume from these two outfalls. Monitoring at Station Number 901 was discontinued in the new NPDES permit effective August 1, 2005. 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.

Uranium discharges in 2005 from external USEC NPDES outfalls (Outfalls 001, 002, 003, 004, 005, 009, 010, and 011) were estimated at 9.3 kilograms. Radioactivity released from the external outfalls was 0.06 curie of technetium-99. These values were calculated using quarterly discharge monitoring reports for the USEC 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 (technetium-99) discharged through the USEC NPDES outfalls. Plutonium-239/240 was detected at 0.187 picocurie per liter (pCi/L) in the sample collected from Outfall 009 in June 2005. Transuranic radionuclides (americium-241, neptunium-237, plutonium-238, and plutonium-239/240) were not detected in any of the other samples collected from USEC NPDES outfalls in 2005.

Discharges of radionuclides from external USEC outfalls are used in the dose calculation for releases to surface water (Section 4.3.6). The dose calculated with these data is significantly less than the 100 mrem/year limit for all radiological releases from a facility.

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 micrograms per liter (μg/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. As a conservative measure, radionuclides that were not detected were assumed to be present at the detection limit. Total uranium was assumed to be 5.2% uranium-235, 94% uranium-238, and 0.8% uranium-234 based on the highest enrichment of uranium produced by PORTS in recent years. 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 (curie/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 calculations assume that a person eats 21 kilograms (46 pounds) of fish caught in the Scioto River, drinks 730 liters (190 gallons) 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 0.025 mrem. This exposure scenario is very conservative because the Scioto River is not used for drinking water downstream of PORTS (89% of the hypothetical dose from liquid effluents is from drinking water) and it is unlikely that a person would eat 46 pounds of fish from the river (7% of the hypothetical dose). This dose (0.025 mrem) is significantly less than the 100 mrem/year DOE limit for all radiological releases from a facility.

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.

Due to increased security at PORTS following September 11, 2001, the general public no longer has uncontrolled access to the entire perimeter of the PORTS facility (Perimeter Road). Some portions of Perimeter Road were reopened to the public in 2005; however, other portions of the road remain closed to the general public. Perimeter Road passes close to the edge of the cylinder yards, which emit radiation from depleted uranium cylinders stored in these areas. This portion of Perimeter Road remains closed to the public; however certain members of the public, such as delivery people, are allowed on this portion of the road. Therefore, data from direct radiation monitoring at the cylinder yards are used to assess potential exposure to the members of the public that drive on Perimeter Road.

In 2005, the average effective dose equivalent recorded at the cylinder yards near Perimeter Road was 1115 mrem/year, 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, which is conservatively estimated at 8.7 hours per year (1 minute per trip, 2 trips per day, 5 work-days per week, and 52 weeks per year).

Based on these assumptions, exposure to a member of the public from radiation from the cylinder yards is approximately 1.1 mrem/year. 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 approximately 0.3 percent of the average yearly radiation exposure for a person in the United States and is significantly less than the 100 mrem/year DOE limit for all radiological releases from a facility.

4.3.8 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 231.1A. This report contains exposure results for all monitored individuals at DOE PORTS, including visitors, with a positive exposure during the previous calendar year. The 2005 Radiation Exposure Information Reporting System report indicated that there were no visitors with a positive exposure.

Over 400 DOE PORTS workers were monitored during 2005. Of these workers, only 39 received a measurable dose (defined as 10 mrem or more). Nineteen cylinder yard workers received a measurable dose that averaged 115 mrem. Twenty other DOE PORTS workers received a measurable dose that averaged 19 mrem.

No administrative guidelines or regulatory dose limits were exceeded in 2005.

4.3.9 Radiological Dose Calculations for Off-site Environmental Monitoring Data

Environmental monitoring at PORTS includes collecting samples at off-site locations around PORTS 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.

The 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 may be completed for detections of radionuclides in environmental media (residential drinking water [well water], sediment, soil, and vegetation) and biota (deer, fish, crops, and dairy products) at off-site sampling locations. Detections of radionuclides on the PORTS facility are not used to assess risk because the public does not have access to the facility. This dose calculation uses a worst-case approach; that is, the calculation assumes that the same individual is exposed to the most extreme conditions from each pathway.

In 2005, dose calculations were completed for public exposure to radionuclides detected in sediment, soil, fish, and milk. Radionuclides were not detected in deer and crop samples collected during 2005. Chapter 6, Section 6.4.13, provides additional information concerning detections of radionuclides in residential drinking water.

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 the 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 4.2 summarizes the results of each dose calculation. Potential doses to the public from radionuclides detected by the PORTS environmental monitoring program in 2005 are significantly less than the DOE limit of 100 mrem/year.

Table 4.2. Summary of potential doses to the public from radionuclides detected by PORTS environmental monitoring programs in 2005

Source of dose	Dose (mrem/year)[a]
Sediment	0.048
Soil	0.072
Fish	0.010
Milk	0.40
Total	0.53

[a]100 mrem/year is the DOE limit.

4.3.9.1 Dose calculation for sediment

The dose calculation for sediment is based on the detection of 4.088 picocuries per gram (pCi/g) of uranium-233/234, 0.1319 pCi/g of uranium-235, and 1.344 pCi/g of uranium-238 in the sediment sample collected in 2005 from monitoring location RM-7, an off-site sampling location on Little Beaver Creek just before it flows into Big Beaver Creek, and the detection of 17.2 pCi/g of technetium-99 at river mile 0.1 on Little Beaver Creek (LBC 0.1) during DOE sampling conducted in conjunction with the Ohio EPA Biological and Water Quality Study. This location is approximately the same as RM-7. 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 0.048 mrem/year. Section 4.6.5 provides additional information on the sediment monitoring program as well as a map of sediment sampling locations.

4.3.9.2 Dose calculation for soil

The dose calculation for soil is based on the detection of 0.9177 pCi/g of uranium-233/234, 0.06182 pCi/g of uranium-235, and 1.025 pCi/g of uranium-238 at the ambient air sampling station southwest of PORTS (A28). 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 0.072 mrem/year. Section 4.6.7 provides additional information on the soil monitoring program as well as a map of soil monitoring locations.

4.3.9.3 Dose calculation for fish

The dose calculation for fish is based on the detection of technetium-99 at 3.4 pCi/g in a channel catfish collected from the Scioto River at river mile 27.0 (SR 27.0) during DOE sampling conducted in conjunction with the Ohio EPA Biological and Water Quality Study. 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 fish contaminated at this level is 0.010 mrem/year. Section 4.6.9.2 provides additional information on this monitoring program.

4.3.9.4 Dose calculation for milk

The dose calculation for consumption of milk is based on the detection of uranium-233/234 at 0.02533 pCi/g in a sample of locally produced milk collected in November 2005. 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 milk throughout the year that contains uranium-233/234 at this concentration is 0.40 mrem/year. Section 4.6.9.4 provides additional information on this monitoring program.

4.4 PROTECTION OF BIOTA

DOE Order 5400.5 sets an absorbed dose rate of 1 rad/day to native aquatic organisms. The DOE Technical Standard *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota* (DOE-STD-1153-2002) was used to demonstrate compliance with this limit.

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 used in the evaluation are sampling data collected at sampling location RW/RM-7 and river mile 0.1 on Little Beaver Creek (LBC 0.1), which are off-site surface water and sediment sampling locations just before Little Beaver Creek flows into Big Beaver Creek. Data for technetium-99 in surface water and sediment at the sampling location on Little Beaver Creek at river mile 0.1 (LBC 0.1) from the DOE surface water and sediment sampling conducted in conjunction with the Ohio EPA Biological and Water Quality Study were used in the assessment because these values were higher than data from samples collected at RW/RM-7. Sections 4.6.4 and 4.6.5 provide more information about these sampling events.

The maximum values of transuranic radionuclides, technetium-99, and uranium isotopes detected in sediment or surface water samples collected from these locations in 2005 were entered into the RESRAD-BIOTA program that is designed to implement the DOE Technical Standard (DOE-STD-1153-2002). 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 from the northern side of the PORTS reservation (surface water sampling location NHP-SW01, the Ohio EPA sampling location at river mile 1.3 on Little Beaver Creek [LBC 1.3], and soil sampling location A8) were used to assess the dose recommendations for terrestrial plants and animals. These locations were selected because concentrations of technetium-99 and uranium detected in surface water and soil from these locations were among the highest detected in samples collected in 2005. Chapter 6, Sect. 6.4.12, Section 4.6.4, and Section 4.6.7 provide additional information for the surface water monitoring programs and soil sampling program, respectively.

Data for the highest concentrations of radionuclides detected at these locations in 2005 were entered into the RESRAD-BIOTA program that is designed to implement the DOE Technical Standard (DOE-STD-1153-2002). The assessment indicates that the concentrations of radionuclides detected in water and soil at this location do not result in a dose of more than 1 rad/day to terrestrial plants and 0.1 rad/day to terrestrial animals.

4.5 UNPLANNED RADIOLOGICAL RELEASES

No unplanned releases of radionuclides took place at DOE PORTS in 2005.

4.6 ENVIRONMENTAL RADIOLOGICAL MONITORING

This section discusses the radiological monitoring programs at PORTS: ambient air monitoring, environmental radiation, surface water, sediment, settleable solids, soil, vegetation and biota (deer, fish, crops, milk, and eggs).

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 Section 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 2005, samples were collected from 15 ambient air monitoring stations located within and around PORTS (see Section 4.3.4, Figure 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.

No transuranic radionuclides (americium-241, neptunium-237, plutonium-238, and plutonium-239/240) were detected in ambient air samples collected during 2005. Technetium-99 was detected once at station A15 and once at Station A41. Uranium-233/234 and uranium-238 were detected in each of the samples. The highest average concentrations of both uranium-233/234 (0.00035 $pCi/m^{3)}$ and uranium-238 (0.00029 $pCi/m^{3)}$ were detected at Station A36, which is on site in the northeast portion of the facility, near the intersection of Shyville Road and Perimeter Road.

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 highest net dose calculation for the ambient air stations (0.00023 mrem/year) was at station A41, which is northwest of PORTS at Zahns Corner. This hypothetical dose 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 Environmental Radiation

Radiation is measured by the DOE at 19 locations that include most of the ambient air monitoring locations (see Section 4.3.4, Figure 4.1) and other on-site locations (see Figure 4.3). Measuring devices 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. Radiation is measured in millirems as a whole body dose, which is the dose that a person would receive if they were continuously present at the monitored location.

Three locations detected elevated levels of radiation in 2005: location #874, which monitors the X-745C Depleted Uranium Cylinder Storage Yard; location #862, which is south of the cylinder yards and west of the X-530A Switchyards; and location #933, which is east of the X-744G building in the X-701B Holding Pond groundwater monitoring area. The cumulative whole body dose calculated for each of the 16 locations excluding locations #874, #862, and #933 ranged from 66 to 98 mrem. The cumulative whole body doses at locations #874, #862, and #933 were 703 mrem, 128 mrem, and 131 mrem, respectively.

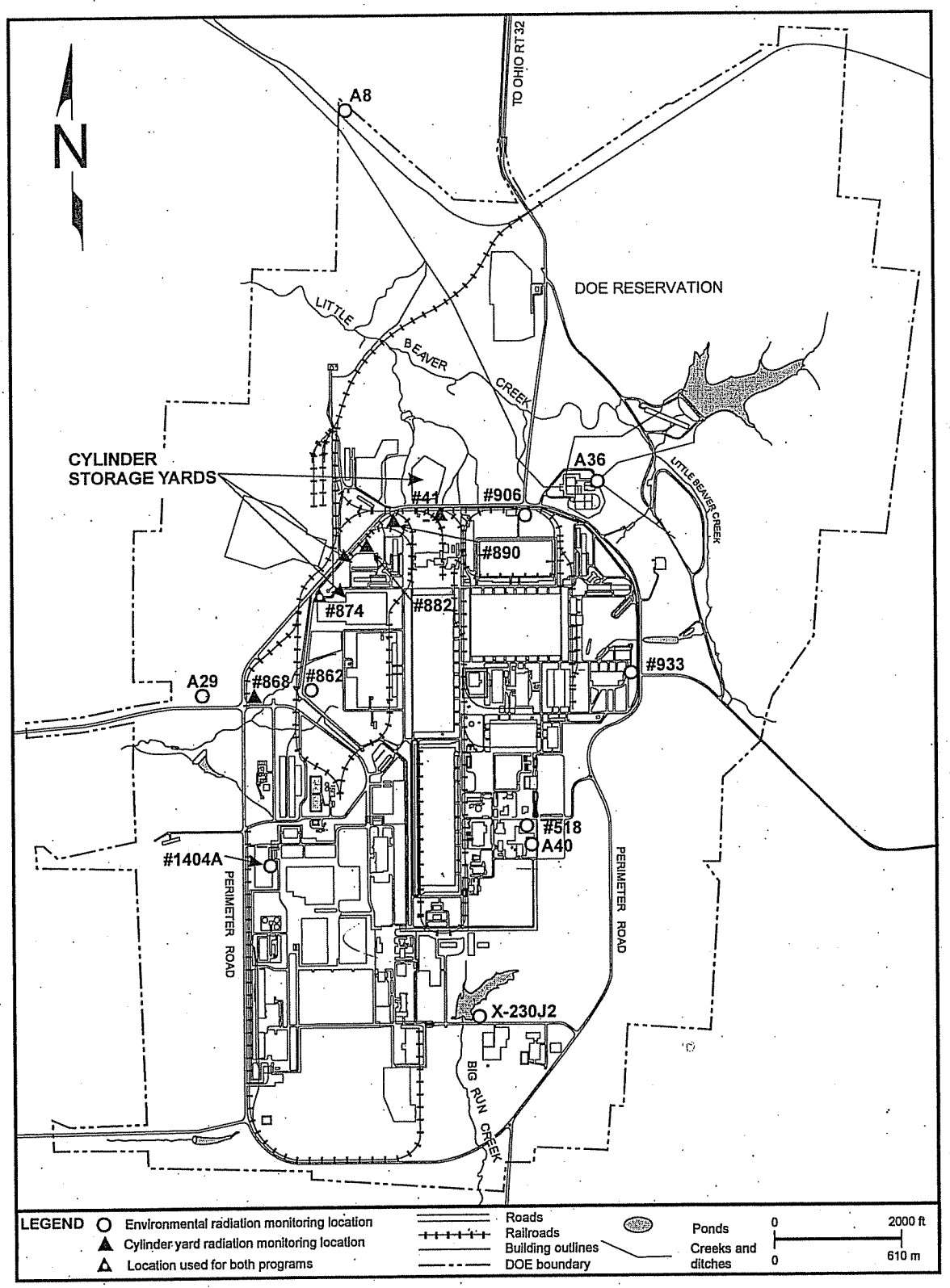

Figure 4.3. On-site radiation and cylinder yard dose monitoring locations.

In addition, the dose resulting from radiation emanating from the DOE cylinder storage yards is measured at five locations around the northwest corner of PORTS just inside Perimeter Road (see Figure 4.3). These locations are not accessible to the general public. The cumulative annual whole body doses at locations #41 and #890 were 159 mrem and 181 mrem, respectively. Locations #874 and #882 recorded cumulative annual whole body doses of 698 mrem and 946 mrem, respectively, and location #868 recorded a cumulative annual whole body dose of 1531 mrem.

4.6.3 Surface Water from DOE Cylinder Storage Yards

The Ohio EPA requires monthly collection of surface water samples from four locations: X-745C1 at the X-745C Depleted Uranium Hexafluoride Cylinder Storage Yards, X-745E1 at the X-745E Depleted Uranium Hexafluoride Cylinder Storage Yard, and X-745G1A and X-745G2 at the X-745G Depleted Uranium Hexafluoride Cylinder Storage Yard. Location X-745G1A replaced location X-745G1 and location X-745G2 was added to the monitoring program in February 2005. The 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 2005 were analyzed for total uranium, uranium isotopes (uranium-233/234, uranium-235, uranium-236, and uranium-238), technetium-99, and transuranic radionuclides (americium-241, neptunium-237, plutonium-238, and plutonium-239/240).

During 2005, maximum detections of technetium-99, uranium, and uranium isotopes were as follows: technetium-99 at 11.1 pCi/L, uranium at 21 μg/L, uranium-233/234 at 3.717 pCi/L, uranium-235 at 0.1408 pCi/L, uranium-236 at 0.03589 pCi/L, and uranium-238 at 3.036 pCi/L. Transuranic radionuclides (americium-241, neptunium-237, plutonium-238, and plutonium-239/240) were not detected in any of the samples collected in 2005. Surface water from the cylinder storage yards flows to USEC NPDES outfalls prior to discharge from the site; therefore, releases of radionuclides from the cylinder yards are monitored by sampling conducted at the USEC outfalls. Radionuclides detected at USEC outfalls (see Section 4.3.5.2) are used in the dose calculation for releases to surface water (see Section 4.3.6).

4.6.4 Local Surface Water

In 2005, local surface water samples were collected from 14 locations upstream and downstream from PORTS. These samples were taken from the Scioto River, Little Beaver Creek, Big Beaver Creek, and Big Run Creek (see Figure 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 semiannually (spring and fall) and 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) in accordance with the DOE *Environmental Monitoring Plan for the Portsmouth Gaseous Diffusion Plant*.

Plutonium-238 and plutonium-239/240 were detected at 0.1479 pCi/L and 0.5362 pCi/L, respectively, in the sample collected from location RW-5 (Big Beaver Creek upstream from PORTS) in the first semiannual sampling event in 2005. Neither of these radionuclides were detected at this location during the second sampling event. These detections are well below the respective DOE derived concentration guides for plutonium isotopes in drinking water (40 pCi/L for plutonium-238 and 30 pCi/L for plutonium-239/240). No other transuranics or technetium-99 were detected in any of the local surface water samples collected in 2005.

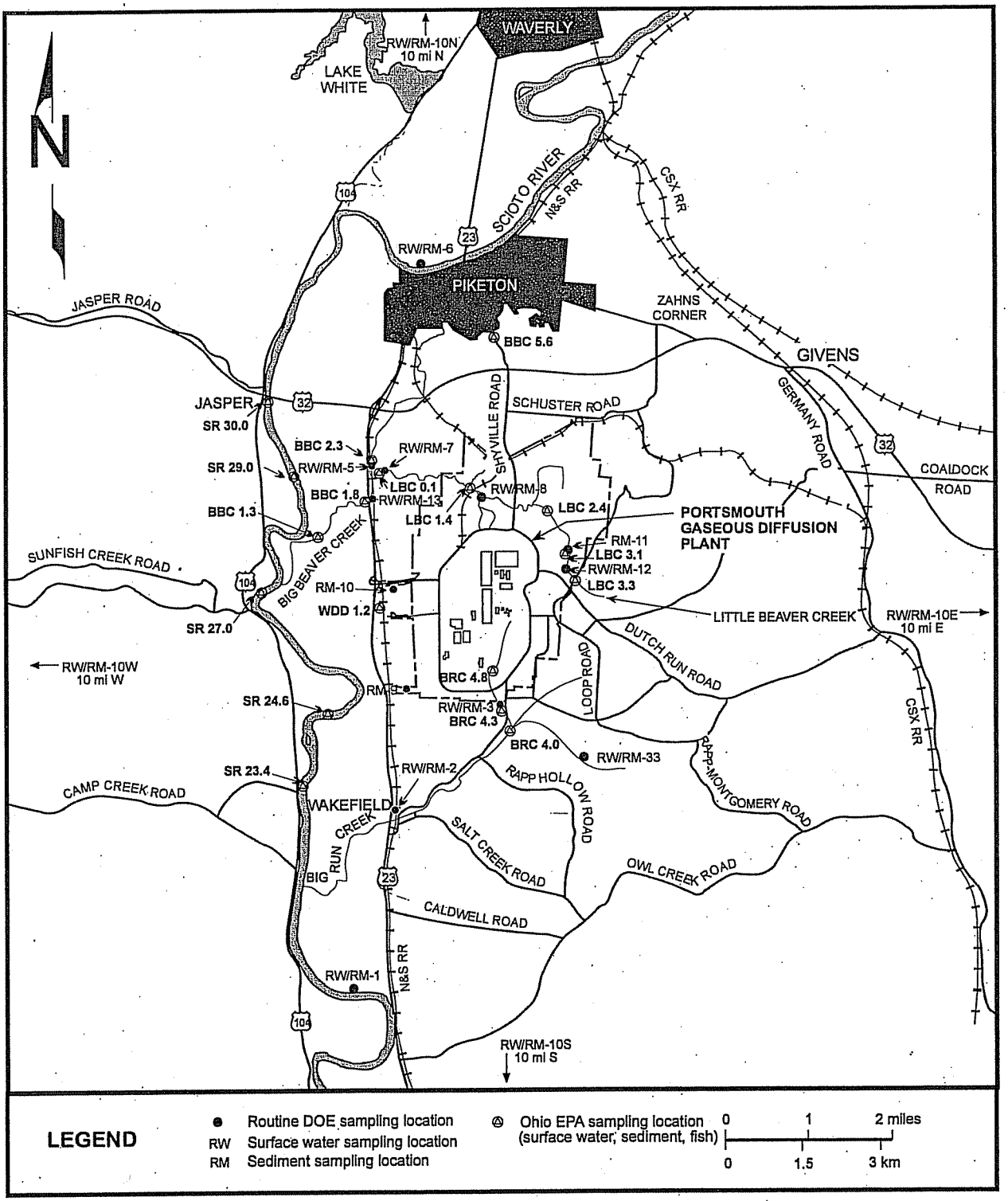

Figure 4.4. Local surface water and sediment monitoring locations.

Maximum detections of uranium and uranium isotopes in local surface water samples were detected at location RW-6 (Scioto River upstream from PORTS in Piketon) and RW-7 (Little Beaver Creek). Uranium was detected at 1.832 μg/L (RW-6), uranium-233/234 was detected at 1.98 pCi/L (RW-7), and uranium-238 was detected at 0.6105 pCi/L (RW-6). Uranium-235 and uranium-236 were not detected in any of the local surface water samples collected in 2005. Detections of uranium and uranium isotopes in local surface water samples in 2005 remain 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).

In addition, the DOE conducted surface water sampling in August and October of 2005 in conjunction with the Ohio EPA Biological and Water Quality Study. Surface water samples were collected from locations on Big Beaver Creek, Big Run Creek, Little Beaver Creek, the Scioto River, and the West Drainage Ditch and analyzed for technetium-99. Technetium-99 was only detected in samples collected from Big Beaver Creek and Little Beaver Creek at activities between 2.8 and 13.2 pCi/L. These detections are well below the EPA drinking water standard for technetium-99 (900 pCi/L based on a dose of 4 mrem/year from beta emitters).

4.6.5 Sediment

Sediment samples are collected from the same locations upstream and downstream from PORTS where local surface water samples are collected and at the NPDES outfalls on the east and west sides of PORTS (see Figure 4.4). Samples are collected annually and 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) in accordance with the DOE *Environmental Monitoring Plan for the Portsmouth Gaseous Diffusion Plant*.

Technetium-99 is often detected in sediment samples collected at locations downstream from PORTS. In 2005, technetium-99 was detected in the samples collected from two of the downstream sampling locations on Little Beaver Creek (RM-7 and RM-8), the downstream sampling location on Big Beaver Creek (RM-13), and a downstream sampling location on Big Run Creek (RM-2). Technetium-99 was also detected in the sediment sample collected at USEC NPDES Outfall 001 (RM-11). Technetium-99 was not detected in sediment samples collected from the Scioto River or any of the background sampling locations.

In general, levels of technetium-99 detected in sediment are consistent with results from 1999 through 2004. Transuranics were not detected in any of the sediment samples collected in 2005.

In addition, the DOE conducted sediment sampling during 2005 in conjunction with sampling conducted for the Ohio EPA Biological and Water Quality Study. Sediment samples were collected from locations on Big Beaver Creek, Big Run Creek, Little Beaver Creek, the Scioto River, and the West Drainage Ditch and analyzed for technetium-99. Technetium-99 was detected in samples collected from Big Beaver Creek, Big Run Creek, Little Beaver Creek, and the West Drainage Ditch at activities between 0.4 and 21.8 pCi/g. These detections are consistent with results from routine sampling conducted by the DOE.

Uranium and uranium isotopes are naturally occurring, but may also be present due to PORTS activities. Uranium and uranium isotopes detected in the 2005 samples have been detected at similar concentrations in previous sampling events from 1999 through 2004.

Section 4.3.9.1 provides a dose assessment to a member of the public based on the highest detections of technetium-99 and uranium isotopes at sediment sampling locations RM-7 and river mile 0.1 on Little

Beaver Creek (LBC 0.1 – a sampling location for the Ohio EPA study), which are substantially the same location. This off-site sampling location had the highest concentrations of radionuclides detected in 2005: 17.2 pCi/g of technetium-99, 4.088 pCi/g of uranium-233/234, 0.1319 pCi/g of uranium-235, and 1.344 pCi/g of uranium-238. The total potential dose to a member of the public resulting from PORTS operations (1.67 mrem/year), which includes this dose calculation (0.048 mrem/year), is well below the DOE standard of 100 mrem/year.

4.6.6 Settleable Solids

The DOE collects water samples from 11 locations (see Figure 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*, 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). Two samples are collected semiannually (June and December) from each monitoring location. One sample is analyzed for total suspended solids, total alpha activity, and total beta activity. The other sample is analyzed for non-settleable solids, total alpha activity, and total beta activity.

In 2005, alpha and beta activity were not detected at any location; therefore, the DOE standards (5 pCi/g for alpha activity and 50 pCi/g for beta activity) were not exceeded at any location.

4.6.7 Soil

Soil samples are collected annually from ambient air monitoring locations (see Figure 4.1) and 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) in accordance with the DOE *Environmental Monitoring Plan for the Portsmouth Gaseous Diffusion Plant*.

No transuranic radionuclides or technetium-99 were detected in any of the soil samples collected from the ambient air monitoring stations in 2005.

Uranium (total), uranium-233/234, and uranium-238 were detected at all of the sampling locations. Uranium-235 was detected at 80% of the sampling locations, and uranium-236 was detected in only one of the soil samples collected in 2005. Uranium and uranium isotopes were detected at similar concentrations at all the soil sampling locations, including the background location (A37), which suggests that the uranium detected in these samples is due to naturally occurring uranium.

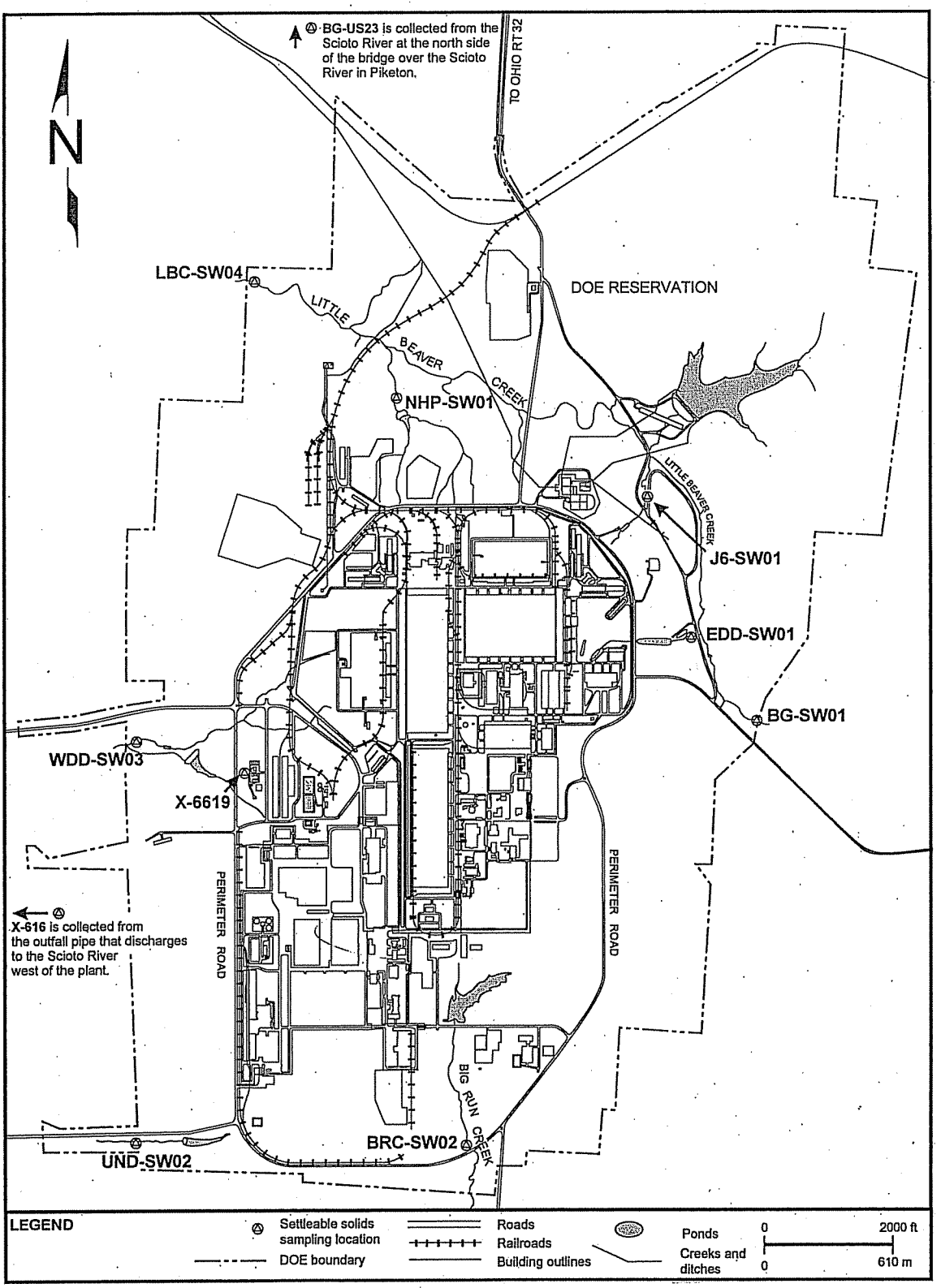

Figure 4.5. DOE settleable solids monitoring locations.

Section 4.3.9.2 provides a dose assessment based on the detections of uranium-233/234, uranium-235, and uranium-238 at the ambient air station southwest of PORTS (A28). The total potential dose to a member of the public resulting from PORTS operations (1.67 mrem/year), which includes this dose calculation (0.072 mrem/year), is well below the DOE standard of 100 mrem/year.

4.6.8 Vegetation

To assess the uptake of radionuclides into plant material, vegetation samples are collected in the same areas where soil samples are collected at the ambient air monitoring stations (see Figure 4.1). Samples are collected annually and 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) in accordance with the DOE *Environmental Monitoring Plan for the Portsmouth Gaseous Diffusion Plant.*

In 2005, no radionuclides were detected in vegetation samples.

4.6.9 Biological Monitoring

The DOE *Environmental Monitoring Plan for the Portsmouth Gaseous Diffusion Plant* requires biological monitoring to assess the uptake of radionuclides into local biota (deer, fish, crops, milk, and eggs).

4.6.9.1 Deer

Samples of liver, kidney, and muscle from a deer killed on site in a collision with a motor vehicle in December 2005 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). None of these radionuclides were detected in the samples.

4.6.9.2 Fish

In 2005, five fish were collected from downstream sampling locations on the Scioto River and Little Beaver Creek. 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). No radionuclides were detected in any of the fish.

In addition, the DOE conducted fish sampling during 2005 in conjunction with sampling for the Ohio EPA Biological and Water Quality Study. Fish were collected from locations on Big Beaver Creek, Big Run Creek, Little Beaver Creek, the Scioto River, and the West Drainage Ditch and analyzed for technetium-99. Technetium-99 was detected in fish collected from Big Run Creek, Little Beaver Creek, and the Scioto River at activities between 2 and 3.4 pCi/g.

Section 4.3.9.3 provides a dose assessment to a member of the public based on consumption of fish (channel catfish) containing technetium-99 at 3.4 pCi/g. The total potential dose to a member of the public resulting from PORTS operations (1.67 mrem/year), which includes this dose calculation (0.010 mrem/year), is well below the DOE standard of 100 mrem/year.

4.6.9.3 Crops

In 2005, 18 crop samples, including green peppers, corn, green beans, tomatoes, cucumbers, and squash, were collected from five residential locations near PORTS.

Each sample was 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). None of these radionuclides were detected in any of the samples.

4.6.9.4 Milk and eggs

In 2005, one sample of locally produced milk and one sample of locally produced eggs 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). None of these radionuclides were detected in the egg sample.

Uranium-233/234 was detected in the milk sample at 0.02533 pCi/g. Section 4.3.9.4 provides a dose assessment to a member of the public based on consumption of milk containing uranium-233/234. The total potential dose to a member of the public resulting from PORTS operations (1.67 mrem/year), which includes this dose calculation (0.40 mrem/year), is well below the DOE standard of 100 mrem/year.

4.7 RELEASE OF PROPERTY CONTAINING RESIDUAL RADIOACTIVE MATERIAL

In 2005, no DOE property (equipment, excess materials, etc.) was released to the public that contained residual radioactive material that exceeded the release limits for DOE PORTS. The release limits are established in accordance with DOE Order 5400.5 and Title 10 of the *Code of Federal Regulations*, Part 835.

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