INL/RPT-23-74930-Revision-0

Assessment of Baseline Monitoring Data for the Remote-Handled Low-Level Waste Disposal Facility at Idaho National Laboratory

September 2023

A Jeffrey Sondrup, Kira Brianne Overin, Thomas Allen Rackow

Changing the World's Energy Future

INL is a U.S. Department of Energy National Laboratory operated by Battelle Energy Alliance, LLC

INL/RPT-23-74930-Revision-0

Assessment of Baseline Monitoring Data for the Remote-Handled Low-Level Waste Disposal Facility at Idaho National Laboratory

A Jeffrey Sondrup, Kira Brianne Overin, Thomas Allen Rackow

September 2023

Idaho National Laboratory
Idaho Falls, Idaho 83415

http://www.inl.gov

Prepared for the
U.S. Department of Energy
Under DOE Idaho Operations Office
Contract DE-AC07-05ID14517

INL/RPT-23-74930

Assessment of Baseline Monitoring Data for the Remote-Handled Low-Level Waste Disposal Facility at Idaho National Laboratory

September 2023

A. Jeffrey Sondrup, Kira B. Overin, and Thomas A. Rackow
Idaho National Laboratory

INL is a U.S. Department of Energy National Laboratory
operated by Batelle Energy Alliance, LLC

INL/RPT-23-74930

Assessment of Baseline Monitoring Data for the Remote-Handled Low-Level Waste Disposal Facility at Idaho National Laboratory

A. Jeffrey Sondrup, Kira B. Overin, and Thomas A. Rackow
Idaho National Laboratory

September 2023

Idaho National Laboratory
Idaho Falls, Idaho 83415

http://www.inl.gov

Prepared for the
U.S. Department of Energy
Office of Nuclear Energy
Under DOE Idaho Operations Office
Contract DE-AC07-05ID14517

Page intentionally left blank

EXECUTIVE SUMMARY

The purpose of this document is to summarize environmental monitoring data collected at the Remote-Handled Low-Level Waste (RHLLW) Disposal Facility during the first four years of facility operations (FY 2019 through FY 2022). This summary provides a "baseline" condition for the facility, which can be used to distinguish contaminant releases from the RHLLW Disposal Facility from pre-existing contamination as well as potential future releases from other sources (i.e., upgradient aquifer sources), as specified in the facility monitoring plan.

Sufficient data has been collected over the first four years of operation of the RHLLW Disposal Facility to establish baseline conditions for future compliance monitoring of aquifer wells and performance monitoring of vadose zone lysimeters. Except for seven elevated tritium measurements from lysimeter HFEF-South believed to have been impacted by waste disposals, all data was deemed appropriate for establishing baseline concentrations.

Monitoring of the aquifer detected indicator analytes gross alpha and gross beta and target analytes tritium and C-14. There were a few C-14 detections prior to an increase in the required detection level (RDL) after the first round of sampling. I-129 and Tc-99 were not detected above RDLs in aquifer samples. Lysimeter samples detected indicator analytes gross alpha and gross beta and target analyte tritium. Target analytes C-14, I-129, and Tc-99 were not detected above RDLs in lysimeter samples.

Except for tritium, baseline concentrations of indicator and target analytes measured during the first four years of RHLLW facility operations are expected to represent conditions through the expected 20-year operating period of the facility. Elevated tritium in the aquifer, a result of past discharges of tritium at upgradient facilities, showed a decline over the first four years of operations, and levels are expected to continue to decline with time as a result of dilution and decay. Current tritium levels in lysimeter samples may be elevated due to tritium in the water applied during construction and infiltration testing of the facility. As a result, tritium concentrations in lysimeters may decline with time as a result of dilution and decay.

Statistical measures (i.e., mean, standard deviation, and 99% upper confidence level [UCL]) were calculated for all detected analytes using the four years of concentration data. These measures will be used to evaluate future monitoring results and to demonstrate the facility is performing, or not performing, as established in the facility performance assessment (PA). Future monitoring results will also be combined with the baseline data in this report to further establish temporal trends and natural variability in the measurements.

Based on the data collected during the baseline period, it is recommended the gross alpha action level for performance monitoring increase from 10 to 20 pCi/L due to several baseline measurements exceeding the preliminary action level of 10. An action level of 20 pCi/L is slightly greater than the 99% UCL, is protective of the aquifer, and would reduce unnecessary sampling. It is also recommended that tritium be added to the lysimeter analyte list for post-baseline period monitoring. Tritium, while not a dose concern, is a good tracer that can provide valuable information on water flow in and around the RHLLW Disposal Facility. Recommendations for a tritium action level are provided if considered necessary.

Page intentionally left blank

CONTENTS

FIGURES

TABLES

ACRONYMS

ATR	Advanced Test Reactor
bls	below land surface
CFR	Code of Federal Regulations
DOE	U.S. Department of Energy
EPA	Environmental Protection Agency
INL	Idaho National Laboratory
LFRG	(DOE) Low-Level Waste Disposal Facility Federal Review Group
MCL	maximum contaminant level
MFC	Materials and Fuels Complex
NRF	Naval Reactors Facility
PA	performance assessment
RDL	required detection level
RHLLW	Remote-Handled Low-Level Waste
UCL	upper confidence level

Page intentionally left blank

Assessment of Baseline Monitoring Data for the Remote-Handled Low-Level Waste Disposal Facility at Idaho National Laboratory

1. INTRODUCTION

The Remote-Handled Low-Level Waste (RHLLW) Disposal Facility at Idaho National Laboratory (INL) began operating and disposing of RHLLW in FY 2019. The facility in its current configuration was designed for an approximate 20-year capacity. Environmental monitoring began in FY 2019 with the commencement of operations and is conducted in accordance with PLN-5501, *Monitoring Plan for the Idaho National Laboratory Remote-Handled Low-Level Waste Disposal Facility*. PLN-5501 was developed to meet the requirements for monitoring the RHLLW Disposal Facility according to the U.S. DOE Order 435.1, "Radioactive Waste Management," and the guidance provided in the associated technical standard, "Disposal Authorization Statement and Tank Closure Documentation" (DOE-STD-5002-2017).

The RHLLW Disposal Facility performance assessment (PA) (DOE-ID 2018) demonstrates the facility design will meet performance objectives established for long-term protection of the public and the environment following facility closure. The facility performance is ensured through a combination of facility location, natural features, and engineered facility design features. The facility monitoring plan (PLN-5501) documents a monitoring strategy that includes (1) compliance monitoring activities to demonstrate compliance with regulatory standards/limits and (2) performance monitoring to build confidence the facility is performing as analyzed in the PA.

The RHLLW Disposal Facility monitoring plan (PLN-5501) calls for a baseline monitoring period to be followed by a surveillance monitoring period. The original length of the baseline period was planned to last three years (FY 2019 through FY 2021). However, a preliminary evaluation of lysimeter data collected during the first three years of operations was performed prior to collection of samples in the spring of FY 2022. This evaluation determined that insufficient data had been collected to determine baseline concentrations for some lysimeters and analytes (see INL 2023, Appendix B, Table B-6). As a result, the baseline period was extended another year, and analyte priorities were modified for specific lysimeters so that samples would be analyzed for analytes with less data.

1.1. Purpose and Scope

The purpose of this document is to summarize environmental monitoring data collected at the RHLLW Disposal Facility during the first four years of facility operations (FY 2019 through FY 2022). This summary provides a "baseline" condition for the facility that can be used to distinguish contaminant releases from the RHLLW Disposal Facility from pre-existing contamination and potential future releases from other sources (i.e., upgradient aquifer sources). This approach also allows early detection of releases from the RHLLW Disposal Facility.

Monitoring activities and data described in this report are associated with the groundwater exposure pathway. Water samples are collected from aquifer monitoring wells and analyzed to determine compliance with groundwater quality standards for radionuclides. Soil-porewater samples, collected from lysimeters in the vadose zone adjacent to and below the base of the vault arrays, are analyzed to establish background concentrations and evaluate facility performance.

2. MONITORING STRATEGY

The RHLLW Disposal Facility monitoring strategy includes (1) compliance monitoring activities to demonstrate compliance with regulatory standards/limits and (2) performance monitoring to build confidence that the facility is performing as analyzed in the PA.

The facility PA determined the groundwater pathway is the primary pathway of concern. Compliance monitoring is conducted to confirm the performance objectives and regulatory limits associated with the groundwater pathway will be met (see Table 1). Compliance monitoring of the aquifer will be conducted throughout the institutional control period, which is assumed to be 100 years following facility closure.

Table 1. Compliance and performance criteria for the RHLLW Disposal Facility groundwater pathway.

Performance Objective or Measure	Standard	Point of Assessment[a]	
		Operations and Post Closure Institutional Control Period (100 Years Post Closure)	Post-Institutional Control Period (1,000 Years Post Closure)
All-pathways dose[b] (DOE Order 435.1)	25-mrem/year effective dose equivalent[c]	INL site boundary	100 m
Groundwater protection – Federal and Idaho State Drinking Water and Groundwater Standards (IDAPA 58.01.08) (IDAPA 58.01.11) (40 CFR 141) (DOE Order 458.1)	Beta-gamma effective dose/dose equivalent[d] ≤4 mrem/year (based on federal maximum contaminant levels) Gross alpha ≤15 pCi/L Ra-226/Ra-228 ≤5 pCi/L Uranium ≤30 µg/L[e] Sr-90 ≤8 pCi/L H-3 ≤20,000 pCi/L	Aquifer	Aquifer

a. The point of assessment is a location where the potential receptor is exposed to the modeled dose or concentration. The point of assessment should not be confused with the location where samples will be collected. Points of assessment noted as "100 m" corresponds to the point of the highest projected dose or concentration beyond a 100-m buffer zone surrounding the disposed waste.

b. For the RHLLW Disposal Facility the groundwater pathway dose is the all-pathways dose.

c. Excluding radon in air.

d. Evaluated as dose equivalent (IDAPA-58.01.08) or effective dose 9IDAPA-58.01.11)

e. Uranium is included in the federal and Idaho State Drinking Water Standards (40 CFR 141, IDAPA 58.01.08) but is not included in the Idaho State Groundwater Quality Rule (IDAPA 58.01.11).

Due to existing low-level variable radionuclide concentrations in the aquifer originating from upgradient facilities, compliance monitoring activities for the groundwater pathway will be augmented by performance monitoring of the shallow alluvium below the drainage course materials, deep alluvium, and vadose zone beneath the RHLLW Disposal Facility (hereafter referred to as near-field monitoring). Performance monitoring will be conducted until the facility is closed. Performance monitoring action levels are established for near-field monitoring because these data support early detection of radionuclide releases from the vault system and conclusively demonstrate that radionuclides detected originate from the RHLLW Disposal Facility.

3. MONITORING ACTIVITIES

3.1. Compliance Monitoring

Compliance monitoring for the groundwater pathway is performed by sampling three aquifer wells near the RHLLW Disposal Facility (see Figure 1). Two wells (USGS-140 and USGS-141) are located approximately 100 m downgradient of the vault-yard fence, and one aquifer well (USGS-136) is located approximately 20 m upgradient of the vault yard. Samples are collected annually from each well and analyzed for indicator analytes gross alpha and gross beta and for four key[1] radionuclides selected as target analytes (i.e., H-3, C-14, Tc-99, and I-129) due to their high degree of mobility and predicted dose consequence.

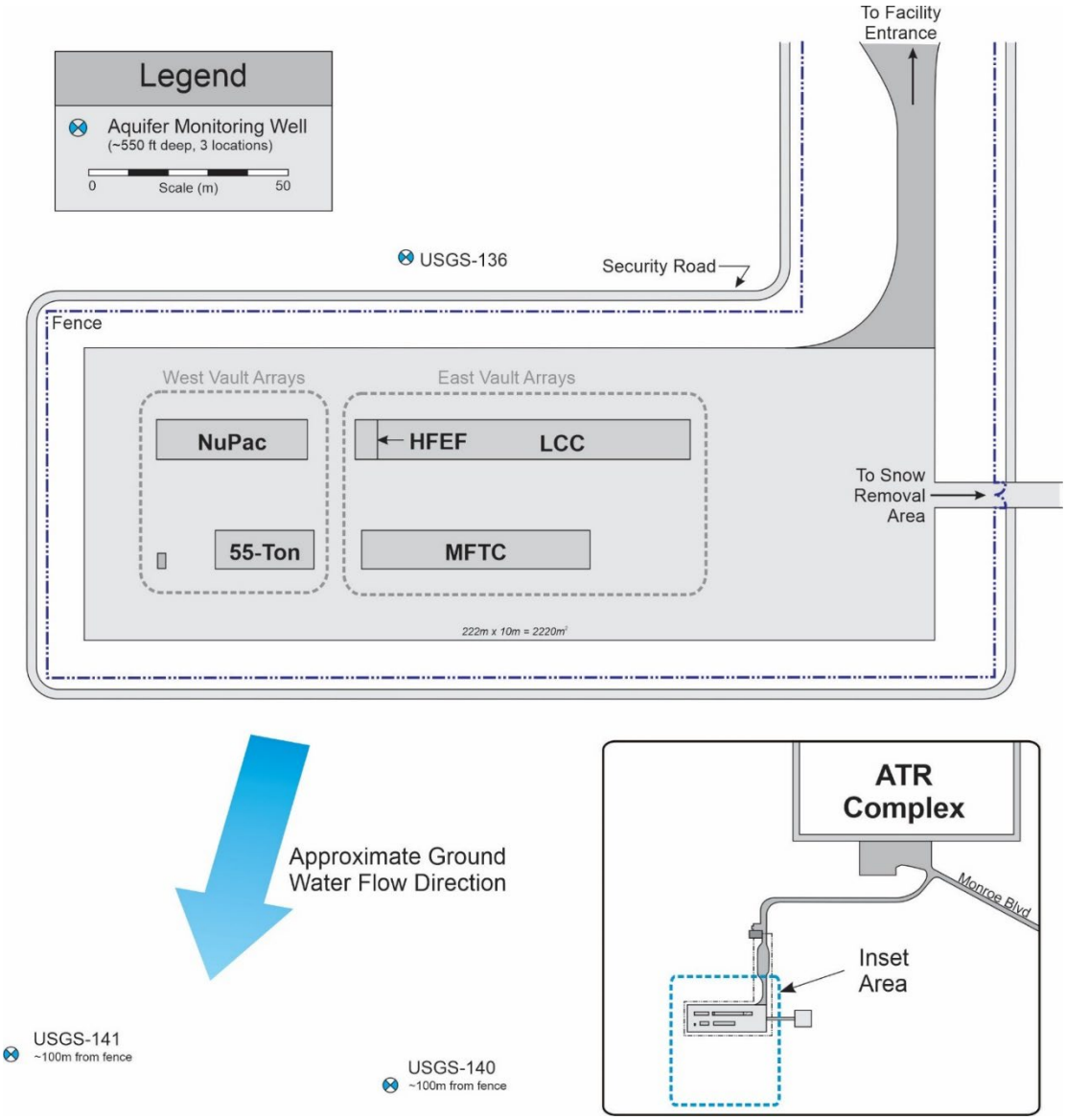

Figure 1. RHLLW Disposal Facility layout showing compliance (aquifer) monitoring well locations.

[1] Key radionuclides are those that were not screened from the groundwater pathway analysis in the PA and were fully evaluated to determine their contribution to the all-pathways dose.

Although the facility monitoring plan specifies annual aquifer sampling, samples were collected semiannually in FY 2019 and FY 2022. Semiannual sampling performed in FY 2022 was in response to the gross alpha action being exceeded in a few lysimeter porewater samples each year. The facility monitoring plan stipulates that if performance monitoring action levels are exceeded, aquifer sampling frequency will be increased from annual to semiannual. Although performance monitoring action levels were only intended to be applied after baseline or background concentrations are established, semiannual sampling was implemented out of caution and because the original baseline period was only intended to last three years.

3.2. Performance Monitoring

Performance monitoring of the facility is achieved by analysis of soil-porewater samples collected from vadose zone lysimeters. All lysimeters are installed adjacent to vault arrays (see Figure 2) in native materials at three general depths: (1) shallow alluvium below the drainage course material at the base of the vaults (~26–29 ft below land surface [bls]), (2) deep alluvium above the upper basalt contact (~40–44 ft bls), and (3) sedimentary interbeds (~171–176 ft bls) (INL 2020a). The monitoring plan specifies that the sample collection from vadose zone monitoring points is only required when sufficient porewater is present and can be collected.

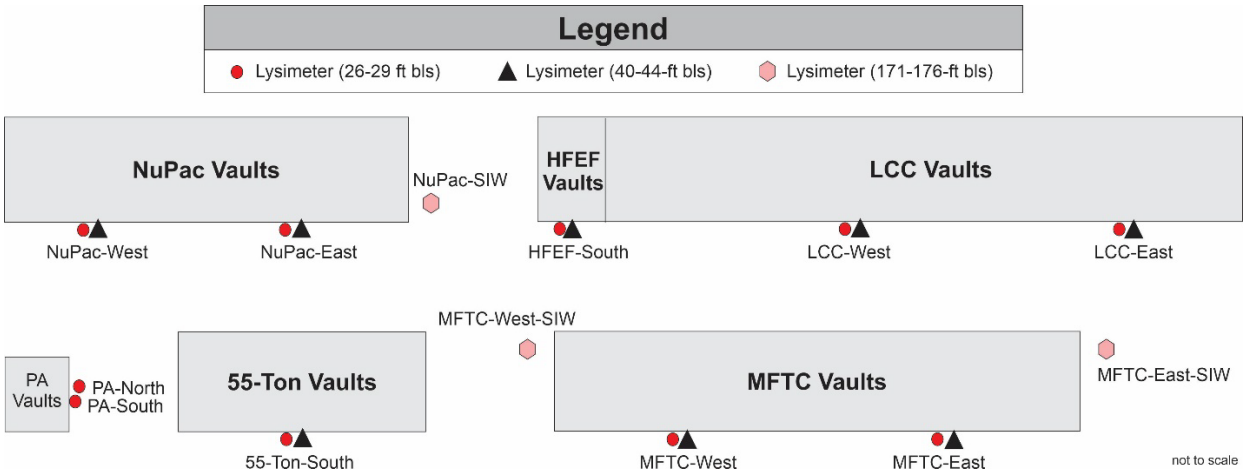

Figure 2. Plan view of the vault arrays showing the lysimeter locations. The legend indicates the approximate depth below land surface (bls).

Sample collection from lysimeters is dependent upon the amount of moisture in the soil surrounding the lysimeter. Sample collection from the shallow lysimeters (~26–29 ft bls) has generally been the most successful in terms of the amount of water collected. Sample collection from the deep alluvium (~40–44 ft bls) and shallow interbed lysimeters (~171–176 ft bls) has been problematic, except for shallow interbed lysimeter MFTC-East-SIW, which generally produces sufficient water for the full suite of analytes.

Approximately 530–730 mL of sample is required for the full suite of analytes. In the event of insufficient porewater for full analysis, the precedence for analysis is gross alpha/beta (requires 200–300 mL), C-14 (100 mL), I-129 (100–200 mL), H-3 (50 mL), and Tc-99 (80 mL). The monitoring plan specifies that after the baseline period, annual sampling will be conducted only at lysimeters near vaults that have received waste, and samples will be analyzed only for indicator analytes gross alpha and gross beta, as sample volumes permit. Annual sampling will continue as long as positive detections of either gross alpha or gross beta do not exceed action levels at any of the monitoring locations. If gross alpha or gross beta action levels are exceeded, as shown through trend analysis, sampling frequency will be increased to semiannual (as soil water is available) and continue for as long as action levels are exceeded. Semiannual samples will be analyzed for target analytes C-14, H-3, I-129, and Tc-99 in addition to gross alpha and gross beta.

4. DATA ASSESSMENT

All sampling results presented in this section were downloaded from the INL Environmental Data Warehouse[2] on January 10, 2023 (aquifer), and January 11, 2023 (lysimeter), and included in Appendix A, "Aquifer and Lysimeter Monitoring Data (2019–2022)." The downloads included all data collected from the three aquifer wells and 21 lysimeters at the RHLLW Disposal Facility. Only aquifer data collected for demonstrating compliance with RHLLW Disposal Facility monitoring requirements were used in this assessment.[3]

4.1. Aquifer Baseline Data

Annual aquifer sampling results are presented each fiscal year in RHLLW Disposal Facility annual summary reports (ASRs) (see Appendix B of INL 2020a, INL 2021, INL 2022, and INL 2023). Although the presence of indicator and target analytes in the aquifer was established using wells installed prior to facility construction (INL 2017), this document focuses on data collected solely from the wells that will serve as compliance wells for the facility collected during the four-year baseline period.

Table 2 presents a summary of the indicator and target analyte data for the first 4 years of facility operations (FY 2019 through FY 2022). The table contains the minimum, maximum, and mean of the data for each of the three compliance monitoring wells and the data for all three wells combined. The table also includes the number of samples and number of detections.[4] The minimum, maximum, and mean results for analytes gross alpha, gross beta, and C-14 are presented graphically in Figure 3. Table 2 also contains the standard deviation and the 99% upper confidence level (UCL)[5] for the data from all three wells and a maximum contaminant level (MCL) based on federal and Idaho State drinking water and groundwater protection standards (i.e., IDAPA 58.01.08, IDAPA 58.01.11, 40 CFR 141, and DOE O 458.1). The results for each analyte are discussed below. All concentrations referenced are in pCi/L.

---

2 The Environmental Data Warehouse (EDW) is the official long-term environmental data management and storage location for the Idaho Completion Projects Core and INL programs. EDW is administered under PLN-1387, "Data Management Plan for the Idaho Cleanup Project Environmental Data Warehouse."

3 In addition to samples collected for RHLLW Disposal Facility compliance verification, additional samples are collected semiannually from Well USGS-136 by the INL Site contractor (BEA) and analyzed for gross alpha, gross beta, and tritium to demonstrate compliance with DOE Order 458.1 for the ATR Complex Cold Waste Pond. Wells USGS-136 and USGS-140 are also sampled periodically by the USGS and analyzed for tritium. These data are not included in this summary.

4 A positive detection is defined as a result greater than three times the uncertainty (sigma) of the measurement.

5 It is expected with 99% confidence that the true mean is less than this value.

Gross Alpha – Gross alpha was detected in all three aquifer wells. The detection frequency (number of detects divided by the number of samples) ranged from 38% (USGS-136) to 50% (USGS-141), and the detection frequency was 43% for all three wells. Detected concentrations ranged from 1.06 to 4.17 pCi/L, with a mean of 2.29 pCi/L. The required detection level (RDL) for gross alpha was 1 pCi/L, but the minimum detectable concentrations (MDCs) ranged from 0.86 to 3.0 pCi/L and exceeded the RDL for most analyses. All concentrations, including the 99% UCL (5.27 pCi/L) are less than the MCL of 15 pCi/L for gross alpha, not including radon and uranium.

Gross Beta – Gross beta was detected in all three aquifer wells and was detected in all seven samples from USGS-140. The overall detection frequency was 78%, and the MDCs were consistently less than the RDL of 4 pCi/L. Detected concentrations ranged from 1.31 to 4.02 pCi/L, with a mean of 2.35 pCi/L. All concentrations, including the 99% UCL (4.54 pCi/L), are less than the gross beta screening level for community water systems (50 pCi/L).[6]

Carbon-14 – C-14 was detected in one sample in each of the three aquifer wells. These were the first samples collected in October 2018 (FY 2019) at the start of the four-year baseline period. The RDL for these samples was 3 pCi/L, but this RDL required a very large sample volume. The RDL for subsequent samples was increased to 50 pCi/L, and although the MDC range for those samples was less than 50 pCi/L (31–37 pCi/L), there have been no detections of C-14 since October 2018. The three detections in 2018 were 6.02 pCi/L (USGS-136), 5.24 pCi/L (USGS-140), and 4.35 pCi/L (USGS-141). All concentrations, including the 99% UCL (10.8 pCi/L), are less than 2,000 pCi/L, which is the concentration that produces an ingestion dose of 4 mrem/yr dose equivalent.

Tritium – H-3 was consistently detected (23 of 23 samples) above the RDL of 400 pCi/L in all three aquifer wells over the four-year period. Detected concentrations ranged from 535 to 1520 pCi/L with a mean of 1046 pCi/L. All concentrations, including the 99% UCL (1,692 pCi/L) are less than the MCL of 20,000 pCi/L. The elevated tritium levels in the aquifer near the RHLLW Disposal Facility and surrounding region are primarily the result of past wastewater discharges at nearby facilities Advanced Test Reactor (ATR) Complex and Idaho Nuclear Technology and Engineering Center (INTEC). Since radioactive discharges to unlined ponds ceased at the ATR Complex and INTEC in 1993, tritium concentrations in the aquifer have been declining due to dispersion and decay (H-3 half-life = 12.3 years). Figure 4 shows the decline of H-3 in the three aquifer wells from FY 2019 through FY 2022.

Iodine-129 – I-129 was not detected in any of the 23 samples analyzed over the four-year period. The RDL for I-129 is 1 pCi/L, but the MDCs were consistently less at 0.11 to 0.92 pCi/L, indicating the actual concentrations are indeed less than 1 pCi/L. INL (2017) identified 14 samples from wells near the ATR Complex that were analyzed for I-129 from 2003 and 2013. Two of the 14 samples positively identified I-129 at 0.002 pCi/L and 0.0029 pCi/L. These detections are less than the current RDL; therefore, it is not surprising that I-129 was not detected. The MCL for I-129 is 1 pCi/L, which is the same as the RDL.

Technetium-99 – Tc-99 was not detected in any of the 23 samples analyzed over the four-year period. The RDL for the first round of samples collected in October 2018 was 10 pCi/L, but this required very large sample volumes. The RDL for subsequent samples was increased to 50 pCi/L, and the MDCs were consistently less at 24–46 pCi/L, indicating the actual concentrations are indeed less than 50 pCi/L and likely less than the MDC range. INL (2017) identified 12 samples from wells near the ATR Complex that were analyzed for Tc-99 from 2003 to 2013. Although the measurement uncertainties were small (3 pCi/L or less), Tc-99 was not detected in any of the samples. The MCL for Tc-99 is 900 pCi/L, which is much greater than the RDL of 50 pCi/L.

---

[6] The U.S. EPA has set an MCL for beta particles and photon emitters at a dosage equivalent to 4 mrem/yr. Compliance with the federal 4 mrem/yr requirement is assumed, providing that the average water concentrations are below the 50 pCi/L gross beta screening level for community water systems.

Table 2. Minimum, maximum, and mean concentration results (pCi/L) and detection frequency for indicator and target analytes in aquifer monitoring wells (October 1, 2018, through September 30, 2022).[a]

Well	Measure	Gross Alpha	Gross Beta	C-14	H-3	I-129
	RDL[b]	1	4	50[d]	400	1
	MDC Range[c]	0.86–3.0	0.49–2.3	31–37	256–365	0.11–0.92
USGS-136	# Samples	8	8	8	8	8
	# Detects	3	5	1	8	0
	% Detect	38%	63%	13%	100%	0%
	Min.	1.62	1.92	6.02	535	ND
	Max.	2.97	3.45	6.02	1,500	ND
	Mean	2.11	2.31	6.02	1,097	ND
USGS-140	# Samples	7	7	7	7	7
	# Detects	3	7	1	7	0
	% Detect	43%	100%	14%	100%	0%
	Min.	1.88	1.77	5.24	624	ND
	Max.	2.57	4.02	5.24	1,490	ND
	Mean	2.17	2.65	5.24	1,014	ND
USGS-141	# Samples	8	8	8	8	8
	# Detects	4	6	1	8	0
	% Detect	50%	75%	13%	100%	0%
	Min.	1.04	1.31	4.35	608	ND
	Max.	4.17	2.96	4.35	1,520	ND
	Mean	2.51	2.05	4.35	968	ND
Combined all three wells	# Samples	23	23	23	23	23
	# Detects	10	18	3	23	0
	% Detect	43%	78%	13%	100%	0%
	Min.	1.04	1.31	4.35	535	ND
	Max.	4.17	4.02	6.02	1,520	ND
	Mean	2.29	2.35	5.20	1,046	ND
Standard Deviation[f]		1.07	0.76	0.84	292	NA
99% UCL[g]		5.3	4.6	10.8	1,692	1
MCL[h]		15	50	2000	20,000	1

a. Minimum, maximum, and mean results include duplicate samples but do not include non-detects (result < 3 sigma).
b. RDL = required detection level.
c. MDC = minimum detectable concentration. A range for all samples is provided because the MDC differs for each sample due to differences in aliquot (sample) size, counting time, etc.
d. RDL for C-14 was 3 pCi/L in 2018 but required very large sample volumes. The MDC for 2018 was 3.4 pCi/L, and C-14 was detected in all three wells. The RDL was changed from 3 to 50 in 2019.
e. RDL for Tc-99 was 10 pCi/L in 2018 but required very large sample volumes. The MDC range for 2018 was 4.7 to 6.1 pCi/L. Even with a lower RDL and MDC, Tc-99 was not detected in 2018. The RDL was changed from 10 to 50 pCi/L in 2019.
f. Standard deviation of all 23 samples from all three wells.
g. 99% UCL is equal to the maximum concentration of 23 samples plus the 99% confidence level. It is expected with 99% confidence that the true mean is less than this value. For analytes not detected (I-129 and Tc-99), the value is set to the RDL.
h. MCL = maximum contaminant level. Gross alpha MCL excludes radon and uranium. Gross beta value is not an MCL but a screening level for community water systems. C-14, H-3, I-129, and Tc-99 MCLs are based on 4 mrem/yr ingestion dose limit for beta-gamma emitting radionuclides.

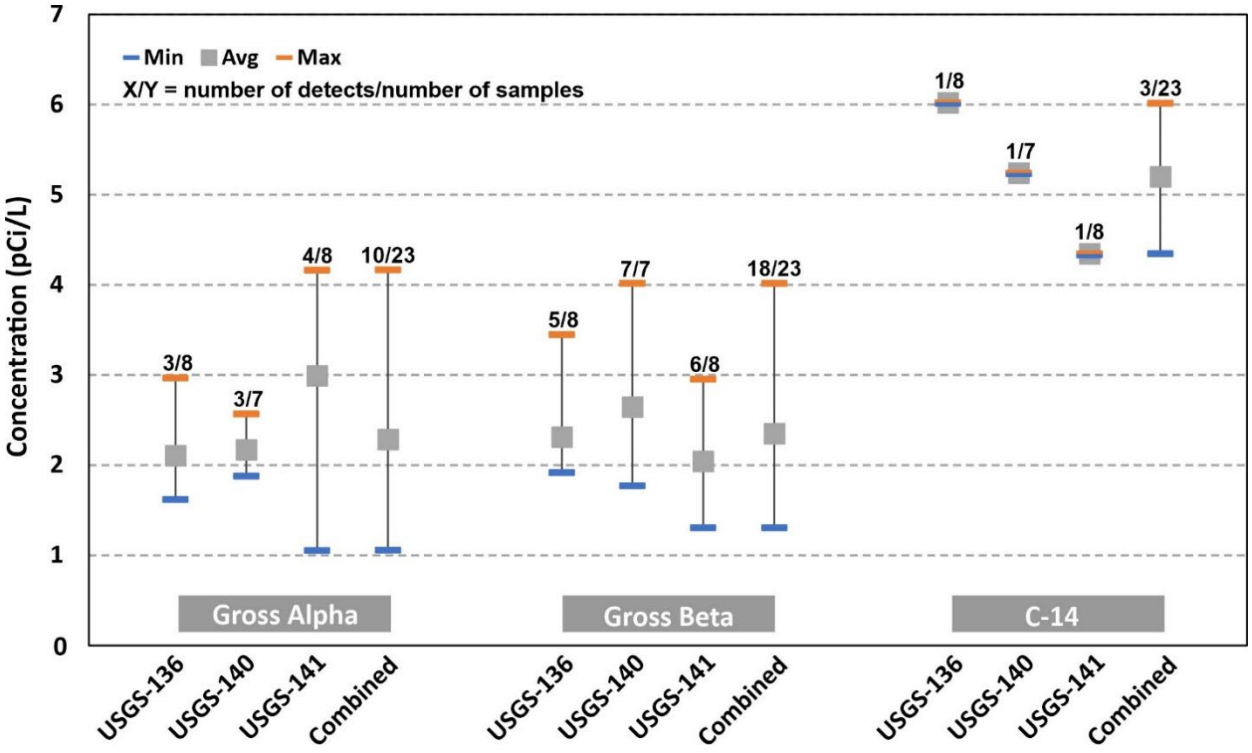

Figure 3. Minimum, maximum, and mean results for gross alpha, gross beta, and C-14 in aquifer monitoring wells (October 1, 2018, through September 30, 2022).

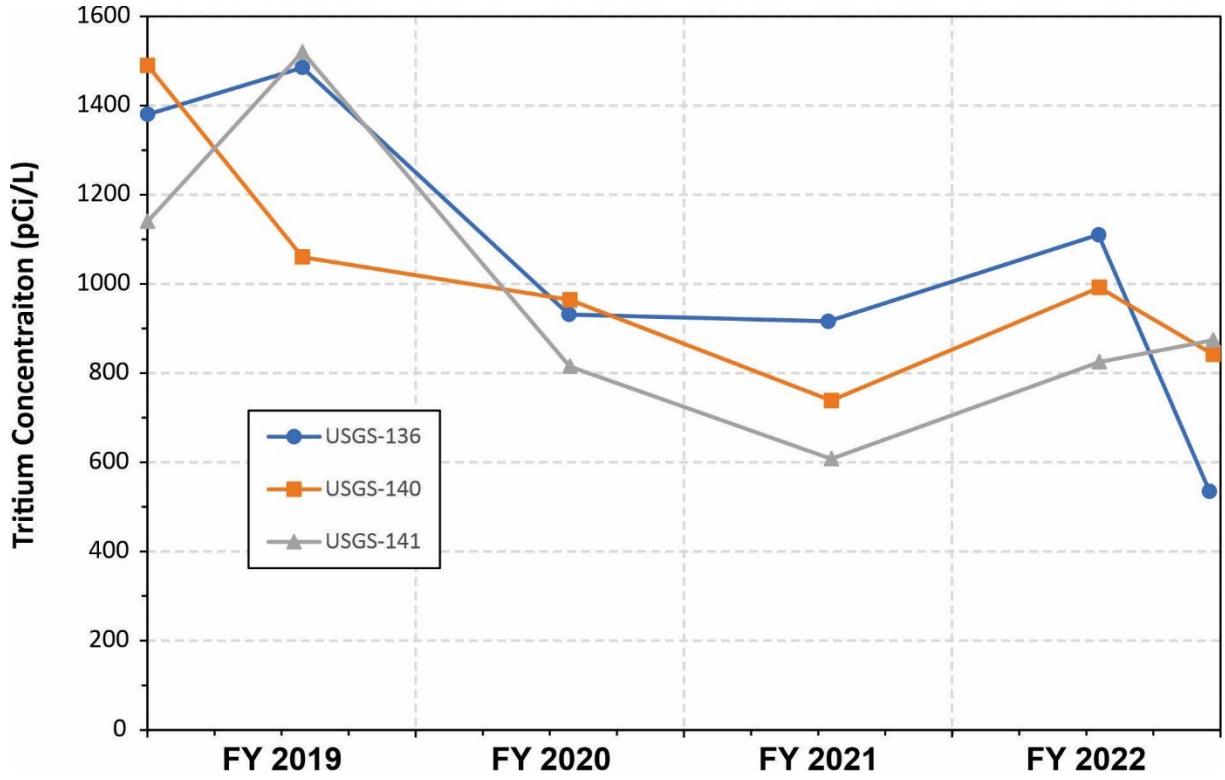

Figure 4. Time history of tritium concentration in aquifer wells near the RHLLW Disposal Facility (FY 2019 through FY 2022).

4.1.1. Compliance Monitoring Data Summary

Four years of aquifer sample analysis from the three compliance wells at the RHLLW Disposal Facility show concentrations of indicator analytes gross alpha and gross beta and target analytes C-14 and tritium detected in concentrations above the RDLs. However, the C-14 detections occurred in 2019 when the RDL was 3, which required a large sample volume. The RDL for C-14 was increased to 50 pCi/L after that, and there have been no detections since. Target analytes I-129 and Tc-99 were not detected above RDLs. Detected concentrations were all much less than MCLs. For detected analytes, 99% UCLs were calculated and those concentrations are also much less than MCLs.

Except for tritium, baseline concentrations of indicator and target analytes measured during the first four years of RHLLW facility operations are expected to represent conditions in the aquifer for several years. Current tritium levels in the regional aquifer are the result of upgradient wastewater discharges at the ATR Complex and INTEC from 1952 to 2000 and are, therefore, expected to continue to decline with time as a result of dilution and decay. Nevertheless, for the foreseeable future, concentrations can be expected to remain below the 99% UCLs determined from the four years of data.

Based on the RHLLW Disposal Facility PA, increases in analyte concentrations due to releases from the RHLLW Disposal Facility are not expected to be detected above RDLs in the monitoring wells during the 1,000-year compliance period (2040–3039). Table 3 shows the PA predicted maximum concentrations at 100 m downgradient from the vault arrays (i.e., the approximate location of monitoring Wells USGS-140 and USGS-141) for both the compliance and post-compliance periods. During the 1,000-year compliance period, the maximum concentrations of indicator and target analytes predicted in the PA are well below the RDLs and 99% UCLs. During the post-compliance period, the maximum Tc-99 concentration is predicted to exceed the RDL, but not until approximately 20,000 years after the facility closure. Therefore, any increase in indicator or target analyte concentrations above the 99% UCL could indicate an early release from the facility or contamination from an upgradient source.

Table 3. Comparison of RDL and 99% UCL to maximum concentrations predicted in the PA for indicator and target analytes. Concentrations are in pCi/L.

	Gross Alpha	Gross Beta	C-14	H-3	I-129	Tc-99
RDL	1	4	50	400	1	50
99% UCL	5.3	4.6	10.8	1,692	NA[a]	NA[a]
PA Max Concentration (1000-yr Compliance Period)	1.43E-26[b]	0.070[c]	1.79E-11	5.61E-18	6.90E-20	0.070
PA Max Concentration Year (1000-yr Compliance Period)	3039	2214 to 3039[g]	3039	2214	3039	3039
PA Max Concentration (Post-Compliance Period)	0.012[b]	110[c,d]	8.46[e]	1.48E-25	0.0042	101[f]
PA Max Concentration Year (Post-Compliance Period)	64789 to 204039[g]	3040 to 30789[g]	24789	3040	30789	21739

a. No detections, 99% UCL not calculated.
b. Gross alpha concentration is based on alpha emitting radionuclides analyzed in the PA. This includes Np-237, Pu-239, Pu-240, U-235, U-238, and alpha emitting progeny.
c. Gross beta concentration is based on beta-gamma emitting radionuclides analyzed in the PA. This includes C-14, Cl-36, H-3, I-129, Mo-93, Nb-94, Ni-59, and Tc-99.
d. Exceeds RDL and 99% UCL. A concentration of this magnitude is likely to be detected. The PA max concentration is mostly due to Tc-99 (101 pCi/L) and C-14 (8.46 pCi/L).
e. Does not exceed RDL or 99% UCL, but a concentration of this magnitude could potentially be detected if the RDL were lower.
f. Exceeds RDL. A concentration of this magnitude is likely to be detected.
g. The PA max concentration represents the sum of maximum values for each contributing alpha- or beta-emitting radionuclide even though the maximum values for each radionuclide may not occur at the same time. Therefore, it is a hypothetical maximum. The time range for occurrence of maximum concentrations is provided.

4.2. Lysimeter Baseline Data

Lysimeter sampling results are presented each fiscal year in RHLLW Disposal Facility ASRs. Data from the first four years of operations are contained in INL 2020a, INL 2021, INL 2022, and INL 2023 (see Appendix B of each). Table 4 presents the number of sample analyses performed for each lysimeter from October 1, 2018, through October 25, 2022. The greatest number of analyses (84) were for tritium because it requires less sample volume than the other analytes and because elevated tritium was measured in a lysimeter near vaults where waste was being placed in 2020. As a result of the elevated tritium measurement, semiannual sampling of nearby lysimeters was initiated in 2021 with an emphasis on tritium measurements. This is documented in Sondrup (2022), *Evaluation of Elevated Tritium in Lysimeter Samples at the Remote-Handled Low-Level Waste Disposal Facility*. After tritium, gross alpha and gross beta (which are analyzed together) had the second most analyses (66). Gross alpha and gross beta analyses were a priority because after baseline concentrations are established, lysimeter samples will only be analyzed for gross alpha and gross beta unless action levels are exceeded. The fewest number of analyses were performed for C-14 (54), Tc-99 (52), and I-129 (51).

Table 4. Total number of lysimeter samples collected/analyzed, including duplicates (October 1, 2018, through October 25, 2022).[a]

Zone	Lysimeter	Gross Alpha/Beta	C-14	H-3	I-129	Tc-99
Shallow Alluvium	PA-North	7	6	7	7	5
	PA-South	4	2	3		
	NuPac-West	6	7	6	6	6
	NuPac-East	5	6	7	5	6
	55-Ton-South	5	4	5	4	4
	HFEF-South	5	3, 1[b]	7, 1[b]	4	2, 1[b]
	LCC-West	3	1, 1[b]	6, 1[b]	2	1, 1[b]
	LCC-East	4	4	4	4	4
	MTFC-West	7	6	8	6	6
	MTFC-East	6	6	7	6	7
	Total[g]	52	46(1)	61(1)	44	42(1)
Deep Alluvium	HFEF-South-45	1[c]	1,[c] 1[e]	5, 1[c]	1[c]	1, 1[c]
	LCC-West-45	1, 1[c]	1,[c] 1[e]	4, 1[c]	1[c]	1, 1[c]
	LCC-East-45	1,[c] 1[d]	1,[c] 1[e]	2, 1[c]	1[c]	1, 1[c]
	Nupac-West-45	1,[c] 1[d]	1[c]	1[c], 1[f]	1[c]	1[c]
	Nupac-East-45	1,[c] 1[d]	1[c]	1[c], 1[f]	1[c]	1[c]
	55-Ton-South-45	1,[c] 1[d]	1[c]	1[c], 1[f]	1[c]	1[c]
	MFTC-West-45	1,[c] 1[d]	1[c]	1[c], 1[f]	1[c]	1[c]
	MFTC-East-45	1[d]		1[f]		
	Total[g]	3(2)	2(2)	13(2)	1(1)	4(1)
Shallow Interbed	NuPac-SIW	1		1		
	MFTC-West-SIW	3		3		
	MFTC-East-SIW	7	6	6	6	6
	Total[g]	11	6	10	6	6
All	Overall Total[g]	66(2)	54(3)	84(3)	51(1)	52(2)

a. Includes samples collected/analyzed in October 2022 (FY 2023).
b. Composite sample from two shallow alluvium lysimeters (LCC-West and HFEF-South).
c. Composite sample from seven deep alluvium lysimeters. Does not include MFTC-East-45.
d. Composite sample from six deep alluvium lysimeters. Does not include HFEF-South-45 or LCC-West-45.
e. Composite sample from three deep alluvium lysimeters (LCC-West-45, LCC-East-45, and HFEF-South-45).
f. Composite sample from five deep alluvium lysimeters (Nupac-East-45, Nupac-West-45, 55-Ton-South-45, MFTC-West-45, and MFTC-East-45).
g. Number in parentheses (2) is the number of composite samples.

Although some amount of porewater has been collected from every lysimeter, some lysimeters are very productive and yield sufficient water for the full suite of analytes, while others produce very little water. As a result, it was sometimes necessary to combine (composite) water from several lysimeters until the volume was sufficient for analysis of a single analyte. This is primarily the case with the deep alluvium lysimeters. Although it was necessary to composite samples from some lysimeters (mostly deep alluvium), data collected over the first four years of operation is sufficient to establish baseline conditions. Most shallow alluvium lysimeters and one shallow interbed lysimeter have sufficient data to establish baseline concentrations for all indicator and target analytes. Baseline conditions for deep alluvium lysimeters are only established for the group due to low sample volumes and compositing.

Table 5 through Table 7 present a statistical summary of detected analytes gross alpha, gross beta, and tritium data for the first four years of facility operations (FY 2019 through FY 2022) plus one month. The minimum, maximum, and mean data from the tables are shown graphically in Figure 5 through Figure 7. Data for the shallow lysimeters are presented individually for each lysimeter and as a group. Due to less data collected from deep alluvium and shallow interbed lysimeters, the data for each was grouped together. The results for each analyte are discussed below. All concentrations referenced are in pCi/L.

Table 5. Summary of gross alpha lysimeter concentration results (pCi/L).

Lysimeter	No. Samples	No. Detects	% Detects	Minimum	Maximum	Mean	Standard Deviation	99% UCL
PA-North[a]	7	7	100%	8.39	13.4	10.5	1.73	15.8
PA-South[a]	4	2	50%	5.02	6.74	5.88	1.22	61.5
Nupac-West[a]	6	5	83%	1.66	3.07	2.17	0.58	4.27
NuPac-East[a]	5	1	20%	2.16	2.16	2.16	NA	NA
55-Ton-South[a]	5	4	80%	1.35	4.66	3.03	1.79	9.88
HFEF-South[a]	5	4	80%	2.12	3.33	2.73	0.66	5.26
LCC-West[a]	3	2	67%	3.93	4.28	4.11	0.25	15.4
LCC-East[a]	4	2	50%	1.34	2.52	1.93	0.83	40.1
MFTC-West[a]	7	3	43%	1.34	2.33	1.90	0.51	5.24
MFTC-East[a]	6	5	83%	1.50	2.19	1.80	0.26	2.73
All Shallow Alluvium	52	35	67%	1.34	13.4	4.24	3.48	15.0
All Deep Alluvium	3	3	100%	8.68	17.9	12.7	4.71	44.9
All Shallow Interbed	11	7	64%	2.03	8.73	4.61	2.62	12.4
All Lysimeters	66	45	68%	1.34	17.9	4.86	3.98	19.5

a. Shallow alluvium lysimeter. Sufficient data exist to calculate statistics for most shallow alluvium lysimeters. Data for deep alluvium and shallow interbed lysimeters are presented only for the groups.

NA = Not applicable. Standard deviation and 99% UCL are not defined for lysimeters with one or fewer detections.

Table 6. Summary of gross beta concentration results (pCi/L).

Lysimeter	No. Samples	No. Detects	% Detects	Minimum	Maximum	Mean	Standard Deviation	99% UCL
PA-North[a]	7	5	71%	6.98	10.7	8.49	1.40	13.6
PA-South[a]	4	3	75%	3.91	7.04	5.77	1.65	16.5
Nupac-West[a]	6	4	67%	1.40	2.52	2.00	0.56	4.15
NuPac-East[a]	5	4	80%	3.22	4.19	3.66	0.42	5.42
55-Ton-South[a]	5	3	60%	1.71	2.59	2.04	0.48	5.34
HFEF-South[a]	5	2	40%	2.16	2.74	2.45	0.41	21.20
LCC-West[a]	3	2	67%	3.55	7.93	5.74	3.10	147.3
LCC-East[a]	4	2	50%	2.39	3.38	2.89	0.70	34.9
MFTC-West[a]	7	4	57%	1.22	2.12	1.67	0.45	3.43
MFTC-East[a]	6	1	17%	4.71	4.71	4.71	NA	NA
All Shallow Alluvium	52	30	58%	1.22	10.7	4.07	2.62	12.0

Lysimeter	No. Samples	No. Detects	% Detects	Minimum	Maximum	Mean	Standard Deviation	99% UCL
All Deep Alluvium	3	3	100%	6.70	15.1	10.9	4.20	39.2
All Shallow Interbed	11	10	91%	1.44	24.2	8.84	7.80	32.2
All Lysimeters	66	43	65%	1.22	24.2	5.65	4.98	26.3

a. Shallow alluvium lysimeter. Sufficient data exist to calculate statistics for most shallow alluvium lysimeters. Data for deep alluvium and shallow interbed lysimeters are presented only for the groups.
NA = Not applicable. Standard deviation and 99% UCL are not defined for lysimeters with one or fewer detections.

Table 7. Summary of tritium lysimeter concentration results (pCi/L).

Lysimeter	No. Samples	No. Detects	% Detects	Minimum	Maximum	Mean	Standard Deviation	99% UCL
PA-North[a]	7	7	100%	626	962	779	136	1,153
PA-South[a]	3	3	100%	458	1,080	766	311	2,862
Nupac-West[a]	6	3	50%	261	924	510	361	2,991
NuPac-East[a]	7	4	57%	612	845	717	101	1,141
55-Ton-South[a]	5	0	0%	NA	NA	NA	NA	NA
HFEF-South[a]	7	7	100%	20,300	50,900	35,643	10,703	65,898
LCC-West[a]	7	7	100%	461	1,070	752	192	1,339
LCC-East[a]	4	0	0%	NA	NA	NA	NA	NA
MFTC-West[a]	8	4	50%	327	456	379	55	617
MFTC-East[a]	7	1	14%	255	255	255	NA	NA
All Shallow Alluvium[b]	54	29	54%	255	1,080	661	238	1,202
All Deep Alluvium	13	8	62%	440	751	561	127	908
All Shallow Interbed	10	1	10%	335	335	335	NA	NA
All Lysimeters[b]	77	38	49%	255	1,080	632	223	1,178

a. Shallow alluvium lysimeter. Sufficient data exist to calculate statistics for most shallow alluvium lysimeters. Data for deep alluvium and shallow interbed lysimeters are presented only for the groups.
b. Does not include seven samples from HFEF-South lysimeter with elevated tritium that are believed to be impacted by waste disposals.
NA = Not applicable. Minimum, maximum, and mean are not defined for lysimeters with no detections. Standard deviation and 99% UCL are not defined for lysimeters with one or fewer detections.

Gross Alpha – Gross alpha was detected in every lysimeter above the RDL of 1 pCi/L.[7] However, the MDCs ranged from 0.7 to 8.5 pCi/L, and the mean MDC (2.4 pCi/L) exceeded the RDL of 1 pCi/L. The detection frequency was 65% for all lysimeters. Detected concentrations ranged from 1.34 to 17.9 pCi/L, with a mean of 4.86 pCi/L for all detections. The 99% UCL for gross alpha is 19.5 pCi/L.

[7] "Detected in every lysimeter" assumes each deep alluvium lysimeter is represented by a composited sample result.

Figure 5 shows the gross alpha concentrations at lysimeter PA-South and especially PA-North are greater than concentrations at the other shallow alluvium lysimeters. However, the three samples from the deep alluvium lysimeters have a higher mean concentration than the mean concentration at PA-North. The mean concentration of the shallow interbed lysimeters is about the same as both the shallow alluvium lysimeters and the mean for all samples. The reason for the higher concentration in the deep alluvium lysimeters is not known. It may simply be a result of fewer samples. More samples from the deep alluvium lysimeters would support or refute this observation but are not required for this baseline assessment.

Gross Beta – Gross beta was detected in every lysimeter above the RDL of 4 pCi/L.[7] The detection frequency was 65% for all lysimeters. This is slightly less than the gross alpha detection frequency (68%). Detected concentrations ranged from 1.22 to 24.4 pCi/L, with a mean of 5.65 pCi/L for all detections. The MDCs ranged from 0.7 to 10.4 pCi/L, and the mean MDC (2.2 pCi/L) was less than the RDL of 4 pCi/L. The 99% UCL for gross beta is 26.3.

Tritium – Tritium was consistently detected in all but two lysimeters above the RDL of 400 pCi/L.[7] The non-detects were both shallow alluvium lysimeters (55-Ton-South and LCC-East). The detection frequency was 49% for all lysimeters. Detected concentrations ranged from 255 to 1080 pCi/L, with a mean of 632 pCi/L for all the detections. Elevated tritium levels (20,300 to 50,900 pCi/L) were detected in seven samples from shallow alluvium lysimeter HFEF-South. The elevated tritium levels in HFEF-South are believed to be the result of contamination on the exterior of waste cans disposed of in the HFEF vault array (Sondrup 2022) and were not included in determining maximum and mean concentration results. The MDCs for all samples ranged from 238 to 1,080 pCi/L, and the mean MDC (330 pCi/L) was less than the RDL of 400 pCi/L. The 99% UCL for tritium is 1,178 pCi/L.

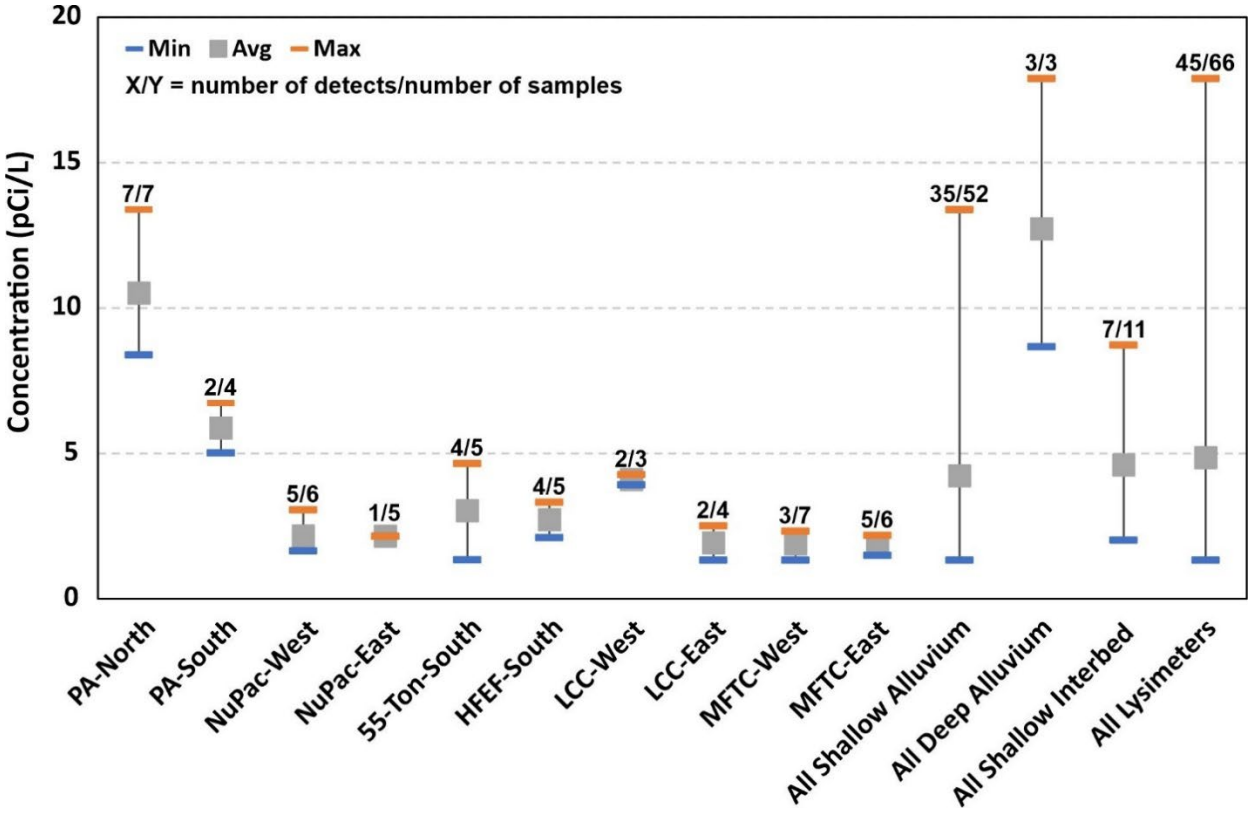

Figure 5. Summary of gross alpha results in lysimeter samples (October 1, 2018, through October 25, 2022).

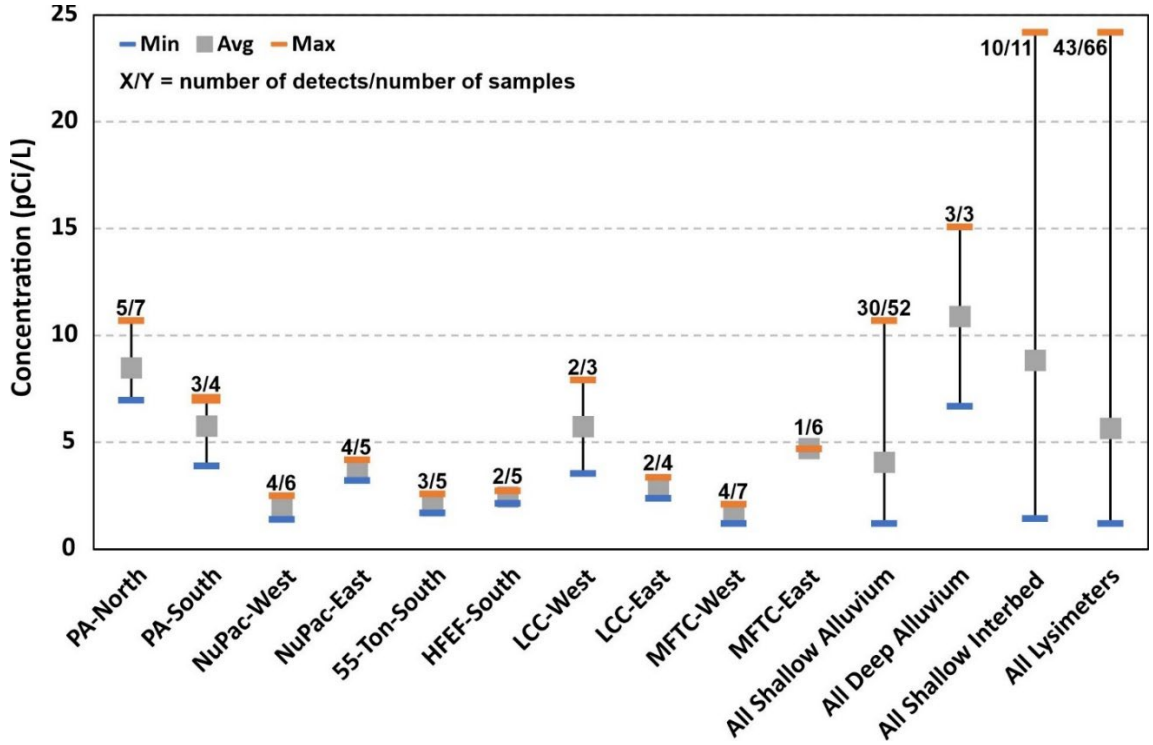

Figure 6. Summary of gross beta results in lysimeter samples (October 1, 2018, through October 25, 2022).

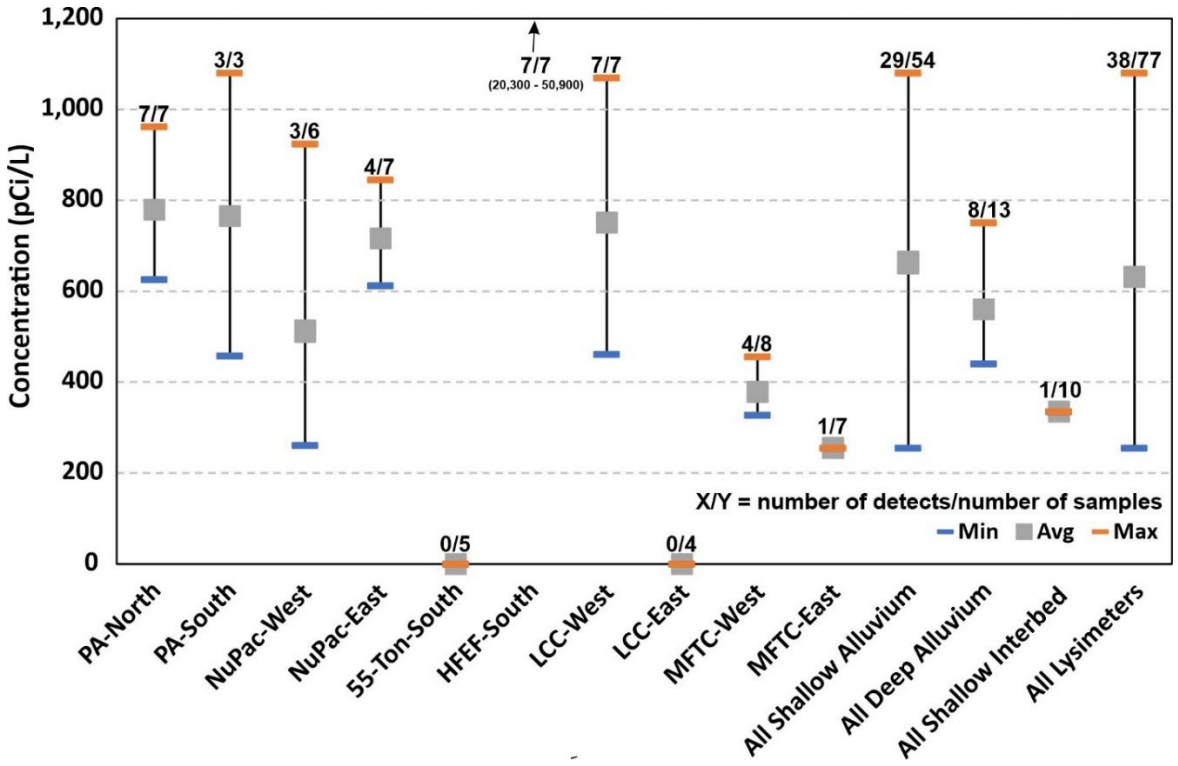

Figure 7. Summary of tritium results in lysimeter samples (October 1, 2018, through October 25, 2022). HFEF-South results are assumed to be impacted by disposals and not shown on the chart. Thus, group results for All Shallow Alluvium and All Lysimeters do not include HFEF-South sample results.

4.2.1. Performance Monitoring Statistical Summary

Table 8 presents a statistical summary of results for all lysimeter samples. This table includes data for C-14, I-129, and Tc-99 in addition to the data from Table 5 through Table 7 for gross alpha, gross beta, and tritium. It is important to note that for all analytes except gross alpha, the MDC is less than the RDL for most of the analyses. This provides confidence that the detected concentrations for gross beta and tritium, and the non-detect results for C-14, I-129, and Tc-99, are valid with respect to the RDL.

For gross alpha, the MDC was less than the RDL for only 4 of the 66 analyses (6%). In all 21 samples in which gross alpha was not detected, the MDC exceeded the RDL. Had the RDL been consistently achieved by the analysis method, the number of gross alpha detections would have likely increased, and the mean concentration (of detects) would have been less. Given that the mean concentration of the detects (4.86 pCi/L) is nearly five times greater than the RDL of 1 pCi/L and is greater than the mean MDC (2.44 pCi/L) for all the samples, the calculated mean concentration of the detects (4.86 pCi/L) can be considered a conservative estimate (biased high) of the true mean concentration. Given that non-detects were not included in the calculation of the means, the calculated mean concentrations of gross beta and tritium can also be considered a conservative estimates of the true mean concentrations.

Table 8. Statistical summary of results by analytes for all lysimeters. Concentrations are in pCi/L.

Statistic	Gross Alpha	Gross Beta	C-14	H-3	I-129	Tc-99
Number of Samples	66	66	54	77[a]	51	52
Number Detections	45	43	0	38[a]	0	0
% Detection	68%	65%	0%	49%	0%	0%
Min Concentration	1.34	1.22	NA[b]	255[a]	NA[b]	NA[b]
Max Concentration	17.9	24.2	NA[b]	1,080[a]	NA[b]	NA[b]
Mean Concentration	4.86	5.65	NA[b]	632[a]	NA[b]	NA[b]
Concentration Std Dev	3.98	4.98	NA[b]	223[a]	NA[b]	NA[b]
Min MDC	0.744	0.695	17.1	238	0.712	24.8
Max MDC	8.50	10.4	41.9	1,080	5.33	49.8
Mean MDC	2.44[c]	2.16	31.1	330	3.82	35.7
RDL	1	4	50	400	5	50
% Analyses MDC < RDL	6%	88%	100%	87%	94%	100%
99% UCL	19.5	26.3	NA	1,178[a]	NA	NA

a. Does not include seven samples from HFEF-South lysimeter with elevated tritium believed to be impacted by waste disposals.
b. Not calculated due to zero detections.
c. Mean MDC for gross alpha exceeds the RDL.

4.2.2. Impact of Water Applied During Construction and Infiltration Testing

Contaminant concentrations in lysimeters may have been impacted by water applied during facility construction when hundreds of thousands of gallons of water were used for dust suppression and backfill compaction of the vault arrays. In addition, thousands of gallons of water were used to conduct infiltration tests near each vault array and near many of the lysimeters. The water came from aquifer wells at Central Facilities Area (CFA), where trucks were filled with potable water pumped from Wells CFA-1 and CFA-2. The well water was pumped into a tank, where it was treated and then distributed through a manifold at CFA-1603.

The mean concentration of gross alpha and gross beta at the CFA-1603 manifold during 2016 and 2017, when most of the water was applied at the RHLLW Disposal Facility, was 1.8 pCi/L and 5.1 pCi/L, respectively. The gross alpha concentration in the applied water (1.8 pCi/L) is less than the mean concentration in shallow lysimeters (4.24 pCi/L), but the mean lysimeter concentration does not account for non-detects. Thus, it is difficult to know what impact the applied water had on gross alpha concentrations.

The mean gross beta concentration in the applied water (5.1 pCi/L) is about the same as the mean concentration in shallow lysimeters (4.07 pCi/L). However, the mean lysimeter concentration does not account for non-detects, so the shallow lysimeter concentrations could have been increased by gross beta in the applied water.

The tritium concentration in the manifold at CFA-1603 ranged from 2,700 to 2,900 pCi/L in 2016 and 2017 (Sondrup 2022). Tritium in the aquifer at CFA is the result of upgradient wastewater discharges at the ATR Complex and INTEC from 1952 to 2000. The mean tritium concentration in shallow lysimeters (not including lysimeter HFEF-South) is 661 pCi/L. The mean concentration in deep alluvium lysimeters and shallow interbeds is 561 pCi/L and 335 pCi/L, respectively, showing some decline with depth.

It is likely the tritium detected in the shallow alluvium lysimeters, and perhaps in the other lysimeters, has been impacted by the applied water. Allowing for some loss of tritium (as water vapor) during water transportation and application and allowing for dilution and migration of the tritium-contaminated water since application, the tritium detected in the lysimeters is consistent with the water applied during facility construction. The decrease in the mean concentration with depth also supports this position.

It is not surprising that tritium was detected in the lysimeter samples as tritium exists in every body of water on earth due to natural and anthropogenic sources. Because there are effluent sources of tritium at the INL Site, air and precipitation samples are collected each year from several locations on the INL Site and surrounding area. According to DOE-ID (2022), tritium measured in these samples is most likely the result of natural production in the atmosphere and remnants of nuclear weapons testing rather than the result of INL Site effluent releases. Although tritium in precipitation near the INL Site reached a maximum concentration of about 4,300 pCi/L in the early 1960s as a result of worldwide nuclear weapons testing, the mean concentration in precipitation samples collected at the INL Site over the three-year period from 2019 to 2021 was 75 pCi/L.[8] Based on this, base tritium levels in subsurface porewater at the RHLLW Disposal Facility were likely amplified due to tritium in the water applied from CFA and were not solely the result of precipitation and other sources. If this is true, concentrations in the shallow alluvium lysimeters are expected to decline with time due to dilution and migration of the tritium-contaminated water applied during construction. Concentrations in the deep alluvium and shallow interbeds could increase as the tritium-contaminated water applied during construction migrates toward the aquifer. This will depend on the rate of migration and the amount of dilution and decay that occurs.

4.2.3. Performance Monitoring Action Levels

Performance monitoring action levels in the monitoring plan (PLN-5501) are defined for indicator analytes gross alpha and gross beta. Once baseline concentrations are established, annual lysimeter samples will only be analyzed for indicator analytes unless action levels are exceeded. If action levels are exceeded, lysimeter samples will be speciated to determine the actual contributing radionuclides, sampling frequency will be increased to semiannual, and all near-field monitoring locations listed under the Augmented Performance Sampling section in Table 7 of the monitoring plan will be sampled.

[8] Calculated from data presented in Annual Site Environmental Reports DOE (2020), DOE (2021), and DOE (2022). 75 pCi/L is the mean concentration of 74 detections in 192 samples collected at three locations: Atomic City, Experimental Field Station near INTEC, and Howe.

Gross Alpha – The action level for gross alpha in the monitoring plan is 10 pCi/L. Of the 66 gross alpha analyses performed over the four-year baseline period, six analyses exceeded the action level of 10 pCi/L. Four of those were from the PA-North lysimeter and the other two were composite samples from deep alluvium lysimeters. The mean concentration of the seven PA-North lysimeter samples (10.5 pCi/L) and the mean concentration of the three deep alluvium lysimeter samples (12.7 pCi/L) are greater than the action level of 10 pCi/L. Of the 66 analyses, only one was greater than 15 pCi/L, which is the drinking water limit for gross alpha. The 99% UCL for all gross alpha detections is 19.5 pCi/L, meaning there is a 99% certainty that the true mean will be less than 19.5 pCi/L. Based on this, it is recommended that the action level for gross alpha increase from 10 to 20 pCi/L in the monitoring plan. This would reduce unnecessary sampling due to an exceedance of the action level, and the new action level would still be protective based on an MCL of 15 pCi/L and the amount of dilution and dispersion expected to occur in the vadose zone and aquifer.

Gross Beta – The action level for gross beta in the monitoring plan is 40 pCi/L. This is slightly greater than the 99% UCL for deep alluvium lysimeters (39.2 pCi/L) and shallow interbed lysimeters (32.2 pCi/L), and nearly double the 99% UCL for all lysimeters (26.3 pCi/L). Because the action level is less than the gross beta screening level for community water systems (50 pCi/L), it is protective. Therefore, it is recommended there be no change to the gross beta action level in the monitoring plan.

Tritium – Although there is no action level for tritium and the monitoring plan does not call for tritium analysis after the baseline period, continued sampling of tritium is recommended for two reasons. First, tritium has been found to be a good indicator of contaminant release and migration from the vaults, and tritium analysis requires only 50 mL of water. The source of elevated tritium detected in lysimeter HFEF-South is believed to have come from tritium on the exterior of some waste canisters placed in the HFEF vault array. The small amount of tritium on the canisters resulted in an easily detectable concentration in the lysimeters using the liquid scintillation analysis method for tritium (method EPA 906.0 Mod). Second, tritium is not likely to show up in a gross beta analysis because it is a low-energy beta emitter. The action level for gross beta in the monitoring plan was intended to indicate the presence of tritium, but that is not the case. In analyzing lysimeter sample results, there was no discernable corresponding increase of gross beta in samples with elevated tritium. This is because radionuclides, such as tritium, are volatile under the gross alpha/beta sample preparation conditions of method EPA 906.0 and cannot reliably be measured.

If tritium sampling and analysis is performed in the future, and an action level is desired, it is recommended the action level be set to a level no less than 20,000 pCi/L, but it may be set to 100,000 pCi/L, depending on the actions. Although the peak tritium concentration in lysimeter HFEF-South (~50,000 pCi/L) is not consistent with PA predictions, it is not a concern from a dose or risk standpoint (Sondrup 2022). Based on the PA modeling, the tritium concentration in the source zone would have to be at least 6.5E+08 pCi/L for concentrations in the aquifer to reach the MCL of 20,000 pCi/L, and it would have to be 2.8E+09 pCi/L to cause the facility dose to reach the 25 mrem/yr performance objective from DOE O 435.1. Therefore, an action level of 20,000 to 100,000 pCi/L would be detectable and indicate something inconsistent with the PA that should be investigated but neither are a dose or risk concern.

4.2.4. Performance Monitoring Data Summary

Four years of lysimeter sample analysis from lysimeters installed in the subsurface below and adjacent to the disposal vaults at the RHLLW Disposal Facility show concentrations of indicator analytes gross alpha and gross beta and target analyte tritium were detected in concentrations above the RDLs. Target analytes C-14, I-129, and Tc-99 were not detected above RDLs.

Except for tritium, concentrations of indicator and target analytes measured during the first four years of RHLLW facility operations are expected to represent baseline conditions for several years. Current tritium levels in the subsurface porewater were likely impacted (increased) by tritium-contaminated water from the aquifer near CFA, which was applied during the construction and infiltration testing of the facility. As a result, tritium concentrations may decline with time due to dilution and decay. Nevertheless, for the foreseeable future, concentrations can be expected to remain below the 99% UCLs determined from the four years of data.

Although the PA does not report estimated porewater concentrations for the future (only fluxes), increases in analyte concentrations due to releases from the RHLLW Disposal Facility are not expected to be detected above RDLs during the 1,000-year compliance period (2040–3039). Therefore, any increase in indicator or target analyte concentrations above the 99% UCLs from Table 8 could indicate the facility is not performing as expected.

5. CONCLUSIONS AND RECOMMENDATIONS

Sufficient data has been collected over the first four years of operation of the RHLLW Disposal Facility to establish baseline conditions for future compliance monitoring of aquifer wells and performance monitoring of vadose zone lysimeters. Except for seven elevated tritium measurements from lysimeter HFEF-South believed to have been impacted by waste disposals, all data was deemed appropriate for establishing baseline concentrations.

Monitoring of the aquifer detected indicator analytes gross alpha and gross beta and target analytes tritium and C-14. There were a few C-14 detections prior to an increase in the RDL after the first round of sampling. I-129 and Tc-99 were not detected above RDLs in aquifer samples. Lysimeter samples detected indicator analytes gross alpha and gross beta and target analyte tritium. Target analytes C-14, I-129, and Tc-99 were not detected above RDLs in lysimeter samples.

Except for tritium, baseline concentrations of indicator and target analytes measured during the first four years of RHLLW facility operations are expected to represent conditions through the expected 20-year operating period of the facility. Elevated tritium in the aquifer, a result of past discharges of tritium at upgradient facilities, showed a decline over the first four years of operations, and levels are expected to continue to decline with time as a result of dilution and decay. Current tritium levels in lysimeter samples may be elevated due to tritium in the water applied during construction and infiltration testing of the facility. As a result, tritium concentrations in lysimeters may decline with time as a result of dilution and decay.

Statistical measures (i.e., mean, standard deviation, and 99% UCL were calculated for all detected analytes using the four years of concentration data. These measures will be used to evaluate future monitoring results and to demonstrate the facility is performing, or not performing, as established in the facility performance assessment (PA). Future monitoring results will also be combined with the baseline data in this report to further establish temporal trends and natural variability in the measurements.

Based on the data collected during the baseline period, it is recommended the gross alpha action level for performance monitoring increase from 10 to 20 pCi/L due to several baseline measurements exceeding the preliminary action level of 10. An action level of 20 pCi/L is slightly greater than the 99% UCL, is protective of the aquifer, and would reduce unnecessary sampling. It is also recommended that tritium be added to the lysimeter analyte list for post-baseline period monitoring. Tritium, while not a dose concern, is a good tracer that can provide valuable information on water flow in and around the RHLLW Disposal Facility. Thus, this information could be useful for understanding the long-term performance of the facility. Recommendations for a tritium action level are provided if considered necessary.

6. REFERENCES

40 CFR 141. 2010. "National Primary Drinking Water Regulations." Code of Federal Regulations, Office of the Federal Register, National Archives and Records Administration.

DOE Order 458.1. 2011. "Radiation Protection of the Public and the Environment." U.S. Department of Energy.

DOE. 2017. "Disposal Authorization Statement and Tank Closure Documentation." DOE-STD-5002-2017, U.S. Department of Energy.

DOE-ID. 2018. "Performance Assessment for the Idaho National Laboratory Remote-Handled Low-Level Waste Disposal Facility." Revision 2, DOE/ID-11421, U.S. Department of Energy, Idaho Operations Office.

DOE Order 435.1 Change 2. 2021. "Radioactive Waste Management." U.S. Department of Energy.

DOE-ID. 2018. "Performance Assessment for the Idaho National Laboratory Remote-Handled Low-Level Waste Disposal Facility." Revision 2, DOE/ID-11421, U.S. Department of Energy, Idaho Operations Office.

DOE-ID. 2020. "Calendar Year 2019 Idaho National Laboratory Site Environmental Report." DOE/ID-12082 (19), Idaho National Laboratory.

DOE-ID. 2021. "Calendar Year 2020 Idaho National Laboratory Site Environmental Report." DOE/ID-12082 (20), Idaho National Laboratory, Idaho Falls, Idaho.

DOE-ID. 2022. "Calendar Year 2021 Idaho National Laboratory Site Environmental Report." DOE/ID-12082 (21), Idaho National Laboratory, Idaho Falls, Idaho.

IDAPA § 58.01.08. 2023. "Idaho Rules for Public Drinking Water Systems." *Idaho Administrative Procedures Ac*t, Idaho Department of Environmental Quality.

IDAPA § 58.01.11. 2023. "Ground Water Quality Rule." Idaho Administrative Procedures Act, Idaho Department of Environmental Quality.

INL. 2017. "Assessment of Aquifer Baseline Conditions at the Idaho National Laboratory Remote Handled Low Level Waste Disposal Facility." INL/EXT-17-40920, Idaho National Laboratory, Idaho Falls, Idaho.

INL. 2020a. "As-Built Characterization and Monitoring System for the Remote-Handled Low-Level Waste Disposal Facility." Revision 1, INL/EXT-17-43081, Idaho National Laboratory, Idaho Falls, Idaho.

INL. 2020b. "Annual Summary Report for the Remote-Handled Low-Level Waste Disposal Facility—FY 2019." INL/EXT-20-57199, Idaho National Laboratory, Idaho Falls, Idaho.

INL. 2021. "Annual Summary Report for the Remote-Handled Low-Level Waste Disposal Facility—FY 2020." INL/EXT-21-61328, Idaho National Laboratory.

INL. 2022. "Annual Summary Report for the Remote-Handled Low-Level Waste Disposal Facility—FY 2022." INL/RPT-22-65681, Idaho National Laboratory, Idaho Falls, Idaho.

INL. 2023. “Annual Summary Report for the Remote-Handled Low-Level Waste Disposal Facility—FY 2022.” INL/RPT-23-70876, Idaho National Laboratory, Idaho Falls, Idaho.

PLN-5501. 2020. “Monitoring Plan for the Idaho National Laboratory Remote-Handled Low-Level Waste Disposal Facility.” Revision 2, Idaho National Laboratory, Idaho Falls, Idaho.

Sondrup, A.J. 2022. “Evaluation of Elevated Tritium in Lysimeter Samples at the Remote-Handled Low-Level Waste Disposal Facility.” Revision 1, Idaho National Laboratory, Idaho Falls, Idaho.

Page intentionally left blank

Appendix A

Aquifer and Lysimeter Monitoring Data
(FY 2019 – FY 2022)

Aquifer Monitoring Data

Result Type[a]	Well	Date Collected	Constituent	Concentration	Units	Uncertainty	Lab Qualifier[b]	Validation Qualifier[b]	Project Qualifier[b]	Data Source[c]	Analytical Method[d]	Sample #
	USGS-136	10/1/2018 11:40	Carbon-14	6.02	pCi/L	1.22				EMP2	LSC	BEA03-868-14
Duplicate	USGS-136	4/30/2019 9:55	Carbon-14	3.15	pCi/L	9.67	U	U		EMP2	LSC	BEA01-1516-01
	USGS-136	4/30/2019 9:55	Carbon-14	23.4	pCi/L	10.2	U	UJ		EMP2	LSC	BEA01-1506-01
	USGS-136	4/27/2020 12:00	Carbon-14	-4.9	pCi/L	10.8	U	U		EMP2	LSC	BEA01-2127-01
Duplicate	USGS-136	4/27/2020 12:00	Carbon-14	-3.83	pCi/L	10.8	U	U		EMP2	LSC	BEA01-2137-01
	USGS-136	4/15/2021 11:30	Carbon-14	-12.9	pCi/L	10.5	U	U		EMP2	LSC	BEA01-3015-01
	USGS-136	4/18/2022 11:30	Carbon-14	-0.36	pCi/L	9.24	U	U		EMP2	LSC	BEA01-3596-01
	USGS-136	9/16/2022 7:55	Carbon-14	-15.3	pCi/L	8.85	U	U		EMP2	LSC	BEA02-3596-01
	USGS-136	10/1/2018 11:40	Gross alpha	1.17	pCi/L	0.65	U	U		EMP2	GPC	BEA03-868-15
	USGS-136	4/30/2019 9:55	Gross alpha	2.97	pCi/L	0.881				EMP2	GPC	BEA01-1506-02
Duplicate	USGS-136	4/30/2019 9:55	Gross alpha	1.95	pCi/L	0.766	U	UJ		EMP2	GPC	BEA01-1516-02
	USGS-136	4/27/2020 12:00	Gross alpha	1.19	pCi/L	0.568	U	UJ		EMP2	GPC	BEA01-2127-02
Duplicate	USGS-136	4/27/2020 12:00	Gross alpha	1.73	pCi/L	0.496				EMP2	GPC	BEA01-2137-02
	USGS-136	4/15/2021 11:30	Gross alpha	0.937	pCi/L	0.317	U	UJ		EMP2	GPC	BEA01-3015-03
	USGS-136	4/18/2022 11:30	Gross alpha	0.591	pCi/L	0.287	U	UJ		EMP2	GPC	BEA01-3596-03
	USGS-136	9/16/2022 7:55	Gross alpha	1.62	pCi/L	0.535				EMP2	GPC	BEA02-3596-03
	USGS-136	10/1/2018 11:40	Gross beta	2.08	pCi/L	0.566				EMP2	GPC	BEA03-868-15
	USGS-136	4/30/2019 9:55	Gross beta	0.471	pCi/L	0.677	U	U		EMP2	GPC	BEA01-1506-02
Duplicate	USGS-136	4/30/2019 9:55	Gross beta	1.79	pCi/L	0.575	U			EMP2	GPC	BEA01-1516-02
	USGS-136	4/27/2020 12:00	Gross beta	1.97	pCi/L	0.324				EMP2	GPC	BEA01-2127-02
Duplicate	USGS-136	4/27/2020 12:00	Gross beta	1.38	pCi/L	0.505	U	UJ		EMP2	GPC	BEA01-2137-02
	USGS-136	4/15/2021 11:30	Gross beta	2.14	pCi/L	0.26				EMP2	GPC	BEA01-3015-03
	USGS-136	4/18/2022 11:30	Gross beta	1.92	pCi/L	0.184				EMP2	GPC	BEA01-3596-03
	USGS-136	9/16/2022 7:55	Gross beta	3.45	pCi/L	0.556				EMP2	GPC	BEA02-3596-03
	USGS-136	10/1/2018 11:40	Iodine-129	0.0125	pCi/L	0.0232	U	U	R (PE Issue)	EMP2	GAMMASPEC	BEA03-868-16
	USGS-136	4/30/2019 9:55	Iodine-129	-0.029	pCi/L	0.213	U	U		EMP2	GAMMASPEC	BEA01-1506-03
Duplicate	USGS-136	4/30/2019 9:55	Iodine-129	0	pCi/L	0.455	U	U		EMP2	GAMMASPEC	BEA01-1516-03
	USGS-136	4/27/2020 12:00	Iodine-129	-0.126	pCi/L	0.164	U	U		EMP2	GAMMASPEC	BEA01-2127-03
Duplicate	USGS-136	4/27/2020 12:00	Iodine-129	0.106	pCi/L	0.135	U	U		EMP2	GAMMASPEC	BEA01-2137-03
	USGS-136	4/15/2021 11:30	Iodine-129	-0.196	pCi/L	0.174	U	U		EMP2	GAMMASPEC	BEA01-3015-04
	USGS-136	4/18/2022 11:30	Iodine-129	-0.0976	pCi/L	0.151	U	U		EMP2	GAMMASPEC	BEA01-3596-04
	USGS-136	9/16/2022 7:55	Iodine-129	0.286	pCi/L	0.183	U	U		EMP2	GAMMASPEC	BEA02-3596-04
	USGS-136	10/1/2018 11:40	Technetium-99	1.85	pCi/L	1.81	U	U		EMP2	LSC	BEA03-868-17
Duplicate	USGS-136	4/30/2019 9:55	Technetium-99	1.57	pCi/L	11.8	U	U		EMP2	LSC	BEA01-1516-15
	USGS-136	4/30/2019 9:55	Technetium-99	2.87	pCi/L	8.36	U	U		EMP2	LSC	BEA01-1506-15
Duplicate	USGS-136	4/27/2020 12:00	Technetium-99	9.59	pCi/L	12.4	U	U		EMP2	LSC	BEA01-2137-15
	USGS-136	4/27/2020 12:00	Technetium-99	8.4	pCi/L	12.6	U	U		EMP2	LSC	BEA01-2127-15
	USGS-136	4/15/2021 11:30	Technetium-99	9.27	pCi/L	8.72	U	U		EMP2	LSC	BEA01-3015-16
	USGS-136	4/18/2022 11:30	Technetium-99	5.92	pCi/L	8.6	U	U		EMP2	LSC	BEA01-3596-16
	USGS-136	9/16/2022 7:55	Technetium-99	-8.51	pCi/L	7.18	U	U		EMP2	LSC	BEA02-3596-16
	USGS-136	10/1/2018 11:40	Tritium	1380	pCi/L	179				EMP2	LSC	BEA03-868-13
	USGS-136	4/30/2019 9:55	Tritium	1470	pCi/L	219				EMP2	LSC	BEA01-1506-17
Duplicate	USGS-136	4/30/2019 9:55	Tritium	1500	pCi/L	222				EMP2	LSC	BEA01-1516-17
	USGS-136	4/27/2020 12:00	Tritium	961	pCi/L	137				EMP2	LSC	BEA01-2127-17
Duplicate	USGS-136	4/27/2020 12:00	Tritium	902	pCi/L	130				EMP2	LSC	BEA01-2137-17
	USGS-136	4/15/2021 11:30	Tritium	916	pCi/L	149				EMP2	LSC	BEA01-3015-18
	USGS-136	4/18/2022 11:30	Tritium	1110	pCi/L	171				EMP2	LSC	BEA01-3596-18
	USGS-136	9/16/2022 7:55	Tritium	535	pCi/L	145				EMP2	LSC	BEA02-3596-18
	USGS-140	10/1/2018 12:45	Carbon-14	5.24	pCi/L	1.18				EMP2	LSC	BEA03-870-14
	USGS-140	4/30/2019 13:00	Carbon-14	1.59	pCi/L	9.62	U	U		EMP2	LSC	BEA01-1515-01

Result Type[a]	Well	Date Collected	Constituent	Concentration	Units	Uncertainty	Lab Qualifier[b]	Validation Qualifier[b]	Project Qualifier[b]	Data Source[c]	Analytical Method[d]	Sample #
	USGS-140	4/28/2020 11:20	Carbon-14	-4.88	pCi/L	10.8	U	U		EMP2	LSC	BEA01-2136-01
	USGS-140	4/19/2021 12:25	Carbon-14	7.01	pCi/L	10.9	U	U		EMP2	LSC	BEA01-3024-01
Duplicate	USGS-140	4/19/2021 12:25	Carbon-14	-3.08	pCi/L	10.7	U	U		EMP2	LSC	BEA01-3025-01
	USGS-140	4/19/2022 10:30	Carbon-14	-0.102	pCi/L	9.06	U	U		EMP2	LSC	BEA01-3605-01
	USGS-140	9/21/2022 9:20	Carbon-14	3.23	pCi/L	9.36	U	U		EMP2	LSC	BEA02-3605-01
	USGS-140	10/1/2018 12:45	Gross alpha	2.57	pCi/L	0.671				EMP2	GPC	BEA03-870-15
	USGS-140	4/30/2019 13:00	Gross alpha	2.06	pCi/L	0.557				EMP2	GPC	BEA01-1515-02
	USGS-140	4/28/2020 11:20	Gross alpha	1.88	pCi/L	0.523				EMP2	GPC	BEA01-2136-02
	USGS-140	4/19/2021 12:25	Gross alpha	0.489	pCi/L	0.315	U	U		EMP2	GPC	BEA01-3024-03
Duplicate	USGS-140	4/19/2021 12:25	Gross alpha	0.528	pCi/L	0.27	U	U		EMP2	GPC	BEA01-3025-03
	USGS-140	4/19/2022 10:30	Gross alpha	0.269	pCi/L	0.258	U	U		EMP2	GPC	BEA01-3605-03
	USGS-140	9/21/2022 9:20	Gross alpha	1.48	pCi/L	0.596	U	UJ		EMP2	GPC	BEA02-3605-03
	USGS-140	10/1/2018 12:45	Gross beta	1.77	pCi/L	0.456				EMP2	GPC	BEA03-870-15
	USGS-140	4/30/2019 13:00	Gross beta	2.32	pCi/L	0.675				EMP2	GPC	BEA01-1515-02
	USGS-140	4/28/2020 11:20	Gross beta	1.84	pCi/L	0.308				EMP2	GPC	BEA01-2136-02
	USGS-140	4/19/2021 12:25	Gross beta	2.47	pCi/L	0.26				EMP2	GPC	BEA01-3024-03
Duplicate	USGS-140	4/19/2021 12:25	Gross beta	2.3	pCi/L	0.254				EMP2	GPC	BEA01-3025-03
	USGS-140	4/19/2022 10:30	Gross beta	3.8	pCi/L	0.277				EMP2	GPC	BEA01-3605-03
	USGS-140	9/21/2022 9:20	Gross beta	4.02	pCi/L	0.552				EMP2	GPC	BEA02-3605-03
	USGS-140	10/1/2018 12:45	Iodine-129	0.0234	pCi/L	0.0273	U	U	R (PE Issue)	EMP2	GAMMASPEC	BEA03-870-16
	USGS-140	4/30/2019 13:00	Iodine-129	0.0425	pCi/L	0.123	U	U		EMP2	GAMMASPEC	BEA01-1515-03
	USGS-140	4/28/2020 11:20	Iodine-129	-0.483	pCi/L	0.203	U	U		EMP2	GAMMASPEC	BEA01-2136-03
Duplicate	USGS-140	4/19/2021 12:25	Iodine-129	-0.0226	pCi/L	0.0985	U	U		EMP2	GAMMASPEC	BEA01-3025-04
	USGS-140	4/19/2021 12:25	Iodine-129	0.0291	pCi/L	0.152	U	U		EMP2	GAMMASPEC	BEA01-3024-04
	USGS-140	4/19/2022 10:30	Iodine-129	0.0957	pCi/L	0.182	U	U		EMP2	GAMMASPEC	BEA01-3605-04
	USGS-140	9/21/2022 9:20	Iodine-129	-0.00982	pCi/L	0.183	U	U		EMP2	GAMMASPEC	BEA02-3605-04
	USGS-140	10/1/2018 12:45	Technetium-99	3.31	pCi/L	1.86	U	U		EMP2	LSC	BEA03-870-17
	USGS-140	4/30/2019 13:00	Technetium-99	19.7	pCi/L	11.6	U	U		EMP2	LSC	BEA01-1515-15
	USGS-140	4/28/2020 11:20	Technetium-99	7.72	pCi/L	12.8	U	U		EMP2	LSC	BEA01-2136-15
	USGS-140	4/19/2021 12:25	Technetium-99	-1.24	pCi/L	8.26	U	U		EMP2	LSC	BEA01-3024-16
Duplicate	USGS-140	4/19/2021 12:25	Technetium-99	-2.15	pCi/L	7.45	U	U		EMP2	LSC	BEA01-3025-16
	USGS-140	4/19/2022 10:30	Technetium-99	16	pCi/L	8.68	U	U		EMP2	LSC	BEA01-3605-16
	USGS-140	9/21/2022 9:20	Technetium-99	-8	pCi/L	6.9	U	U		EMP2	LSC	BEA02-3605-16
	USGS-140	10/1/2018 12:45	Tritium	1490	pCi/L	191				EMP2	LSC	BEA03-870-13
	USGS-140	4/30/2019 13:00	Tritium	1060	pCi/L	175				EMP2	LSC	BEA01-1515-17
	USGS-140	4/28/2020 11:20	Tritium	964	pCi/L	138				EMP2	LSC	BEA01-2136-17
Duplicate	USGS-140	4/19/2021 12:25	Tritium	853	pCi/L	143				EMP2	LSC	BEA01-3025-18
	USGS-140	4/19/2021 12:25	Tritium	624	pCi/L	126				EMP2	LSC	BEA01-3024-18
	USGS-140	4/19/2022 10:30	Tritium	992	pCi/L	161				EMP2	LSC	BEA01-3605-18
	USGS-140	9/21/2022 9:20	Tritium	842	pCi/L	182				EMP2	LSC	BEA02-3605-18
Duplicate	USGS-141	10/1/2018 14:00	Carbon-14	4.35	pCi/L	1.14				EMP2	LSC	BEA03-872-14
	USGS-141	10/1/2018 14:00	Carbon-14	2.6	pCi/L	1.08	U	UJ		EMP2	LSC	BEA03-971-14
	USGS-141	4/30/2019 12:10	Carbon-14	18.3	pCi/L	10	U	U		EMP2	LSC	BEA01-1502-01
	USGS-141	4/28/2020 10:15	Carbon-14	-6.55	pCi/L	10.8	U	U		EMP2	LSC	BEA01-2123-01
	USGS-141	4/19/2021 11:15	Carbon-14	-5.16	pCi/L	10.6	U	U		EMP2	LSC	BEA01-3011-01
Duplicate	USGS-141	4/19/2022 9:25	Carbon-14	11.1	pCi/L	9.59	U	U		EMP2	LSC	BEA01-3606-01
	USGS-141	4/19/2022 9:25	Carbon-14	2.67	pCi/L	9.22	U	U		EMP2	LSC	BEA01-3592-01
	USGS-141	9/21/2022 8:15	Carbon-14	-0.921	pCi/L	9.21	U	U		EMP2	LSC	BEA02-3592-01
Duplicate	USGS-141	10/1/2018 14:00	Gross alpha	3.76	pCi/L	0.765				EMP2	GPC	BEA03-872-15
	USGS-141	10/1/2018 14:00	Gross alpha	4.17	pCi/L	0.682				EMP2	GPC	BEA03-971-15
	USGS-141	4/30/2019 12:10	Gross alpha	2.52	pCi/L	0.947	U	UJ		EMP2	GPC	BEA01-1502-02
	USGS-141	4/28/2020 10:15	Gross alpha	1.52	pCi/L	0.535	U	UJ		EMP2	GPC	BEA01-2123-02

Result Type[a]	Well	Date Collected	Constituent	Concentration	Units	Uncertainty	Lab Qualifier[b]	Validation Qualifier[b]	Project Qualifier[b]	Data Source[c]	Analytical Method[d]	Sample #
	USGS-141	4/19/2021 11:15	Gross alpha	1.06	pCi/L	0.337				EMP2	GPC	BEA01-3011-03
	USGS-141	4/19/2022 9:25	Gross alpha	0.73	pCi/L	0.335	U	UJ		EMP2	GPC	BEA01-3592-03
Duplicate	USGS-141	4/19/2022 9:25	Gross alpha	1.04	pCi/L	0.295				EMP2	GPC	BEA01-3606-03
	USGS-141	9/21/2022 8:15	Gross alpha	-0.112	pCi/L	0.497	U	U		EMP2	GPC	BEA02-3592-03
Duplicate	USGS-141	10/1/2018 14:00	Gross beta	1.31	pCi/L	0.336				EMP2	GPC	BEA03-872-15
	USGS-141	10/1/2018 14:00	Gross beta	2.23	pCi/L	0.448				EMP2	GPC	BEA03-971-15
	USGS-141	4/30/2019 12:10	Gross beta	1.22	pCi/L	0.479	U	UJ		EMP2	GPC	BEA01-1502-02
	USGS-141	4/28/2020 10:15	Gross beta	1	pCi/L	0.361	U	UJ		EMP2	GPC	BEA01-2123-02
	USGS-141	4/19/2021 11:15	Gross beta	1.65	pCi/L	0.254				EMP2	GPC	BEA01-3011-03
	USGS-141	4/19/2022 9:25	Gross beta	1.59	pCi/L	0.27				EMP2	GPC	BEA01-3592-03
Duplicate	USGS-141	4/19/2022 9:25	Gross beta	2.96	pCi/L	0.264				EMP2	GPC	BEA01-3606-03
	USGS-141	9/21/2022 8:15	Gross beta	2.54	pCi/L	0.489				EMP2	GPC	BEA02-3592-03
	USGS-141	10/1/2018 14:00	Iodine-129	0.0189	pCi/L	0.0325	U	U	R (PE Issue)	EMP2	GAMMASPEC	BEA03-971-16
Duplicate	USGS-141	10/1/2018 14:00	Iodine-129	-0.00041	pCi/L	0.0362	U	U	R (PE Issue)	EMP2	GAMMASPEC	BEA03-872-16
	USGS-141	4/30/2019 12:10	Iodine-129	0.33	pCi/L	0.248	U	U		EMP2	GAMMASPEC	BEA01-1502-03
	USGS-141	4/28/2020 10:15	Iodine-129	0.0407	pCi/L	0.13	U	U		EMP2	GAMMASPEC	BEA01-2123-03
	USGS-141	4/19/2021 11:15	Iodine-129	-0.115	pCi/L	0.166	U	U		EMP2	GAMMASPEC	BEA01-3011-04
	USGS-141	4/19/2022 9:25	Iodine-129	-0.195	pCi/L	0.181	U	U		EMP2	GAMMASPEC	BEA01-3592-04
Duplicate	USGS-141	4/19/2022 9:25	Iodine-129	0.0158	pCi/L	0.11	U	U		EMP2	GAMMASPEC	BEA01-3606-04
	USGS-141	9/21/2022 8:15	Iodine-129	0.113	pCi/L	0.131	U	U		EMP2	GAMMASPEC	BEA02-3592-04
	USGS-141	10/1/2018 14:00	Technetium-99	0.603	pCi/L	1.67	U	U		EMP2	LSC	BEA03-971-17
Duplicate	USGS-141	10/1/2018 14:00	Technetium-99	0.547	pCi/L	1.41	U	U		EMP2	LSC	BEA03-872-17
	USGS-141	4/30/2019 12:10	Technetium-99	13.3	pCi/L	8.38	U	U		EMP2	LSC	BEA01-1502-15
	USGS-141	4/28/2020 10:15	Technetium-99	2.49	pCi/L	13.4	U	U		EMP2	LSC	BEA01-2123-15
	USGS-141	4/19/2021 11:15	Technetium-99	11.7	pCi/L	8.07	U	U		EMP2	LSC	BEA01-3011-16
	USGS-141	4/19/2022 9:25	Technetium-99	7.91	pCi/L	8.62	U	U		EMP2	LSC	BEA01-3592-16
Duplicate	USGS-141	4/19/2022 9:25	Technetium-99	11.5	pCi/L	8.68	U	U		EMP2	LSC	BEA01-3606-16
	USGS-141	9/21/2022 8:15	Technetium-99	-11.6	pCi/L	6.81	U	U		EMP2	LSC	BEA02-3592-16
	USGS-141	10/1/2018 14:00	Tritium	1200	pCi/L	163				EMP2	LSC	BEA03-971-13
Duplicate	USGS-141	10/1/2018 14:00	Tritium	1080	pCi/L	155				EMP2	LSC	BEA03-872-13
	USGS-141	4/30/2019 12:10	Tritium	1520	pCi/L	219				EMP2	LSC	BEA01-1502-17
	USGS-141	4/28/2020 10:15	Tritium	815	pCi/L	124				EMP2	LSC	BEA01-2123-17
	USGS-141	4/19/2021 11:15	Tritium	608	pCi/L	125				EMP2	LSC	BEA01-3011-18
	USGS-141	4/19/2022 9:25	Tritium	877	pCi/L	154				EMP2	LSC	BEA01-3592-18
Duplicate	USGS-141	4/19/2022 9:25	Tritium	773	pCi/L	145				EMP2	LSC	BEA01-3606-18
	USGS-141	9/21/2022 8:15	Tritium	874	pCi/L	186				EMP2	LSC	BEA02-3592-18

a. Duplicate is a field duplicate.
b. U = The radionuclide is not considered to be present in the sample (non-detect).
UJ = The radionuclide may or may not be present in the sample and the result is considered highly questionable.
J = The radionuclide is considered to be present in the sample; however, the result may not be an accurate representation of the amount of activity actually present in the sample.
R = The radionuclide may or may not be present, and the result is known to be inaccurate or imprecise.
PE = Performance Evaluation
c. EMP = Environmental Monitoring Program
d. LSC = liquid scintillation counting
GPC = gas proportional counting
GAMMASPEC = gamma spectrometry

Lysimeter Monitoring Data

Result Type[a]	Location	Date Collected	Constituent	Concentration	Units	Uncertainty	Lab Qualifier[b]	Validation Qualifier[b]	Data Source[c]	Analytical Method[d]	Sample #	Detection Limit	Reporting Limit
	55-Ton-South	4/1/2019 11:35	Carbon-14	-15.5	pCi/L	11.4	U	U	EMP2	LSC	BEA01-1469-01	39.5	50
	55-Ton-South	4/9/2020 11:45	Carbon-14	-0.491	pCi/L	7.77	U	U	EMP2	LSC	BEA01-2088-01	26.8	50
	55-Ton-South	4/7/2021 14:04	Carbon-14	15.4	pCi/L	8.62	U	U	EMP2	LSC	BEA01-2985-01	27.9	50
Duplicate	55-Ton-South	4/7/2021 14:04	Carbon-14	-11.2	pCi/L	7.95	U	U	EMP2	LSC	BEA01-3087-01	28.3	50
	55-Ton-South	4/9/2020 11:45	Gross alpha	1.35	pCi/L	0.305			EMP2	GPC	BEA01-2088-02	0.849	1
Duplicate	55-Ton-South	4/9/2020 11:45	Gross alpha	1.62	pCi/L	0.341			EMP2	GPC	BEA01-2187-02	0.937	1
	55-Ton-South	4/7/2021 14:04	Gross alpha	1.09	pCi/L	0.386	U	UJ	EMP2	GPC	BEA01-2985-02	1.19	1
	55-Ton-South	5/23/2022 10:11	Gross alpha	4.49	pCi/L	0.639			EMP2	GPC	BEA01-3617-02	1.64	1
	55-Ton-South	10/25/2022 10:48	Gross alpha	4.66	pCi/L	0.597			EMP2	GPC	BEA02-3617-02	1.32	1
Duplicate	55-Ton-South	4/9/2020 11:45	Gross beta	2.06	pCi/L	0.324		UJ	EMP2	GPC	BEA01-2187-02	0.962	4
	55-Ton-South	4/9/2020 11:45	Gross beta	1.71	pCi/L	0.245		J	EMP2	GPC	BEA01-2088-02	0.695	4
	55-Ton-South	4/7/2021 14:04	Gross beta	1.17	pCi/L	0.665	U	U	EMP2	GPC	BEA01-2985-02	2.18	4
	55-Ton-South	5/23/2022 10:11	Gross beta	1.82	pCi/L	0.349			EMP2	GPC	BEA01-3617-02	1.08	4
	55-Ton-South	10/25/2022 10:48	Gross beta	2.59	pCi/L	0.33			EMP2	GPC	BEA02-3617-02	0.906	4
	55-Ton-South	4/9/2020 11:45	Iodine-129	0.916	pCi/L	1.04	U	U	EMP2	GAMMASPEC	BEA01-2088-03	3.75	5
	55-Ton-South	4/7/2021 14:04	Iodine-129	1.86	pCi/L	1.02	U	U	EMP2	GAMMASPEC	BEA01-2985-03	4.1	5
	55-Ton-South	5/23/2022 10:11	Iodine-129	2.09	pCi/L	1.43	U	U	EMP2	GAMMASPEC	BEA01-3617-03	4.89	5
	55-Ton-South	10/25/2022 10:48	Iodine-129	2.18	pCi/L	1.24	U	U	EMP2	GAMMASPEC	BEA02-3617-03	4.19	5
	55-Ton-South	4/9/2020 11:45	Technetium-99	-12.5	pCi/L	12.4	U	U	EMP2	LSC	BEA01-2088-04	42.6	50
	55-Ton-South	4/7/2021 14:04	Technetium-99	-17.4	pCi/L	7.67	U	U	EMP2	LSC	BEA01-2985-04	26.9	50
	55-Ton-South	5/23/2022 10:11	Technetium-99	-10.4	pCi/L	7.18	U	U	EMP2	LSC	BEA01-3617-04	24.8	50
	55-Ton-South	10/25/2022 10:48	Technetium-99	-20.2	pCi/L	9.73	U	U	EMP2	LSC	BEA02-3617-04	35.1	50
	55-Ton-South	4/9/2020 11:45	Tritium	-12.5	pCi/L	68.5	U	U	EMP2	LSC	BEA01-2088-05	260	400
Duplicate	55-Ton-South	4/7/2021 14:04	Tritium	52.1	pCi/L	81.6	U	U	EMP2	LSC	BEA01-3087-05	277	400
	55-Ton-South	4/7/2021 14:04	Tritium	60.8	pCi/L	79.6	U	U	EMP2	LSC	BEA01-2985-05	269	400
	55-Ton-South	5/23/2022 10:11	Tritium	-173	pCi/L	114	U	U	EMP2	LSC	BEA01-3617-05	394	400
	55-Ton-South	10/25/2022 10:48	Tritium	-14.6	pCi/L	96.8	U	U	EMP2	LSC	BEA02-3617-05	336	400
	HFEF-South	5/21/2020 11:20	Carbon-14	7.67	pCi/L	7.04	U	U	EMP2	LSC	BEA01-2092-01	23.3	50
	HFEF-South	5/23/2022 9:40	Carbon-14	187	pCi/L	164	U	U	EMP2	LSC	BEA01-3621-01	539	50
	HFEF-South	10/25/2022 10:23	Carbon-14	12.4	pCi/L	9.19	U	U	EMP2	LSC	BEA02-3621-01	30.3	50
	HFEF-South	3/25/2019 15:10	Gross alpha	2.2	pCi/L	0.409			EMP2	GPC	BEA02-1432-02	1.11	1
	HFEF-South	5/21/2020 11:20	Gross alpha	2.09	pCi/L	0.775	U	UJ	EMP2	GPC	BEA01-2092-02	2.42	1
	HFEF-South	5/21/2020 11:20	Gross alpha	3.33	pCi/L	0.758			EMP2	GPC	BEA01-2092-02	2.11	1
	HFEF-South	5/6/2021 9:31	Gross alpha	2.12	pCi/L	0.598			EMP2	GPC	BEA01-2989-02	1.78	1
	HFEF-South	5/23/2022 9:40	Gross alpha	3.28	pCi/L	0.623			EMP2	GPC	BEA01-3621-02	1.65	1
	HFEF-South	3/25/2019 15:10	Gross beta	2.16	pCi/L	0.403			EMP2	GPC	BEA02-1432-02	1.23	4
	HFEF-South	5/21/2020 11:20	Gross beta	2.43	pCi/L	0.897	U	UJ	EMP2	GPC	BEA01-2092-02	2.88	4
	HFEF-South	5/21/2020 11:20	Gross beta	0.317	pCi/L	0.941	U	U	EMP2	GPC	BEA01-2092-02	3.17	4
	HFEF-South	5/6/2021 9:31	Gross beta	1.14	pCi/L	0.734	U	U	EMP2	GPC	BEA01-2989-02	2.42	4
	HFEF-South	5/23/2022 9:40	Gross beta	2.74	pCi/L	0.452			EMP2	GPC	BEA01-3621-02	1.38	4
	HFEF-South	5/21/2020 11:20	Iodine-129	0.384	pCi/L	0.702	U	U	EMP2	GAMMASPEC	BEA01-2092-03	2.72	5
	HFEF-South	10/28/2021 10:31	Iodine-129	-1.64	pCi/L	0.975	U	U	EMP2	GAMMASPEC	BEA02-2989-03	2.01	5
	HFEF-South	5/23/2022 9:40	Iodine-129	-1.73	pCi/L	1.24	U	U	EMP2	GAMMASPEC	BEA01-3621-03	4.09	5
	HFEF-South	10/25/2022 10:23	Iodine-129	0.254	pCi/L	1.27	U	U	EMP2	GAMMASPEC	BEA02-3621-03	4.25	5
	HFEF-South	5/21/2020 11:20	Technetium-99	0.743	pCi/L	9.6	U	U	EMP2	LSC	BEA01-2092-04	33.3	50

Result Type[a]	Location	Date Collected	Constituent	Concentration	Units	Uncertainty	Lab Qualifier[b]	Validation Qualifier[b]	Data Source[c]	Analytical Method[d]	Sample #	Detection Limit	Reporting Limit
	HFEF-South	5/6/2021 9:31	Technetium-99	-8.65	pCi/L	9.8	U	U	EMP2	LSC	BEA01-2989-04	33.7	50
	HFEF-South	5/21/2020 11:20	Tritium	50900	pCi/L	5050			EMP2	LSC	BEA01-2092-05	362	400
	HFEF-South	5/21/2020 11:20	Tritium	47100	pCi/L	4670			EMP2	LSC	BEA01-2092-05	251	400
	HFEF-South	10/20/2020 12:22	Tritium	37300	pCi/L	3700			EMP2	LSC	BEA02-2092-05	271	400
	HFEF-South	5/6/2021 9:31	Tritium	34100	pCi/L	3380			EMP2	LSC	BEA01-2989-05	302	400
	HFEF-South	10/28/2021 10:31	Tritium	32800	pCi/L	3260			EMP2	LSC	BEA02-2989-05	249	400
	HFEF-South	5/23/2022 9:40	Tritium	27000	pCi/L	2680			EMP2	LSC	BEA01-3621-05	397	400
	HFEF-South	10/25/2022 10:23	Tritium	20300	pCi/L	2030			EMP2	LSC	BEA02-3621-05	342	400
	HFEF-South-45	5/23/2022 9:36	Technetium-99	-6.11	pCi/L	11	U	U	EMP2	LSC	BEA01-3611-04	37.5	50
	HFEF-South-45	10/20/2020 12:13	Tritium	-868	pCi/L	305	U	U	EMP2	LSC	BEA02-2082-05	1080	400
	HFEF-South-45	5/6/2021 9:26	Tritium	442	pCi/L	143			EMP2	LSC	BEA01-2979-05	433	400
	HFEF-South-45	10/28/2021 10:23	Tritium	474	pCi/L	126			EMP2	LSC	BEA02-2979-05	369	400
	HFEF-South-45	5/23/2022 9:36	Tritium	235	pCi/L	141	U	U	EMP2	LSC	BEA01-3611-05	459	400
	HFEF-South-45	10/25/2022 10:20	Tritium	440	pCi/L	120			EMP2	LSC	BEA02-3611-05	345	400
	LCC-East	4/1/2019 12:23	Carbon-14	-16.3	pCi/L	11.4	U	U	EMP2	LSC	BEA02-1431-01	39.4	50
	LCC-East	4/23/2020 14:00	Carbon-14	9.33	pCi/L	8.13	U	U	EMP2	LSC	BEA01-2090-01	27	50
	LCC-East	4/22/2021 9:28	Carbon-14	0.505	pCi/L	12.4	U	U	EMP2	LSC	BEA01-2987-01	41.4	50
	LCC-East	10/19/2022 10:13	Carbon-14	5.22	pCi/L	8.84	U	U	EMP2	LSC	BEA02-3619-01	30	50
	LCC-East	4/23/2020 14:00	Gross alpha	1.34	pCi/L	0.28			EMP2	GPC	BEA01-2090-02	0.744	1
	LCC-East	4/22/2021 9:28	Gross alpha	-0.677	pCi/L	0.865	U	U	EMP2	GPC	BEA01-2987-02	3.07	1
	LCC-East	5/23/2022 9:19	Gross alpha	1.25	pCi/L	0.616	U	UJ	EMP2	GPC	BEA01-3619-02	2	1
	LCC-East	10/19/2022 10:13	Gross alpha	2.52	pCi/L	0.56			EMP2	GPC	BEA02-3619-02	1.57	1
	LCC-East	4/23/2020 14:00	Gross beta	2.22	pCi/L	0.318		UJ	EMP2	GPC	BEA01-2090-02	0.923	4
	LCC-East	4/22/2021 9:28	Gross beta	1.85	pCi/L	1.47	U	U	EMP2	GPC	BEA01-2987-02	4.86	4
	LCC-East	5/23/2022 9:19	Gross beta	2.39	pCi/L	0.401			EMP2	GPC	BEA01-3619-02	1.21	4
	LCC-East	10/19/2022 10:13	Gross beta	3.38	pCi/L	0.423			EMP2	GPC	BEA02-3619-02	1.23	4
	LCC-East	4/23/2020 14:00	Iodine-129	0.296	pCi/L	0.906	U	U	EMP2	GAMMASPEC	BEA01-2090-03	3.27	5
	LCC-East	4/22/2021 9:28	Iodine-129	0.562	pCi/L	1.21	U	U	EMP2	GAMMASPEC	BEA01-2987-03	4.35	5
	LCC-East	5/23/2022 9:19	Iodine-129	-1.45	pCi/L	1.27	U	U	EMP2	GAMMASPEC	BEA01-3619-03	4.04	5
	LCC-East	10/19/2022 10:13	Iodine-129	0	pCi/L	0.922	UI	U	EMP2	GAMMASPEC	BEA02-3619-03	0.712	5
	LCC-East	4/23/2020 14:00	Technetium-99	5.96	pCi/L	10.4	U	U	EMP2	LSC	BEA01-2090-04	34.9	50
	LCC-East	4/22/2021 9:28	Technetium-99	-4.36	pCi/L	10.3	U	U	EMP2	LSC	BEA01-2987-04	35.2	50
	LCC-East	5/23/2022 9:19	Technetium-99	-4.14	pCi/L	8.38	U	U	EMP2	LSC	BEA01-3619-04	28.5	50
	LCC-East	10/19/2022 10:13	Technetium-99	-3.84	pCi/L	10.6	U	U	EMP2	LSC	BEA02-3619-04	36.7	50
	LCC-East	4/23/2020 14:00	Tritium	3.57	pCi/L	101	U	U	EMP2	LSC	BEA01-2090-05	363	400
	LCC-East	4/22/2021 9:28	Tritium	185	pCi/L	97.4	U	U	EMP2	LSC	BEA01-2987-05	314	400
	LCC-East	5/23/2022 9:19	Tritium	268	pCi/L	103	U	UJ	EMP2	LSC	BEA01-3619-05	319	400
	LCC-East	10/19/2022 10:13	Tritium	180	pCi/L	94	U	U	EMP2	LSC	BEA02-3619-05	294	400
	LCC-East-45	5/23/2022 9:25	Gross alpha	17.9	pCi/L	1.77			EMP2	GPC	BEA01-3616-02	3.61	1
	LCC-East-45	5/23/2022 9:25	Gross beta	15.1	pCi/L	0.962			EMP2	GPC	BEA01-3616-02	2.34	4
	LCC-East-45	10/25/2022 10:07	Technetium-99	-10.9	pCi/L	10.6	U	U	EMP2	LSC	BEA02-3616-04	37.3	50
	LCC-East-45	5/6/2021 9:05	Tritium	82.5	pCi/L	91.8	U	U	EMP2	LSC	BEA01-2984-05	307	400
	LCC-East-45	10/25/2022 10:07	Tritium	328	pCi/L	114	U	UJ	EMP2	LSC	BEA02-3616-05	348	400
	LCC-West	4/1/2019 12:11	Carbon-14	-9.12	pCi/L	11.5	U	U	EMP2	LSC	BEA02-1433-01	39.6	50
	LCC-West	5/21/2020 11:00	Carbon-14	10.1	pCi/L	7.11	U	U	EMP2	LSC	BEA01-2094-01	23.3	50
	LCC-West	5/21/2020 11:00	Gross alpha	2.66	pCi/L	1.52	U	U	EMP2	GPC	BEA01-2094-02	4.99	1
	LCC-West	5/20/2021 9:50	Gross alpha	3.93	pCi/L	0.861			EMP2	GPC	BEA01-2991-02	2.26	1

Result Type[a]	Location	Date Collected	Constituent	Concentration	Units	Uncertainty	Lab Qualifier[b]	Validation Qualifier[b]	Data Source[c]	Analytical Method[d]	Sample #	Detection Limit	Reporting Limit
	LCC-West	5/23/2022 9:32	Gross alpha	4.28	pCi/L	0.729			EMP2	GPC	BEA01-3623-02	1.87	1
	LCC-West	5/21/2020 11:00	Gross beta	1.56	pCi/L	0.928	U	U	EMP2	GPC	BEA01-2094-02	3.03	4
	LCC-West	5/20/2021 9:50	Gross beta	7.93	pCi/L	0.877			EMP2	GPC	BEA01-2991-02	2.47	4
	LCC-West	5/23/2022 9:32	Gross beta	3.55	pCi/L	0.493			EMP2	GPC	BEA01-3623-02	1.48	4
	LCC-West	5/21/2020 11:00	Iodine-129	1.12	pCi/L	0.761	U	U	EMP2	GAMMASPEC	BEA01-2094-03	2.81	5
	LCC-West	10/25/2022 10:16	Iodine-129	0.104	pCi/L	0.912	U	U	EMP2	GAMMASPEC	BEA02-3623-03	3.98	5
	LCC-West	4/1/2019 12:11	Technetium-99	27.8	pCi/L	12.6	U	UJ	EMP2	LSC	BEA02-1433-04	40.9	50
	LCC-West	5/21/2020 11:00	Technetium-99	3.32	pCi/L	8.98	U	U	EMP2	LSC	BEA01-2094-04	30.8	50
	LCC-West	4/1/2019 12:11	Tritium	461	pCi/L	103			EMP2	LSC	BEA02-1433-05	281	400
	LCC-West	5/21/2020 11:00	Tritium	797	pCi/L	144			EMP2	LSC	BEA01-2094-05	344	400
	LCC-West	10/20/2020 11:33	Tritium	646	pCi/L	112			EMP2	LSC	BEA02-2094-05	265	400
	LCC-West	5/20/2021 9:50	Tritium	860	pCi/L	124			EMP2	LSC	BEA01-2991-05	243	400
	LCC-West	10/28/2021 10:12	Tritium	1070	pCi/L	144			EMP2	LSC	BEA02-2991-05	248	400
	LCC-West	5/23/2022 9:32	Tritium	650	pCi/L	145			EMP2	LSC	BEA01-3623-05	407	400
	LCC-West	10/25/2022 10:16	Tritium	778	pCi/L	141			EMP2	LSC	BEA02-3623-05	342	400
	LCC-West-45	4/1/2019 12:14	Carbon-14	-16.4	pCi/L	11.4	U	U	EMP2	LSC	BEA02-1429-01	39.4	50
	LCC-West-45	6/9/2020 15:10	Carbon-14	21.6	pCi/L	10.9	U	U	EMP2	LSC	BEA01-2091-01	35	50
	LCC-West-45	6/9/2020 15:10	Gross alpha	11.6	pCi/L	1.57			EMP2	GPC	BEA01-2091-02	4.11	1
	LCC-West-45	5/23/2022 9:30	Gross alpha	8.68	pCi/L	0.893			EMP2	GPC	BEA01-3620-02	1.87	1
	LCC-West-45	6/9/2020 15:10	Gross beta	10.9	pCi/L	1.37			EMP2	GPC	BEA01-2091-02	4.04	4
	LCC-West-45	5/23/2022 9:30	Gross beta	6.7	pCi/L	0.539			EMP2	GPC	BEA01-3620-02	1.44	4
	LCC-West-45	6/9/2020 15:10	Iodine-129	1.11	pCi/L	1.14	U	U	EMP2	GAMMASPEC	BEA01-2091-03	4.08	5
	LCC-West-45	6/9/2020 15:10	Technetium-99	-0.736	pCi/L	12.6	U	U	EMP2	LSC	BEA01-2091-04	43.8	50
	LCC-West-45	5/6/2021 9:14	Technetium-99	-10.3	pCi/L	9.61	U	U	EMP2	LSC	BEA01-2988-04	33.2	50
	LCC-West-45	6/9/2020 15:10	Tritium	439	pCi/L	188	U	UJ	EMP2	LSC	BEA01-2091-05	595	400
	LCC-West-45	10/20/2020 11:51	Tritium	670	pCi/L	114			EMP2	LSC	BEA02-2091-05	263	400
	LCC-West-45	5/6/2021 9:14	Tritium	701	pCi/L	127			EMP2	LSC	BEA01-2988-05	311	400
	LCC-West-45	10/28/2021 10:05	Tritium	751	pCi/L	117			EMP2	LSC	BEA02-2988-05	246	400
	LCC-West-45	10/25/2022 10:12	Tritium	533	pCi/L	125			EMP2	LSC	BEA02-3620-05	343	400
	MFTC-East	4/1/2019 10:52	Carbon-14	4.73	pCi/L	11.7	U	U	EMP2	LSC	BEA01-1475-01	39.4	50
	MFTC-East	4/9/2020 12:05	Carbon-14	18.7	pCi/L	8.49	U	UJ	EMP2	LSC	BEA01-2093-01	27	50
Duplicate	MFTC-East	4/9/2020 12:05	Carbon-14	-2.1	pCi/L	7.85	U	U	EMP2	LSC	BEA01-2190-01	27.2	50
	MFTC-East	4/7/2021 14:39	Carbon-14	0.276	pCi/L	8.12	U	U	EMP2	LSC	BEA01-2990-01	27.9	50
	MFTC-East	4/25/2022 9:50	Carbon-14	-1.91	pCi/L	8.61	U	U	EMP2	LSC	BEA01-3622-01	29.9	50
	MFTC-East	10/19/2022 11:46	Carbon-14	5.25	pCi/L	8.71	U	U	EMP2	LSC	BEA02-3622-01	29.5	50
	MFTC-East	3/25/2019 13:03	Gross alpha	1.08	pCi/L	0.362	U	UJ	EMP2	GPC	BEA01-1475-02	1.11	1
Duplicate	MFTC-East	4/9/2020 12:05	Gross alpha	1.65	pCi/L	0.434			EMP2	GPC	BEA01-2190-02	1.29	1
	MFTC-East	4/9/2020 12:05	Gross alpha	1.8	pCi/L	0.361			EMP2	GPC	BEA01-2093-02	1.01	1
	MFTC-East	4/7/2021 14:39	Gross alpha	1.88	pCi/L	0.502			EMP2	GPC	BEA01-2990-02	1.46	1
	MFTC-East	4/25/2022 9:50	Gross alpha	1.5	pCi/L	0.47			EMP2	GPC	BEA01-3622-02	1.42	1
	MFTC-East	10/19/2022 11:46	Gross alpha	2.19	pCi/L	0.461			EMP2	GPC	BEA02-3622-02	1.22	1
	MFTC-East	3/25/2019 13:03	Gross beta	0.861	pCi/L	0.295	U	UJ	EMP2	GPC	BEA01-1475-02	0.938	4
Duplicate	MFTC-East	4/9/2020 12:05	Gross beta	1.64	pCi/L	0.51		UJ	EMP2	GPC	BEA01-2190-02	1.64	4
	MFTC-East	4/9/2020 12:05	Gross beta	2.29	pCi/L	0.349		UJ	EMP2	GPC	BEA01-2093-02	1.06	4
	MFTC-East	4/7/2021 14:39	Gross beta	0.556	pCi/L	0.639	U	U	EMP2	GPC	BEA01-2990-02	2.12	4
	MFTC-East	4/25/2022 9:50	Gross beta	0.272	pCi/L	0.334	U	U	EMP2	GPC	BEA01-3622-02	1.11	4
	MFTC-East	10/19/2022 11:46	Gross beta	4.71	pCi/L	0.409			EMP2	GPC	BEA02-3622-02	1.11	4

Result Type[a]	Location	Date Collected	Constituent	Concentration	Units	Uncertainty	Lab Qualifier[b]	Validation Qualifier[b]	Data Source[c]	Analytical Method[d]	Sample #	Detection Limit	Reporting Limit
	MFTC-East	4/1/2019 10:52	Iodine-129	0.54	pCi/L	1.43	U	U	EMP2	GAMMASPEC	BEA01-1475-03	4.69	5
	MFTC-East	4/9/2020 12:05	Iodine-129	0.323	pCi/L	1.01	U	U	EMP2	GAMMASPEC	BEA01-2093-03	4.01	5
Duplicate	MFTC-East	4/9/2020 12:05	Iodine-129	0.257	pCi/L	1.59	U	U	EMP2	GAMMASPEC	BEA01-2190-03	5.01	5
	MFTC-East	4/7/2021 14:39	Iodine-129	-1.45	pCi/L	1.25	U	U	EMP2	GAMMASPEC	BEA01-2990-03	4.07	5
	MFTC-East	4/25/2022 9:50	Iodine-129	-1.53	pCi/L	1.13	U	U	EMP2	GAMMASPEC	BEA01-3622-03	3.63	5
	MFTC-East	10/19/2022 11:46	Iodine-129	0.00679	pCi/L	0.508	U	U	EMP2	GAMMASPEC	BEA02-3622-03	1.98	5
	MFTC-East	4/1/2019 10:52	Technetium-99	-19.8	pCi/L	11.2	U	U	EMP2	LSC	BEA01-1475-04	39	50
	MFTC-East	4/9/2020 12:05	Technetium-99	4.83	pCi/L	12.4	U	U	EMP2	LSC	BEA01-2093-04	41.7	50
	MFTC-East	4/7/2021 14:39	Technetium-99	-2.25	pCi/L	10.9	U	U	EMP2	LSC	BEA01-2990-04	36.8	50
Duplicate	MFTC-East	4/25/2022 9:50	Technetium-99	6.71	pCi/L	9.42	U	U	EMP2	LSC	BEA01-3726-04	31.9	50
	MFTC-East	4/25/2022 9:50	Technetium-99	5.34	pCi/L	10.4	U	U	EMP2	LSC	BEA01-3622-04	35.3	50
	MFTC-East	10/19/2022 11:46	Technetium-99	-21.1	pCi/L	10.1	U	U	EMP2	LSC	BEA02-3622-04	36.5	50
	MFTC-East	10/19/2022 11:46	Technetium-99	-13.8	pCi/L	14.7	U	U	EMP2	LSC	BEA01-4256-04	49.8	50
	MFTC-East	4/1/2019 10:52	Tritium	21.7	pCi/L	83.1	U	U	EMP2	LSC	BEA01-1475-05	284	400
	MFTC-East	4/9/2020 12:05	Tritium	-2.88	pCi/L	70.5	U	U	EMP2	LSC	BEA01-2093-05	265	400
	MFTC-East	4/7/2021 14:39	Tritium	255	pCi/L	84.7	U		EMP2	LSC	BEA01-2990-05	256	400
Duplicate	MFTC-East	4/7/2021 14:39	Tritium	249	pCi/L	87.5	U	UJ	EMP2	LSC	BEA01-3086-05	267	400
	MFTC-East	4/25/2022 9:50	Tritium	85.9	pCi/L	87.7	U	U	EMP2	LSC	BEA01-3622-05	306	400
Duplicate	MFTC-East	4/25/2022 9:50	Tritium	262	pCi/L	105	U	UJ	EMP2	LSC	BEA01-3726-05	309	400
	MFTC-East	10/19/2022 11:46	Tritium	9.83	pCi/L	72.2	U	U	EMP2	LSC	BEA02-3622-05	283	400
	MFTC-East-SIW	6/18/2020 10:20	Carbon-14	13	pCi/L	11.2	U	U	EMP2	LSC	BEA01-2086-01	36.9	50
	MFTC-East-SIW	6/25/2020 8:43	Carbon-14	0.324	pCi/L	8.82	U	U	EMP2	LSC	BEA02-2086-01	30.2	50
	MFTC-East-SIW	4/7/2021 14:48	Carbon-14	-14.1	pCi/L	7.75	U	U	EMP2	LSC	BEA01-2983-01	27.9	50
Duplicate	MFTC-East-SIW	4/25/2022 9:58	Carbon-14	0.352	pCi/L	8.7	U	U	EMP2	LSC	BEA01-3725-01	30	50
	MFTC-East-SIW	4/25/2022 9:58	Carbon-14	-13	pCi/L	12.4	U	U	EMP2	LSC	BEA01-3615-01	41.9	50
	MFTC-East-SIW	10/19/2022 11:53	Carbon-14	7.32	pCi/L	8.66	U	U	EMP2	LSC	BEA02-3615-01	29.1	50
	MFTC-East-SIW	6/18/2020 10:20	Gross alpha	1.29	pCi/L	1.28	U	U	EMP2	GPC	BEA01-2086-02	4.34	1
	MFTC-East-SIW	6/25/2020 8:43	Gross alpha	-0.539	pCi/L	1.19	U	U	EMP2	GPC	BEA02-2086-02	4.31	1
	MFTC-East-SIW	4/7/2021 14:48	Gross alpha	2.2	pCi/L	0.509			EMP2	GPC	BEA01-2983-02	1.41	1
Duplicate	MFTC-East-SIW	4/7/2021 14:48	Gross alpha	1.27	pCi/L	0.575	U	UJ	EMP2	GPC	BEA01-3085-02	1.85	1
	MFTC-East-SIW	4/25/2022 9:58	Gross alpha	3.75	pCi/L	0.791			EMP2	GPC	BEA01-3615-02	2.1	1
	MFTC-East-SIW	10/19/2022 11:53	Gross alpha	2.03	pCi/L	0.487		J	EMP2	GPC	BEA01-4257-02	1.34	1
	MFTC-East-SIW	10/19/2022 11:53	Gross alpha	1.21	pCi/L	0.446	U	UJ	EMP2	GPC	BEA02-3615-02	1.37	1
	MFTC-East-SIW	6/18/2020 10:20	Gross beta	20.6	pCi/L	1.57			EMP2	GPC	BEA01-2086-02	4.18	4
	MFTC-East-SIW	6/25/2020 8:43	Gross beta	24.2	pCi/L	1.81			EMP2	GPC	BEA02-2086-02	4.99	4
Duplicate	MFTC-East-SIW	4/7/2021 14:48	Gross beta	1.8	pCi/L	0.68	U	UJ	EMP2	GPC	BEA01-3085-02	2.2	4
	MFTC-East-SIW	4/7/2021 14:48	Gross beta	2.07	pCi/L	0.567			EMP2	GPC	BEA01-2983-02	1.8	4
	MFTC-East-SIW	4/25/2022 9:58	Gross beta	6.7	pCi/L	0.683			EMP2	GPC	BEA01-3615-02	1.92	4
	MFTC-East-SIW	10/19/2022 11:53	Gross beta	2.12	pCi/L	0.384			EMP2	GPC	BEA01-4257-02	1.12	4
	MFTC-East-SIW	10/19/2022 11:53	Gross beta	1.44	pCi/L	0.287			EMP2	GPC	BEA02-3615-02	0.856	4
	MFTC-East-SIW	6/18/2020 10:20	Iodine-129	1.38	pCi/L	1.28	U	U	EMP2	GAMMASPEC	BEA01-2086-03	4.88	5
	MFTC-East-SIW	6/25/2020 8:43	Iodine-129	-0.00353	pCi/L	1.51	U	U	EMP2	GAMMASPEC	BEA02-2086-03	4.76	5
	MFTC-East-SIW	4/7/2021 14:48	Iodine-129	0.874	pCi/L	1.22	U	U	EMP2	GAMMASPEC	BEA01-2983-03	4.67	5
Duplicate	MFTC-East-SIW	4/25/2022 9:58	Iodine-129	0.111	pCi/L	1.06	U	U	EMP2	GAMMASPEC	BEA01-3725-03	4	5
	MFTC-East-SIW	4/25/2022 9:58	Iodine-129	0.829	pCi/L	1.14	U	U	EMP2	GAMMASPEC	BEA01-3615-03	4.32	5
	MFTC-East-SIW	10/19/2022 11:53	Iodine-129	0.565	pCi/L	1.01	U	U	EMP2	GAMMASPEC	BEA02-3615-03	4.14	5
	MFTC-East-SIW	6/18/2020 10:20	Technetium-99	-0.585	pCi/L	13.7	U	U	EMP2	LSC	BEA01-2086-04	47.7	50

Result Type[a]	Location	Date Collected	Constituent	Concentration	Units	Uncertainty	Lab Qualifier[b]	Validation Qualifier[b]	Data Source[c]	Analytical Method[d]	Sample #	Detection Limit	Reporting Limit
	MFTC-East-SIW	6/25/2020 8:43	Technetium-99	-21.6	pCi/L	12	U	U	EMP2	LSC	BEA02-2086-04	43.8	50
	MFTC-East-SIW	4/7/2021 14:48	Technetium-99	-5.81	pCi/L	10.1	U	U	EMP2	LSC	BEA01-2983-04	34.4	50
	MFTC-East-SIW	4/25/2022 9:58	Technetium-99	2.41	pCi/L	8.93	U	U	EMP2	LSC	BEA01-3615-04	30.6	50
Duplicate	MFTC-East-SIW	4/25/2022 9:58	Technetium-99	17.3	pCi/L	11	U	U	EMP2	LSC	BEA01-3725-04	36.3	50
	MFTC-East-SIW	10/19/2022 11:53	Technetium-99	-17.5	pCi/L	10.6	U	U	EMP2	LSC	BEA02-3615-04	38	50
	MFTC-East-SIW	6/18/2020 10:20	Tritium	147	pCi/L	106	U	U	EMP2	LSC	BEA01-2086-05	349	400
	MFTC-East-SIW	6/25/2020 8:43	Tritium	-35	pCi/L	89.1	U	U	EMP2	LSC	BEA02-2086-05	319	400
Duplicate	MFTC-East-SIW	4/7/2021 14:48	Tritium	-0.636	pCi/L	78.8	U	U	EMP2	LSC	BEA01-3085-05	273	400
	MFTC-East-SIW	4/7/2021 14:48	Tritium	72.8	pCi/L	78.8	U	U	EMP2	LSC	BEA01-2983-05	265	400
	MFTC-East-SIW	4/25/2022 9:58	Tritium	-9.22	pCi/L	78.2	U	U	EMP2	LSC	BEA01-3615-05	301	400
	MFTC-East-SIW	10/19/2022 11:53	Tritium	-47.9	pCi/L	81.3	U	U	EMP2	LSC	BEA02-3615-05	315	400
	MFTC-West	4/1/2019 11:08	Carbon-14	-16.2	pCi/L	11.4	U	U	EMP2	LSC	BEA01-1473-01	39.5	50
	MFTC-West	4/9/2020 11:55	Carbon-14	7.07	pCi/L	8.02	U	U	EMP2	LSC	BEA01-2101-01	26.9	50
	MFTC-West	4/22/2021 10:39	Carbon-14	4.13	pCi/L	8.35	U	U	EMP2	LSC	BEA01-2998-01	28.3	50
	MFTC-West	10/28/2021 10:51	Carbon-14	5.44	pCi/L	11.8	U	U	EMP2	LSC	BEA02-2998-01	39.5	50
	MFTC-West	4/25/2022 9:41	Carbon-14	3.09	pCi/L	8.74	U	U	EMP2	LSC	BEA01-3629-01	29.9	50
	MFTC-West	10/19/2022 11:35	Carbon-14	-1.86	pCi/L	8.06	U	U	EMP2	LSC	BEA02-3629-01	28	50
	MFTC-West	3/25/2019 13:37	Gross alpha	0.714	pCi/L	0.491	U	U	EMP2	GPC	BEA01-1473-02	1.63	1
Duplicate	MFTC-West	4/9/2020 11:55	Gross alpha	1.34	pCi/L	0.404			EMP2	GPC	BEA01-2188-02	1.23	1
	MFTC-West	4/9/2020 11:55	Gross alpha	0.954	pCi/L	0.398	U	UJ	EMP2	GPC	BEA01-2101-02	1.25	1
	MFTC-West	4/22/2021 10:39	Gross alpha	1.02	pCi/L	0.636	U	U	EMP2	GPC	BEA01-2998-02	2	1
	MFTC-West	10/28/2021 10:51	Gross alpha	2.62	pCi/L	0.978	U	UJ	EMP2	GPC	BEA02-2998-02	3.07	1
	MFTC-West	4/25/2022 9:41	Gross alpha	2.03	pCi/L	0.489			EMP2	GPC	BEA01-3629-02	1.32	1
	MFTC-West	10/19/2022 11:35	Gross alpha	2.33	pCi/L	0.57			EMP2	GPC	BEA02-3629-02	1.66	1
	MFTC-West	3/25/2019 13:37	Gross beta	1.98	pCi/L	0.399			EMP2	GPC	BEA01-1473-02	1.23	4
	MFTC-West	4/9/2020 11:55	Gross beta	1.95	pCi/L	0.283		UJ	EMP2	GPC	BEA01-2101-02	0.837	4
Duplicate	MFTC-West	4/9/2020 11:55	Gross beta	1.22	pCi/L	0.267		J	EMP2	GPC	BEA01-2188-02	0.813	4
	MFTC-West	4/22/2021 10:39	Gross beta	0.626	pCi/L	0.724	U	U	EMP2	GPC	BEA01-2998-02	2.41	4
	MFTC-West	10/28/2021 10:51	Gross beta	0.602	pCi/L	0.937	U	U	EMP2	GPC	BEA02-2998-02	3.14	4
	MFTC-West	4/25/2022 9:41	Gross beta	1.35	pCi/L	0.356			EMP2	GPC	BEA01-3629-02	1.12	4
	MFTC-West	10/19/2022 11:35	Gross beta	2.12	pCi/L	0.486			EMP2	GPC	BEA02-3629-02	1.52	4
	MFTC-West	4/1/2019 11:08	Iodine-129	-1.51	pCi/L	1.26	U	U	EMP2	GAMMASPEC	BEA01-1473-03	4.63	5
	MFTC-West	4/9/2020 11:55	Iodine-129	-0.831	pCi/L	0.983	U	U	EMP2	GAMMASPEC	BEA01-2101-03	2.99	5
	MFTC-West	4/22/2021 10:39	Iodine-129	0.304	pCi/L	0.608	U	U	EMP2	GAMMASPEC	BEA01-2998-03	2.34	5
Duplicate	MFTC-West	4/25/2022 9:41	Iodine-129	-0.174	pCi/L	0.677	U	U	EMP2	GAMMASPEC	BEA01-3727-03	3.35	5
	MFTC-West	4/25/2022 9:41	Iodine-129	0.157	pCi/L	1.4	U	U	EMP2	GAMMASPEC	BEA01-3629-03	5.33	5
	MFTC-West	10/19/2022 11:35	Iodine-129	-1.24	pCi/L	0.959	U	U	EMP2	GAMMASPEC	BEA02-3629-03	3.16	5
	MFTC-West	4/1/2019 11:08	Technetium-99	7.57	pCi/L	10.3	U	U	EMP2	LSC	BEA01-1473-04	34.6	50
	MFTC-West	4/9/2020 11:55	Technetium-99	-14.2	pCi/L	11.2	U	U	EMP2	LSC	BEA01-2101-04	38.7	50
	MFTC-West	4/22/2021 10:39	Technetium-99	-10.5	pCi/L	8.65	U	U	EMP2	LSC	BEA01-2998-04	29.9	50
	MFTC-West	10/28/2021 10:51	Technetium-99	-4.32	pCi/L	9.86	U	U	EMP2	LSC	BEA02-2998-04	33.6	50
	MFTC-West	4/25/2022 9:41	Technetium-99	16.1	pCi/L	10.2	U	U	EMP2	LSC	BEA01-3629-04	33.8	50
	MFTC-West	10/19/2022 11:35	Technetium-99	0.462	pCi/L	10.7	U	U	EMP2	LSC	BEA02-3629-04	36.6	50
	MFTC-West	4/1/2019 11:08	Tritium	456	pCi/L	101			EMP2	LSC	BEA01-1473-05	275	400
	MFTC-West	4/9/2020 11:55	Tritium	327	pCi/L	97.2			EMP2	LSC	BEA01-2101-05	254	400
	MFTC-West	10/20/2020 12:50	Tritium	195	pCi/L	119	U	U	EMP2	LSC	BEA02-2101-05	388	400
Duplicate	MFTC-West	4/22/2021 10:39	Tritium	166	pCi/L	92.8	U	U	EMP2	LSC	BEA01-3090-05	300	400

Result Type[a]	Location	Date Collected	Constituent	Concentration	Units	Uncertainty	Lab Qualifier[b]	Validation Qualifier[b]	Data Source[c]	Analytical Method[d]	Sample #	Detection Limit	Reporting Limit
	MFTC-West	4/22/2021 10:39	Tritium	259	pCi/L	93.2	U	UJ	EMP2	LSC	BEA01-2998-05	282	400
	MFTC-West	10/28/2021 10:51	Tritium	359	pCi/L	88.9			EMP2	LSC	BEA02-2998-05	248	400
	MFTC-West	4/25/2022 9:41	Tritium	372	pCi/L	113			EMP2	LSC	BEA01-3629-05	303	400
	MFTC-West	10/19/2022 11:35	Tritium	56.1	pCi/L	78	U	U	EMP2	LSC	BEA02-3629-05	285	400
	MFTC-West-SIW	6/25/2020 9:00	Gross alpha	7.71	pCi/L	1.08			EMP2	GPC	BEA01-2096-02	2.13	1
	MFTC-West-SIW	5/20/2021 10:41	Gross alpha	4.36	pCi/L	0.565			EMP2	GPC	BEA01-2993-02	0.998	1
	MFTC-West-SIW	5/23/2022 10:18	Gross alpha	8.73	pCi/L	0.849			EMP2	GPC	BEA01-3625-02	1.58	1
	MFTC-West-SIW	6/25/2020 9:00	Gross beta	11.3	pCi/L	1.2			EMP2	GPC	BEA01-2096-02	3.41	4
	MFTC-West-SIW	5/20/2021 10:41	Gross beta	8.08	pCi/L	0.449			EMP2	GPC	BEA01-2993-02	1.02	4
	MFTC-West-SIW	5/23/2022 10:18	Gross beta	6.29	pCi/L	0.446			EMP2	GPC	BEA01-3625-02	1.12	4
	MFTC-West-SIW	5/20/2021 10:41	Tritium	335	pCi/L	84.2			EMP2	LSC	BEA01-2993-05	238	400
	MFTC-West-SIW	5/23/2022 10:18	Tritium	106	pCi/L	95.3	U	U	EMP2	LSC	BEA01-3625-05	318	400
	MFTC-West-SIW	10/25/2022 10:52	Tritium	147	pCi/L	101	U	U	EMP2	LSC	BEA02-3625-05	333	400
	NuPac-East	4/1/2019 11:53	Carbon-14	-17.1	pCi/L	11.8	U	U	EMP2	LSC	BEA01-1479-01	40.7	50
	NuPac-East	4/23/2020 14:05	Carbon-14	13.1	pCi/L	8.24	U	U	EMP2	LSC	BEA01-2103-01	26.9	50
	NuPac-East	5/6/2021 9:55	Carbon-14	0.653	pCi/L	8.25	U	U	EMP2	LSC	BEA01-3000-01	28.3	50
	NuPac-East	10/28/2021 10:41	Carbon-14	-5.52	pCi/L	5.02	U	U	EMP2	LSC	BEA02-3000-01	17.1	50
	NuPac-East	5/16/2022 9:50	Carbon-14	-7.09	pCi/L	5.05	U	U	EMP2	LSC	BEA01-3631-01	17.4	50
	NuPac-East	10/19/2022 10:46	Carbon-14	-4.19	pCi/L	8.43	U	U	EMP2	LSC	BEA02-3631-01	29.5	50
	NuPac-East	3/25/2019 14:47	Gross alpha	1.23	pCi/L	0.505	U	UJ	EMP2	GPC	BEA01-1479-02	1.58	1
	NuPac-East	4/23/2020 14:05	Gross alpha	2.16	pCi/L	0.711	U		EMP2	GPC	BEA01-2103-02	2.16	1
	NuPac-East	5/6/2021 9:55	Gross alpha	1.19	pCi/L	0.982	U	U	EMP2	GPC	BEA01-3000-02	3.3	1
	NuPac-East	5/16/2022 9:50	Gross alpha	1.86	pCi/L	0.971	U	U	EMP2	GPC	BEA01-3631-02	3.16	1
	NuPac-East	10/19/2022 10:46	Gross alpha	0.419	pCi/L	0.728	U	U	EMP2	GPC	BEA02-3631-02	2.53	1
	NuPac-East	3/25/2019 14:47	Gross beta	3.22	pCi/L	0.404			EMP2	GPC	BEA01-1479-02	1.11	4
	NuPac-East	4/23/2020 14:05	Gross beta	2.21	pCi/L	0.382		UJ	EMP2	GPC	BEA01-2103-02	1.11	4
	NuPac-East	5/6/2021 9:55	Gross beta	3.44	pCi/L	0.756			EMP2	GPC	BEA01-3000-02	2.37	4
	NuPac-East	5/16/2022 9:50	Gross beta	4.19	pCi/L	0.574			EMP2	GPC	BEA01-3631-02	1.72	4
	NuPac-East	10/19/2022 10:46	Gross beta	3.77	pCi/L	0.444			EMP2	GPC	BEA02-3631-02	1.24	4
	NuPac-East	4/1/2019 11:53	Iodine-129	1.37	pCi/L	1.1	U	U	EMP2	GAMMASPEC	BEA01-1479-03	4.43	5
	NuPac-East	4/23/2020 14:05	Iodine-129	-0.6	pCi/L	0.838	U	U	EMP2	GAMMASPEC	BEA01-2103-03	2.58	5
	NuPac-East	5/6/2021 9:55	Iodine-129	-1.66	pCi/L	1.28	U	U	EMP2	GAMMASPEC	BEA01-3000-03	3.83	5
	NuPac-East	5/16/2022 9:50	Iodine-129	1.52	pCi/L	1.4	U	U	EMP2	GAMMASPEC	BEA01-3631-03	4.48	5
	NuPac-East	10/19/2022 10:46	Iodine-129	-1.31	pCi/L	1.16	U	U	EMP2	GAMMASPEC	BEA02-3631-03	3.91	5
	NuPac-East	4/1/2019 11:53	Technetium-99	2.13	pCi/L	8.86	U	U	EMP2	LSC	BEA01-1479-04	29.9	50
	NuPac-East	4/23/2020 14:05	Technetium-99	-6.01	pCi/L	12.1	U	U	EMP2	LSC	BEA01-2103-04	41.2	50
	NuPac-East	5/6/2021 9:55	Technetium-99	-8.7	pCi/L	10.8	U	U	EMP2	LSC	BEA01-3000-04	36.9	50
	NuPac-East	10/28/2021 10:41	Technetium-99	21	pCi/L	11.9	U	U	EMP2	LSC	BEA02-3000-04	39	50
	NuPac-East	5/16/2022 9:50	Technetium-99	6.05	pCi/L	7.38	U	U	EMP2	LSC	BEA01-3631-04	25.4	50
	NuPac-East	10/19/2022 10:46	Technetium-99	-4.87	pCi/L	10.8	U	U	EMP2	LSC	BEA02-3631-04	37.4	50
	NuPac-East	4/1/2019 11:53	Tritium	665	pCi/L	121			EMP2	LSC	BEA01-1479-05	300	400
	NuPac-East	4/23/2020 14:05	Tritium	845	pCi/L	140			EMP2	LSC	BEA01-2103-05	245	400
	NuPac-East	10/20/2020 12:35	Tritium	220	pCi/L	87.7	U	UJ	EMP2	LSC	BEA02-2103-05	274	400
	NuPac-East	5/6/2021 9:55	Tritium	612	pCi/L	122			EMP2	LSC	BEA01-3000-05	295	400
	NuPac-East	10/28/2021 10:41	Tritium	744	pCi/L	117			EMP2	LSC	BEA02-3000-05	247	400
	NuPac-East	5/16/2022 9:50	Tritium	269	pCi/L	100	U	UJ	EMP2	LSC	BEA01-3631-05	275	400
	NuPac-East	10/19/2022 10:46	Tritium	276	pCi/L	102	U	UJ	EMP2	LSC	BEA02-3631-05	284	400

Result Type[a]	Location	Date Collected	Constituent	Concentration	Units	Uncertainty	Lab Qualifier[b]	Validation Qualifier[b]	Data Source[c]	Analytical Method[d]	Sample #	Detection Limit	Reporting Limit
	NuPac-East-45	5/6/2021 9:59	Tritium	474	pCi/L	111			EMP2	LSC	BEA01-2996-05	295	400
	NuPac-SIW	5/23/2022 9:48	Gross alpha	3.52	pCi/L	0.708			EMP2	GPC	BEA01-3628-02	1.92	1
	NuPac-SIW	5/23/2022 9:48	Gross beta	5.61	pCi/L	0.489			EMP2	GPC	BEA01-3628-02	1.31	4
	NuPac-SIW	5/6/2021 9:48	Tritium	185	pCi/L	94.1	U	U	EMP2	LSC	BEA01-2997-05	302	400
	NuPac-West	4/1/2019 11:39	Carbon-14	5.54	pCi/L	11.7	U	U	EMP2	LSC	BEA01-1477-01	39.4	50
	NuPac-West	4/9/2020 11:40	Carbon-14	-0.00712	pCi/L	7.81	U	U	EMP2	LSC	BEA01-2097-01	26.9	50
Duplicate	NuPac-West	4/9/2020 11:40	Carbon-14	24.3	pCi/L	8.81	U	UJ	EMP2	LSC	BEA01-2189-01	27.2	50
	NuPac-West	4/7/2021 11:58	Carbon-14	7.36	pCi/L	8.37	U	U	EMP2	LSC	BEA01-2994-01	28.1	50
Duplicate	NuPac-West	4/25/2022 10:42	Carbon-14	10.2	pCi/L	8.99	U	U	EMP2	LSC	BEA01-3728-01	29.9	50
	NuPac-West	4/25/2022 10:42	Carbon-14	0.213	pCi/L	8.71	U	U	EMP2	LSC	BEA01-3626-01	30	50
	NuPac-West	10/19/2022 11:01	Carbon-14	-20.4	pCi/L	7.5	U	U	EMP2	LSC	BEA02-3626-01	27.8	50
	NuPac-West	3/25/2019 14:31	Gross alpha	1.66	pCi/L	0.494			EMP2	GPC	BEA01-1477-02	1.49	1
	NuPac-West	4/9/2020 11:40	Gross alpha	2.33	pCi/L	0.574			EMP2	GPC	BEA01-2097-02	1.71	1
Duplicate	NuPac-West	4/9/2020 11:40	Gross alpha	2.15	pCi/L	0.447			EMP2	GPC	BEA01-2189-02	1.24	1
	NuPac-West	4/7/2021 11:58	Gross alpha	0.904	pCi/L	0.634	U	U	EMP2	GPC	BEA01-2994-02	2.11	1
	NuPac-West	4/25/2022 10:42	Gross alpha	1.66	pCi/L	0.491			EMP2	GPC	BEA01-3626-02	1.46	1
	NuPac-West	10/19/2022 11:01	Gross alpha	3.07	pCi/L	0.721			EMP2	GPC	BEA02-3626-02	2.12	1
	NuPac-West	3/25/2019 14:31	Gross beta	1.66	pCi/L	0.422			EMP2	GPC	BEA01-1477-02	1.33	4
Duplicate	NuPac-West	4/9/2020 11:40	Gross beta	1.87	pCi/L	0.404		UJ	EMP2	GPC	BEA01-2189-02	1.26	4
	NuPac-West	4/9/2020 11:40	Gross beta	1.4	pCi/L	0.284		J	EMP2	GPC	BEA01-2097-02	0.849	4
	NuPac-West	4/7/2021 11:58	Gross beta	0.966	pCi/L	0.683	U	U	EMP2	GPC	BEA01-2994-02	2.25	4
	NuPac-West	4/25/2022 10:42	Gross beta	2.52	pCi/L	0.316			EMP2	GPC	BEA01-3626-02	0.908	4
	NuPac-West	10/19/2022 11:01	Gross beta	2.43	pCi/L	0.344			EMP2	GPC	BEA02-3626-02	0.976	4
	NuPac-West	4/1/2019 11:39	Iodine-129	0.878	pCi/L	0.714	U	U	EMP2	GAMMASPEC	BEA01-1477-03	2.88	5
Duplicate	NuPac-West	4/9/2020 11:40	Iodine-129	0.76	pCi/L	0.847	U	U	EMP2	GAMMASPEC	BEA01-2189-03	3.63	5
	NuPac-West	4/9/2020 11:40	Iodine-129	-0.132	pCi/L	0.613	U	U	EMP2	GAMMASPEC	BEA01-2097-03	2.58	5
	NuPac-West	4/7/2021 11:58	Iodine-129	2.15	pCi/L	1.28	U	U	EMP2	GAMMASPEC	BEA01-2994-03	3.47	5
	NuPac-West	4/25/2022 10:42	Iodine-129	-0.789	pCi/L	1.34	U	U	EMP2	GAMMASPEC	BEA01-3626-03	4.44	5
	NuPac-West	10/19/2022 11:01	Iodine-129	0.326	pCi/L	0.846	U	U	EMP2	GAMMASPEC	BEA02-3626-03	3.23	5
	NuPac-West	4/1/2019 11:39	Technetium-99	-5.44	pCi/L	9.08	U	U	EMP2	LSC	BEA01-1477-04	31.1	50
	NuPac-West	4/9/2020 11:40	Technetium-99	13.1	pCi/L	12.2	U	U	EMP2	LSC	BEA01-2097-04	40.6	50
	NuPac-West	4/7/2021 11:58	Technetium-99	-3.12	pCi/L	12.1	U	U	EMP2	LSC	BEA01-2994-04	40.7	50
Duplicate	NuPac-West	4/25/2022 10:42	Technetium-99	14.7	pCi/L	10	U	U	EMP2	LSC	BEA01-3728-04	33.2	50
	NuPac-West	4/25/2022 10:42	Technetium-99	-0.0949	pCi/L	9.58	U	U	EMP2	LSC	BEA01-3626-04	33.2	50
	NuPac-West	10/19/2022 11:01	Technetium-99	-12.5	pCi/L	10.3	U	U	EMP2	LSC	BEA02-3626-04	36.5	50
	NuPac-West	4/1/2019 11:39	Tritium	924	pCi/L	135			EMP2	LSC	BEA01-1477-05	275	400
	NuPac-West	4/9/2020 11:40	Tritium	261	pCi/L	89.7		J	EMP2	LSC	BEA01-2097-05	250	400
	NuPac-West	4/7/2021 11:58	Tritium	346	pCi/L	94.5			EMP2	LSC	BEA01-2994-05	272	400
	NuPac-West	4/25/2022 10:42	Tritium	88.2	pCi/L	89.5	U	U	EMP2	LSC	BEA01-3626-05	312	400
Duplicate	NuPac-West	4/25/2022 10:42	Tritium	234	pCi/L	102	U	UJ	EMP2	LSC	BEA01-3728-05	311	400
	NuPac-West	10/19/2022 11:01	Tritium	23.1	pCi/L	74.3	U	U	EMP2	LSC	BEA02-3626-05	285	400
	PA-North	4/1/2019 11:26	Carbon-14	23.2	pCi/L	12.2	U	U	EMP2	LSC	BEA01-1467-01	39.5	50
Duplicate	PA-North	4/9/2020 11:15	Carbon-14	7.4	pCi/L	8.02	U	U	EMP2	LSC	BEA01-2186-01	26.8	50
	PA-North	4/9/2020 11:15	Carbon-14	30	pCi/L	10.6	U	UJ	EMP2	LSC	BEA01-2085-01	33.3	50
	PA-North	4/7/2021 13:48	Carbon-14	-2.1	pCi/L	8.1	U	U	EMP2	LSC	BEA01-2982-01	28	50
	PA-North	5/9/2022 10:31	Carbon-14	-11.5	pCi/L	10.2	U	U	EMP2	LSC	BEA01-3614-01	34.9	50
	PA-North	10/25/2022 10:38	Carbon-14	5.48	pCi/L	8.47	U	U	EMP2	LSC	BEA02-3614-01	28.7	50

Result Type[a]	Location	Date Collected	Constituent	Concentration	Units	Uncertainty	Lab Qualifier[b]	Validation Qualifier[b]	Data Source[c]	Analytical Method[d]	Sample #	Detection Limit	Reporting Limit
	PA-North	3/25/2019 14:13	Gross alpha	11.1	pCi/L	1.59			EMP2	GPC	BEA01-1467-02	3.58	1
	PA-North	3/25/2019 14:13	Gross alpha	8.39	pCi/L	2.03			EMP2	GPC	BEA01-1467-02	5.95	1
	PA-North	6/12/2019 13:45	Gross alpha	9.55	pCi/L	2.05			EMP2	GPC	BEA02-1467-02	6.01	1
	PA-North	4/9/2020 11:15	Gross alpha	13.4	pCi/L	2.3			EMP2	GPC	BEA01-2085-02	6.33	1
Duplicate	PA-North	4/9/2020 11:15	Gross alpha	8.8	pCi/L	1.92			EMP2	GPC	BEA01-2186-02	5.61	1
	PA-North	4/7/2021 13:48	Gross alpha	11.3	pCi/L	2.94			EMP2	GPC	BEA01-2982-02	8.5	1
	PA-North	5/9/2022 10:31	Gross alpha	11.1	pCi/L	1.97			EMP2	GPC	BEA01-3614-02	5.02	1
	PA-North	3/25/2019 14:13	Gross beta	7.9	pCi/L	1.03			EMP2	GPC	BEA01-1467-02	2.84	4
	PA-North	3/25/2019 14:13	Gross beta	10.7	pCi/L	1.32			EMP2	GPC	BEA01-1467-02	3.81	4
	PA-North	6/12/2019 13:45	Gross beta	-0.27	pCi/L	1.67	U	U	EMP2	GPC	BEA02-1467-02	5.6	4
	PA-North	4/9/2020 11:15	Gross beta	8.86	pCi/L	1.21		J	EMP2	GPC	BEA01-2085-02	3.55	4
Duplicate	PA-North	4/9/2020 11:15	Gross beta	6.98	pCi/L	0.909		J	EMP2	GPC	BEA01-2186-02	2.54	4
	PA-North	4/7/2021 13:48	Gross beta	8.56	pCi/L	3.22	U	UJ	EMP2	GPC	BEA01-2982-02	10.4	4
	PA-North	5/9/2022 10:31	Gross beta	8.02	pCi/L	1.33			EMP2	GPC	BEA01-3614-02	4.08	4
	PA-North	4/1/2019 11:26	Iodine-129	0.478	pCi/L	1.08	U	U	EMP2	GAMMASPEC	BEA01-1467-03	4.19	5
	PA-North	4/9/2020 11:15	Iodine-129	-0.119	pCi/L	0.865	U	U	EMP2	GAMMASPEC	BEA01-2085-03	3.09	5
Duplicate	PA-North	4/9/2020 11:15	Iodine-129	3.05	pCi/L	1.43	U	UJ	EMP2	GAMMASPEC	BEA01-2186-03	5.26	5
	PA-North	4/7/2021 13:48	Iodine-129	-1.26	pCi/L	1.53	U	U	EMP2	GAMMASPEC	BEA01-2982-03	4.85	5
Duplicate	PA-North	4/7/2021 13:48	Iodine-129	-0.000344	pCi/L	1.22	U	U	EMP2	GAMMASPEC	BEA01-3089-03	4.46	5
	PA-North	5/9/2022 10:31	Iodine-129	0.336	pCi/L	1.36	U	UJ	EMP2	GAMMASPEC	BEA01-3614-03	4.93	5
	PA-North	10/25/2022 10:38	Iodine-129	-1.01	pCi/L	1.05	U	U	EMP2	GAMMASPEC	BEA02-3614-03	3.21	5
	PA-North	4/1/2019 11:26	Technetium-99	11.9	pCi/L	9.27	U	U	EMP2	LSC	BEA01-1467-04	30.7	50
	PA-North	4/9/2020 11:15	Technetium-99	-11.6	pCi/L	14.3	U	U	EMP2	LSC	BEA01-2085-04	48.2	50
	PA-North	4/7/2021 13:48	Technetium-99	6.27	pCi/L	8.31	U	U	EMP2	LSC	BEA01-2982-04	27.7	50
	PA-North	5/9/2022 10:31	Technetium-99	-3.88	pCi/L	6.89	U	U	EMP2	LSC	BEA01-3614-04	25.5	50
	PA-North	10/25/2022 10:38	Technetium-99	-21.7	pCi/L	9.69	U	U	EMP2	LSC	BEA02-3614-04	35.1	50
	PA-North	4/1/2019 11:26	Tritium	962	pCi/L	139			EMP2	LSC	BEA01-1467-05	278	400
	PA-North	4/9/2020 11:15	Tritium	880	pCi/L	210			EMP2	LSC	BEA01-2085-05	507	400
Duplicate	PA-North	4/9/2020 11:15	Tritium	788	pCi/L	206			EMP2	LSC	BEA01-2186-05	524	400
	PA-North	4/7/2021 13:48	Tritium	893	pCi/L	161			EMP2	LSC	BEA01-2982-05	386	400
Duplicate	PA-North	4/7/2021 13:48	Tritium	652	pCi/L	115			EMP2	LSC	BEA01-3089-05	270	400
	PA-North	5/9/2022 10:31	Tritium	626	pCi/L	173			EMP2	LSC	BEA01-3614-05	481	400
	PA-North	10/25/2022 10:38	Tritium	655	pCi/L	130			EMP2	LSC	BEA02-3614-05	333	400
	PA-South	4/1/2019 11:24	Carbon-14	-22	pCi/L	11.3	U	U	EMP2	LSC	BEA01-1468-01	39.4	50
	PA-South	10/25/2022 10:40	Carbon-14	6.4	pCi/L	8.78	U	U	EMP2	LSC	BEA02-3612-01	29.6	50
	PA-South	6/17/2019 13:30	Gross alpha	1.95	pCi/L	1.24	U	U	EMP2	GPC	BEA02-1468-02	4.09	1
	PA-South	4/23/2020 13:57	Gross alpha	6.74	pCi/L	0.967			EMP2	GPC	BEA01-2083-02	2.36	1
	PA-South	5/20/2021 10:00	Gross alpha	3.13	pCi/L	1.15	U	UJ	EMP2	GPC	BEA01-2980-02	3.63	1
	PA-South	5/23/2022 10:01	Gross alpha	5.02	pCi/L	1.16			EMP2	GPC	BEA01-3612-02	3.27	1
	PA-South	6/17/2019 13:30	Gross beta	2.37	pCi/L	1.54	U	U	EMP2	GPC	BEA02-1468-02	5.08	4
	PA-South	4/23/2020 13:57	Gross beta	7.04	pCi/L	0.775		J	EMP2	GPC	BEA01-2083-02	2.22	4
	PA-South	5/20/2021 10:00	Gross beta	6.36	pCi/L	0.726			EMP2	GPC	BEA01-2980-02	2.06	4
	PA-South	5/23/2022 10:01	Gross beta	3.91	pCi/L	0.768			EMP2	GPC	BEA01-3612-02	2.37	4
	PA-South	5/20/2021 10:00	Tritium	1080	pCi/L	224			EMP2	LSC	BEA01-2980-05	584	400
	PA-South	5/23/2022 10:01	Tritium	458	pCi/L	135			EMP2	LSC	BEA01-3612-05	406	400
	PA-South	10/25/2022 10:40	Tritium	759	pCi/L	141			EMP2	LSC	BEA02-3612-05	347	400

a. Duplicate is a field duplicate.

b. U = The radionuclide is not considered to be present in the sample (non-detect).
UJ = The radionuclide may or may not be present in the sample and the result is considered highly questionable.
J = The radionuclide is considered to be present in the sample; however, the result may not be an accurate representation of the amount of activity actually present in the sample.
c. EMP = Environmental Monitoring Program
d. LSC = liquid scintillation counting
GPC = gas proportional counting
GAMMASPEC = gamma spectrometry