4. Environmental Radiological Protection and Monitoring

Each year DOE and its contractors estimate the potential radiological dose to the public from site operations and effluents. Estimates are calculated to confirm that no individual could have received a dose that exceeded the limits established by DOE, Ohio EPA, or US EPA for protection of the public. This section includes estimates of the maximum potential dose to the public and to plants and animals from PORTS activities.

To help readers understand the information in this section, Appendix B, *Introduction to Radiation*, answers the following questions:

- What is radiation?
- What is a radionuclide?
- What are some radionuclides of concern?
- What is radioactivity and how is it measured?
- What is dose and how is it measured?
- How are radioactivity and dose reported?
- What is an exposure pathway?
- What radiation sources and doses are we exposed to?
- What are the potential health effects of radiation exposure?

2021 Highlights

The paragraphs below summarize the radiological dose a member of the public, known as the maximally exposed individual, or MEI, could have received from PORTS assuming exposure from all relevant pathways. Atmospheric releases, external radiation, and incidental ingestion of surface water, soil, and sediment contribute to the dose that could be received by a member of the public.

As in previous years, the estimated potential dose from PORTS to a member of the public was below applicable US EPA standards and DOE public dose limits, and represents a very small fraction compared to the estimated 620 mrem members of the public receive annually from both natural and man-made sources.

Total dose from all pathways: The calculated dose of radiation a member of the public could receive from all pathways of exposure at PORTS was 0.48 mrem/year, which is 0.48 percent of the DOE annual dose limit of 100 mrem/year, and this dose is considered ALARA.

Dose from the air pathway: US EPA regulates annual radionuclide air emissions and sets a limit of 10 mrem/year at the maximally exposed off-site receptor. The total annual dose from airborne emissions from PORTS was 0.11 mrem/year, or 1.1 percent of the US EPA limit. The total annual dose to a member of the public based on detections of radionuclides in ambient air was 0.227 mrem/year, or 2.27 percent of the US EPA limit. The ambient air dose (0.227 mrem/year) is used to calculate the total dose from all pathways.

Dose from the surface water pathway: Dose from the surface water pathway is evaluated by how much it contributes to the DOE total dose limit of 100 mrem/year from all relevant pathways. The estimated dose from incidental ingestion of surface water was 0 mrem because levels of radionuclides detected at the upstream monitoring location on the Scioto River were higher than the levels of radionuclides detected downstream from PORTS.

Dose from the sediment pathway: Like surface water, dose from the sediment pathway is evaluated by its contribution to the DOE total dose limit of 100 mrem/year from all relevant pathways. The estimated dose from incidental ingestion of sediment from PORTS was 0.040 mrem/year. This level is 0.040 percent of the DOE annual dose limit of 100 mrem/year.

Dose from the soil pathway: Dose from the soil pathway is evaluated by its contribution to the DOE total dose limit of 100 mrem/year from all relevant pathways. The estimated dose from incidental ingestion of soil from PORTS was 0.006 mrem/year. This level is 0.006 percent of the DOE annual dose limit of 100 mrem/year.

Dose associated with the On-Site Waste Disposal Facility: DOE Order 458.1 and Ohio Department of Health regulations limit the dose to a member of the public resulting from management, storage, and disposal of low-level radioactive waste to 25 mrem/year. DOE estimates that the dose attributable to operation of the On-Site Waste Disposal Facility in 2021 was 0.0853 mrem/year. This level is 0.34 percent of the Ohio Department of Health and DOE annual dose limit of 25 mrem/year. The *2021 On-Site Waste Disposal Facility Annual Project Status Report* (DOE 2022b) and data collected in 2021 are available on the PEGASIS website here.

Dose from the direct radiation pathway: Dose from direct radiation is also evaluated by its contribution to the DOE total dose limit of 100 mrem/year from all relevant pathways. The estimated dose from external radiation from PORTS was 0.21 mrem/year, which represents 0.21 percent of the DOE annual dose limit of 100 mrem/year.

Dose to biota: Biota dose modeling indicates that the plants and animals living on or near PORTS are not exposed to doses in excess of the DOE Order limits.

4.1 Environmental Radiological Program

Routine DOE operations at PORTS release radioactive materials to the environment through atmospheric and liquid pathways. These releases may result in a radiation exposure to the public. In accordance with DOE Order 458.1, *Radiation Protection of the Public and the Environment*, DOE has an environmental monitoring program that includes radiological monitoring of pathways that may contribute to the overall dose to the public. Monitoring includes analyses of ambient air, surface water, groundwater, sediment, soil, external radiation, and biota. The goals of the environmental radiological program are as follows:

- To conduct radiological activities so that exposure to members of the public is within the dose limits established by DOE Order 458.1
- To control the radiological clearance of DOE real and personal property
- To ensure that potential radiation exposures to members of the public are ALARA
- To monitor routine and nonroutine radiological releases and to assess the radiation dose to members of the public
- To protect the environment from the effects of radiation and radioactive material

4.2 Radiological Dose

DOE Order 458.1 establishes 100 mrem/year above background levels as the total annual dose limit due to DOE activities to a member of the public. DOE Order 458.1 also limits the dose from management and storage of radioactive waste to 25 mrem/year. DOE operations at PORTS contribute to the yearly public dose through radiological releases and external radiation. DOE controls emissions and effluents to maintain releases at levels that are ALARA. To confirm that doses to the public and biota are below established limits, DOE calculates annual dose estimates using air emissions data, external radiation monitoring data, and environmental monitoring data combined with relevant site-specific data such as meteorological conditions and population characteristics. Background radiation from natural cosmic and terrestrial sources is subtracted from radiological measurements to determine the PORTS dose.

4.2.1 Dose Assessment Methodology

Radiological dose assessments are completed for exposure pathways applicable to PORTS using methods consistent with the requirements of DOE Order 458.1 and other guidance, including the *Methods for Conducting Human Health Risk Assessments and Risk Evaluations at the Portsmouth Gaseous Diffusion Plant* (DOE 2017b). For air, measurements or estimates of radionuclide concentrations in air released from PORTS are assembled for the calendar year. Models approved by US EPA and DOE (or factors derived from those models) are then used to estimate the total effective dose to a member of the public, known as the MEI, which represents the resident most likely to be affected by a radiological release for that pathway, and the collective total effective dose to the population within a 50-mile radius of PORTS.

To determine compliance with the DOE public dose requirements, PORTS calculates potential off-site doses by collecting samples at off-site locations around PORTS and analyzing the samples for radionuclides that could be present due to past or present activities at PORTS. DOE Order 458.1 states that the pathway and exposure assumptions for the MEI are to be reasonable and should neither underestimate nor substantially overestimate the dose. Radiological dose calculations include the dose to the public from radionuclides released to the air, external radiation, and radionuclides detected by environmental monitoring programs. This summary of the dose calculations assumes that the same MEI, or representative person, routinely drove on Perimeter Road past the cylinder yards when the road was open in 2021 and lives in the immediate vicinity of PORTS.

The MEI is assumed to be exposed to the maximum dose calculated from each pathway. The model assumes the MEI was exposed to radiation at the location where the highest concentration of radionuclides in air has been modeled; consumes milk, meat, and vegetables produced at that location; spends time on or near the Scioto River and local creeks; and hunts or fishes in the local area. The dose is expected to represent an upper limit for exposure because certain activities, such as swimming in the Scioto River, are assumed to occur but are not expected.

4.2.2 Dose Summary

Table 4.1 summarizes the potential dose to the hypothetical MEI, which uses an upper bounding scenario to determine the dose to the MEI from exposure to radionuclides in ambient air. The monitoring results in this table demonstrate the continued effectiveness of radiological control measures practiced at PORTS.

Table 4.1. Summary of potential annual doses to the public from PORTS in 2021

Source of dose	Dose[a]
Airborne radionuclides (ambient air)	0.227[b]
External radiation near cylinder yards (northwest portion of Perimeter Rd)	0.21
Radionuclides detected in the Scioto River	0
Radionuclides detected in off-site sediment	0.040
Radionuclides detected in off-site soil	0.006
Total	0.48[c]

Notes:
[a]Dose is shown in millirem per year.
[b]10 mrem/year is the US EPA limit for airborne radionuclides in the NESHAP (40 *CFR* Part 61, Subpart H).
[c]100 mrem/year is the DOE limit for all potential pathways in DOE Order 458.1.

4.3 Air Monitoring and Estimated Dose

This section discusses airborne discharges of radionuclides from PORTS, ambient air monitoring, and the dose calculations associated with airborne discharges and ambient air.

4.3.1 Air Monitoring

Airborne discharges of radionuclides from PORTS are subject to 40 *CFR* Part 61, Subpart H, NESHAP, which contains the national standards for emissions of radionuclides other than radon from DOE facilities. The applicable standard is a maximum of 10 mrem dose to any member of the public in any year. Releases of radionuclides are used to calculate an annual dose to members of the public, which is reported annually to US EPA and Ohio EPA.

In 2021, Fluor-BWXT Portsmouth was responsible for air emission sources associated with the former gaseous diffusion plant operations, including continuously monitored vents in the X-330 Process Building and the X-344A Uranium Hexafluoride Sampling Building. The vents in the X-330 Process Buildings can be operated to support decontamination and decommissioning activities, but were not in use in 2021. The X-344A vents were in use for ongoing sampling of uranium product. Vents in the X-326 and X-333 Process Buildings have been permanently shut down as part of decontamination and decommissioning activities.

Other radionuclide air emission sources included room ventilation exhausts and pressure relief vents associated with the X-710 Technical Services Building, X-705 Decontamination Facility, and XT-847 Glove Box, which is inactive. These emission sources were not continuously monitored; emissions from these sources, when in use, were estimated based on operating data and US EPA emission factors.

The X-622, X-623, X-624, and X-627 Groundwater Treatment Facilities treated groundwater contaminated with radionuclides or other site water in accordance with the Fluor-BWXT Portsmouth NPDES permit. Wastewater treatment facilities that support decontamination and decommissioning treat water potentially contaminated with radionuclides. Emissions from these treatment facilities were calculated based on influent and effluent sampling at each facility. Total emissions from the Fluor-BWXT Portsmouth airborne sources in 2021 were calculated to be 0.209 Ci (2.09E-01 Ci).

Mid-America Conversion Services was responsible for air emission sources associated with the DUF_6 Conversion Facility, which did not operate in 2021 due to the COVID-19 pandemic. Emissions from the DUF_6 Conversion Facility were based on continuous monitoring of the conversion building stack. Total emissions from the Mid-America Conversion Services airborne sources in 2021 were calculated to be 0.0000284 Ci (2.84E-05 Ci).

The Centrus demonstration cascade was the only source of radionuclide air emissions from Centrus subject to NESHAP reporting. There were no emissions from Centrus in 2021, however, because the demonstration cascade was shut down in 2016.

4.3.2 Air Estimated Dose

An annual dose calculation for atmospheric, or airborne, radionuclides is required by US EPA under NESHAP and is provided to US EPA in an annual report. The effect of radionuclides released to the atmosphere by PORTS during 2021 was determined by calculating the effective annual dose to the MEI, the individual who resides at the most exposed point near the plant, and to the entire population (approximately 662,000 residents) within 50 miles of the plant. Dose was calculated using the CAP-88-PC computer program, Version 4.1, which was developed under the sponsorship of US EPA for use in demonstrating compliance with the radionuclide NESHAP. The program uses models to calculate levels of radionuclides in the air, on the ground, and in food (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 each of the air emission sources discussed in Section 4.2.1. 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 NESHAP background documents. This pattern specifies that 70 percent of the vegetables and produce, 44 percent of the meat, and 40 percent of the milk consumed by each person are produced in the local area, such as in a home garden. The remaining portion of each food is assumed to be produced within 50 miles of PORTS. In reality, the majority of the food consumed locally is purchased at supermarkets that receive food items from all over the world. As a result, these assumptions most likely overestimate 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 annual dose to an off-site individual from radiological releases from PORTS air emission sources in 2021 was 0.11 mrem/year. This annual dose is below the 10 mrem/year limit applicable to PORTS and the approximate 311 mrem/year annual dose that the average individual in the United States receives from natural sources of radiation (National Council on Radiation Protection 2009).

The collective annual dose (or population dose) is the sum of doses to all individual members of the public within 50 miles of PORTS. In 2021, the population dose from PORTS emissions was 1.32 person-rem/year.

4.3.3 Ambient Air Monitoring

Ambient air monitoring measures pollutants in surrounding outdoor air. The ambient air monitoring stations measure radionuclides released from DOE point sources, fugitive air emissions (emissions from PORTS that are not associated with a stack or pipe such as decontamination and decommissioning activities or normal building ventilation), and background levels of radionuclides (radionuclides that occur naturally, such as uranium). The radionuclides measured are isotopic uranium (uranium-233/234, uranium-235/236, and uranium-238), technetium-99, and selected transuranic radionuclides (americium-241, neptunium-237, plutonium-238, and plutonium-239/240). Thorium isotopes (thorium-228, thorium-230, and thorium-232) were added to the ambient air monitoring program in 2020 because these radionuclides are present in the gaseous diffusion process buildings and could be released during decontamination and decommissioning. These thorium isotopes are also naturally present in the environment.

Ambient air samples were collected from 18 ambient air monitoring stations in accordance with the *Environmental Monitoring Plan for the Portsmouth Gaseous Diffusion Plant* (DOE 2017c). As shown in Figure 4.1, these ambient air monitoring stations are located within and around PORTS and include a background ambient air monitoring station (A37) approximately 13 miles southwest of the plant. The analytical results from air sampling stations closer to the plant are compared to the background measurements.

The Ohio Department of Health collects air samples at the same 18 air monitoring locations sampled by DOE. The Ohio Department of Health sampling uses separate sampling equipment and analytical laboratories to independently measure airborne radioactivity levels around PORTS. Using separate sampling equipment and analytical laboratories means that analytical results for samples collected at the same location can be different. Data collected by the Ohio Department of Health are available on the state government data portal here. Data collected by DOE are available on the PEGASIS website here.

Ambient air monitoring began at the On-Site Waste Disposal Facility in April 2021. Samples are collected and analyzed for radionuclides at seven monitoring stations around the perimeter of the On-Site Waste Disposal Facility project area, as shown on Figure 4.1. The *2021 On-Site Waste Disposal Facility Annual Project Status Report* (DOE 2022b) and data collected in 2021 are available on the PEGASIS website here.

Ambient concentrations of uranium and uranium isotopes at the monitoring stations are affected by the presence of uranium isotopes in the filters used for sampling. Uranium and uranium isotopes were detected in quality control samples associated with the ambient air samples, and subsequently in unused filters obtained from the manufacturer that are placed at the ambient air stations to collect samples. The presence of uranium and uranium isotopes in the unused filters may have caused slightly elevated analytical results for uranium and uranium isotopes.

To aid in comparing sampling results for air and water to the 100 mrem/year dose limit, DOE converted the 100 mrem/year limit to a derived concentration standard (DOE 2021f). The derived concentration standard is the concentration of a radionuclide in air or water that, under conditions of continuous exposure for one year by one exposure mode (ingestion of water or inhalation of air), would result in a dose of 100 mrem/year. Table 4.2 lists the maximum activities of detected radionuclides in ambient air samples in 2021.

Table 4.2. Maximum levels of radionuclides detected in ambient air in 2021

Radionuclide	Maximum activity in picocuries per cubic meter	Location	Derived concentration standard[a]	Percentage of derived concentration standard
Technetium-99	0.0123	A36	2000	0.0006%
Thorium-228	0.0000269	X780-A02[b]	0.10	0.027%
Thorium-230	0.0000432	A36	0.15	0.03%
Thorium-232	0.0000639	X780-A03[b]	0.037	0.17%
Uranium-233/234	0.00106	A52	1.5	0.07%
Uranium-235/236	0.0000545	A52	1.7	0.003%
Uranium-238	0.000125	T7	1.8	0.007%

Notes:
[a]The derived concentration standard (air inhalation) has been converted to picocuries per cubic meter from units of microcuries per milliliter provided in the *Derived Concentration Technical Standard* (DOE 2021f).
[b]On-Site Waste Disposal Facility monitoring locations.

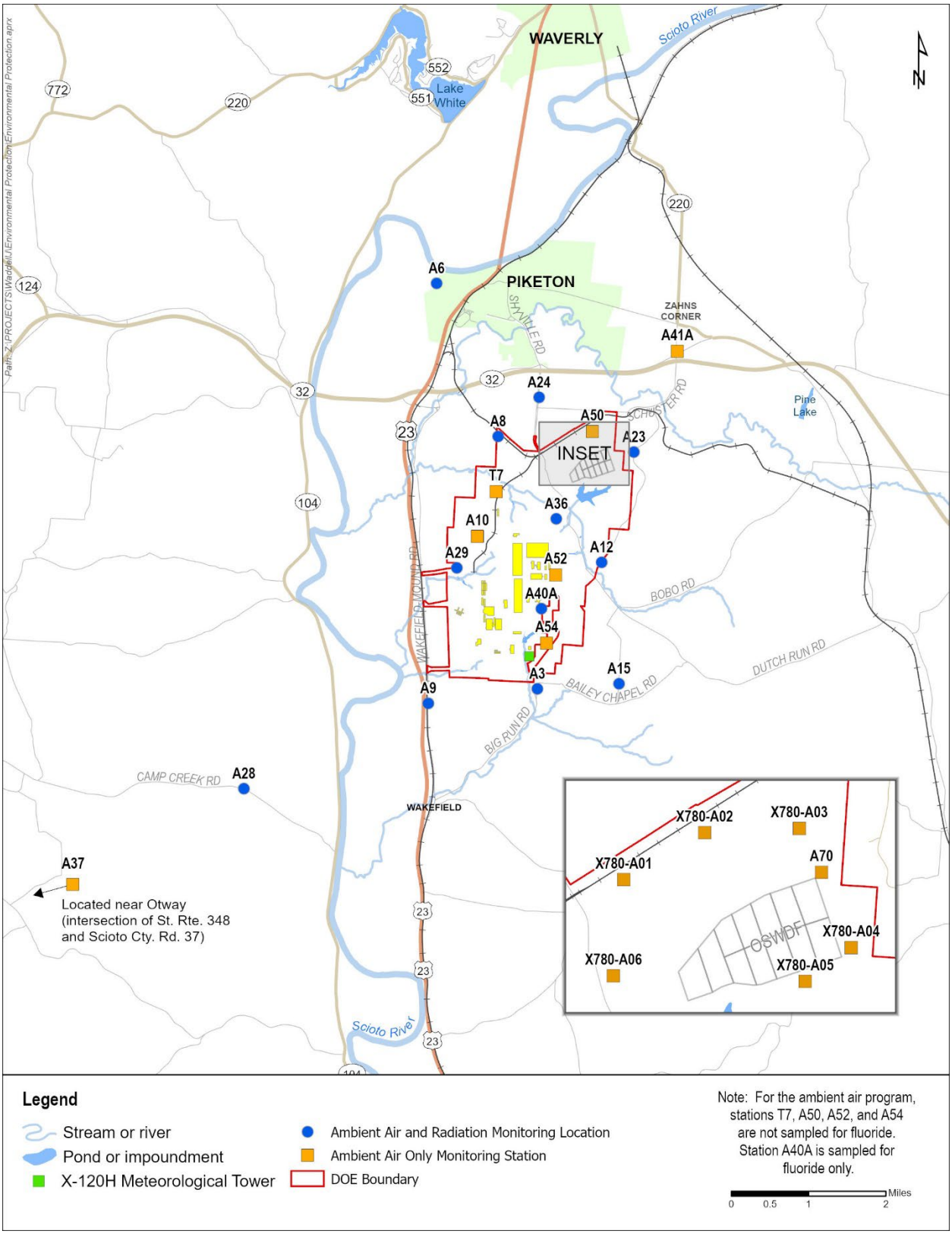

Figure 4.1. Ambient air and radiation monitoring locations

4.3.4 Ambient Air Estimated Dose

The CAP-88 model generates a dose conversion factor that was used to calculate an annual dose for a given level of each radionuclide in air (mrem/pCi/m3). The highest level of each radionuclide detected in 2021 was assumed to be present for the entire year or, if a radionuclide was not detected, the radionuclide was assumed to be present for the entire year at half the highest undetected result. This graded approach is used to calculate an upper bounding dose; the realistic dose to a member of the public (the hypothetical MEI) is less than this upper bounding dose. This approach may overestimate the annual dose because it assumes an individual resides at the location of the monitoring station and breathes the highest levels of radionuclides in air at that location for 24 hours per day, 365 days per year. The dose that a member of the public could receive from radionuclides in ambient air at the background station is subtracted from the dose calculated for the stations closer to PORTS.

The highest annual net dose for ambient air monitoring stations is 0.227 mrem/year at Station A29, which is on the west side of PORTS at the Ohio Valley Electric Corporation (see Figure 4.1). This hypothetical dose of 0.227 mrem/year is below the 10 mrem/year limit applicable to PORTS in NESHAP (40 *CFR* Part 61, Subpart H).

4.4 Liquid Discharge Monitoring and Estimated Dose

PORTS monitors effluent and surface water runoff for radiological constituents to protect human health and the environment.

4.4.1 Surface Water Monitoring

Surface water is monitored for radionuclides in several ways. On-site monitoring includes water discharged through NPDES outfalls and runoff from cylinder storage yards and the On-Site Waste Disposal Facility. The settleable solids monitoring program assesses the concentration of radioactive material present in the sediment suspended in the water sample at selected water discharge locations. The local surface water monitoring program monitors radionuclides in on-site and off-site creeks and the Scioto River. A dose is calculated for a recreational user who swims in the Scioto River.

4.4.1.1 Discharges of Radionuclides from NPDES Outfalls

Fluor-BWXT Portsmouth, Mid-America Conversion Services, and Centrus were responsible for NPDES outfalls at PORTS during 2021 (see Figure 4.2). The Mid-America Conversion Services NPDES outfall is not monitored for radionuclides, so it is not discussed in this section.

Fluor-BWXT Portsmouth monitored NPDES Outfalls 001, 002, 003, 004, 005, 009, 010, 011, 015, 608, and 611 for radiological discharges by collecting water samples and analyzing the samples for uranium, uranium isotopes (uranium-233/234, uranium-235/236, and uranium-238), technetium-99, and transuranic radionuclides (americium-241, neptunium-237, plutonium-238, and plutonium-239/240). No transuranics (americium-241, neptunium-237, plutonium-238, and plutonium-239/240) were detected in samples collected from the Fluor-BWXT Portsmouth NPDES outfalls during 2021. Activities of technetium-99 and uranium isotopes discharged through the NPDES outfalls were assessed by comparing the activities of the radionuclides to the DOE derived concentration standards (DOE 2021f). Discharges of radionuclides in 2021 were within ALARA goals and were compliant with DOE Order 458.1.

In 2021 Centrus was responsible for three NPDES outfalls through which water is discharged from the site (see Figure 4.2). Outfalls 012 and 013 discharge directly to surface water, and Outfall 613 discharges to the X-6619 Sewage Treatment Plant (Fluor-BWXT Portsmouth NPDES Outfall 003) before leaving the site.

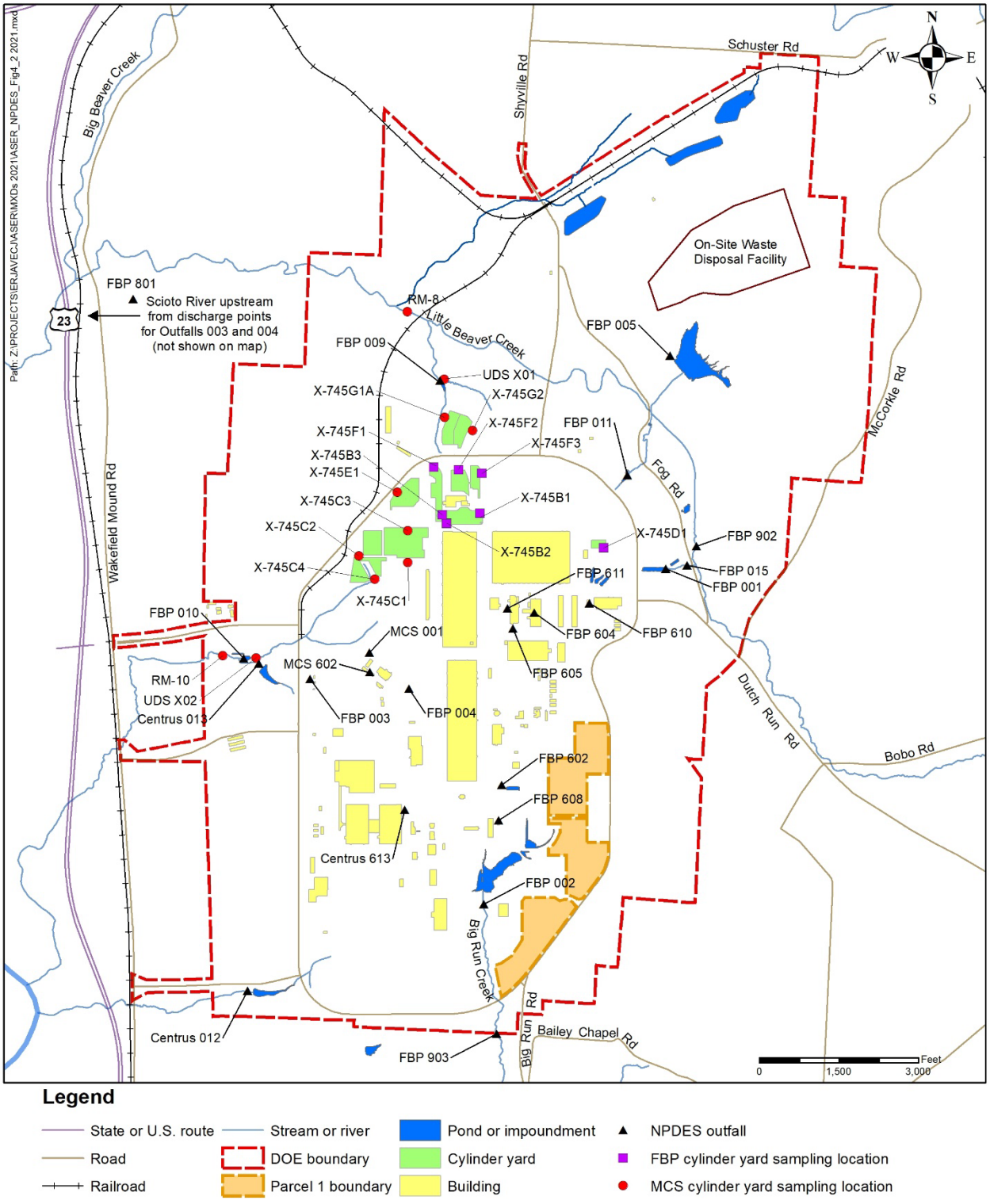

Figure 4.2. PORTS NPDES outfalls/monitoring points and cylinder storage yards sampling locations

Centrus Outfalls 012 and 013 were monitored for radiological discharges by collecting water samples and analyzing the samples for transuranic radionuclides (americium-241, neptunium-237, plutonium-238, and plutonium-239/240), technetium-99, and uranium. Transuranic radionuclides and technetium-99 were not detected in any of the samples collected from Centrus NPDES outfalls in 2021. Uranium was detected at low levels, which is typical for these outfalls.

4.4.1.2 Fluor-BWXT Portsmouth Cylinder Storage Yards

Fluor-BWXT Portsmouth collected surface water samples in 2021 from seven locations at the on-site X-745B, X-745D, and X-745F Cylinder Storage Yards. Figure 4.2 shows the sampling locations. Samples were collected monthly if water was available and samples were analyzed for alpha activity, beta activity, and uranium. Table 4.3 shows the maximum levels of alpha activity, beta activity, and uranium detected in 2021.

Table 4.3. Maximum detections of radionuclides at Fluor-BWXT Portsmouth cylinder storage yards in 2021

Radionuclide	Result[a]	Location	Month
Alpha activity	450	X-745B1	March
Beta activity	450	X-745B1	March
Uranium	147	X-745B3	February

Note:
[a]Results are shown in picocuries per liter for alpha activity and beta activity and microgram per liter for uranium.

Surface water from the cylinder storage yards flows to Fluor-BWXT Portsmouth NPDES outfalls prior to discharge from the site; therefore, releases of radionuclides from the cylinder yards are monitored by sampling conducted at the Fluor-BWXT Portsmouth outfalls.

4.4.1.3 Mid-America Conversion Services Cylinder Storage Yards

Ohio EPA requires monthly collection of surface water samples from seven locations at the on-site X-745C, X-745E, and X-745G Cylinder Storage Yards, as shown in Figure 4.2. Samples were analyzed for alpha activity, beta activity, and uranium. Table 4.4 shows the maximum levels of alpha activity, beta activity, and uranium detected in 2021.

Table 4.4. Maximum detections of radionuclides at Mid-America Conversion Services cylinder storage yards in 2021

Radionuclide	Result[a]	Location	Month
Alpha activity	8.77	X-745C1	August
Beta activity	56.7	X-745C3	May
Uranium	7.76	X-745C1	August

Note:
[a]Results are shown in picocuries per liter for alpha activity and beta activity and microgram per liter for uranium.

Surface water from the cylinder storage yards flows to Fluor-BWXT Portsmouth NPDES outfalls prior to discharge from the site; therefore, releases of radionuclides from the cylinder yards are monitored by sampling conducted at the Fluor-BWXT Portsmouth outfalls.

4.4.1.4 On-Site Waste Disposal Facility Surface Water

Environmental surveillance monitoring of surface water is conducted downstream of discharges from sedimentation ponds and at locations downstream from areas where surface water runoff directly enters

streams from On-Site Waste Disposal Facility peripheral areas. These locations include tributaries to Little Beaver Creek and Big Beaver Creek that may have continuous or intermittent flow.

Eight locations were monitored for radionuclides in 2021. Low levels of technetium and uranium were detected in the samples. Data collected at the On-Site Waste Disposal Facility surface water sampling locations in 2021 did not identify any issues to be addressed in the operation of the On-Site Waste Disposal Facility. The *2021 On-Site Waste Disposal Facility Annual Project Status Report* (DOE 2022b) and data collected in 2021 are available on the PEGASIS website here.

4.4.1.5 Settleable Solids

DOE collects water samples semiannually from nine effluent locations and three background locations to determine the concentration of radioactive material present in the sediment suspended in the water sample. Figure 4.3 shows these settleable solids monitoring locations. The data are used to determine compliance with DOE Order 458.1, *Radiation Protection of the Public and the Environment*, which states that operators of DOE facilities discharging or releasing liquids containing radionuclides from DOE activities must ensure that the discharges do not exceed an annual average (at the point of discharge) of either 5 pCi/g above background of settleable solids for alpha-emitting radionuclides, or 50 pCi/g above background for beta-gamma-emitting radionuclides.

When a low concentration of settleable solids is detected in a water sample, accurate measurement of the alpha and beta-gamma activity in the settleable solids portion of the sample is not practical due to the small sample size. DOE Handbook *Environmental Radiological Effluent Monitoring and Environmental Surveillance* (DOE 2015d) states that if settleable solids are not detected or the quantity of solids is so small that the radionuclides cannot be detected, the requirements are satisfied. In accordance with the *Environmental Monitoring Plan for the Portsmouth Gaseous Diffusion Plant* (DOE 2017c) samples with settleable solids less than 40 mg/L are not analyzed for radionuclides. In 2021, settleable solids were not detected at concentrations above 40 mg/L at any of the monitoring locations; therefore, monitoring results for the settleable solids monitoring program are in compliance with DOE Order 458.1.

4.4.1.6 Local Surface Water

Local surface water samples are collected from 14 locations upstream and downstream from PORTS surface water discharges. Figure 4.4 shows the monitoring locations on the Scioto River, Little Beaver Creek, Big Beaver Creek, and Big Run Creek. Samples collected from local streams approximately 10 miles north, south, east, and west of PORTS were used as background measurements.

Samples are collected semiannually and analyzed for transuranic radionuclides (americium-241, neptunium-237, plutonium-238, and plutonium-239/240), technetium-99, uranium, and uranium isotopes (uranium-233/234, uranium-235/236, and uranium-238) in accordance with the DOE *Environmental Monitoring Plan for the Portsmouth Gaseous Diffusion Plant* (DOE 2017c). No transuranic radionuclides were detected in the local surface water samples collected during 2021. Table 4.5 lists the maximum detections of technetium-99 and uranium isotopes in local surface water in 2021. These detected concentrations of radionuclides were 0.16 percent or less of the DOE derived concentration standards (DOE 2021f). These derived concentration standards are based on drinking water but the surface water around PORTS is not used as a source of drinking water.

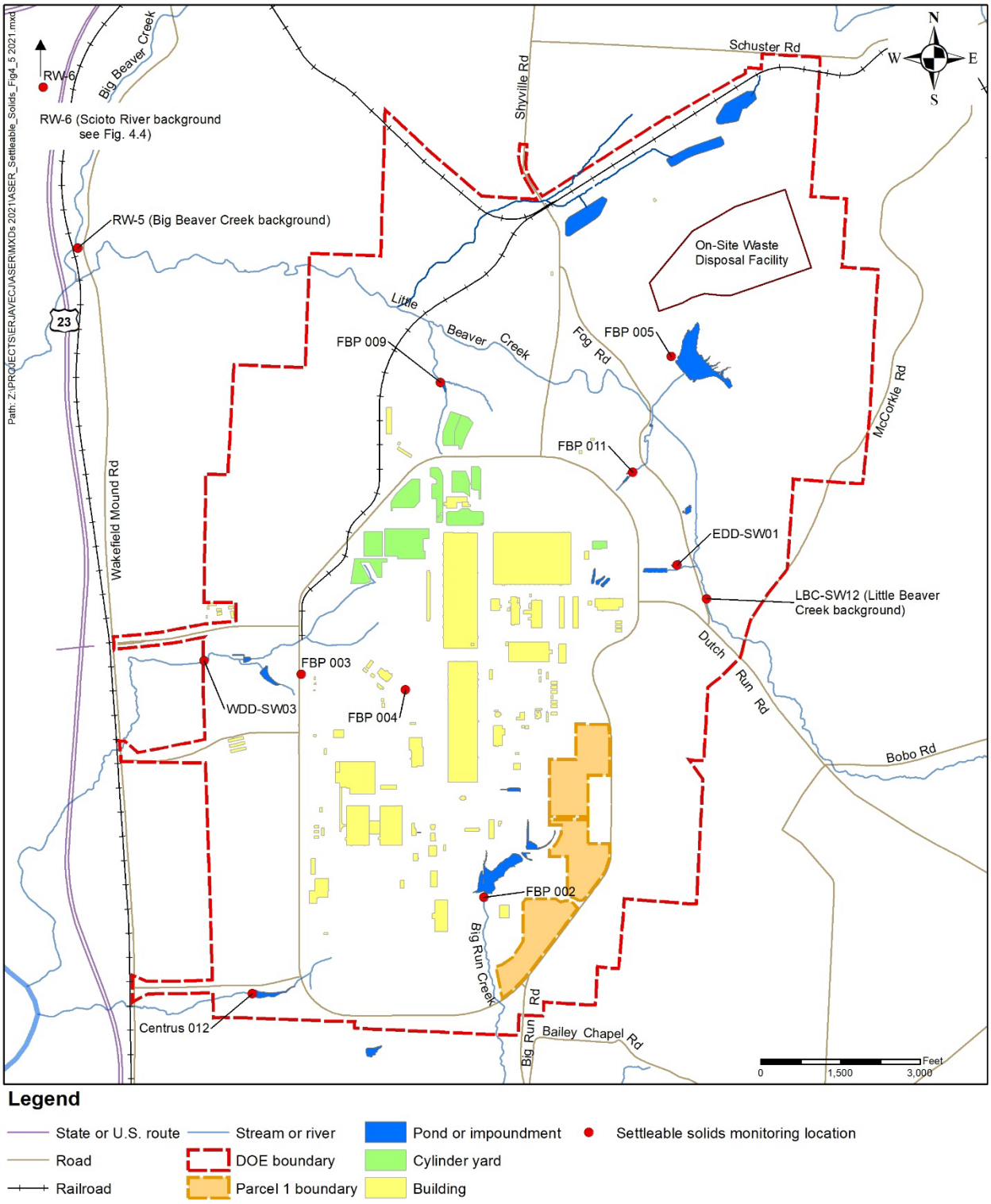

Figure 4.3. Settleable solids monitoring locations

Table 4.5. Maximum levels of radionuclides detected in local surface water in 2021

Radionuclide	Maximum activity[a]	Location	Derived concentration standard[b]	Percentage of derived concentration standard
Technetium-99	14.7	RW-3	390,000	0.0038%
Uranium-233/234	1.94	RW-7	1200	0.16%
Uranium-235/236	0.111	RW-7	1300	0.0085%
Uranium-238	0.504	RW-7	1400	0.036%

Notes:
[a]Results are shown in picocuries per liter.
[b]The derived concentration standard has been converted to picocuries per liter from units of microcurie per milliliter provided in the *Derived Concentration Technical Standard* (DOE 2021f).

4.4.2 Surface Water Estimated Dose

The Scioto River downstream from PORTS and the streams in the area around PORTS are not intentionally used by the public as sources of drinking water. However, a member of the public could be exposed to radionuclides present in surface water through recreational activities such as swimming.

A dose calculation has been developed consistent with the recreational use scenario in the *Methods for Conducting Human Health Risk Assessments and Risk Evaluations at the Portsmouth Gaseous Diffusion Plant* (DOE 2017b). This dose calculation assumes that a member of the public would swim in the Scioto River for 2 hours per day, 100 days per year. While swimming, a person is assumed to swallow 0.05 liters (less than 2 ounces) of water per hour. This is called incidental ingestion.

Surface water samples are collected semiannually at the Scioto River sampling location in Piketon upstream from PORTS discharges (RW-6) and at the downstream sampling location (RW-1A). Table 4.6 lists the average levels of radionuclides detected in the Scioto River in 2021.

Table 4.6. Average activity of radionuclides detected in the Scioto River in 2021

Radionuclide[a]	Upstream Piketon RW-6	Downstream RW-1A
Uranium-233/234	0.435	0.245
Uranium-238	0.443	0.240

Note:
[a]Average activity is shown in picocuries per liter.

The dose that a member of the public could receive from incidental ingestion of water due to swimming in the Scioto River in Piketon is 0.0014 mrem/year. The dose that a member of the public could receive from incidental ingestion of water due to swimming in the Scioto River downstream from PORTS discharges is 0.00075 mrem/year. Because the dose at the upstream location in Piketon is higher than at the downstream location, the dose to a member of the public from exposure to surface water is considered to be zero.

4.5 Sediment and Soil Monitoring and Estimated Dose

This section discusses the results of sediment and soil monitoring completed in and around PORTS in 2021. The results of this monitoring are used to assess the dose that a member of the public could receive from radionuclides detected in sediment and soil.

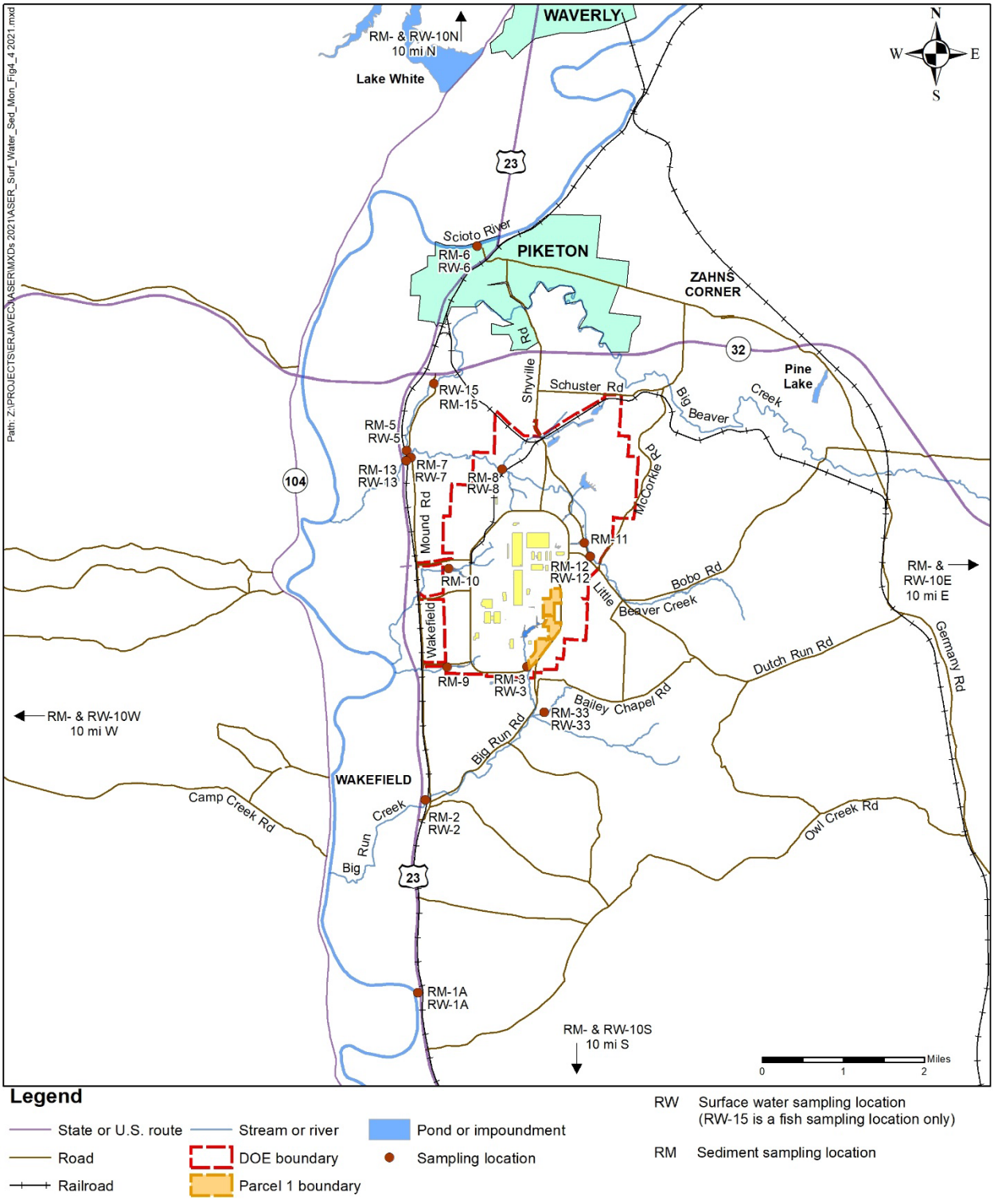

Figure 4.4. Local surface water and sediment monitoring locations

4.5.1 Sediment Monitoring

Sediment samples are collected from the locations upstream and downstream from PORTS where local surface water samples are collected, at the NPDES outfalls on the east and west sides of PORTS, and at a location on Big Beaver Creek upstream from the confluence with Little Beaver Creek (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, uranium, and uranium isotopes (uranium-233/234, uranium-235/236, and uranium-238) in accordance with the DOE *Environmental Monitoring Plan for the Portsmouth Gaseous Diffusion Plant* (DOE 2017c).

No transuranics were detected in the sediment samples collected in 2021. Technetium-99 is often detected in sediment samples collected at locations downstream from PORTS surface water discharges. In 2021, technetium-99 was detected at off-site sampling locations on Little Beaver Creek (RM-7) and Big Beaver Creek (RM-13). Technetium-99 was also detected on site at RM-10, RM-11, and RM-8.

Uranium and uranium isotopes occur naturally, but may also be present due to PORTS activities. Maximum detections of uranium and uranium isotopes in sediment samples were identified at RM-8, the on-site sampling location on Little Beaver Creek. Uranium and uranium isotopes detected in the 2021 samples have been detected at similar levels in previous sampling events from 2005 through 2020.

4.5.2 Sediment Estimated Dose

Because members of the public may use streams around PORTS for recreation, a dose calculation has been developed consistent with the recreational use scenario in the *Methods for Conducting Human Health Risk Assessments and Risk Evaluations at the Portsmouth Gaseous Diffusion Plant* (DOE 2017b). This dose calculation assumes that a member of the public could access off-site streams 100 days per year. While engaging in recreational activities, a person is assumed to swallow 200 milligrams per day (0.007 ounces per day) of sediment.

Sediment samples are collected annually at off-site locations on the Scioto River, Big Beaver Creek, Little Beaver Creek, and Big Run Creek. Samples are also collected from four background creeks approximately 10 miles from PORTS. Table 4.7 lists the radionuclides detected in Big Beaver Creek (RM-13) and the average levels of radionuclides detected at background locations in 2021. The Big Beaver Creek location is shown in Table 4.7 because this location had the highest levels of radionuclides detected at an off-site location in 2021.

Table 4.7. Radionuclides detected in sediment in 2021

Radionuclide[a]	Big Beaver Creek (RM-13)[b]	Average background[c]
Technetium-99	25.9	-0.0401U[d]
Uranium-233/234	6.68	0.438
Uranium-235/236	0.311	0.0199
Uranium-238	0.963	0.424

Notes:
[a]All values are shown in picocuries per gram.
[b]Duplicate sample
[c]Sampling locations RM-10N, RM-10S, RM-10E, and RM-10W
[d]The reported result is undetected (U). Negative results may be reported due to a statistical determination of the counts seen by a detector, minus a background count.

The dose that a member of the public could receive from incidental ingestion of sediment from the Big Beaver Creek at sampling location RM-13 is 0.045 mrem/year. The dose that a member of the public

could receive from incidental ingestion of sediment with average levels of radionuclides detected at background locations is 0.0048 mrem/year. When the dose from background levels of radionuclides is subtracted from the dose at sampling location RM-13 on Big Beaver Creek, the dose to a member of the public from exposure to sediment is 0.040 mrem/year.

4.5.3 Soil Monitoring

Soil samples are collected annually from 15 ambient air monitoring locations (see Figure 4.5). Samples are analyzed for transuranic radionuclides (americium-241, neptunium-237, plutonium-238, and plutonium-239/240), technetium-99, uranium, and uranium isotopes (uranium-233/234, uranium-235/236, and uranium-238) in accordance with the DOE *Environmental Monitoring Plan for the Portsmouth Gaseous Diffusion Plant* (DOE 2017c).

No transuranic radionuclides or technetium-99 were detected at the soil sampling locations in 2021. Uranium, uranium-233/234, uranium-235/236, or uranium-238 were detected at each of the sampling locations. Uranium and uranium isotopes are usually detected at similar levels at the off-site soil sampling locations, including the background location (A37), which suggests that the uranium detected in these samples occurs naturally.

4.5.4 Soil Estimated Dose

Off-site areas around PORTS could be used for recreation by members of the public, so a dose calculation has been developed consistent with the recreational use scenario in the *Methods for Conducting Human Health Risk Assessments and Risk Evaluations at the Portsmouth Gaseous Diffusion Plant* (DOE 2017b). This dose calculation assumes that a member of the public could access off-site soil sampling locations 350 days per year. While engaging in recreational activities, a person is assumed to swallow 200 milligrams per day (0.007 ounces per day) of soil.

Soil samples are collected annually at off-site locations and at a background location approximately 10 miles from PORTS in Otway (A37). Table 4.8 lists the radionuclides detected in soil at sampling location A12 (east of PORTS on McCorkle Road) and at the background location A37 in 2021. Location A12 is shown in Table 4.8 because this location had the highest levels of uranium detected at an off-site location in 2021.

Table 4.8. Radionuclides detected in soil in 2021

Radionuclide[a]	A12[b]	A37
Uranium-233/234	0.566	0.366
Uranium-235/236	0.0333	0.0146U[c]
Uranium-238	0.465	0.358

Notes:
[a]All values are shown in picocuries per gram.
[b]Duplicate sample
[c]The reported result is not detected (U).

The dose that a member of the public could receive from incidental ingestion of soil at sampling location A12 is 0.020 mrem/year. The dose that a member of the public could receive from incidental ingestion of soil at background location A37 is 0.014 mrem/year. When the dose from the background level of radionuclides at location A37 is subtracted from the dose at sampling location A12, the dose to a member of the public from exposure to radionuclides in soil is 0.006 mrem/year.

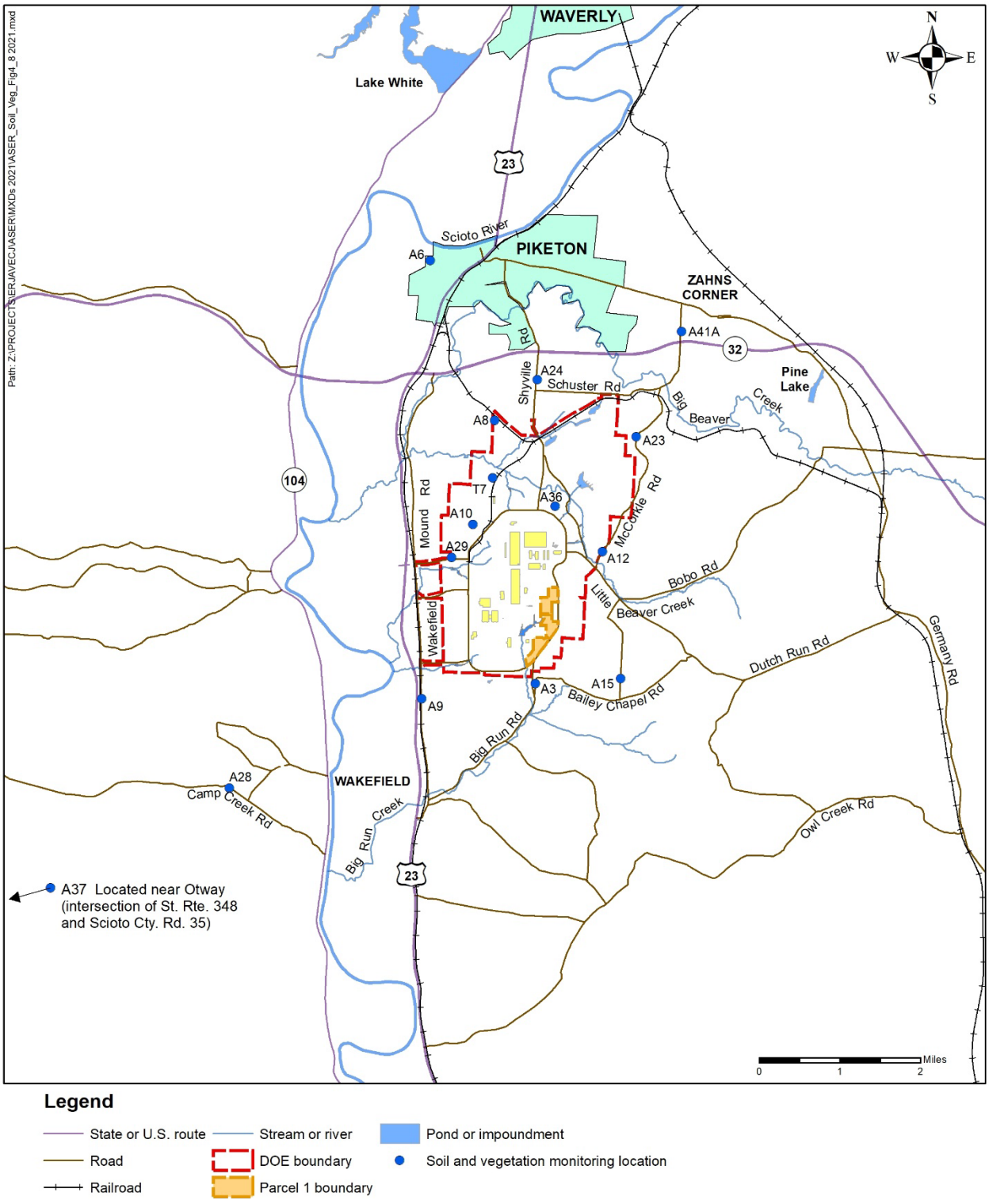

Figure 4.5. Soil and vegetation monitoring locations

4.6 External Radiation Monitoring and Estimated Dose

The external radiation monitoring program at PORTS measures both background radiation and radiation due to radiological sources at PORTS. These data are used to assess the dose that a member of the public could receive from radiation attributable to sources at PORTS.

4.6.1 External Radiation Monitoring

External radiation is measured at on-site and off-site locations in accordance with the DOE *Environmental Monitoring Plan for the Portsmouth Gaseous Diffusion Plant* (DOE 2017c). External radiation is measured continuously with thermoluminescent dosimeters at five locations near the DUF_6 cylinder storage yards (Figure 4.6), 12 of the ambient air monitoring stations (Figure 4.1), and seven additional on-site locations (Figure 4.6). Five locations around the perimeter of the On-Site Waste Disposal Facility project area are also monitored for external radiation.

Dosimeters are placed at the monitoring locations at the beginning of each quarter. They 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 new dosimeter replaces the device that was removed. 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.

The dosimeters measure background radiation and any radiation that may be present due to radiological sources at PORTS. Background radiation is primarily cosmic and terrestrial radiation, but also includes global fallout from historic nuclear testing or nuclear accidents such as Chernobyl. Background radiation varies at specific locations based on local geology, nearby structures that could provide shielding or contain naturally-occurring radiation, agricultural use of fertilizer, and many other factors.

Higher concentrations of naturally-occurring radionuclides are present in the shale and sandstone hills at the northern PORTS property line and surrounding PORTS than in the clay and silt present in the center of PORTS where the former gaseous diffusion building are located. Therefore, background radiation measured in areas where the Cuyahoga sandstone is present is expected to be higher than in areas where it is absent.

4.6.2 External Radiation Estimated Dose

Radiation is emitted from DUF_6 cylinders stored on site at PORTS in the cylinder storage yards in the northwest portion of the site near Perimeter Road. External radiation is measured at five locations along Perimeter Road near the boundaries of the cylinder storage yards.

Data from radiation monitoring at the cylinder yards are used to assess potential exposure to a representative on-site member of the public who drives on Perimeter Road. The radiological exposure to an on-site member of the general public is estimated as the time a person drives on Perimeter Road past the cylinder yards (one minute per trip, two trips per day, five workdays per week). Beginning on May 1, 2021, public access to the portion of Perimeter Road next to the cylinder yards was restricted, which means the public had access to Perimeter Road for only 4 months in 2021.

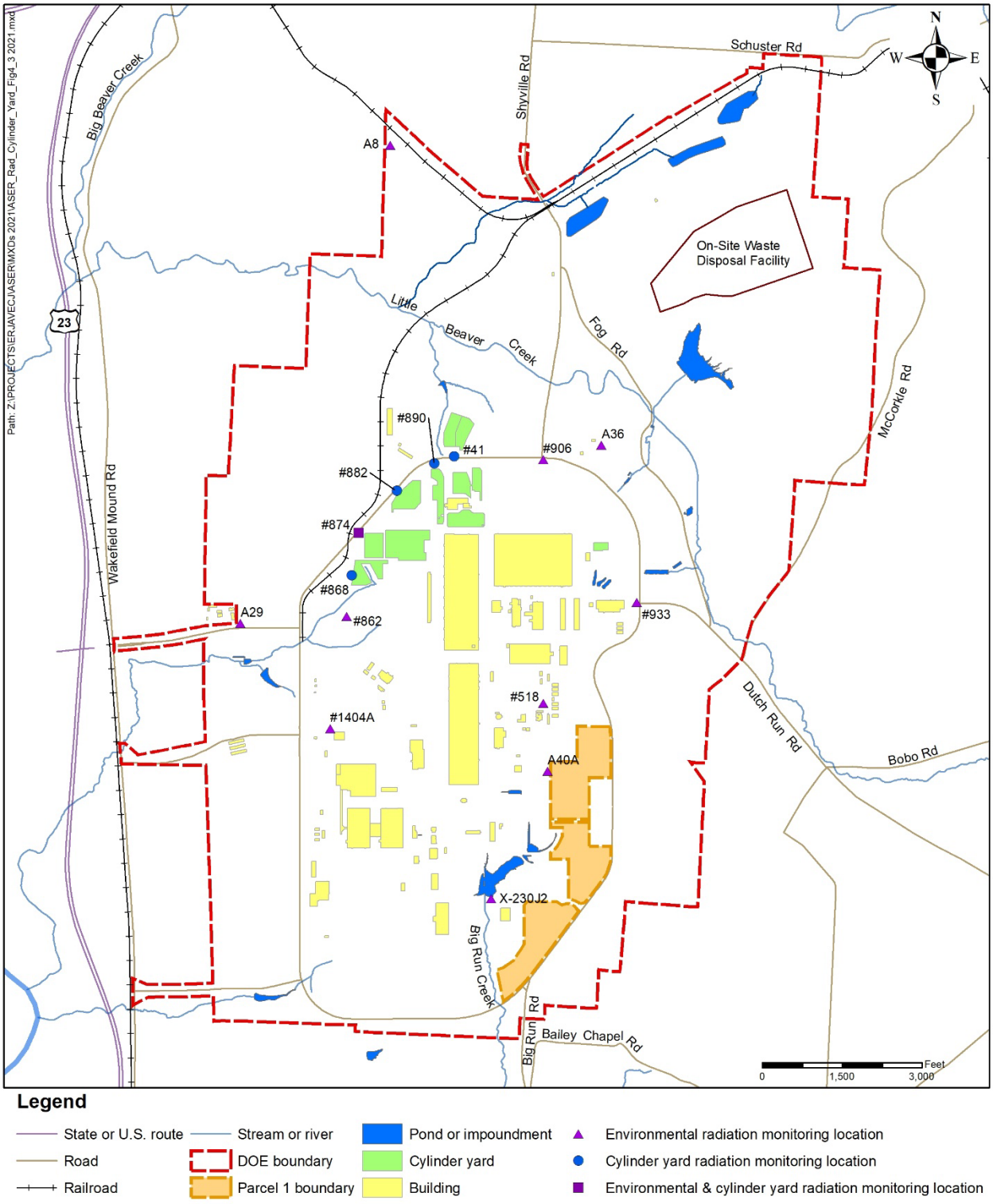

Figure 4.6. External radiation monitoring locations

In 2021, the average annual dose recorded by thermoluminescent dosimeters at the cylinder yards near Perimeter Road was 736 mrem/year, based on dosimeter measurements for an entire year at locations #41, #868, #874, #882, and #890. The average dose measured at off-site external radiation monitoring stations, considered the background dose, was 85 mrem/year. Although the total annual external radiation dose near the cylinder yards is high, a person would receive this dose only if they were present at the cylinder yards for 24 hours per day, 365 days per year. Access to the cylinder yard area is controlled by PORTS security forces, however, so a member of the public could not be continuously exposed to this level of radiation from the cylinder yards. External radiation levels associated with the cylinder yards diminish quickly to background levels with distance from the cylinder yards, as demonstrated by radiation measurements at other on-site and all off-site monitoring locations.

The net dose near the cylinder yards in 2021 was 651 mrem/year (the total dose of 736 mrem/year minus the background dose of 85 mrem/year). Based on the estimated time a person would drive on Perimeter Road near the cylinder yards from January through April of 2021, the dose to an on-site member of the public from radiation from the cylinder yards in 2021 is approximately 0.21 mrem/year.

Data collected in 2021 at the external radiation locations for the On-Site Waste Disposal Facility did not identify any issues to be addressed in the operation of the On-Site Waste Disposal Facility. The *2021 On-Site Waste Disposal Facility Annual Project Status Report* (DOE 2022b) and data collected in 2021 are available on the PEGASIS website here.

4.7 Monitoring of Plants and Animals and Estimated Dose

Wildlife and farm-raised animal products, including meat, eggs, and milk may become contaminated when animals ingest contaminated water, sediment, or other animals, or through direct contact with contaminated areas.

4.7.1 Wildlife, Animal Products, and Crops Monitoring

The *Environmental Monitoring Plan for the Portsmouth Gaseous Diffusion Plant* (DOE 2017c) requires biological monitoring to assess the uptake of radionuclides in selected local biota (vegetation, deer, fish, crops, milk, and eggs).

4.7.1.1 Vegetation

To assess the uptake of radionuclides in plant material, vegetation samples (primarily grass) are collected in the same areas where soil samples are collected at the ambient air monitoring stations (see Figure 4.5). Samples are collected annually and analyzed for transuranic radionuclides (americium-241, neptunium-237, plutonium-238, and plutonium-239/240), technetium-99, uranium, and uranium isotopes (uranium-233/234, uranium-235/236, and uranium-238).

Uranium, uranium-233/234, or uranium-238 were detected in the vegetation samples collected at on-site sampling locations A10, A29, A36, A8, and T7. Uranium and uranium-238 were also detected at off-site sampling locations A6 (north of PORTS in Piketon), A9 (southwest of PORTS on old US Route 23), A3 (south of PORTS on Bailey Chapel Road), and A41A (northwest of PORTS at Zahns Corner). Uranium and uranium isotopes are detected occasionally in vegetation samples.

4.7.1.2 Deer

Samples of liver, kidney, and muscle from deer killed on site in motor vehicle collisions are collected annually, if available. Samples are analyzed for transuranic radionuclides (americium-241, neptunium-237, plutonium-238, and plutonium-239/240), technetium-99, uranium, and uranium isotopes

(uranium-233/234, uranium-235/236, and uranium-238). Deer samples were collected in June of 2021. No radionuclides were detected in these deer samples.

4.7.1.3 Fish

Fish samples are collected annually, if available, from locations on Little Beaver Creek (RW-8), Big Beaver Creek (RW-13 and RW-15), and the Scioto River (RW-1A and RW-6), as shown on Figure 4.4. In 2021 fish samples were collected from Little Beaver Creek (RW-8) and Big Beaver Creek (RW-13) and analyzed for transuranic radionuclides (americium-241, neptunium-237, plutonium-238, and plutonium-239/240), technetium-99, uranium, and uranium isotopes (uranium-233/234, uranium-235/236, and uranium-238). No radionuclides were detected in the fish samples collected during 2021.

4.7.1.4 Crops

In 2021 samples of crops including corn, tomatoes, and grapes were collected from three off-site locations near PORTS. The samples were analyzed for transuranic radionuclides (americium-241, neptunium-237, plutonium-238, and plutonium-239/240), technetium-99, uranium, and uranium isotopes (uranium-233/234, uranium-235/236, and uranium-238). No radionuclides were detected in these crop samples.

4.7.1.5 Milk and Eggs

Samples were collected from milk and eggs produced near PORTS in 2021. The samples were analyzed for transuranic radionuclides (americium-241, neptunium-237, plutonium-238, and plutonium-239/240), technetium-99, uranium, and uranium isotopes (uranium-233/234, uranium-235/236, and uranium-238). No radionuclides were detected in these milk and egg samples.

4.7.2 Wildlife, Animal Products, and Crops Estimated Dose

Methods for Conducting Human Health Risk Assessments and Risk Evaluations at the Portsmouth Gaseous Diffusion Plant (DOE 2017b) provides exposure scenarios for ingestion of radionuclides detected in deer and fish. If radionuclides are detected in deer or fish, dose is calculated in accordance with the exposure scenarios and assumptions provided in this document. No radionuclides were detected in deer and fish samples collected in 2021.

Exposures to radionuclides that could be present in vegetation (grass) and locally produced crops, milk, and eggs are captured in the food chain models associated with the CAP-88 PC air program discussed in Section 4.3.2.

4.7.3 Biota Monitoring and Estimated Dose

DOE Order 458.1 sets absorbed dose rate limits for aquatic animals, riparian animals (animals that live on the banks of a river or in wetlands adjacent to a body of water), terrestrial plants, and terrestrial animals. Radionuclides from both natural and man-made sources may be found in environmental media such as water, sediments, and soils. Contaminants may accumulate in animals from eating contaminated feed, drinking contaminated water, and breathing contaminated air, and in fish when they eat contaminated food and live in contaminated waters. Because plant and animal populations residing in or near, or taking food or water from these media may be exposed to a greater extent than humans, DOE prepared technical standard DOE-STD-1153-2019, *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota* (DOE 2019). This standard provides methods and guidance for evaluating doses from ionizing radiation to populations of aquatic animals, riparian animals (those that live along banks of streams or rivers), terrestrial plants, and terrestrial animals. It was used to demonstrate compliance with these limits.

4.7.3.1 Aquatic and Riparian Animals Monitoring

Analytical data for surface water and sediment samples collected during 2021 from Big Run Creek on the south side of the PORTS reservation (surface water sampling location BRC-SW05 and sediment sampling location RM-3) were used to assess the dose limits for aquatic and riparian animals (1 rad/day to aquatic animals and 0.1 rad/day to riparian animals). These locations were selected because levels of radionuclides detected in surface water and sediment from these locations were among the highest detected in samples collected in 2021. Use of maximum detections of radionuclides is required when using the general screening phase to estimate dose as described in the following section. Section 6.3.3 and Section 4.5.1 provide more information about these surface water and sediment sampling programs, respectively. The maximum levels of radionuclides (technetium-99 and uranium isotopes) are shown in Table 4.9.

Table 4.9. Detections of radionuclides used in dose assessment for aquatic and riparian animals

Radionuclide[a]	BRC-SW01	RM-3
Technetium-99	1710	0.118U[b]
Uranium-233/234	86.1	0.535
Uranium-235/236	2.83	0.0263
Uranium-238	2.31	0.326

Note:
[a]Values are shown in picocuries per liter for BRC-SW01 and picocuries per gram for RM-3.
[b]The reported result is undetected (U).

4.7.3.2 Aquatic and Riparian Animals Estimated Dose

DOE used the general screening phase to determine if radiation doses to aquatic and riparian animals were in compliance with the specified dose limits (1 rad/day to aquatic animals and 0.1 rad/day to riparian animals). The maximum levels of radionuclides listed in Table 4.9 were entered in the RESRAD-BIOTA software designed to implement the DOE Technical Standard (DOE 2019). The software compares concentration data from PORTS environmental sampling with biota concentration guide screening values to estimate maximum doses to biota. If the maximum levels of radionuclides detected at the selected PORTS sampling locations result in an output from the software calculations of less than 1, the doses to aquatic and riparian animals are within the dose limits.

In 2021, the RESRAD-BIOTA software output for the maximum levels of radionuclides detected at sampling locations BRC-SW05 in surface water and RM-3 in sediment was 0.453, which is less than 1. Therefore, the assessment indicates that the levels of radionuclides detected in water and sediment at these locations did not result in a dose of more than 1 rad/day to aquatic animals and 0.1 rad/day to riparian animals.

4.7.3.3 Terrestrial Plants and Animals Monitoring

Analytical data for surface water and soil samples collected during 2021 from the northern side of the PORTS reservation (surface water sampling location RW-8 and soil sampling location A8) were used to assess the dose limits for terrestrial plants and animals. These locations were selected because levels of radionuclides detected in surface water and soil from these locations were among the highest detected in samples collected in 2021. Use of maximum detections of radionuclides is required when using the general screening phase to estimate dose as described in the following section. Section 4.4.1.6 and Section 4.5.3 provide additional information about these surface water and soil sampling programs, respectively.

No transuranic radionuclides were detected in 2021 from samples collected at RW-8 in surface water and A8 in soil. Table 4.10 shows the maximum levels of technetium-99 and uranium isotopes.

Table 4.10. Detections of radionuclides used in dose assessment for terrestrial plant and animals

Radionuclide[a]	RW-8	A8
Technetium-99	4.46	-0.134U[b]
Uranium-233/234	1.56	1.12
Uranium-235/236	0.0818	0.0572
Uranium-238	0.486	0.971

Note:
[a]Values are shown in picocuries per liter for RW-8 and picocuries per gram for A8.
[b]The reported result is undetected (U). Negative results may be reported due to a statistical determination of the counts seen by a detector, minus a background count.

4.7.3.4 Terrestrial Plants and Animals Estimated Dose

DOE used the general screening phase to determine if radiation doses to terrestrial plant and animals were in compliance with the specified dose limits (1 rad/day to terrestrial plants and 0.1 rad/day to terrestrial animals). The maximum levels of radionuclides listed in Table 4.10 were entered in the RESRAD-BIOTA software designed to implement the DOE Technical Standard (DOE 2019). The software compares concentration data from PORTS environmental sampling with biota concentration guide screening values to estimate maximum doses to biota. If the maximum levels of radionuclides detected at the selected PORTS sampling locations result in an output from the software calculations of less than 1, the doses to terrestrial plants and animals are within the dose limits.

In 2021, the RESRAD-BIOTA software output for the maximum levels of radionuclides detected at sampling locations RW-8 in surface water and A8 in soil was 0.00086, which is less than 1. Therefore, the assessment indicates that the levels of radionuclides detected in water and soil at these locations did not result in a dose of more than 1 rad/day to terrestrial plants and 0.1 rad/day to terrestrial animals.

4.8 Unplanned Radiological Releases

No unplanned releases of radionuclides took place at PORTS in 2021.

4.9 Release of Property Containing Residual Radioactive Material

Real property is defined as land, anything permanently affixed to the land such as buildings and fences, and things attached to buildings such as light fixtures, plumbing, heating fixtures, or other items that would be personal property if not attached. Personal property is defined as property of any kind, except for real property.

DOE and its contractors use the processes, guidelines, and limits in DOE Order 458.1 and associated guidance for clearance of property with residual radioactive material. Release criteria for surface contamination limits as specified in DOE Order 458.1 are used for clearance of objects with potential surface contamination, while specific authorized limits have been derived to control whether items with potential volumetric contamination are released. Property that may contain residual radioactive material will not be cleared from PORTS unless the level of radiation for the property is demonstrated to be within acceptable limits. Property clearance requirements are governed by procedures established by each DOE

contractor. Section 2.2.2.1 provides the authorized limits used by DOE contractors at PORTS. The type and quantity of releases for PORTS contractors are discussed below.

4.9.1 Fluor-BWXT Portsmouth Property Releases

Fluor-BWXT Portsmouth uses pre-approved authorized limits established by DOE orders to evaluate and release materials defined as personal property (see Section 2.2.2.1). Fluor-BWXT Portsmouth also handles releases of personal property for Portsmouth Mission Alliance. In 2021, Fluor-BWXT Portsmouth authorized approximately 1,435 release requests for materials or items of personal property. These include vehicles, equipment, waste and recyclables such as batteries, light bulbs, used oil, and construction debris, and other materials.

DOE has approved authorized limits for real property release at PORTS (see Section 2.2.2.1). DOE did not transfer any real property at PORTS in 2021.

4.9.2 Mid-America Conversion Services Property Releases

In 2021, Mid-America Conversion Services authorized approximately 56 requests for materials to be released off site. These releases included vehicles, equipment, waste and recyclables (batteries, light bulbs, used oil, waste water and debris from the hydrogen fluoride tank relining project, and construction debris), contractor equipment, equipment sent out for calibration, and other items that met the criteria to be released off site.

Mid-America Conversion Services authorized approximately 133 items that met the criteria for exemption in 2021. These items included contractor equipment that was surveyed prior to coming on site, was on site for a short time, and never entered an area controlled for radioactive material; new and unused items sent to Mid-America Conversion Services by mistake; new, unused items that had expired or needed to be returned to the vender for repair or calibration; and other items that met the criteria for exemption. All of these items were thoroughly evaluated before a determination was made.

In 2021, Mid-America Conversion Services did not process any DUF_6. However, Mid-America Conversion Services continued off-site shipment of aqueous hydrogen fluoride produced by the DUF_6 Conversion Facility the previous year. Each shipment met the release limit of less than 3 picocuries per milliliter (0.003 pCi/L) of total uranium activity. Approximately 15,070 gallons of aqueous hydrogen fluoride were shipped off site in 2021.