
2019 Highlight

Routine Surveillance Soil Sampling

A total of 86 surface soil samples were collected in calendar year 2019; 68 samples were collected on the Hanford Site and 18 samples were collected from offsite locations. The concentrations of radionuclides at these locations are consistent with those seen in previous years.

Radiological Surveys

Radiological surveys performed near operational areas on the Hanford Site in calendar year 2019 identified seven instances of radiological contamination in surface soil, resulting in six locations posted as contamination areas and one location cleaned up and the soil disposed of in licensed burial grounds.

9.0 Soil Monitoring

JE Cranna

Radiological monitoring of soil is conducted onsite near Hanford Site facilities and operations, as well as, onsite away from facilities and operations. Soil sampling is also performed offsite at perimeter and distant locations and in nearby communities. The environmental surveillance soil monitoring program complements Hanford Site emissions monitoring, including the Hanford Site ambient air monitoring network. Contaminant data collected are used to:

- Assess the impact of Hanford Site operations on the concentrations of manmade radionuclides in soil
- Determine the effectiveness of effluent monitoring and controls within facilities
- Confirm contaminant control measures at waste disposal sites during waste site remediation and at radioactive contamination areas
- Determine concentrations of naturally occurring radionuclides and those from fallout unrelated to Hanford Site activities
- Provide long-term radionuclide contamination trends in soil at undisturbed locations
- Detect and monitor unusual conditions associated with a potential release or spread of radioactive material.

Soil is an integrating sample medium that accounts for contaminants released to the atmosphere either directly (gaseous effluent), indirectly (re-suspension/deposition), or through liquid effluent waste streams that are subsequently used for irrigation.

Soil samples have been collected on and around the Hanford Site for more than 50 years; consequently, a significant data set exists that documents onsite and offsite levels of manmade radionuclides in and

around the Hanford Site. These data provide a baseline to which Hanford Site emissions and unplanned releases can be compared.

Soil samples from offsite locations are collected every 3 to 5 years and were collected in 2019. Offsite soil sampling is used for long-term trend analysis and is not used in dose model calculations. The sampling frequency of every 3 to 5 years is consistent with the guidance provided in the U.S. Department of Energy (DOE) handbook DOE-HDBK-1216-2015, *Environmental Radiological Effluent Monitoring and Environmental Surveillance*.

9.1 Hanford Site Soil Sampling

Surface soil sampling is required by the *Hanford Site Radioactive Air Emissions License #FF-01* (FF-01) (Section 5.1.2) as a qualitative indicator of the environmental monitoring program. It also is a recommended practice per DOE-HDBK-1216-2015.

Soil sampling data is used to evaluate long-term accumulation trends and provide baseline data to quantify short-term accumulations due to fugitive or accidental releases of Hanford Site radiological materials. Soil contamination can occur as the result of direct deposition from facility emissions, re-suspension and movement of contaminants from radioactively contaminated surface soil areas, or translocation of buried waste by biological intrusion.

Surface soil samples were collected on or adjacent to waste disposal sites, as well as from locations downwind, near, or within the boundaries of operating facilities and remedial action sites. The location and analyses of soil samples collected in calendar year (CY) 2019 are depicted in Table 9-1. The number of soil samples per operational area are summarized in Table 9-2.

Table 9-1. Hanford Site Soil Monitoring Locations and Sample Analyses. (2 Pages)

Soil Monitoring Location	EDP Codes ^a	Collection Period	Analyses
200-East Area	D053, D055, D057, D059, D061, D063 ^b , D065, D067, D069, D071, D073, D075, D077, D079, D143 ^c	May-June	⁹⁰ Sr, Pu-iso, U-iso, GEA
Trench 94 (200-East Area)	D458, D460, D461	May-June	⁹⁰ Sr, Pu-iso, U-iso, GEA
200-West Area	D001, D005, D013, D015, D019, D023, D025, D027, D029, D035, D037, D039, D041, D047 ^b , D049, D051, D111 ^c	May-June	⁹⁰ Sr, Pu-iso, U-iso, GEA, ²⁴¹ Am
Plutonium Finishing Plant (200-West Area)	D007, D009, D031, D033, D043, D045 ^b	May-June	⁹⁰ Sr, Pu-iso, U-iso, GEA, ²⁴¹ Am
ERDF at N482 (200-West Area)	D146	May-June	⁹⁰ Sr, Pu-iso, U-iso, GEA
300 Area	D120, D121, D123 ^b , D125, D126, D132 ^c , D140 ^c , D207	May-June	⁹⁰ Sr, Pu-iso, U-iso, GEA
400 Area	D130	May-June	⁹⁰ Sr, Pu-iso, U-iso, GEA

Table 9-1. Hanford Site Soil Monitoring Locations and Sample Analyses. (2 Pages)

Soil Monitoring Location	EDP Codes ^a	Collection Period	Analyses
600 Area	D081, D083, D085, D087, D089, D091 ^b , D093, D095, D097, D099, D101, D103, D105, D107, D109, D113 ^c , D145 ^c	May-June	⁹⁰ Sr, Pu-iso, U-iso, GEA
^a EDP Code=environmental data point code = sample location code ^b Collocated sampling location with WDOH ^c Quality assurance duplicate sample ERDF = Environmental Restoration Disposal Facility GEA = Gamma Energy Analysis ⁹⁰ Sr = Strontium-90 ²⁴¹ Am = Americium-241 Pu-iso = isotopic plutonium (²³⁸ Pu, ^{239/240} Pu) U-iso = isotopic uranium (²³⁴ U, ²³⁵ U, ²³⁸ U) WDOH = Washington State Department of Health			

Table 9-2. Number of Soil Samples per Operational Area.

Number of Samples	Operational Area (discrete samples analyzed)						
	200-East ^a	200-West ^a	Trench 94	ERDF	300 Area ^a	400 Area	600 Area ^a
68	15	23	3	1	8	1	17
^a Includes one or more duplicate samples. ERDF = Environmental Restoration Disposal Facility							

9.1.1 Sampling and Analysis

Samples were collected and analyzed according to DOE/RL-2013-53, *Hanford Site Environmental Surveillance Master Sampling Schedule for Calendar Year 2019*. Onsite soil samples are collected annually and, as a cost-savings measure, collections in the 200 and 600 Areas are alternated between even and odd numbered years, aligning with even and odd numbered sample locations. Individual soil samples are approximately 2.2 lb (1.0 kg) and consist of five plugs of soil. The soil is sampled using a shallow (cookie cutter) coring device producing a core approximately 1 in. (2.5 cm) deep and 4.3 in. (11 cm) in diameter (RC-PRO-RC-60561). Five cores are combined to create one sample. Areas with heavy vegetation cover are avoided and any vegetation in the sample is removed. Soil samples are sieved in the field to remove potential sample intrusions (e.g., rocks and plant debris). The soil samples are packaged in two plastic bags (double bagged) and transported to an analytical laboratory. Samples are dried in the laboratory prior to analysis to remove residual moisture.

Soil samples were analyzed for strontium-90, uranium-234, uranium-235, uranium-238, plutonium-238, plutonium-239/240, and gamma-emitting radionuclides. In support of the current deactivation and decommissioning project at the Plutonium Finishing Plant (PFP) in the 200-West Area, and especially for monitoring during the demolition of the 242-Z Americium Recovery Facility, an americium-241 alpha energy analysis was added to the analyte list for all 200-West soil monitoring locations near the PFP complex.

9.1.2 Soil Sampling Results

The analytical results from soil samples collected on the Hanford Site in CY 2019 are summarized in Appendix C, Table C-4. While there are no specific DOE limits for radionuclide concentrations in soil, the 2019 onsite soil sample results can be compared to other benchmarks including Hanford Site background concentrations (DOE/RL-96-12), radionuclide concentrations resulting from natural sources and worldwide fallout as observed in offsite soil samples, and dose-based limits for soil that have been developed for the Environmental Surveillance program to support calculation of a 1 mrem/yr dose threshold to an offsite member of the public (DOE/RL-91-50). More recently, soil radiological preliminary remediation goals (PRGs) have been developed for an outdoor worker exposure scenario for use in the Remedial Investigation/Feasibility Study reports for the Inner Area source operable units located within the Central Plateau of the Hanford Site (ECF-HANFORD-16-0133). These values may also be useful for comparison with onsite soil sample results. Values for these various soil benchmarks for key radionuclides are shown in Table 9-3. These levels are listed for comparison only and are not regulatory requirements. Generally, radionuclide concentrations in soil samples collected from the 200, 300, 400, and 600 Areas were near or below the Hanford Site background concentrations and below the dose-based reporting limits for an offsite member of the public and the PRGs for the outdoor worker exposure scenario. The average cesium-137 soil values in the 200 Areas were slightly above the Hanford Site background level but lower than the PRGs for the 200 Area outdoor worker exposure scenario. However, there was an elevated cesium-137 result in a sample collected from the 200-East Area that exceeded the PRGs for the 200 Area outdoor worker exposure scenario. The average strontium-90 soil values in the 200-West Area were also slightly higher than the Hanford Site background level but well below the Environmental Surveillance dose-based limit for an offsite member of the public.

In general, radionuclide concentrations in soil samples collected in CY 2019 at locations in the 200-East, 200-West, 300, 400, and 600 Areas were comparable to those seen in previous years. Radionuclide concentrations in soil samples collected from or adjacent to waste disposal facilities in 2019 were higher than the concentrations in samples collected further away. Historically, the predominant radionuclides detected are activation and fission products in the 100 Areas, fission products in the 200 and 600 Areas, and uranium in the 300 and 400 Areas. Consistent with historical detections, cesium-137, strontium-90, plutonium-239/240, uranium-234, and uranium-238 were detected in the 2019 soil samples. Figure 9-1 shows the annual average soil concentrations of selected radionuclides in the 100, 200, 300, 400, and 600 Areas compared to the Hanford Site background concentrations (DOE/RL-96-12) for 2019 and the preceding 5 years. Appendix C, Table C-4 shows the annual average and maximum concentrations of radionuclides in surface soil samples by area during 2019 and the preceding 5 years.

Table 9-3. Concentration Limits for Selected Radionuclides (pCi/g). (2 Pages)

Isotope	Hanford Background (90 th Percentile) ^a	Environmental Surveillance Dose-based Reporting Limit for Offsite Exposure Scenarios ^b	Preliminary Remediation Goal for the Outdoor Worker Exposure Scenario ^c
Americium-241	N/A	20	613
Cesium-137	1.05	0.51	10.8
Plutonium-238	0.004	33	3,438

Table 9-3. Concentration Limits for Selected Radionuclides (pCi/g). (2 Pages)

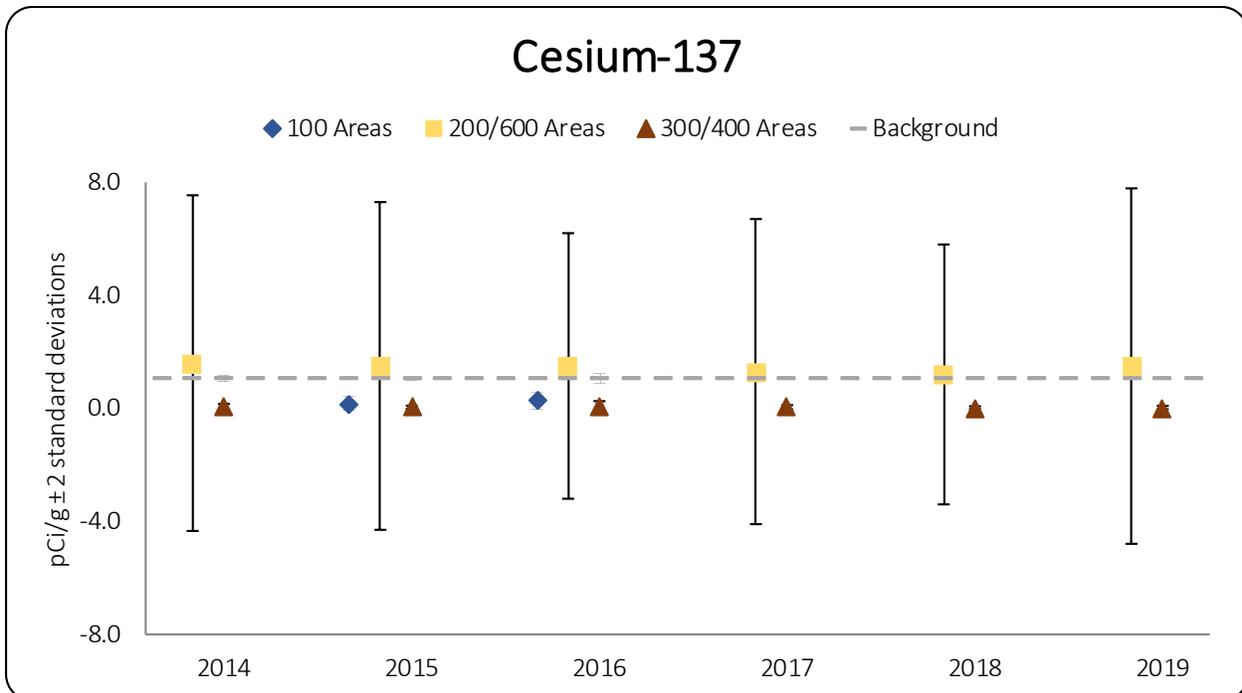
Isotope	Hanford Background (90 th Percentile) ^a	Environmental Surveillance Dose-based Reporting Limit for Offsite Exposure Scenarios ^b	Preliminary Remediation Goal for the Outdoor Worker Exposure Scenario ^c
Plutonium-239/240	0.025	31	2,971
Strontium-90	0.178	55	1,190
Uranium-234	1.10	150	2,201
Uranium-235	0.109	2.3	36
Uranium-238	1.06	11	170

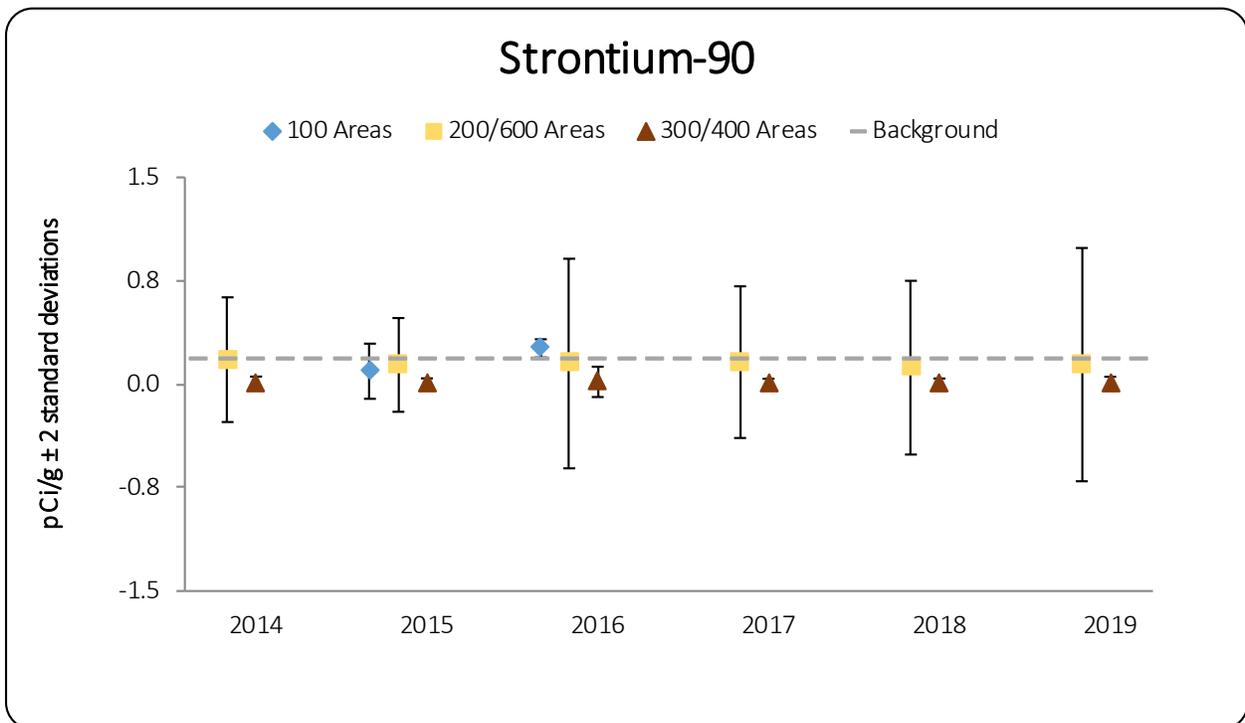
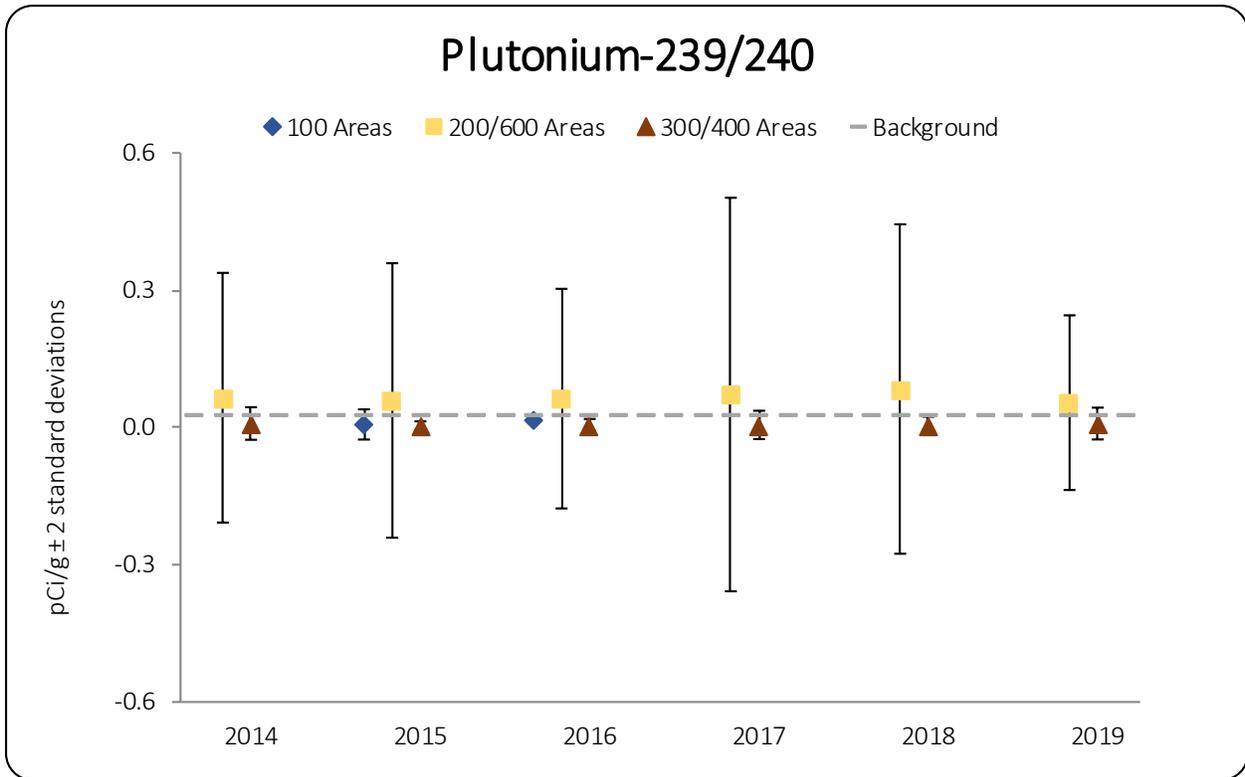
^a Values published in Hanford Site Background: Part 2, Soil Background for Radionuclides (DOE/RL-96-12).

^b Dose-based reporting limits established in reference to radionuclide contamination that could lead to an offsite public receptor dose of 1 mrem/yr if the condition persisted for an entire year. These limits are based on the inadvertent ingestion and external radiation exposure pathways as specified in Table 4-1 of the Hanford Site Environmental Monitoring Plan (DOE/RL-91-50, Rev. 7).

^c Soil radiological Preliminary Remediation Goals developed using U.S. Environmental Protection Agency guidance as specified in *Calculation of Soil Radiological Preliminary Remedial Goals for the Outdoor Worker Scenario* (ECF-HANFORD-16-0133) that correspond to a target cancer risk level of 1×10^{-4} that are protective of an outdoor worker based on direct contact (incidental soil ingestion and direct external gamma exposure) and the inhalation pathways.

N/A = not available





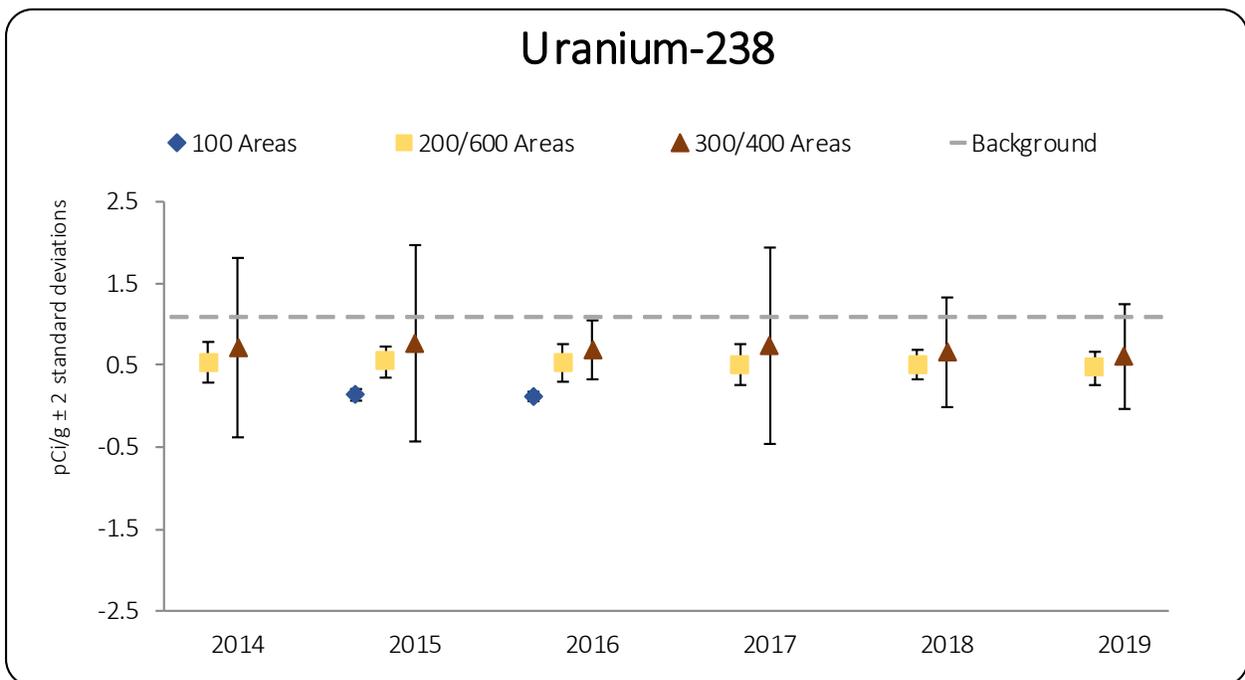
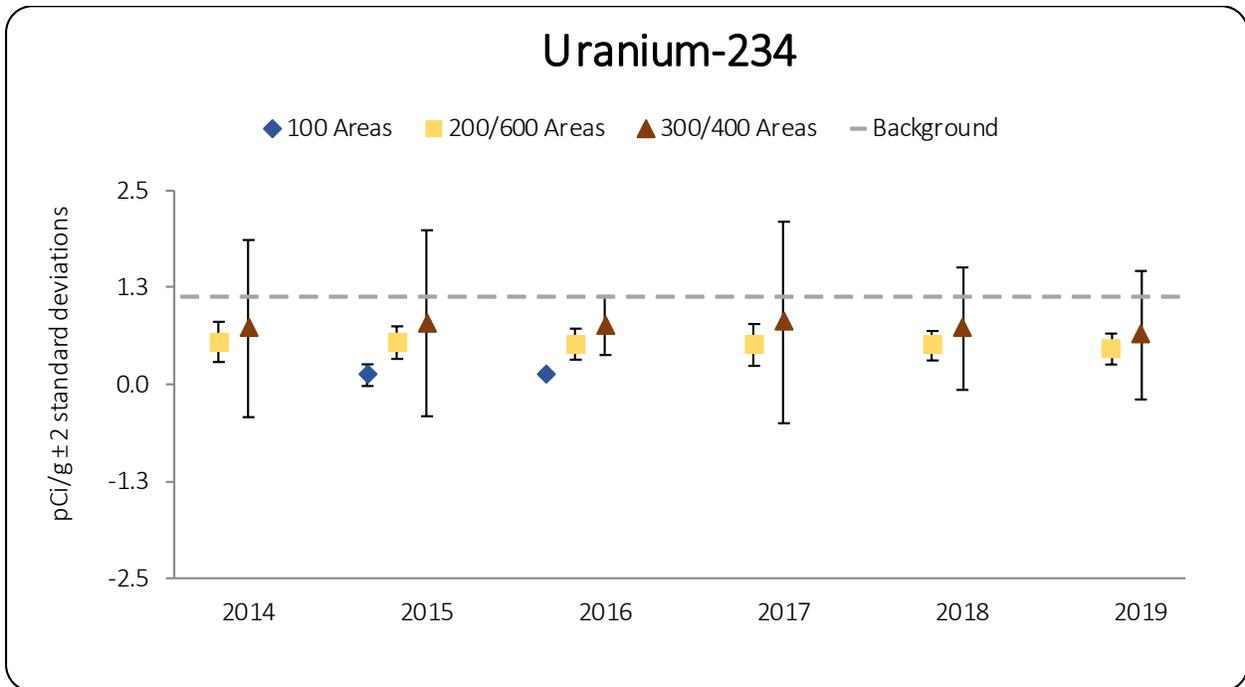


Figure 9.1. Average Concentrations of Select Radionuclides in Hanford Site Soil Samples, 2014–2019.
 (As a result of figure scale, some uncertainties [error bars] are concealed by the point symbol)

Soil sampling was conducted at 18 locations in the 200-East Area, including Trench 94 during CY 2019. Generally, radionuclide levels measured in the 2019 soil samples were similar to those measured in previous years. Cesium-137, strontium-90, uranium-234, and uranium-238 detection frequencies were also similar to those seen in previous years.

During CY 2019, routine soil sampling was conducted at 24 locations in the 200-West Area including the Environmental Restoration Disposal Facility (ERDF). Radionuclide levels measured were similar to previous years. Frequency of detection percentages for cesium-137, strontium-90, uranium-234, uranium-238, plutonium-239/240, and americium-241 were also similar to those seen in previous years.

Soil sampling was conducted at 17 locations in the 600 Area in CY 2019. Radionuclide levels measured in these samples were similar to those measured in previous years. Frequencies of detection for cesium-137, strontium-90, uranium-234, uranium-238, and plutonium-239/240 were also similar to those seen in previous years.

Soil samples were collected at eight locations in the 300 Area and one location in the 400 Area. These samples measured cesium-137, uranium-234, and uranium-238 at concentrations similar to those seen in previous years.

To comply with Washington State Department of Health Notice of Construction requirements, surface soil deposition sampling was conducted during CY 2019 around Trench 94 of the 218-E-12B waste site in the 200-East Area. Radionuclide levels measured in the 2019 soil samples were similar to those measured in previous years.

A soil sample is collected annually at the ERDF from a predominantly downwind sampling location. Radionuclide levels measured downwind of ERDF were comparable to previous years.

9.1.2.1 Uranium.

Uranium-234 and uranium-238 were detected in all 86 surface soil samples collected from the Hanford Site in CY 2019. Soil samples in the 300 Area showed concentrations of uranium-234 and uranium-238 that were comparable to historical data but remained slightly higher than those measured in the 200 Area. The higher uranium levels in the 300 Area were expected due to known uranium releases to the environment during historical fuel-fabrication operations and later remediation efforts.

9.1.2.2 Plutonium.

Plutonium-239/240 was detected in approximately 20% of the soil samples collected in the 300/400 Areas and 55% of soil samples collected from the 200 and 600 Areas. Of the 32 detections in the 200/600 Areas, 25 were from locations in and around the 200-West Area. The concentrations measured were within historical ranges.

9.1.2.3 Strontium-90.

Strontium-90 was detected in approximately 44% of the samples collected in the 200 and 600 Areas. In general, the concentrations measured were within historical ranges. However, at location D009 in the 200-West Area near the PFP, the strontium-90 result was slightly higher than the Hanford Site 5-year maximum concentration.

9.1.2.4 Cesium-137.

Cesium-137 was detected in over 90% of the soil samples collected from the 200, 300, 400, and 600 Areas at concentrations similar to those seen in previous years. However, cesium-137 concentrations in the 200 and 600 Areas are consistently higher than those measured in the 300 and 400 Areas, with a noticeable elevation in the cesium-137 concentration at location D053 in the 200-East Area.

9.1.2.5 Americium-241.

Americium-241 analysis was performed on 23 samples in the 200-West Area in support of the current deactivation and decommissioning project at the PFP. Americium-241 was detected at 15 of the 23 locations at concentrations similar to those seen in 2016, 2017, and 2018.

9.2 Offsite Soil Sampling

Soil samples from offsite locations are collected every 3 to 5 years. Offsite soil sampling is used for long-term trend analysis and is not used in dose model calculations. The sampling frequency of every 3 to 5 years is consistent with the guidance provided in the handbook DOE-HDBK-1216-2015.

During 2019, soil samples were collected from 18 locations around the perimeter of the Hanford Site and nearby and distant communities. The locations and analyses of offsite soil samples collected in CY 2019 are depicted in Table 9-4.

Table 9-4. Offsite Soil Monitoring Locations and Sample Analyses. (2 Pages)

Soil Monitoring Location ^{a, b}	EDP Codes ^c	Analyses
N end Vernita Bridge	D424	GEA, ⁹⁰ Sr, U-iso, Pu-iso
Wahluke Slope	D425	GEA, ⁹⁰ Sr, U-iso, Pu-iso
Berg Ranch	D426	GEA, ⁹⁰ Sr, U-iso, Pu-iso
Ringold	D427	GEA, ⁹⁰ Sr, U-iso, Pu-iso
W end Fir Road	D428	GEA, ⁹⁰ Sr, U-iso, Pu-iso
Taylor Flats No. 2	D429	GEA, ⁹⁰ Sr, U-iso, Pu-iso
Sagemoor Farms	D430, D493 ^d	GEA, ⁹⁰ Sr, U-iso, Pu-iso, ²⁴¹ Am
Byers Landing	D431	GEA, ⁹⁰ Sr, U-iso, Pu-iso
Benton City	D433	GEA, ⁹⁰ Sr, U-iso, Pu-iso
Sunnyside	D434	GEA, ⁹⁰ Sr, U-iso, Pu-iso, ²⁴¹ Am
McNary Dam	D435	GEA, ⁹⁰ Sr, U-iso, Pu-iso
Walla Walla	D436	GEA, ⁹⁰ Sr, U-iso, Pu-iso
Washtucna	D437	GEA, ⁹⁰ Sr, U-iso, Pu-iso
Toppenish	D438	GEA, ⁹⁰ Sr, U-iso, Pu-iso
George	D439 ^e	GEA, ⁹⁰ Sr, U-iso, Pu-iso
Othello	D440 ^e	GEA, ⁹⁰ Sr, U-iso, Pu-iso
Wanapum	D441 ^e	GEA, ⁹⁰ Sr, U-iso, Pu-iso

Table 9-4. Offsite Soil Monitoring Locations and Sample Analyses. (2 Pages)

^a	Samples are collected approximately every 3-5 years
^b	Samples were collected in June 2019
^c	EDP Code=environmental data point code = sample location code
^d	Quality assurance duplicate sample
^e	Collocated sampling location with WDOH
GEA	= Gamma Energy Analysis
⁹⁰ Sr	= Strontium-90
²⁴¹ Am	= Americium-241
Pu-iso	= isotopic plutonium (²³⁸ Pu, ^{239/240} Pu)
U-iso	= isotopic uranium (²³⁴ U, ²³⁵ U, ²³⁸ U)
WDOH	= Washington State Department of Health

9.2.1 Offsite Soil Sampling Results

The analytical results from soil samples collected from around the perimeter of the Hanford Site and nearby and distant communities in CY 2019 are summarized in Appendix C, Table C-5. Radionuclide concentrations in soil samples collected in CY 2019 at offsite locations were compared to results from 2001, 2004, 2008, and 2015. In 2019, the observed average concentrations in soil samples for all isotopes were generally similar to their respective averages from 2001, 2004, 2008, and 2015. The maximum concentrations for cesium-137, americium-241, plutonium-238, and plutonium-239/240 were similar to the maximum concentrations observed in 2001, 2004, 2008, and 2015; however, the maximum concentrations for strontium-90 and uranium were lower than the maximum concentrations observed in previous years. The Hanford sitewide average soil concentrations in 2019 were higher than at site perimeter and distant locations for the radionuclides measured (Appendix C, Table C-6). This was consistent with historical data and reflected the higher sitewide soil concentrations associated with years of nuclear materials production.

9.3 Radiological Contamination Surveys

Radiological surveys are performed in and near Hanford Site operational areas to monitor the presence or movement of radioactive materials or to verify radiological conditions at specific project sites. All sites are field surveyed for alpha and beta-gamma radiation.

Radiological surveys performed in CY 2019 identified seven instances of radiological contamination in surface soil. Of the seven soil contamination events reported, six were posted as contamination areas and one was cleaned up and contaminated material disposed of onsite in licensed burial grounds. Table 9-5 summarizes the general locations of soil contamination incidents discovered during 2019 and Table 9-6 provides the number of contamination incidents from 2000 through 2019.

Table 9-5. Hanford Site Soil Contamination Occurrences discovered in CY 2019.

Location	2019 Incidents
100 Area	0
200-East Area	
Tank farms	1
Burial grounds	1
Cribs, ponds, and ditches	3
Fence lines	0
Roads and railroads	1
Unplanned release sites	0
Underground pipelines	0
Liquid Effluent Treatment Facility/Effluent Treatment Facility	0
Miscellaneous	1
200-West Area	
Tank farms	0
Burial grounds	0
Cribs, ponds, and ditches	0
Fence lines	0
Roads and railroads	0
Unplanned release sites	0
Underground pipelines	0
Miscellaneous	0
Cross-site transfer line	0
200-BC cribs and trenches	0
200-North Area	0
300 Area	0
400 Area	0
600 Area	0
Total	7

Table 9-6. Hanford Site Soil Contamination Occurrences from 2000 through 2019.

Year	Incidents
2000	25
2001	20
2002	22
2003	30
2004	19
2005	20
2006	25
2007	17
2008	16
2009	28
2010	22
2011	10
2012	10
2013	21
2014	22
2015	20
2016	17
2017	16
2018	18
2019	7

9.4 References

- DOE-HDBK-1216-2015. *Environmental Radiological Effluent Monitoring and Environmental Surveillance*. U.S. Department of Energy, Washington, D.C.
- DOE/RL-91-50. 2018. *Hanford Site Environmental Monitoring Plan*. Rev. 8. U.S. Department of Energy, Richland Operations Office, Richland, Washington. Online at https://www.hanford.gov/files.cfm/2018_EMP_estars.pdf.
- DOE/RL-96-12. 1997. *Hanford Site Background: Part 2, Soil Background for Radionuclides*. U.S. Department of Energy, Richland Operations Office, Richland, Washington. Online at <https://pdw.hanford.gov/arpir/pdf.cfm?accession=D1808987>.
- DOE/RL-2013-53. 2019. *Hanford Site Environmental Surveillance Master Sampling Schedule for Calendar Year 2019*. U.S. Department of Energy, Richland Operations Office, Richland, Washington.
- ECF-HANFORD-16-0133. 2016. *Calculation of Soil Radiological Preliminary Remedial Goals for the Outdoor Worker Scenario*. Rev. 0. U.S. Department of Energy, Richland Operations Office, Richland, Washington. Online at <https://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0071881H>.

Hanford Site Radioactive Air Emissions License #FF-01, Washington State Department of Health, Olympia, Washington. Online at https://fortress.wa.gov/ecy/nwp/permitting/AOP/renewal/two/Revision_B/07_28_16/Att-2/Att-2_R2RB.pdf.

RC-PRO-RC-60561. *Environmental Soil Sampling*. Rev. 9. Mission Support Alliance, LLC, Richland, Washington.

This Page Intentionally Left Blank

Contents

9.0	Soil Monitoring.....	9-1
9.1	Hanford Site Soil Sampling	9-2
9.2	Offsite Soil Sampling	9-9
9.3	Radiological Contamination Surveys	9-10
9.4	References	9-12
Contents.....		9-15
Figure 9.1. Average Concentrations of Select Radionuclides in Hanford Site Soil Samples, 2014–2019. (As a result of figure scale, some uncertainties [error bars] are concealed by the point symbol)		
		9-7
Table 9-1. Hanford Site Soil Monitoring Locations and Sample Analyses. (2 Pages).....		
		9-2
Table 9-2. Number of Soil Samples per Operational Area.		
		9-3
Table 9-3. Concentration Limits for Selected Radionuclides (pCi/g). (2 Pages).....		
		9-4
Table 9-4. Offsite Soil Monitoring Locations and Sample Analyses. (2 Pages).....		
		9-9
Table 9-5. Hanford Site Soil Contamination Occurrences discovered in CY 2019. (2 Pages).....		
		9-11
Table 9-6. Hanford Site Soil Contamination Occurrences from 2000 through 2019.....		
		9-12