

## 5.0 Air Pathway

This chapter describes the air pathway monitoring program used to track and evaluate airborne emissions from the Fernald site. It includes a discussion of radiological air particulates, radon, and direct radiation monitoring. In addition, this chapter provides a summary of radiological emissions from stacks and vents, as well as non-radiological emissions associated with the combustion of fossil fuel.

### Results in Brief: 2002 Air Pathway

**Radiological Air Particulates** - Data collected from fenceline air monitoring stations show that average concentrations for each radionuclide monitored were less than one percent of the corresponding DOE-derived concentration guide.

**Radon** - There were no exceedances of the DOE standard (3 pCi/L annual average above background) at the site fenceline and off-property locations. The maximum annual average concentration at the FCP fenceline measured by continuous radon monitors was 0.3 pCi/L above background.

**Direct Radiation** - Direct radiation measurements increased slightly at the site fenceline and the K-65 Silos boundary when compared to 2001. However, the K-65 Silos boundary levels are still approximately 50 percent lower than the radiation levels measured in 1991 prior to the addition of the bentonite layer within the K-65 Silos. These measurements are consistent with the fact that the K-65 Silos contain radium and its decay products, which contribute to direct radiation levels.

**Boiler Plant** - There were no opacity excursions reported during 2002.

Air pathway monitoring focuses on airborne pollutants that may be carried from the site as a particle or gas, and how these pollutants are distributed in the environment. The physical form and chemical composition of pollutants influence how they are dispersed in the environment and how they may deliver radiation doses. For example, fine particles and gases remain suspended, while larger, heavier particles tend to settle and deposit on the ground. Chemical properties determine whether the pollutant will dissolve in water, be absorbed by plants and animals, or settle in sediment and soil.

Monitoring the air pathway is critical to ensuring the continued protection of the public and the environment during the remediation process because airborne contaminants can potentially migrate beyond the Fernald site. The site's air monitoring approach (presented in the IEMP) provides an ongoing assessment of the collective emissions originating from remediation activities. The results of this assessment are used to provide feedback to remediation project organizations regarding the sitewide effectiveness of project-specific emission controls relative to DOE, EPA, and OEPA standards. In response to this feedback, project organizations modify or maintain emission controls.

### 5.1 Remediation Activities Affecting the Air Pathway

When the mission of the Fernald site changed from production to remediation, work activities also changed. This change in work scope changed the characteristics of sources that emit pollutants in the environment via the air pathway. During the production years, the primary emission sources were point sources (i.e., stacks and vents) from process facilities. Today the dominant emission sources are associated with remediation activities in the form of fugitive emissions (i.e., excavation, hauling and processing of waste and contaminated soil, demolition of production facilities, and general construction activities supporting the remediation process), and the storage of radon-generating waste materials.

The following primary emission sources were active during 2002:

- Decontamination and Demolition Project activities, most notably Plant 2/3 and Plant 8 (Operable Unit 3).
- Excavation of the waste pits and the associated waste processing and rail car load-out operations at the Waste Pits Remedial Action Project (Operable Unit 1).
- Excavation of contaminated soil and debris (Operable Unit 5).
- Construction activities associated with the on-site disposal facility including excavation, screening, and hauling activities in the on-site disposal facility borrow area (Operable Unit 2).
- Transportation and placement of contaminated material in the on-site disposal facility and interim storage at the on-site material transfer area (Operable Unit 2).
- Start-up testing of the RCS (Operable Unit 4).

Each project is responsible for designing and implementing engineered and administrative controls for each remediation activity. The fugitive emissions control policy mandates that fugitive emissions be visually monitored and controls be implemented as necessary. The following types of controls are used to keep point source and fugitive emissions to a minimum.

- **Engineered Controls** - Typical engineered controls include physical barriers, wetting agents, filtration, fixatives, sealants, dust suppressants and control, collection, and treatment systems. Engineered designs help reduce point source and fugitive emissions by using the best available technology. The selection of the best available technology for controlling project emissions is conducted during the design process and frequently includes the evaluation of several treatment alternatives.
- **Administrative Controls** - Typical administrative controls include management and control procedures, record keeping, periodic assessments, and establishing speed limits, control zones, and construction zones.

## 5.2 Air Monitoring Program Summary for 2002

The site's air monitoring program, as defined in the IEMP, is comprised of three distinct components:

- Radiological air particulate monitoring.
- Radon monitoring.
- Direct radiation monitoring.

Each component of the air monitoring program is designed to address a unique aspect of air pathway monitoring, and as such, reflects distinct sampling methodologies and analytical procedures. The key elements of the air monitoring program design are:

- **Sampling** – Sample locations, frequency, and the constituents were selected to address DOE and EPA requirements for assessing radiological emissions from the Fernald site. Key considerations in the design of the sampling program included prevailing wind directions, location of potential sources of emissions, and the location of off-property receptors. The IEMP program includes monitoring radiological air particulates at 19 locations, radon measurements at 34 locations, and direct radiation at 37 locations on and off the property.
- **Data Evaluation** – The data evaluation process focuses on tracking and trending data against historical ranges and DOE, EPA, and OEPA standards. Each section in this chapter presents an evaluation of data and a comparison to applicable standards and guidelines.
- **Reporting** – All data are reported through the IEMP program and annual site environmental reports.

### 5.3 Radiological Air Particulate Sampling Results

As described in the IEMP, a network of 19 high-volume air particulate monitoring stations is used to measure the collective contributions from all fugitive and point source particulate emissions from the site. This monitoring network includes 16 monitoring locations on the fenceline and two background locations. In addition, one thorium monitor was operated on the western fenceline. Figure 5-1 provides the locations of the IEMP air monitoring stations.

The sampling and analysis program for the 16 fenceline and two background locations consists of biweekly total uranium, isotopic thorium, and total particulate analyses in addition to a quarterly composite sample. The quarterly composite sample is analyzed for the expected major contributors (i.e., uranium, thorium, and radium) to the radiological air inhalation dose at the site's boundary. The thorium monitor includes biweekly particulate and isotopic thorium analyses. Analytical data from this program are used to assess the effectiveness of the emission control practices throughout the year to ensure particulate emissions remain below health protective standards.

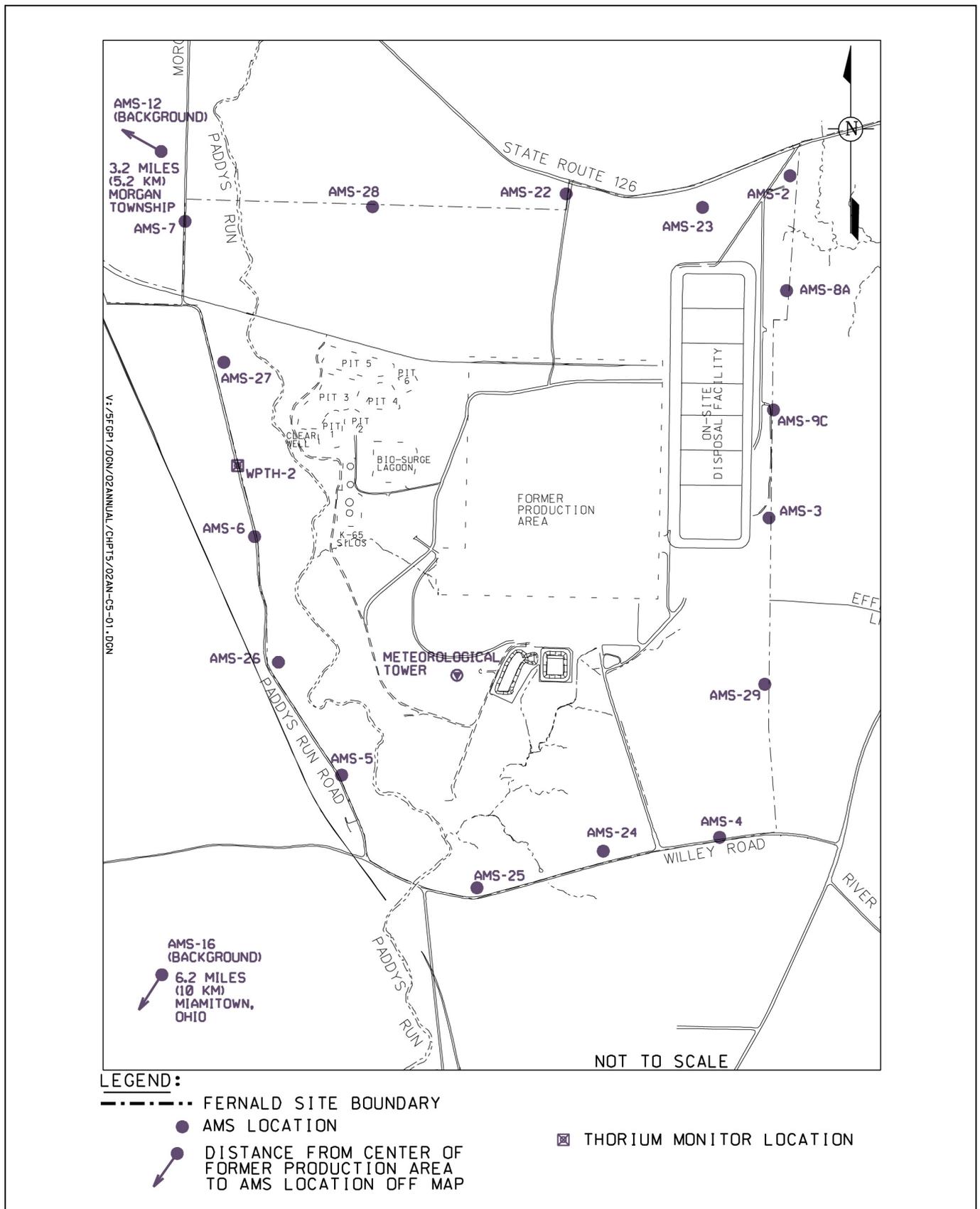


Figure 5-1. Radiological Air Monitoring Locations

The radiological air particulate monitoring program is designed to demonstrate compliance with the following:

- NESHAP Subpart H requirements which stipulate that radionuclide emissions (not including radon) to the ambient air from DOE facilities shall not exceed those amounts that would cause any member of the public to receive an effective dose equivalent of 10 mrem in a year above background levels. This dose is reported in the annual NESHAP Subpart H compliance report and is included as Appendix D of this report.
- DOE Order 5400.5, Radiation Protection of the Public and Environment, guidelines for concentrations of radionuclides in air emissions. These guidelines, referred to as derived concentration guide values, are concentrations of radionuclides that, under conditions of continuous exposure for one year by one exposure mode (e.g., inhalation or ingestion), would result in a dose of 100 mrem to the public. These derived concentration guide values are not limits, but serve as reference values to assist in evaluating the radiological air particulate data.

Table 5-1 presents a summary of the minimum, maximum, and average concentrations for total uranium, thorium-230, and total particulate in 2002 and 2001 based on the biweekly sample results used for monitoring air emission trends. For 2002 the annual average concentrations of total uranium at all fenceline air monitoring stations were less than one percent of the DOE-derived concentration guide value (0.1 picoCuries per cubic meter [pCi/m<sup>3</sup>]). In 2002 total uranium at all air monitoring locations ranged from less than detectable concentrations to a maximum concentration of 1.9E-03 pCi/m<sup>3</sup> at AMS-8A. For comparison, background locations ranged from less than detectable to 6.3 E-05 pCi/m<sup>3</sup> at AMS-16.

**TABLE 5-1**  
**SUMMARY OF BIWEEKLY TOTAL URANIUM, TOTAL PARTICULATE,**  
**AND THORIUM-230 CONCENTRATIONS IN AIR**

Location	2002 Total Uranium (pCi/m <sup>3</sup> )	2001 Total Uranium (pCi/m <sup>3</sup> )	2002 Total Particulate (µg/m <sup>3</sup> )	2001 Total Particulate (µg/m <sup>3</sup> )	2002 Thorium-230 (pCi/m <sup>3</sup> )	2001 Thorium-230 (pCi/m <sup>3</sup> )
<b>Fenceline Locations</b>						
Minimum	0.0E+00	0.0E+00	13	3.0	0.0E+00	0.0E+00
Maximum	1.9E-03	9.9E-04	94	82	5.8E-04	7.4E-04
Average	1.1E-04	1.1E-04	34	33	6.2E-05	5.1E-05
<b>Background Locations</b>						
Minimum	0.0E+00	0.0E+00	4	14	0.0E+00	0.0E+00
Maximum	6.3E-05	5.6E-05	100	62	1.5E-04	4.2E-05
Average	1.8E-05	2.0E-05	27	34	1.1E-05	9.5E-06

Biweekly thorium monitoring at the fenceline provides timely feedback on project engineered and administrative controls that are implemented to control fugitive emissions, primarily at the Waste Pits Remedial Action Project. The fenceline concentrations of thorium-230 (the primary thorium isotope of concern in the waste pit material being excavated) ranged from less-than-detectable to 5.8 E-04 pCi/m<sup>3</sup>, which was detected at AMS-3. For comparison, background locations ranged from less than detectable to 1.5 E-04 pCi/m<sup>3</sup> at AMS-16.

In addition to the total uranium and isotopic thorium analyses, total particulate measurements are also obtained from each filter every two weeks as summarized in Table 5-1. Total particulate concentrations at the fenceline ranged from 13 micrograms per cubic meter milligrams per cubic meter (mg/m<sup>3</sup>) to a maximum of 94 mg/m<sup>3</sup> at AMS-9C. There are no general or site-specific regulatory limits associated with total particulate measurements used in the data evaluation process.

Total particulate, total uranium, and thorium-230 data were collectively evaluated to identify any increasing trends that may be related to remediation activities. Several temporary increases of these three constituents were observed at various monitoring locations; however, the short-lived increases did not pose a potential exceedance of the NESHAP dose limit of 10 mrem or DOE guidelines. The majority of increases in total uranium and thorium-230 concentrations were detected at some of the air monitoring stations on the eastern fenceline (AMS-3, AMS-8A, and AMS-9C) during the first quarter of 2002. Figures 5-2 and 5-3 show total uranium and thorium-230 concentrations, respectively, at the selected eastern fenceline locations. These temporary increases were due to the remediation activities associated with the Waste Pits Remedial Action Project, on-site disposal facility and its associated material transfer area, and Decontamination and Demolition Project activities. The radiological air particulate data are discussed with remediation project personnel to ensure that emission controls are operating as expected and to consider actions as necessary. Appendix C, Attachment 1, of this report provides graphical displays of the 2002 total uranium, thorium-230, and total particulate data.

Quarterly composite air filter samples were formed from the biweekly samples at each IEMP air monitoring station during 2002 to determine the radiological air inhalation dose for each location. The samples were analyzed for isotopes of radium, thorium, and uranium. The quarterly results were used to track compliance with the NESHAP 10-mrem dose limit throughout the year and to demonstrate compliance with the limit at the end of 2002. The maximum dose associated with the quarterly composite results for 2002 was 0.8 mrem (compared to the 10 mrem limit) and occurred at AMS-9C. The composite results from the fenceline monitors show that, on average, thorium isotopes contribute 61 percent of the dose from 2002 airborne emissions. Isotopes of uranium and radium account for 32 and 6 percent of the dose, respectively. The higher percentage of dose from thorium isotopes is a result of thorium-230 becoming the major dose contributor through fugitive emissions from the Waste Pits Remedial Action Project operations. Thorium-230 became the major dose contributor beginning in 2000 with the commencement of Waste Pits Remedial Action Project excavation activities. Given the methods required to excavate, transport, and process waste pit material, fugitive emissions were expected to increase the average concentration of thorium-230 at the fenceline. Although the project uses several environmental compliance-based dust abatement practices and controls, some fugitive emissions are expected to be generated from the project based on the large-scale waste handling operations. Chapter 6 and Appendix D of this report provide more detailed information on the dose associated with the composite results.

The annual average radionuclide concentrations at each air monitoring station, as determined from the quarterly composite results, were compared to the DOE-derived concentration guide values. At each monitoring station, the annual average radionuclide concentrations were below one percent of the corresponding DOE-derived concentration guide values.

The WPTH-2 fenceline monitor was installed in late 1998 on the west property boundary to specifically monitor thorium emissions from the Waste Pits Remedial Action Project on a biweekly basis. Measured airborne concentrations of thorium-228 and thorium-232 were comparable to background concentrations throughout 2002. These fenceline data reflect the fact that, in comparison to thorium-230, the concentrations of thorium-228 and thorium-232 in the waste pit material are relatively low thus far into the excavation of waste. The Waste Pits Remedial Action Project operations are not expected to significantly impact the fenceline concentrations of thorium-228 and thorium-232. Appendix C, Attachment 1, of this report provides graphical displays of the isotopic thorium data from the WPTH-2 monitor.

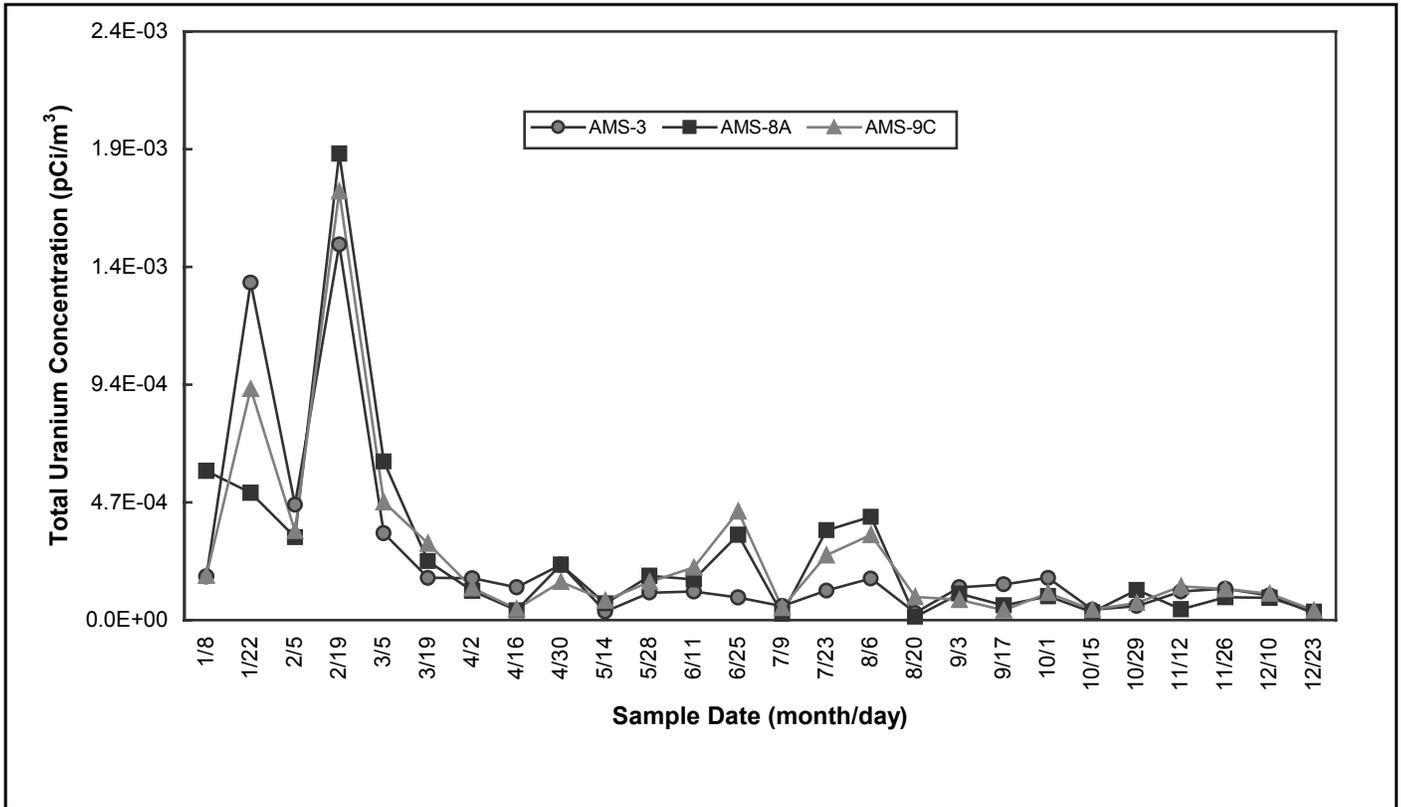


Figure 5-2. 2002 Total Uranium Concentrations in Air at Selected East Fenceline Monitors (AMS-3, AMS-8A, and AMS-9C)

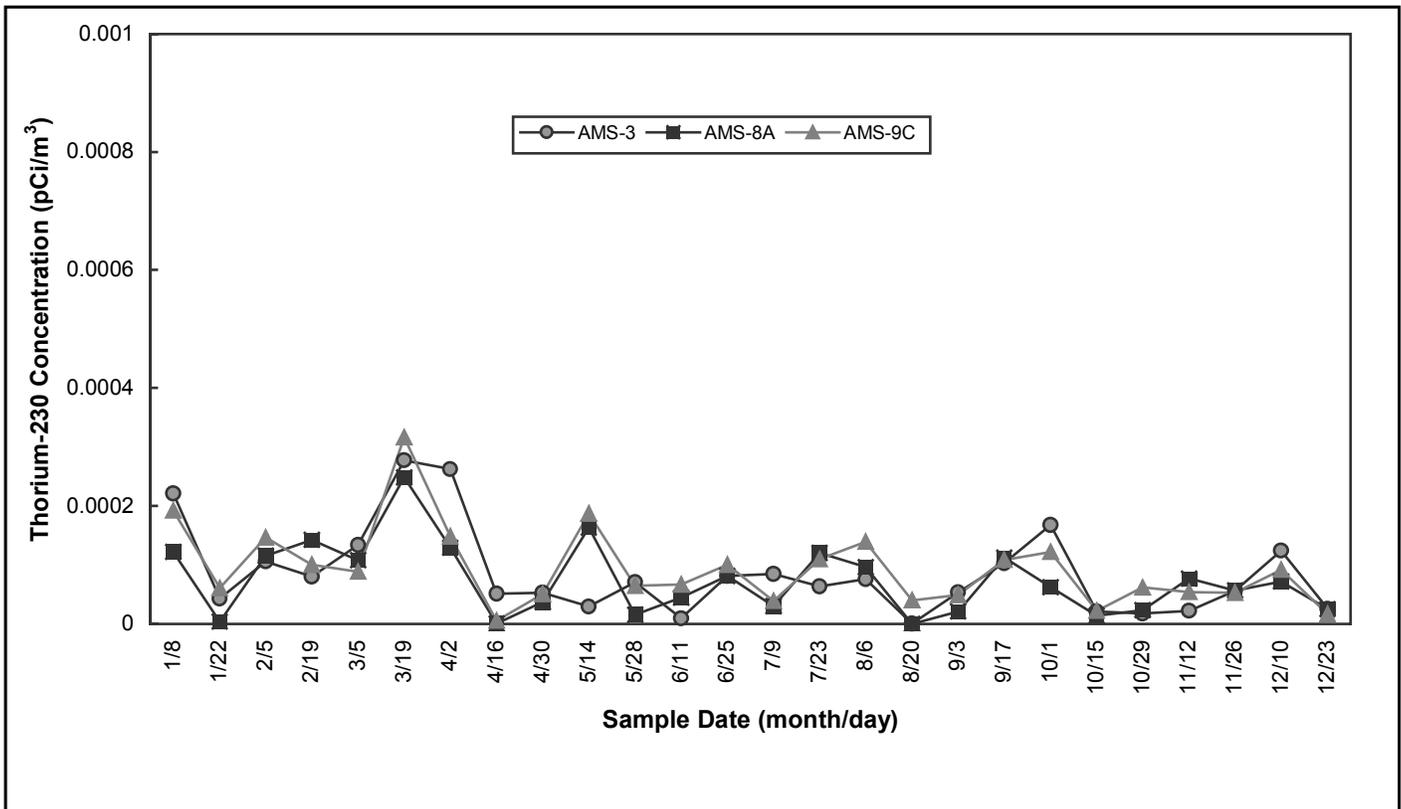


Figure 5-3. 2002 Thorium-230 Concentrations in Air at Selected East Fenceline Monitors (AMS-3, AMS-8A, and AMS-9C)

## 5.4 Radon Monitoring

Radon-222 (referred to in this section as radon) is a naturally occurring radioactive gas. It is produced by radioactive decay of radium-226, which can be found in varying concentrations in the earth's crust. Radon is also chemically inert, and tends to diffuse from the earth's crust to the atmosphere. The concentration of radon in the environment is dynamic and exhibits daily, seasonal, and annual variability.

Many factors influence the concentration of radon in the environment, including the distribution of radium-226 in the ground, porosity of the soil, weather conditions, etc. For instance, radon diffusion from the ground is minimized by the presence of precipitation and snow cover. Alternatively, elevated temperatures and the absence of precipitation can produce cracks in the ground and changes in porosity that increase the rate at which radon escapes. Summary level meteorological data from 2002 are presented in Appendix C, Attachment 4, and Figures 1-7 through 1-10 of this report.

Environmental radon concentrations are also influenced by atmospheric conditions. During periods of calm winds and temperature inversions (the air near the earth's surface is cooler than the air above it), air is held near the earth's surface, minimizing the mixing of air. Consequently, when these inversions occur, radon's movement is limited vertically and concentrations tend to increase near the ground.

Waste material that produces radon is stored at the Fernald site. This waste was generated from uranium extraction processes performed decades ago and contains radium-226. This material is contained in K-65 Silos 1 and 2, and Silo 3 (part of the Operable Unit 4 remediation) and the waste pits (currently being remediated per the Operable Unit 1 Record of Decision).

DOE Order 5400.5, Radiation Protection of the Public and the Environment, defines radiological protection requirements, guidelines for cleanup of residual radioactive material, management of resulting wastes and residues, and the release of radiological property. Radon limits at interim storage facilities (such as at the Fernald site) are also defined under DOE Order 5400.5 and must not exceed:

- 100 pCi/L at any given location and any given time.
- Annual average concentration of 30 pCi/L (above background) over the facility.
- Annual average concentration of 3 pCi/L (above background) at and beyond the facility fenceline.

Figure 5-4 illustrates the continuous radon-monitoring network used in 2002 for determining compliance with the above limits. The continuous monitoring network provides frequent feedback to remediation projects, regulatory agencies, and stakeholders on trends in ambient radon concentrations, while providing sufficient radon monitoring to ensure compliance with DOE Order 5400.5 requirements. Access to real-time radon monitoring data from selected continuous radon monitoring locations is available at the Public Environmental Information Center.



In general, monitoring locations were selected near radon-emitting sources, at the property fenceline, and at background locations. The FFA identifies additional environmental radon monitoring locations, as well as continuous measurement of radon concentrations in the headspace of the K-65 Silos. DOE guidance and EPA air monitor siting criteria were considered when selecting monitoring locations.

#### **5.4.1 Continuous Radon Monitors**

Continuous radon monitors use scintillation cells to continuously monitor environmental radon concentrations based on an hourly average. Radon gas in ambient air diffuses into the scintillation cell through a foam barrier without the aid of a pump (this technique is called passive sampling). Inside the cell, radon decays into more radioactive material (daughter products), which give off alpha particles. The alpha particles interact with the scintillation material inside the cell, producing light pulses. The light pulses are amplified and counted. The number of light pulses counted is proportional to the radon concentration inside the cell.

Continuous monitors reveal important information regarding the dynamics of radon concentrations at different times during the day and at various locations on and off site. These monitors allow for timely review of radon concentrations, which may indicate concentrations are significantly changing from day to day and week to week. However, the use of these monitors is restricted by certain conditions. For example, potential monitoring sites are limited by the availability of electricity.

Table 5-2 provides monthly average radon concentration data from the continuous radon monitors for 2002. The data are used to track radon concentrations throughout the year to ensure the DOE limits are not exceeded. In addition to the summary data presented here, Appendix C, Attachment 2, of this report provides graphical displays of monthly average radon concentrations from continuous radon monitors during 2002 and 2001.

Results from the fenceline monitoring locations indicate radon levels for 2002 were within historical ranges and well below the DOE limit of 3 pCi/L above background. The annual average radon concentrations at the fenceline ranged from 0.2 to 0.5 pCi/L. The annual average radon concentration at the background monitoring locations was 0.2 pCi/L. A review of site fenceline data suggests that during 2002, Waste Pits Remedial Action Project operations did not significantly impact the radon concentrations at the site fenceline (refer to Table 5-2).

**TABLE 5-2**  
**CONTINUOUS ENVIRONMENTAL RADON MONITORING MONTHLY AVERAGE CONCENTRATIONS<sup>a</sup>**

Location <sup>b</sup>	2002 Summary Results <sup>c</sup> (Instrument Background Corrected) (pCi/L)			2001 Summary Results <sup>c</sup> (Instrument Background Corrected) (pCi/L)		
	Min.	Max.	Avg.	Min.	Max.	Avg.
<b>Fenceline</b>						
AMS-02	0.0	0.8	0.4	0.1	0.6	0.3
AMS-03	0.2	0.8	0.4	0.1	0.7	0.3
AMS-04	0.1	0.7	0.3	0.1	0.5	0.3
AMS-05	0.1	0.9	0.4	0.1	0.8	0.4
AMS-06	0.1	0.8	0.4	0.1	0.6	0.3
AMS-07	0.2	1.2	0.5	0.2	0.8	0.4
AMS-08A	0.1	0.7	0.3	0.1	0.7	0.4
AMS-09C	0.0	0.7	0.3	0.0	0.8	0.3
AMS-22	0.1	0.6	0.2	0.1	0.3	0.2
AMS-23	0.0	0.4	0.2	0.1	0.3	0.2
AMS-24	0.1	1.1	0.4	0.1	0.7	0.3
AMS-25	0.1	0.8	0.3	0.1	0.7	0.3
AMS-26	0.1	0.7	0.3	0.2	0.5	0.3
AMS-27	0.1	1.0	0.4	0.1	0.8	0.4
AMS-28	0.1	0.8	0.4	0.1	0.6	0.3
AMS-29	0.1	0.5	0.3	0.1	0.5	0.2
<b>Background</b>						
AMS-12	0.1	0.5	0.2	0.1	0.5	0.3
AMS-16	0.1	0.4	0.2	0.0	0.3	0.1
<b>On Site</b>						
KNE-B <sup>d</sup>	1.4	5.6	3.7	1.1	13.1	3.9
KNO	1.1	2.7	1.7	0.9	2.3	1.9
KNW-A	0.5	2.0	1.1	0.4	1.9	0.8
KSE	1.1	3.6	2.4	0.9	4.5	2.1
KSO	0.2	1.2	0.6	0.3	1.6	0.6
KSW-A	0.7	1.7	1.0	0.2	1.8	0.8
KTOP	2.8	8.8	4.7	3.0	9.0	5.5
LP2	0.4	1.4	0.8	0.3	1.2	0.6
Pilot Plant Warehouse	0.1	0.7	0.4	0.3	0.8	0.4
PR-1	0.1	1.2	0.5	0.3	0.9	0.6
Rally Point 4	0.2	0.8	0.4	0.2	0.7	0.4
Surge Lagoon	0.4	1.3	0.8	0.2	1.4	0.6
T117	0.2	1.0	0.4	0.2	1.3	0.5
T28	0.4	1.0	0.6	0.3	1.1	0.6
TS4	0.1	1.1	0.6	0.2	1.0	0.5
WP-17A	0.1	1.1	0.5	0.2	0.7	0.4

<sup>a</sup>Monthly average radon concentrations are calculated from the daily average concentrations.

<sup>b</sup>Refer to Figure 5-4 for sample locations.

<sup>c</sup>Instrument background changes as monitors are replaced.

<sup>d</sup>Instrument relocated 60' North on November 25, 2002; formerly identified as KNE-A.

In accordance with the FFA, radon concentrations within the headspace of K-65 Silos 1 and 2 are continuously monitored to assess the effectiveness of control measures in reducing radon emissions. From 1993 to 2001, there was a gradual upward trend in silo headspace radon concentrations. The increases in the headspace concentration were attributable to degradation of the 1991 application of bentonite clay to the surface of the K-65 Silo residues. During 2002 seasonal fluctuations in the silo headspace radon concentrations were observed, but the upward trend slowed and headspace concentrations stabilized. In December 2002, the headspace radon concentrations were temporarily lowered through the initial short-term test of the RCS. Appendix C, Attachment 2, of this report provides a graphical display of quarterly average headspace radon concentrations from 1992 to 2002. During 2002 there were 10 exceedance events related to the 100-pCi/L DOE limit measured on site (refer to Table C.2-1) compared with 15 recorded in 2001. As in past years, the exceedances were observed at monitoring locations adjacent to the K-65 Silos and occurred during periods of atmospheric inversions.

Long-term comparisons are performed on average radon concentrations recorded at the K-65 Silos exclusion fence locations. Historical alpha track-etch and alpha scintillation detector data were used for this comparison (refer to Figure 5-5). The average concentrations adjacent to the K-65 Silos are still below the levels observed prior to the addition of bentonite to the K-65 Silos in 1991.

Long-term comparisons are also performed on average radon concentrations at western property fenceline locations and background locations as a basis for comparison to the 3 pCi/L annual average limit. In 2002 a marginal difference in radon concentrations was observed between background and western property fenceline monitoring locations (refer to Figure 5-6). The on-property monitoring locations also recorded radon levels well below the applicable DOE limit of 30 pCi/L annual average.

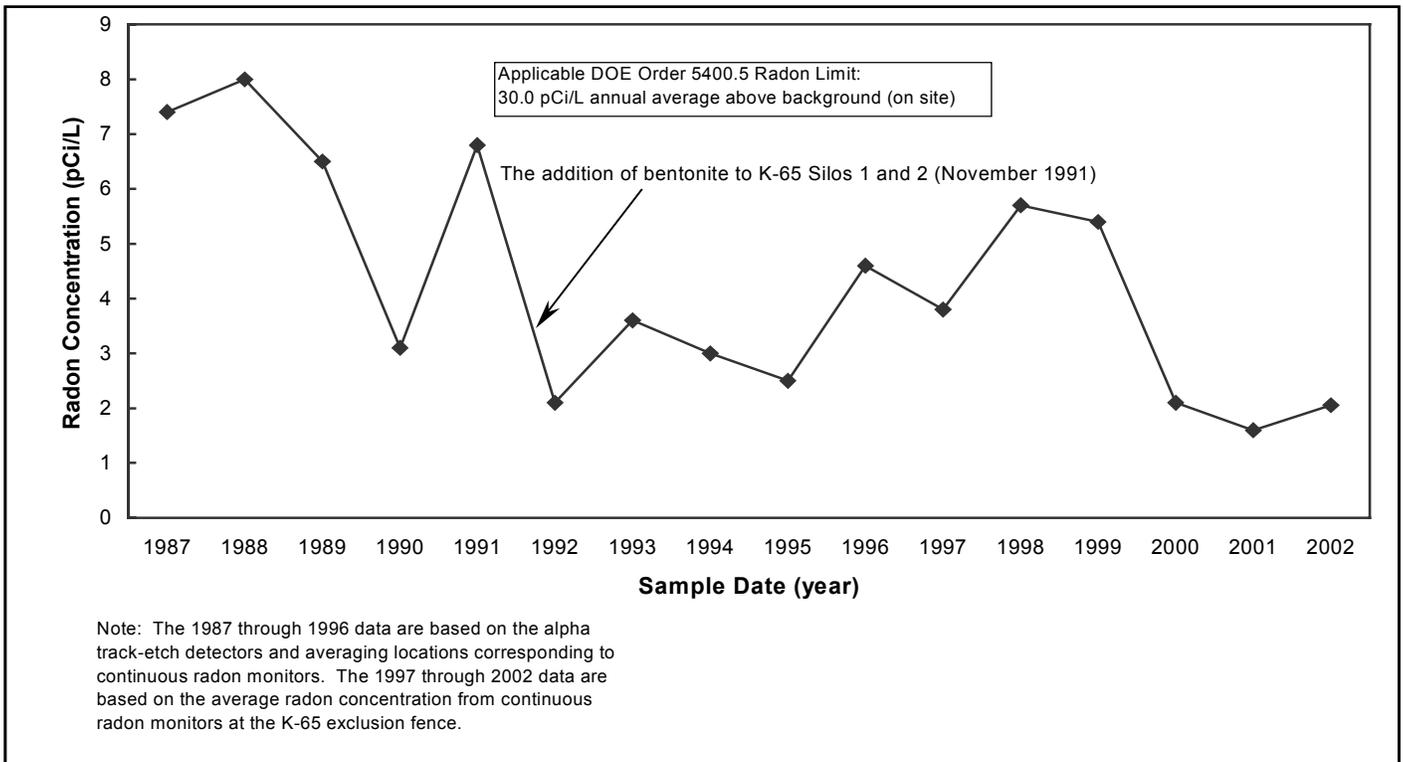


Figure 5-5. Annual Average Radon Concentrations at K-65 Silos Exclusion Fence, 1987-2002

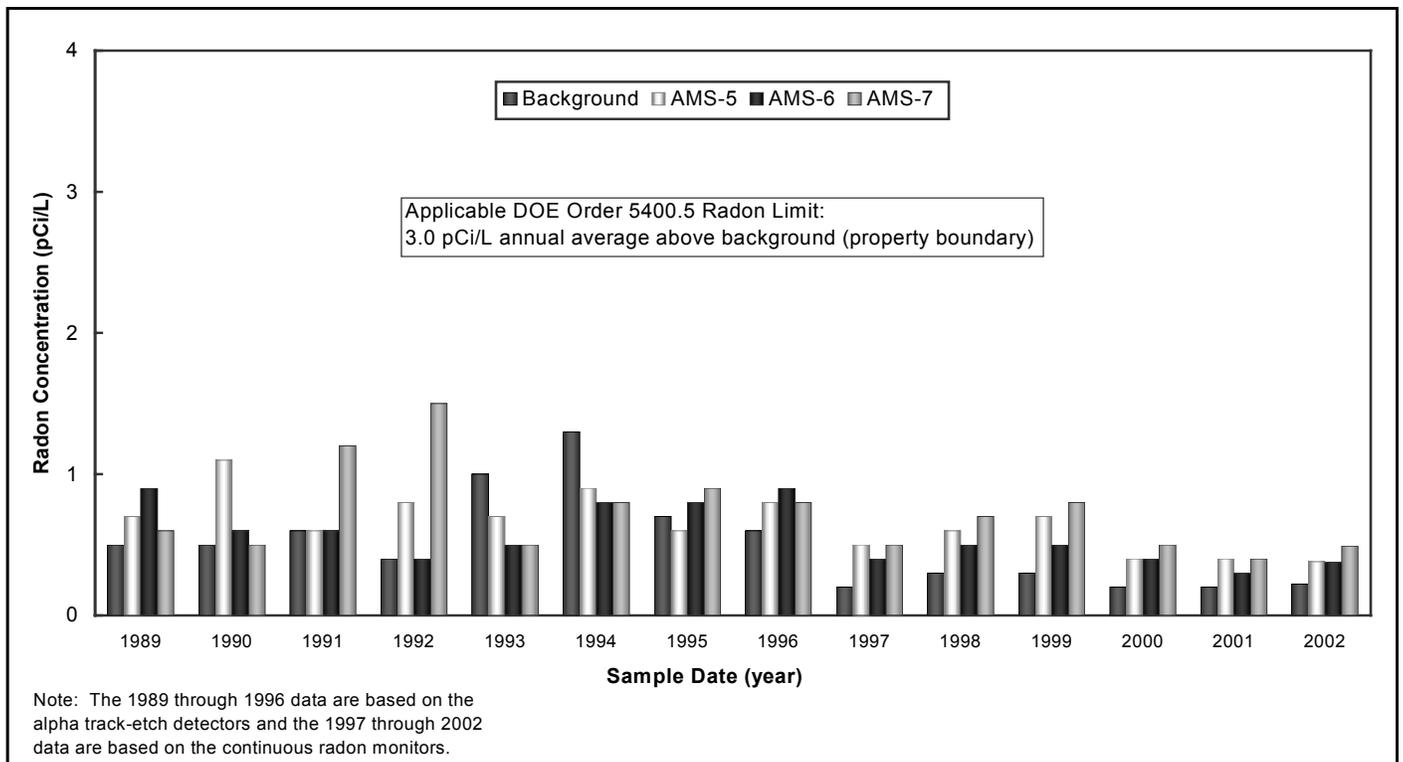


Figure 5-6. Annual Average Radon Concentrations at Selected Radon Locations, 1989-2002

## 5.5 Monitoring for Direct Radiation

Direct radiation (e.g., x-rays, gamma rays, energetic beta particles, and neutrons) originates from sources such as cosmic radiation, naturally occurring radionuclides in soil, as well as radioactive materials at the Fernald site. The largest source of direct radiation is the material stored in K-65 Silos 1 and 2. Gamma rays and x-rays are the dominant types of radiation emitted from the silos. Energetic beta particles, alpha particles, and neutrons are not a significant component of direct radiation at the Fernald site because uranium, thorium, and their decay products do not emit these types of radiation at levels that create a public exposure concern.

Direct radiation levels at and around the Fernald site were continuously measured at 37 locations with thermoluminescent dosimeters (TLDs) during 2002. The TLD monitoring network was modified in late 2002 to take into account the pending relocation of the wastes stored in Silos 1 and 2. The following additional TLD locations were added to the Silo area:

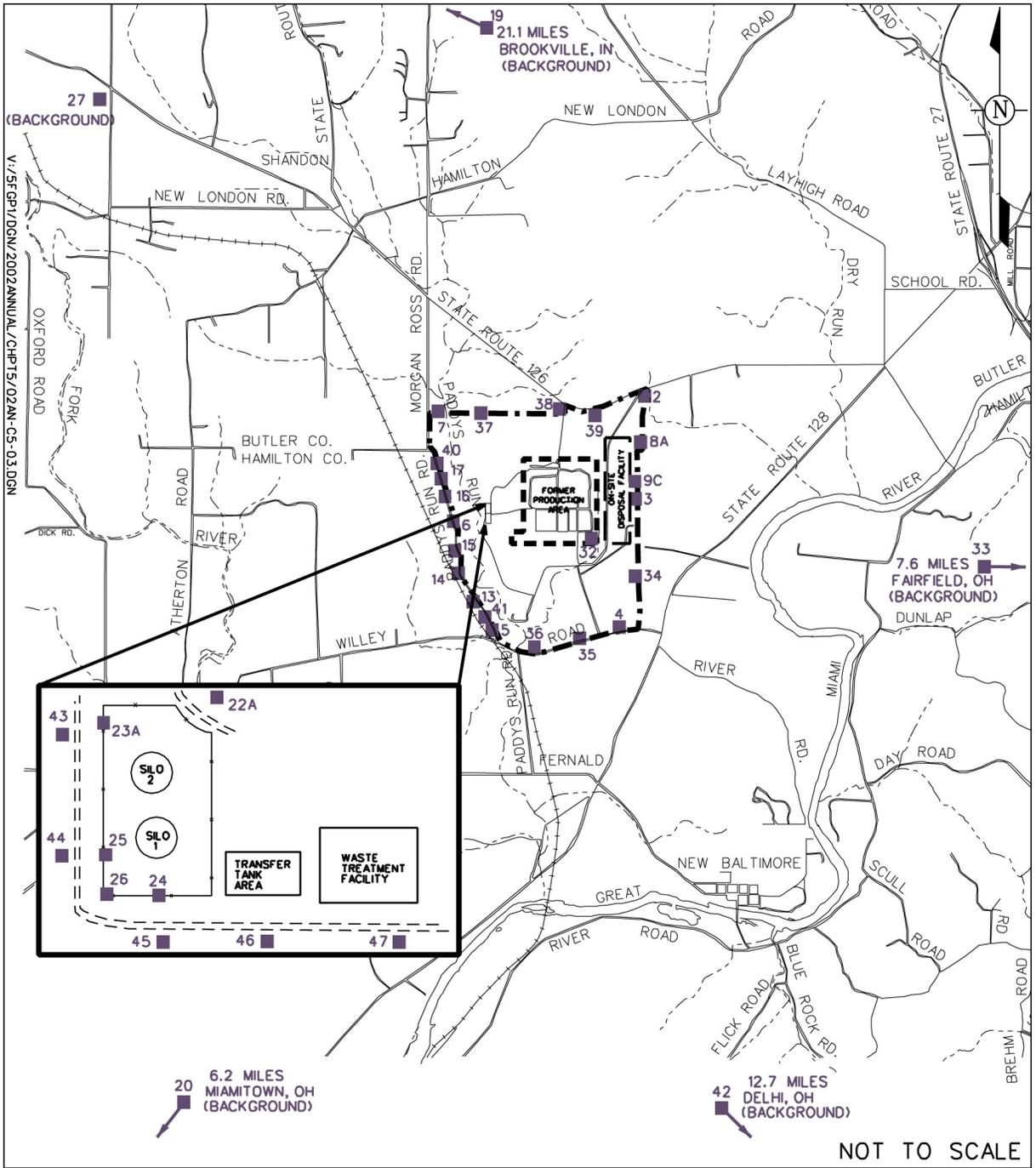
- Location 43, on the western side of the silos near the KNW-A radon monitor.
- Location 44, on the western side of the silos near the KSW-A radon monitor.
- Location 45, on the southern side of the silos near the KSO radon monitor.
- Location 46, on the project boundary south of the transfer tank area building.
- Location 47, on the project boundary south of the waste treatment facility.

Two of the five new monitoring locations (43 and 44) were selected based on the need to monitor direct radiation levels from the silo wastes as the berm is excavated. The excavation of the berm will change the radiation shielding in place at the silos and may affect radiation levels at the fenceline. These locations will also serve as secondary monitoring locations in the event that Silo construction activity eliminates locations 23A, 24, 25, and 26. Three new monitoring locations (45, 46, and 47) were selected based on the need to monitor direct radiation levels from the silo wastes and their associated high levels of radon as the wastes are transferred from the silos, to the transfer tank area, and eventually to the waste treatment facility. More specifically, the new locations were selected to monitor the movement of these materials as it affects radiation levels at the site fenceline.

TLDs absorb and store the energy of direct radiation within the thermoluminescent material. By heating the thermoluminescent material under controlled conditions in a laboratory, the stored energy is released as light, measured, and correlated to the amount of direct radiation. Figure 5-7 identifies the TLD monitoring locations. These monitoring locations were selected based on the need to monitor the K-65 Silos, the fenceline, and background locations. Table 5-3 provides summary level information pertaining to direct radiation measurements for 2002 and 2001.

**TABLE 5-3**  
**DIRECT RADIATION (THERMOLUMINESCENT DOSIMETER) MEASUREMENT SUMMARY**

TLD Location	Direct Radiation (mrem)	
	Summary of 2002 Results	Summary of 2001 Results
<b>Fenceline (21 locations)</b>		
Minimum	71	69
Maximum	97	90
<b>On Site (11 locations)</b>		
Minimum (Health & Safety Bldg.)	56	58
Maximum (K-65 Silo area)	1220	1204
<b>Background (5 locations)</b>		
Minimum	70	67
Maximum	83	79



**LEGEND:**

- DISTANCE FROM CENTER OF FORMER PRODUCTION AREA TO SAMPLE LOCATIONS OFF MAP
- FERNALD SITE BOUNDARY
- DIRECT RADIATION (TLD) MONITORING LOCATION

Figure 5-7. Direct Radiation (TLD) Monitoring Locations

All monitoring results from TLDs for 2002 were within historical or expected ranges. From 1993 to 2001, there was a gradual upward trend in direct radiation measurements in the immediate area of the K-65 Silos (refer to Figure 5-8). During 2002, the upward trend slowed and direct radiation measurements near the K-65 Silos stabilized. The change in the upward trend was attributable to comparatively stable radon concentrations and associated decay products within the K-65 Silos' headspace. As noted earlier, in December 2002 the headspace radon concentrations were temporarily lowered through the initial short-term test of the RCS. The decrease in the direct radiation levels during the fourth quarter of 2002 is in some part attributable to the operation of the RCS.

The increasing trend in direct radiation levels at the site's western fenceline (1998 through 2001) also stabilized in 2002, particularly at TLD location 6 which is located closest to the K-65 Silos (refer to Figure 5-9). The relatively small changes in direct radiation levels at the fenceline are difficult to measure consistently due to small variations in the sensitivity and accuracy of the environmental TLDs. These changes at the fenceline are also attributable to the radon concentrations and associated decay products within the K-65 Silos' headspace. The slight upward trend in background radiation levels shown in Figure 5-9 is attributed to changes in the laboratory processing of the TLDs. These trends will continue to be monitored and presented through the annual site environmental reports.

Chapter 6 provides more information on the dose associated with the direct radiation results. Detailed results of direct radiation measurements for 2002 and 2001 are provided in Appendix C, Attachment 3, of this report.

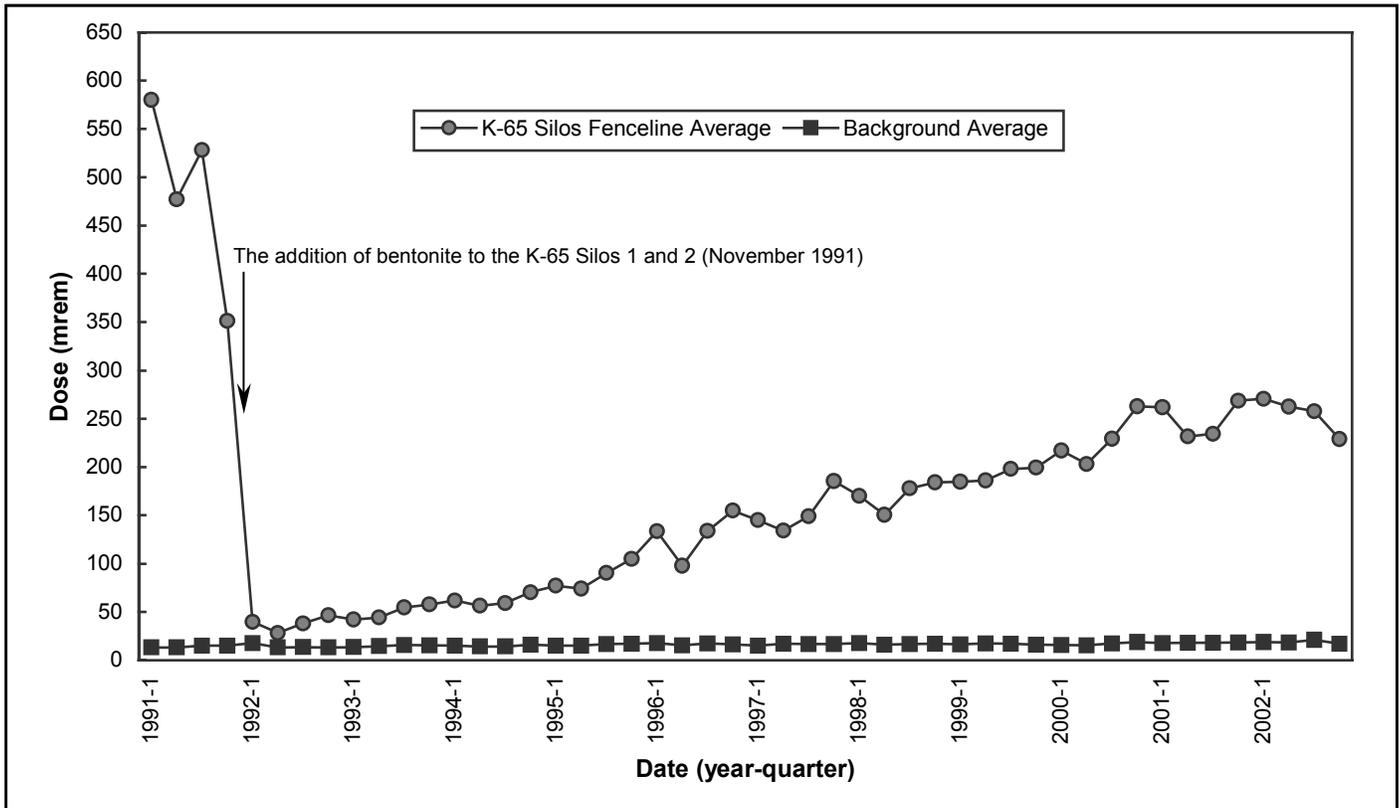


Figure 5-8. Direct Radiation (TLD) Measurements at K-65 Silos Boundary, 1991-2002 (K-65 Silos Fenceline Average Versus Background Average)

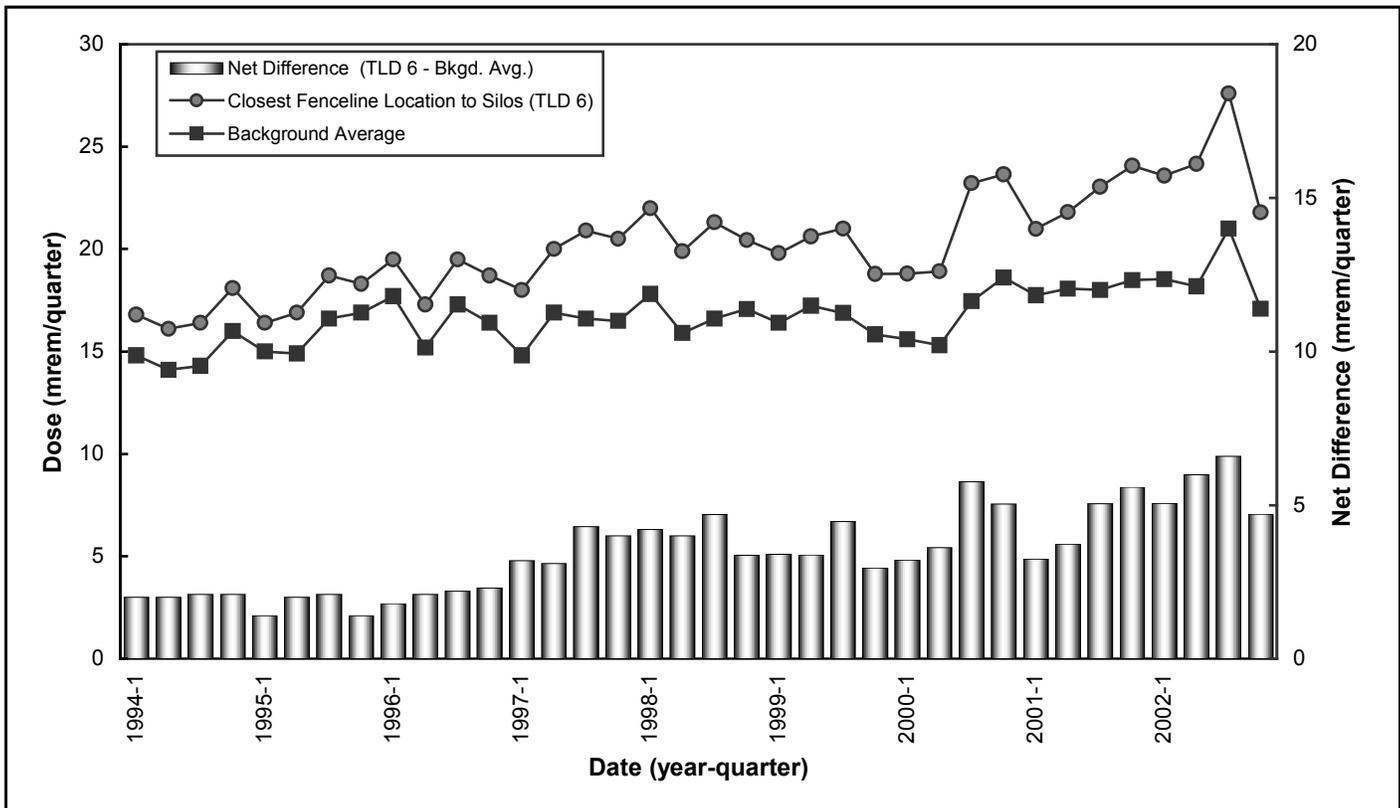


Figure 5-9. Direct Radiation (TLD) Measurements, 1994-2002 (Location 6 Versus Background Average)

## 5.6 Stack Monitoring for Radionuclide Emissions

During 2002 there were four stacks (or vents) that were monitored for radionuclide emissions as part of the requirements under the NESHAP Subpart H. The locations of the four stacks are shown in Figure 5-10. Stack sampling systems typically consist of a continuously operating pump that draws a representative volume of air from the stack through a filter or, in the case of radon monitoring, through a detector. Periodically, the filter is exchanged and analyzed for radiological contaminants that have the potential to be released during remediation activities or processes.

The Building 71 stack filters were analyzed for isotopes of uranium, thorium, and total particulate. Results for 2002 were very low and comparable to 2001 results. The results confirm that emissions from the waste processing operations conducted in Building 71 were not a significant source of airborne emissions to the environment. No significant changes in source operations associated with the Building 71 stack were noted during 2002.

The Waste Pits Remedial Action Project dryer stack particulate filters were analyzed for isotopes of uranium, thorium, and radium. The results confirmed that Waste Pits Remedial Action Project stack particulate emissions are very low and are not the primary source of the increases in thorium-230 concentrations at the fence line in recent years. The stack also contains a continuous radon monitor (i.e., radon-220 and radon-222). The maximum daily release of radon (radon-220 and radon-222) during 2002 was 195,255  $\mu\text{Ci}$ . This equates to 8,136  $\mu\text{Ci/hr}$  (microCuries per hour), which is below the estimated maximum hourly release rate of 13,000  $\mu\text{Ci/hr}$  (DOE 1998a) for radon-222. The daily average release rate of radon in 2002 was 12,268  $\mu\text{Ci}$ , which equates to 511  $\mu\text{Ci/hr}$ , and is well below the estimated maximum hourly release rate of 13,000  $\mu\text{Ci/hr}$  for radon-222.

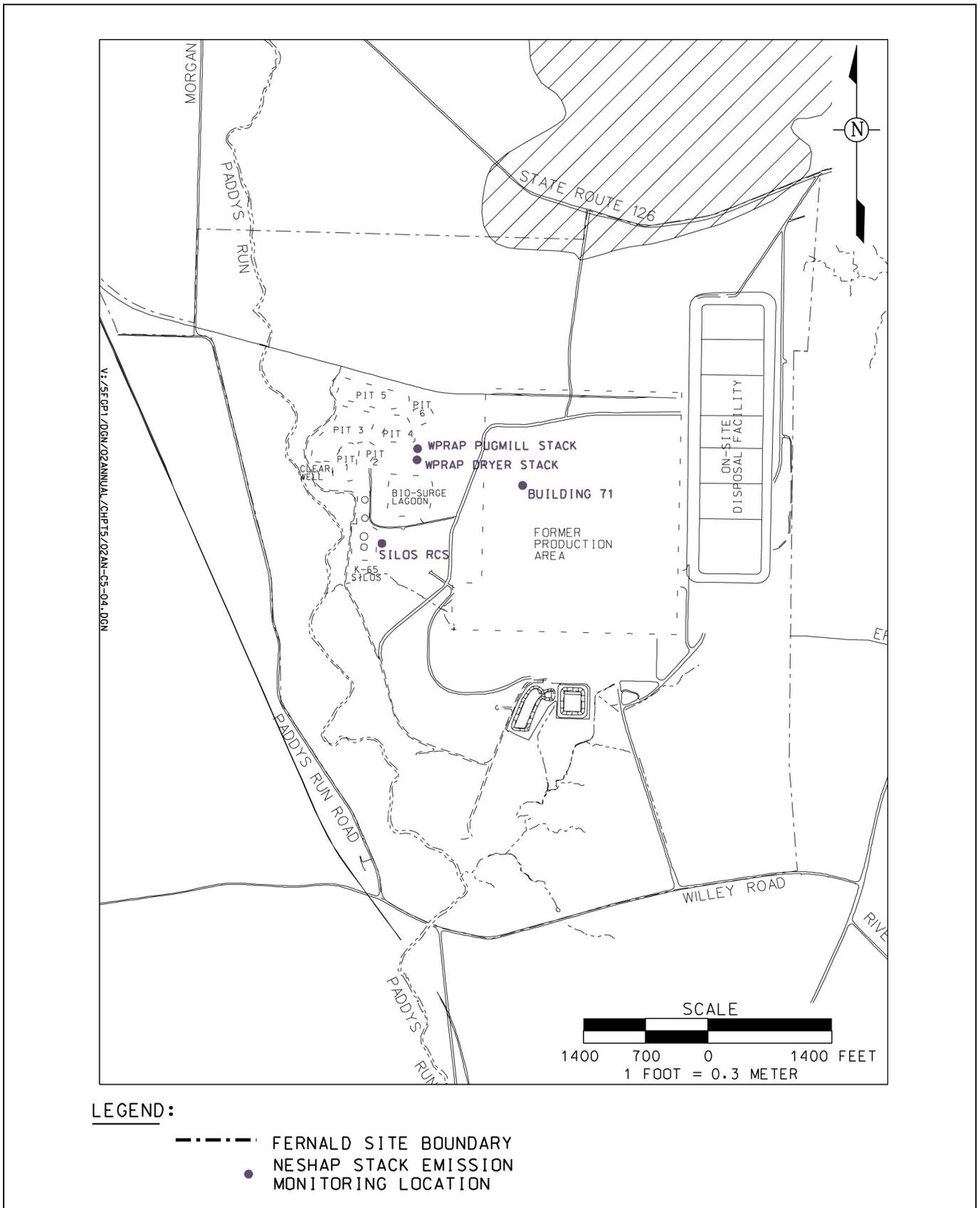


Figure 5-10. NESHA Stack Emission Monitoring Locations

In 2002 the Waste Pits Remedial Action Project installed a new ventilation system to control emissions of steam and fine particulate from the pugmill discharge bin. The pugmill discharge bin collects the dried solids from the Waste Pits Remedial Action Project dryer. Waste Pits Remedial Action Project personnel concluded that fine radioactive particles were entrained with the steam being emitted from the discharge bin. The radionuclide releases were believed to be responsible for elevated airborne radiological levels in the area of the pugmill as well as the increased levels of thorium-230 at the site fence line. The ventilation system was installed to control these fugitive emissions and minimize the spread of radioactive contamination from the pugmill discharge bin. The system also controls fugitive emissions from designated areas in the Material Handling Building. The pugmill ventilation system (PVS) began operation in April 2002. The PVS stack particulate filters were analyzed for isotopes of uranium, thorium, and radium, and are presented in Table 5-4.

**TABLE 5-4**  
**2002 NESHAP STACK EMISSIONS**

<b>Radionuclide (Unit)</b>	<b>WPRAP Dryer Stack<sup>a</sup></b>	<b>WPRAP PVS Stack<sup>a</sup></b>	<b>Silos RCS Stack<sup>a</sup></b>	<b>Building 71 Stack<sup>a</sup></b>
Total Uranium (lbs/yr)	NS	NS	NS	2.7E-05
Uranium-238 (lbs/yr)	1.6E-05	9.1E-04	ND	1.5E-05
Uranium-235/236 (lbs/yr)	2.5E-08	3.3E-06	ND	ND
Uranium-234 (lbs/yr)	5.8E-10	2.5E-08	ND	1.0E-09
Thorium-232 (lbs/yr)	1.0E-06	2.1E-04	ND	3.1E-05
Thorium-230 (lbs/yr)	2.4E-10	5.8E-08	1.5E-09	4.3E-10
Thorium-228 (lbs/yr)	3.2E-16	3.5E-14	ND	4.2E-15
Thorium-227 (lbs/yr)	NS	NS	ND	NS
Radium-226 (lbs/yr)	4.4E-13	6.1E-11	ND	NS
Polonium-210 (lbs/yr)	NS	NS	2.9E-15	NS
Total Particulates (lbs/yr)	NS	NS	0.0E+00	1.1E-01
Total Radon (mCi/yr)	4,500	NS	23 <sup>b</sup>	NS

<sup>a</sup>NS = not sampled

ND = not detectable

<sup>b</sup>Estimated value due to difficulties with RCS stack monitor.

In 2002 the Silos Project installed an RCS as part of the Accelerated Waste Retrieval Project. The operation of the RCS was tested for 15 hours in December 2002. The RCS was designed to control radon emissions for the Accelerated Waste Retrieval Project and from the future operation of the Silos 1 and 2 remediation facility. Specifically, emissions from the Silos 1 and 2 headspace, the Silos Waste Retrieval System, and the Transfer Tank Area are controlled by the RCS. The RCS is designed to maintain negative pressure in the silo headspaces, Silos 1 and 2 Waste Retrieval System, and Transfer Tank Area tanks, and to control process emissions from the Silos 1 and 2 remediation facility. Airflow in the air emission control system will be closely controlled to minimize the release of air emissions to the environment during all phases of operation. To the extent practical, the system will be operated in a “recycle” mode where all or most of the air is withdrawn from the silo or Transfer Tank Area headspace, circulated through the RCS, and discharged back into the silo or Transfer Tank Area. A continuous stack monitoring system has been installed on the exhaust stack to continuously monitor/sample air emissions (particulate radionuclides and radon) from the exhaust stack in accordance with 40 Code of Federal Regulations 61 Subpart H. The results of the RCS stack filter analysis are presented in Table 5-4. There were difficulties with the RCS stack radon monitor during the initial test; therefore, RCS stack radon data is not reported in Table 5-4. However, radon monitoring data from monitoring points within the RCS (and upstream of stack radon monitor) indicated that radon emissions during the test were not large enough to exceed the maximum allowable release rate. Furthermore, monitoring data from environmental monitors in the vicinity of the silos and at the site fenceline detected no significant increase in radon concentrations during the RCS test.

Typically, post-production era (1990 and later) monitoring data have shown stack emissions of radionuclides to be very low or not detectable. The use of high-efficiency particulate air (HEPA) filtration systems in many remediation activities and processes effectively controls stack emissions and limits the release of airborne contaminants. In summary, the 2002 stack emissions are consistent with the low stack emission data for the post-production period.

## 5.7 Monitoring for Non-Radiological Pollutants

The FCP continued to operate the Waste Pits Remedial Action Project gas-fired dryers during 2002. The estimated emissions from the dryer operations were based on emission factors from the AP-42 technical reference document (Compilation of Air Pollution Emission Factors, Vol. 1; Stationary Point and Area Sources, 5th edition, January 1995 [EPA 1995]). The sulfur dioxide emissions were estimated to be 188 pounds (85 kg). Nitrogen oxide emissions for 2002 were estimated to be 25,410 pounds (11,536 kg). Carbon monoxide emissions were estimated to be 19,136 pounds (8,688 kg). The estimate for particulate as PM10 (particles with an aerodynamic diameter less than or equal to a nominal 10 micron) was 4,298 pounds (1,951 kg). Total organic compound emissions for 2002 were estimated to be 1,819 pounds (826 kg). There are no regulatory limits associated with non-radiological pollutants from the dryers; however, the dryers are required to employ the best available technology to limit emissions. In order to meet the best available technology requirement, burners designed to lower emissions of nitrogen oxides are used in the dryers.

OEPA requires an estimate of emissions from the boiler plant as part of the FCP's effort to demonstrate compliance with the Clean Air Act. The boilers at the site are dual fired by natural gas and diesel fuel. Non-radiological pollutants from boiler operations include particulate matter, sulfur dioxide, nitrogen oxides, carbon monoxide, and non-methane volatile organic compounds. Opacity is a measure of how much light is blocked by particulate matter present in stack emissions. Excursions occur when regulatory limits for opacity are exceeded. There were no opacity excursions at the boilers for 2002. There have been no excursions since the site converted from coal-fired boilers to natural gas/diesel-fired boilers in 1997.

In order to estimate sulfur dioxide emissions, scientists determine the sulfur and heat content of the fuel. Using this information and the total amount of fuel burned, the amount of sulfur dioxide emissions can be calculated. For 2002 sulfur dioxide emissions from all boilers were calculated to be 59 pounds (27 kg). This was well below the allowable limit of over 79 tons (72 metric tons) per year calculated from information in the permits issued by OEPA.

The nitrogen oxide emissions are estimated using data obtained from stack emission test results. Nitrogen oxide emissions for all boilers for 2002 were estimated to be 8,367 pounds (3,799 kg). Particulate matter emissions, based on emission factors from AP-42 for all boilers in 2002, were estimated to be 1,244 pounds (565 kg). This was below the allowable limit of over 6.3 tons (5.7 metric tons) per year calculated from information in the permits issued by OEPA. Carbon monoxide emissions, based on emission factors from AP-42 for all boilers in 2002, were estimated to be 3,202 pounds (1,454 kg). To date, OEPA has not set nitrogen oxide or carbon monoxide limits for the Fernald site. Table 5-5 provides a comprehensive list of 2002 emissions from the Waste Pits Remedial Action Project dryers and boiler plant.

**TABLE 5-5**  
**CHEMICAL EMISSIONS FROM WASTE PITS REMEDIAL ACTION PROJECT DRYERS AND BOILER PLANT**

<b>Chemical Name</b>	<b>Emissions from WPRAP Dryers (lb/kg)</b>	<b>Emissions from Boiler Plant (lb/kg)</b>	<b>Sources of Emissions</b>	<b>Basis of Estimate</b>
Particulates	4,298/1,951	1,244/565	Fossil Fuel Combustion	AP-42 Emission Factors <sup>a</sup>
Sulfur Dioxide	188/85	59/27	Fossil Fuel Combustion	AP-42 Emission Factors <sup>a</sup> or sulfur content of fuel
Nitrogen Oxide	25,410/11,536	8,367/3,799	Fossil Fuel Combustion	Stack Emission Test Results for natural gas or AP-42 Emission Factors <sup>a</sup> for diesel fuel
Carbon Monoxide	19,13/8,688	3,202/1,454	Fossil Fuel Combustion	AP-42 Emission Factors <sup>a</sup>
Non-Methane Volatile Organic Compounds	1,819/826	221/100	Fossil Fuel Combustion	AP-42 Emission Factors <sup>a</sup>

<sup>a</sup>Compilation of Air Pollution Emission Factors, Vol. 1; Stationary Point and Area Sources, 5<sup>th</sup> edition, January 1995 (EPA 1995)

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