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Department of Energy

Portsmouth/Paducah Project Office
1017 Majestic Drive, Suite 200
Lexington, Kentucky 40513
(859) 219-4000

November 21, 2024

Ms. Lauren Linehan
Division of Waste Management
Kentucky Department for Environmental Protection
625 Hospital Drive
Madisonville, Kentucky 42431

PPPO-02-10030151-25

Ms. April Webb
Hazardous Waste Branch Manager
Division of Waste Management
Kentucky Department for Environmental Protection
300 Sower Boulevard, 2nd Floor
Frankfort, Kentucky 40601

Dear Ms. Linehan and Ms. Webb:

C-404 HAZARDOUS WASTE LANDFILL NOVEMBER 2024 SEMIANNUAL GROUNDWATER REPORT (APRIL 2024–SEPTEMBER 2024), PADUCAH GASEOUS DIFFUSION PLANT, PADUCAH, KENTUCKY, FRNP-RPT-0343/V2, HAZARDOUS WASTE MANAGEMENT FACILITY PERMIT NO. KY8-890-008-982, AGENCY INTEREST ID NO. 3059

Enclosed is the subject report for the second reporting period, fiscal year 2024. This report is required in accordance with Part II, Specific Condition II.K.6.d, of Hazardous Waste Management Facility Permit No. KY8-890-008-982 (Permit).

Results of the statistical analyses indicate that compliance well concentrations of permit-required parameters are not statistically different from those in background wells, with the exception of trichloroethene (TCE) in compliance well MW84A and technetium-99 (Tc-99) in compliance wells MW84A and MW90A. Although TCE and Tc-99 concentrations in compliance wells showed statistically significant concentrations compared to concentrations observed in the background wells, the concentrations did not show increasing trends, so there are no confirmed TCE or Tc-99 exceedances attributable to the C-404 landfill for this reporting period.

If you have any questions or require additional information, please contact Tom Reed at (859) 397-7003.

Sincerely,

APRIL LADD

Digitally signed by APRIL LADD
Date: 2024.11.21 09:38:55 -06'00'

April Ladd
Paducah Site Lead
Portsmouth/Paducah Project Office

Enclosures:
1. Certification Page
2. *C-404 Hazardous Waste Landfill November 2024 Semiannual Groundwater Report (April 2024–September 2024), Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, FRNP-RPT-0343/V2

cc w/enclosures:
abigal.parish@pppo.gov, PPPO
angus.mackelvey@pppo.gov, PPPO
april.ladd@pppo.gov, PPPO
april.webb@ky.gov, KDEP
bruce.ford@pad.pppo.gov, FRNP
bryan.smith@pad.pppo.gov, FRNP
dennis.greene@pad.pppo.gov, FRNP
frnpcorrespondence@pad.pppo.gov
jaime.morrow@pad.pppo.gov, FRNP
ken.davis@pad.pppo.gov, FRNP
lauren.linehan@ky.gov, KDEP
leo.williamson@ky.gov, KDEP
mary.evans@ky.gov, KDEP
megan.mulry@pad.pppo.gov, FRNP
myrna.redfield@pad.pppo.gov, FRNP
pad.rmc@pppo.gov
ryan.callihan@pppo.gov, PPPO
stephaniec.brock@ky.gov, KYRHB
tom.reed@pppo.gov, PPPO
victor.weeks@epa.gov EPA

CERTIFICATION

Document Identification: ***C-404 Hazardous Waste Landfill November 2024 Semiannual Groundwater Report (April 2024–September 2024), Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, FRNP-RPT-0343/V2, Permit No. KY8-890-008-982, Agency Interest ID No. 3059**

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision according to a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Four Rivers Nuclear Partnership, LLC

CHRISTOPHER LUCAS (Affiliate) Digitally signed by CHRISTOPHER LUCAS (Affiliate)
Date: 2024.11.13 13:15:42 -06'00'

Myrna E. Redfield, Program Manager/Date Signed
Four Rivers Nuclear Partnership, LLC

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision according to a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

U.S. Department of Energy

APRIL LADD Digitally signed by APRIL LADD
Date: 2024.11.21 09:39:24 -06'00'

April Ladd, Paducah Site Lead/Date Signed
Portsmouth/Paducah Project Office
U.S. Department of Energy

FRNP-RPT-0343/V2

C-404 Hazardous Waste Landfill November 2024 Semiannual Groundwater Report (April 2024–September 2024), Paducah Gaseous Diffusion Plant, Paducah, Kentucky

FOUR RIVERS NUCLEAR PARTNERSHIP, LLC

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C-404 Hazardous Waste Landfill November 2024 Semiannual Groundwater Report (April 2024–September 2024), Paducah Gaseous Diffusion Plant, Paducah, Kentucky

Date Issued—November 2024

U.S. DEPARTMENT OF ENERGY
Office of Environmental Management

Prepared by
FOUR RIVERS NUCLEAR PARTNERSHIP, LLC,
managing the
Deactivation and Remediation Project at the
Paducah Gaseous Diffusion Plant
under Contract DE-EM0004895

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CONTENTS

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ACRONYMS

AKGWA	Assembled Kentucky Groundwater
MW	monitoring well
RCRA	Resource Conservation and Recovery Act
RGA	Regional Gravel Aquifer
UCRS	Upper Continental Recharge System
URGA	Upper Regional Gravel Aquifer

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EXECUTIVE SUMMARY

This report, *C-404 Hazardous Waste Landfill November 2024 Semiannual Groundwater Report (April 2024–September 2024), Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* FRNP-RPT-0343/V2, is being submitted by the U.S. Department of Energy in accordance with requirements in Kentucky Division of Waste Management Hazardous Waste Management Facility Permit, KY8-890-008-982 (Permit). The period covered by this report is April 2024 through September 2024; and the report includes analytical data from the July 2024 semiannual sampling for all parameters of monitoring wells (MWs) located in the vicinity of the closed C-404 Hazardous Waste Landfill (C-404 Landfill).

The groundwater monitoring analytical data were subjected to statistical analyses. The statistical analyses were conducted in accordance with the Hazardous Waste Management Facility Permit. With the exception of trichloroethene (TCE) in compliance well MW84A and technetium-99 (Tc-99) observed in compliance wells MW84A and MW90A, the statistical tests on all other parameters showed no statistically significant differences above concentrations observed in background wells. TCE concentrations in compliance well MW84A and Tc-99 concentrations in compliance wells MW84A and MW90A showed statistically significant concentrations compared to concentrations observed in the background wells; however, the concentrations did not show increasing trends, so there are no confirmed TCE or Tc-99 exceedances attributable to C-404.

The leachate in the C-404 Landfill leachate collection system is monitored at least monthly and, at a minimum, is removed and sampled when the level exceeds 3 ft in depth. During this reporting period of April 2024 through September 2024, the depth of the leachate did not exceed 36 inches. The maximum leachate depth in this reporting period was 16 inches, which was recorded on August 8, 2024, and September 10, 2024. Because the depth of leachate did not exceed 36 inches, no leachate was removed from the sump or sampled.

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1. INTRODUCTION

This report contains the statistical evaluation of data from groundwater sampling and analysis for the closed C-404 Hazardous Waste Landfill (C-404 Landfill) at the U.S. Department of Energy Paducah Site (Paducah Site), Paducah, Kentucky. This semiannual report is required by the Kentucky Division of Waste Management Hazardous Waste Management Facility Permit, KY8-890-008-982 (Permit), Specific Condition II.K.6.d—Recordkeeping, Reporting, and Response (KDWM 2020). The period covered by this report is April 2024 through September 2024.

Groundwater analytical results are provided in Appendix A. The statistical analyses and qualification statement are provided in Appendix B. The annual groundwater flow rate and direction determination are provided in Appendix C.

1.1 BACKGROUND

The closed C-404 Landfill is located in the west-central portion of the Paducah Site secured area. The 1.2-acre facility operated as a surface impoundment from approximately 1952 until early 1957. During this time, influents to the impoundment originated from the C-400 Cleaning Building. In 1957, the impoundment was converted to a solid waste disposal facility for uranium-contaminated solid waste. When the impoundment was converted into a disposal facility, a sump was installed at the former weir to collect the leachate from the facility. Leachate is pumped from the sump, as needed, into a mobile tank. The leachate then is transferred to a permitted hazardous waste storage facility on-site prior to characterization; once characterized, the leachate is transferred off-site for treatment.

In 1986, the disposal of waste at the C-404 Landfill was halted, and a portion of the disposed-of waste was found to be Resource Conservation and Recovery Act (RCRA)-hazardous. The landfill was covered with a RCRA multilayered cap and certified closed in 1987. It currently is regulated under RCRA as a land disposal unit and compliance is monitored under the current Hazardous Waste Management Facility Permit (KDWM 2020).

Previous groundwater monitoring documented that concentrations of trichloroethene (TCE) found in compliance wells were statistically different from those found in background wells. The *C-404 Landfill Source Demonstration, Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, PRS-ENM-0031/R2, demonstrated that the source of TCE in compliance wells is not from the C-404 Landfill, but rather, the source is located upgradient/crossgradient of the C-404 Landfill (PRS 2007a).

Regional Gravel Aquifer (RGA) compliance monitoring well (MW) MW90 was abandoned and replaced by MW90A in 2001. RGA compliance well MW420 was installed in 2007 to better assess groundwater quality at the C-404 Landfill (PRS 2007b).

Previous groundwater monitoring of RGA compliance well MW87 documented that concentrations in the compliance well were statistically different from background wells for lead and uranium (FRNP 2018). The *C-404 Hazardous Waste Landfill Alternate Source Demonstration—Source of Lead and Uranium in MW87 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, concluded that the statistical differences were a result of infiltration of Upper Continental Recharge System (UCRS) groundwater into the RGA well due to compromised integrity of the well (FRNP 2019). The integrity of the well had deteriorated to a point that it no longer was suitable for its intended purpose. RGA compliance wells MW84, MW87, and background well MW93 were abandoned and replaced with MW84A, MW87A, and MW93A in 2019. RGA wells MW84 and MW93 were abandoned and replaced because they were the same age (installed in 1988) as

MW87. MW84A and MW87A were placed 10 ft north of MW84 and MW87, respectively, and screened at the same depth intervals. MW93A was placed 6 ft west of MW93 and screened at the same depth interval.

In the first semiannual reporting period for 2021 (October 2020–March 2021), statistical analysis of technetium-99 (Tc-99) detections in downgradient compliance well MW84A indicated a statistically significant exceedance over background concentrations. Notification of the statistically significant difference for Tc-99 in MW84A was submitted, pursuant to Part II, Specific Condition II.K.6.a, to the Kentucky Department of Waste Management.

An alternate source demonstration investigation for Tc-99 in MW84A was performed in June 2021. The *C-404 Hazardous Waste Landfill Alternate Source Demonstration—Source of Technetium-99 in MW84A at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, FRNP-RPT-0206, consisted of redevelopment and over pumping of MW84A, and review of the lines of evidence relating redevelopment of MW84A and the associated Tc-99 levels (FRNP 2021). The lines of evidence concluded that the observed trend of increasing Tc-99 in MW84A is not a result of contamination introduced into the well boring during drilling and well installation, but it is indicative of dissolved Tc-99 contamination in the RGA. Quarterly compliance monitoring for Tc-99 and other radionuclides was conducted at the C-404 Landfill through November 2022. The radionuclide statistics of the current semiannual report contains results from additional quarterly compliance sampling for radiological constituents conducted in November 2022, in addition to the routine semiannual groundwater sampling.

In accordance with Permit Specific Condition II.K.6.j, development and submittal of an engineering feasibility plan for a corrective action program is not required when a statistically significant exceedance has been confirmed for radionuclides (i.e., Tc-99).

1.2 MONITORING PERIOD ACTIVITIES

1.2.1 Groundwater Monitoring

There are nine MWs sampled under the Permit for the C-404 Landfill: four UCRS wells and five Upper Regional Gravel Aquifer (URGA) wells. A map of the MW locations is provided in Figure 1.

Table 1 presents the well number for URGA wells located upgradient and downgradient of the C-404 Landfill. Table 1 also presents the well numbers for the UCRS wells located in proximity to the URGA wells. This table refers to the UCRS wells as being adjacent to an upgradient or downgradient URGA well location and are identified relative to URGA groundwater flow direction. The conceptual model for the C-404 Landfill indicates that groundwater in the UCRS wells flows primarily vertically downward until it reaches the URGA; therefore, UCRS wells are not considered "upgradient" or "downgradient" of other UCRS wells in the area.

Table 1. Monitoring Well Locations

UCRS	
Located south of C-404 Landfill, adjacent to upgradient URGA background well MW93A	MW94
Located north of C-404 Landfill, adjacent to downgradient URGA compliance wells	MW85, MW88, MW91A*
URGA	
Upgradient background wells	MW93A*, MW420
Downgradient compliance wells	MW84A*, MW87A*, MW90A*

*MW90 was abandoned in 2001 and replaced with MW90A. MW91 was abandoned in 2017 and replaced with MW91A. MW84, MW87, and MW93 were abandoned in 2019 and replaced with MW84A, MW87A, and MW93A.

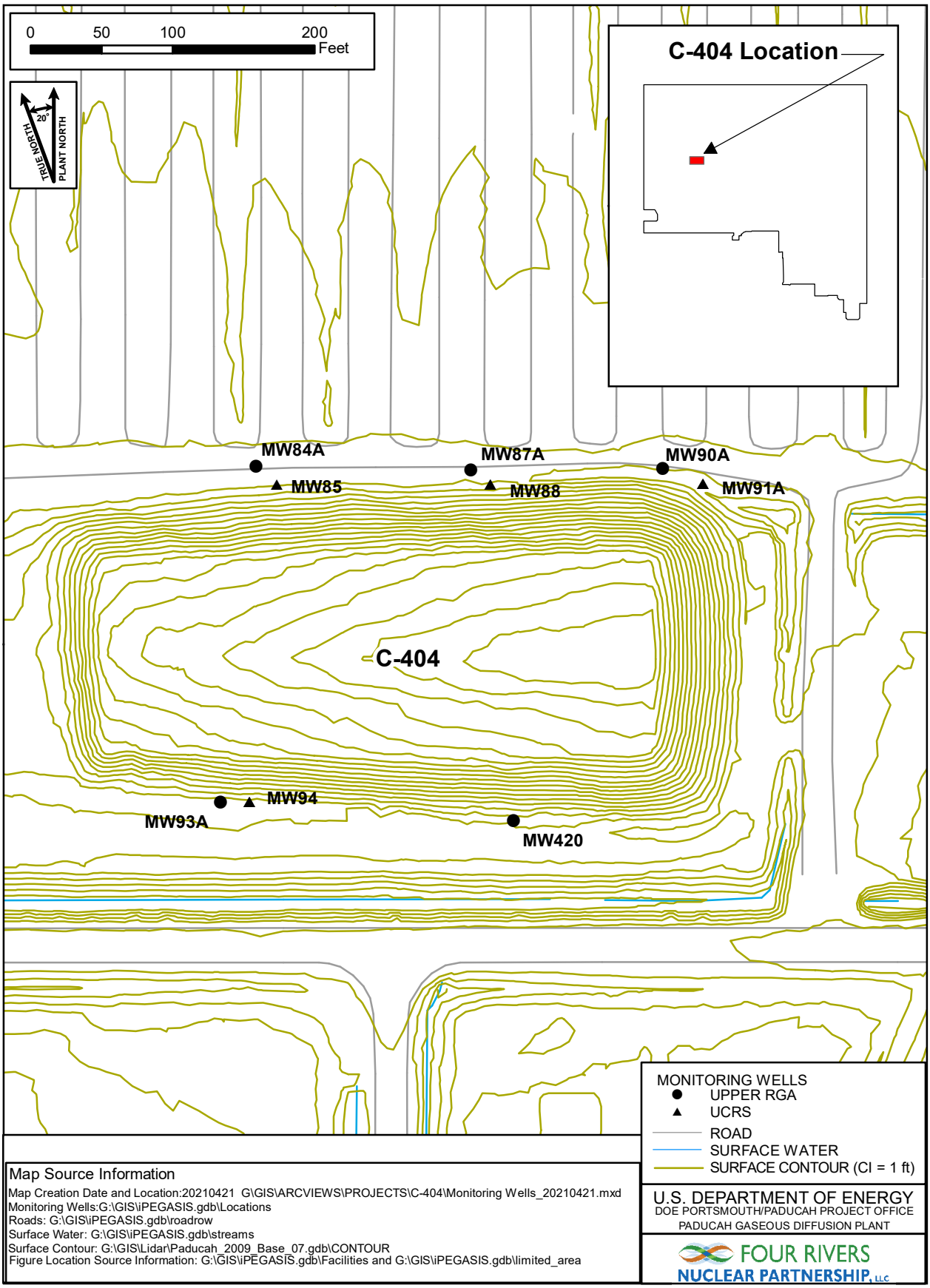

Figure 1. Monitoring Wells

Table 2 presents the Assembled Kentucky Groundwater (AKGWA) numbers for each MW.

Table 2. Assembled Kentucky Groundwater Numbers

Paducah Site Well Number	AKGWA Number
MW84A	8007-4849
MW85	8000-5234
MW87A	8007-4850
MW88	8000-5237
MW90A	8004-0357
MW91A	8007-2917
MW93A	8007-4851
MW94	8000-5103
MW420	8005-3263

All nine MWs were sampled in July 2024 during this reporting period. Samples collected in July 2024 were analyzed for the parameters that are required by Part VIII.E of the Permit. Groundwater sampling was conducted using procedure CP4-ES-2101, *Groundwater Sampling*. The appropriate sample containers and preservatives were used. The laboratory that performed the analyses used U.S. Environmental Protection Agency-approved methods, as applicable. Appendix A of this report contains the analytical results. Appendix B of this report contains the statistical analyses.

1.2.2 Landfill Leachate

In accordance with Appendix I2, C-404 Landfill Closure Plan (Section 1.2 of the Permit), the quantity of liquid in the leachate collection system is monitored (at least monthly) and, at a minimum, will be "removed when the quantity exceeds 36 inches in depth." Once the leachate depth reaches 36 inches, the leachate is pumped into a mobile tank. The leachate then is transferred to a permitted hazardous waste storage facility on-site prior to characterization; once characterized, the leachate is transferred off-site for treatment. During this reporting period (April 2024 through September 2024), the maximum depth of the leachate was 16 inches, measured on August 8, 2024, and September 10, 2024. Because the depth of the leachate has not exceeded 36 inches during any of the monthly monitoring events within the reporting period, no leachate was removed or sampled during this reporting period.

The annual leachate sump integrity test, as required by Section 1.2 of Appendix I2 of the Permit, was conducted between August 7, 2024, and September 10, 2024. Data was collected at a known depth at 1-hour increments to determine the change in leachate levels over time. Results of the integrity test were within normal limits.

2. STATISTICAL SYNOPSIS

The statistical analyses conducted on the data collected from the C-404 Landfill were performed in accordance with procedures in the Permit, Part VIII.E, reissued in February 2020. Appendix B of this report contains the statistical analyses performed for this reporting period. Statistical analyses utilized data from the URGA background wells, MW93A and MW420, and URGA compliance wells, MW84A, MW87A, and MW90A. Quarterly compliance monitoring groundwater sampling for radiological constituents was initiated during third quarter 2021 (July 2021) and concluded in November 2022. The additional quarters of groundwater data for radiological constituents alters the available data sets for the statistical analyses. For this reporting period, the data set includes nonradionuclide data from July–August 2022, January 2023, July 2023, January 2024, and July 2024. The reporting period data set for radionuclides includes November 2022, January 2023, July 2023, January 2024, and July 2024.

Appendix B provides a summary of the statistical analyses performed. The statistical test results on all wells and parameters showed no statistically significant exceedances above concentrations observed in the background wells with the exception of TCE in MW84A and Tc-99 in MW84A and MW90A. Concentrations of TCE in compliance well MW84A and concentrations of Tc-99 in MW84A and MW90A were statistically significant above concentrations observed in the background wells; however, the observed TCE and Tc-99 concentrations did not show increasing trends, so there are no confirmed Tc-99 or TCE exceedances attributable to C-404.

3. DATA VALIDATION AND QUALITY ASSURANCE/QUALITY CONTROL SUMMARY

The data and the data validation qualifiers for the July 2024 data sets are provided in Appendix A. All data for these data sets were considered useable as reported. Data validation was performed on the analytical data by an independent, third-party validator.

Field quality control samples are collected during each semiannual sampling event. Equipment rinseate blanks, field blanks, field duplicates, and trip blanks are obtained to ensure quality control and are reported in the analytical results in Appendix A. Laboratory quality control samples, such as matrix spikes, matrix spike duplicates, and method blanks, are performed by the laboratory and reported in the laboratory report. Both field and laboratory quality control sample results are reviewed as part of the data validation process.

4. PROFESSIONAL GEOLOGIST AUTHORIZATION

DOCUMENT IDENTIFICATION: *C-404 Hazardous Waste Landfill*
November 2024 Semiannual Groundwater Report
(April 2024–September 2024),
Paducah Gaseous Diffusion Plant, Paducah, Kentucky
(FRNP-RPT-0343/V2)

Stamped and signed pursuant to my authority as a duly registered geologist under the provisions of *KRS* Chapter 322A.

PG113927
KDavis 11-13-2024

Kenneth R. Davis
Kenneth R. Davis

PG113927

November 13, 2024
Date

5. REFERENCES

FRNP (Four Rivers Nuclear Partnership, LLC) 2018. *C-404 Hazardous Waste Landfill November 2018 Semiannual Groundwater Report (April 2018—September 2018), Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, FRNP-RPT-0026/V2, U.S. Department of Energy, Paducah, KY, November.

FRNP 2019. *C-404 Hazardous Waste Landfill Alternate Source Demonstration—Source of Lead and Uranium in MW87 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, FRNP-RPT-0078, Four Rivers Nuclear Partnership, LLC, Paducah, KY, February.

FRNP 2021. *C-404 Hazardous Waste Landfill Alternate Source Demonstration—Source of Technetium-99 in MW84A at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, FRNP-RPT-0206, Four Rivers Nuclear Partnership, LLC, Paducah, KY, August.

KDWM (Kentucky Division of Waste Management) 2020. Hazardous Waste Management Facility Permit for the U.S. Department of Energy, Paducah Gaseous Diffusion Plant, KY8-890-008-982, effective February 21.

PRS (Paducah Remediation Services, LLC) 2007a. *C-404 Landfill Source Demonstration Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, PRS-ENM-0031/R2, Paducah Remediation Services, LLC, Kevil, KY, August.

PRS 2007b. *Well Plan for Addition of Wells for C-404 Monitoring Well Network, Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, PRS/PROJ/0028, Paducah Remediation Services, LLC, Kevil, KY, July.

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APPENDIX A

C-404 HAZARDOUS WASTE LANDFILL GROUNDWATER ANALYTICAL RESULTS

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Paducah OREIS
GROUNDWATER MONITORING REPORT

Facility: C-404 Landfill **County:** McCracken **Permit #:** KY8-890-008-982

Sampling Point: MW84A REG Downgradient URGA **Period:** Semiannual Report

AKGWA Well Tag #: 8007-4849

Parameter	Qualifier	Result	Units	Reporting Limit	Date Collected	Counting Error (+/-)	TPU	Method	Validation
Arsenic		0.0334	mg/L	0.03	7/9/2024			SW846-6010D	J
		0.037	mg/L	0.005	7/9/2024			SW846-6020B	=
Arsenic, Dissolved		0.0289	mg/L	0.005	7/9/2024			SW846-6020B	J
	J	0.0232	mg/L	0.03	7/9/2024			SW846-6010D	J
Barometric Pressure Reading		29.9	Inches/Hg		7/9/2024				X
Cadmium	U	0.001	mg/L	0.001	7/9/2024			SW846-6020B	=
Cadmium, Dissolved	U	0.001	mg/L	0.001	7/9/2024			SW846-6020B	UJ
Chromium	U	0.01	mg/L	0.01	7/9/2024			SW846-6020B	=
Chromium, Dissolved	U	0.01	mg/L	0.01	7/9/2024			SW846-6020B	UJ
Conductivity		466	µmhos/cm		7/9/2024				X
Depth to Water		51.01	ft		7/9/2024				X
Dissolved Oxygen		4.09	mg/L		7/9/2024				X
Eh (approx)		450	mV		7/9/2024				X
Lead	U	0.002	mg/L	0.002	7/9/2024			SW846-6020B	=
Lead, Dissolved	U	0.002	mg/L	0.002	7/9/2024			SW846-6020B	UJ
Mercury	U	0.0002	mg/L	0.0002	7/9/2024			SW846-7470A	UJ
Mercury, Dissolved	U	0.0002	mg/L	0.0002	7/9/2024			SW846-7470A	UJ
pH		5.81	Std Unit		7/9/2024				X
Selenium	U	0.005	mg/L	0.005	7/9/2024			SW846-6020B	=
Selenium, Dissolved	U	0.005	mg/L	0.005	7/9/2024			SW846-6020B	UJ
Sulfate		7.46	mg/L	0.4	7/9/2024			SW846-9056A	=
Technetium-99		80	pCi/L	21.1	7/9/2024	14.5	17.1	HASL 300, Tc-02-RC M	=
Temperature		66	deg F		7/9/2024				X
Trichloroethene		5110	ug/L	100	7/9/2024			SW846-8260D	=
Turbidity		9.89	NTU		7/9/2024				X
Uranium	U	0.0002	mg/L	0.0002	7/9/2024			SW846-6020B	=
Uranium-234	U	-0.238	pCi/L	1.35	7/9/2024	0.48	0.48	HASL 300, U-02-RC M	=
Uranium-235	U	0.00781	pCi/L	1.29	7/9/2024	0.579	0.579	HASL 300, U-02-RC M	=
Uranium-238	U	0.126	pCi/L	1.11	7/9/2024	0.566	0.567	HASL 300, U-02-RC M	=

Paducah OREIS
GROUNDWATER MONITORING REPORT

Facility: C-404 Landfill **County:** McCracken **Permit #:** KY8-890-008-982

Sampling Point: MW84A FR Downgradient URGA **Period:** Semiannual Report

AKGWA Well Tag #: 8007-4849

Parameter	Qualifier	Result	Units	Reporting Limit	Date Collected	Counting Error (+/-)	TPU	Method	Validation
Arsenic		0.0355	mg/L	0.03	7/9/2024			SW846-6010D	J
		0.0379	mg/L	0.005	7/9/2024			SW846-6020B	=
Arsenic, Dissolved	J	0.0283	mg/L	0.03	7/9/2024			SW846-6010D	J
		0.0286	mg/L	0.005	7/9/2024			SW846-6020B	J
Cadmium	U	0.001	mg/L	0.001	7/9/2024			SW846-6020B	=
Cadmium, Dissolved	U	0.001	mg/L	0.001	7/9/2024			SW846-6020B	UJ
Chromium	U	0.01	mg/L	0.01	7/9/2024			SW846-6020B	=
Chromium, Dissolved	U	0.01	mg/L	0.01	7/9/2024			SW846-6020B	UJ
Lead	U	0.002	mg/L	0.002	7/9/2024			SW846-6020B	=
Lead, Dissolved	U	0.002	mg/L	0.002	7/9/2024			SW846-6020B	UJ
Mercury	U	0.0002	mg/L	0.0002	7/9/2024			SW846-7470A	UJ
Mercury, Dissolved	U	0.0002	mg/L	0.0002	7/9/2024			SW846-7470A	UJ
Selenium	U	0.005	mg/L	0.005	7/9/2024			SW846-6020B	=
Selenium, Dissolved	U	0.005	mg/L	0.005	7/9/2024			SW846-6020B	UJ
Sulfate		7.22	mg/L	0.4	7/9/2024			SW846-9056A	=
Technetium-99		93.5	pCi/L	21.5	7/9/2024	15.1	18.4	HASL 300, Tc-02-RC M	=
Trichloroethene		4560	ug/L	100	7/9/2024			SW846-8260D	=
Uranium	U	0.0002	mg/L	0.0002	7/9/2024			SW846-6020B	=
Uranium-234	U	0.0157	pCi/L	1.11	7/9/2024	0.504	0.505	HASL 300, U-02-RC M	=
Uranium-235	U	-0.0425	pCi/L	0.848	7/9/2024	0.366	0.367	HASL 300, U-02-RC M	=
Uranium-238	U	0.47	pCi/L	0.875	7/9/2024	0.642	0.645	HASL 300, U-02-RC M	=

Paducah OREIS
GROUNDWATER MONITORING REPORT

Facility: C-404 Landfill **County:** McCracken **Permit #:** KY8-890-008-982

Sampling Point: MW85 REG Downgradient UCRS **Period:** Semiannual Report

AKGWA Well Tag #: 8000-5234

Parameter	Qualifier	Result	Units	Reporting Limit	Date Collected	Counting Error (+/-)	TPU	Method	Validation
Arsenic		0.00591	mg/L	0.005	7/11/2024			SW846-6020B	=
	U	0.03	mg/L	0.03	7/11/2024			SW846-6010D	=
Arsenic, Dissolved		0.00598	mg/L	0.005	7/11/2024			SW846-6020B	J
	U	0.03	mg/L	0.03	7/11/2024			SW846-6010D	UJ
Barometric Pressure Reading		30.06	Inches/Hg		7/11/2024				X
Cadmium	U	0.001	mg/L	0.001	7/11/2024			SW846-6020B	=
Cadmium, Dissolved	U	0.001	mg/L	0.001	7/11/2024			SW846-6020B	UJ
Chromium	J	0.00485	mg/L	0.01	7/11/2024			SW846-6020B	=
Chromium, Dissolved	J	0.00364	mg/L	0.01	7/11/2024			SW846-6020B	J
Conductivity		317	µmhos/cm		7/11/2024				X
Depth to Water		10.73	ft		7/11/2024				X
Dissolved Oxygen		3.9	mg/L		7/11/2024				X
Eh (approx)		437	mV		7/11/2024				X
Lead	U	0.002	mg/L	0.002	7/11/2024			SW846-6020B	=
Lead, Dissolved	U	0.002	mg/L	0.002	7/11/2024			SW846-6020B	UJ
Mercury	U	0.0002	mg/L	0.0002	7/11/2024			SW846-7470A	=
Mercury, Dissolved	U	0.0002	mg/L	0.0002	7/11/2024			SW846-7470A	UJ
pH		6.11	Std Unit		7/11/2024				X
Selenium	U	0.005	mg/L	0.005	7/11/2024			SW846-6020B	=
Selenium, Dissolved	U	0.005	mg/L	0.005	7/11/2024			SW846-6020B	UJ
Sulfate		10.7	mg/L	0.4	7/11/2024			SW846-9056A	=
Technetium-99		43	pCi/L	20.6	7/11/2024	13.2	14.1	HASL 300, Tc-02-RC M	=
Temperature		69.4	deg F		7/11/2024				X
Trichloroethene	J	0.58	ug/L	1	7/11/2024			SW846-8260D	=
Turbidity		15.61	NTU		7/11/2024				X
Uranium		0.000542	mg/L	0.0002	7/11/2024			SW846-6020B	=
Uranium-234	U	0.373	pCi/L	1.14	7/11/2024	0.671	0.674	HASL 300, U-02-RC M	=
Uranium-235	U	0.118	pCi/L	0.743	7/11/2024	0.442	0.442	HASL 300, U-02-RC M	=
Uranium-238	U	0.381	pCi/L	0.826	7/11/2024	0.565	0.567	HASL 300, U-02-RC M	=

Paducah OREIS
GROUNDWATER MONITORING REPORT

Facility: C-404 Landfill **County:** McCracken **Permit #:** KY8-890-008-982

Sampling Point: MW87A REG Downgradient URGA **Period:** Semiannual Report

AKGWA Well Tag #: 8007-4850

Parameter	Qualifier	Result	Units	Reporting Limit	Date Collected	Counting Error (+/-)	TPU	Method	Validation
Arsenic	U	0.03	mg/L	0.03	7/9/2024			SW846-6010D	UJ
		0.0078	mg/L	0.005	7/9/2024			SW846-6020B	=
Arsenic, Dissolved	U	0.03	mg/L	0.03	7/9/2024			SW846-6010D	UJ
		0.00567	mg/L	0.005	7/9/2024			SW846-6020B	J
Barometric Pressure Reading		29.88	Inches/Hg		7/9/2024				X
Cadmium	U	0.001	mg/L	0.001	7/9/2024			SW846-6020B	=
Cadmium, Dissolved	U	0.001	mg/L	0.001	7/9/2024			SW846-6020B	UJ
Chromium	U	0.01	mg/L	0.01	7/9/2024			SW846-6020B	=
Chromium, Dissolved	U	0.01	mg/L	0.01	7/9/2024			SW846-6020B	UJ
Conductivity		337	µmhos/cm		7/9/2024				X
Depth to Water		51.07	ft		7/9/2024				X
Dissolved Oxygen		3.62	mg/L		7/9/2024				X
Eh (approx)		413	mV		7/9/2024				X
Lead	U	0.002	mg/L	0.002	7/9/2024			SW846-6020B	=
Lead, Dissolved	U	0.002	mg/L	0.002	7/9/2024			SW846-6020B	UJ
Mercury	U	0.0002	mg/L	0.0002	7/9/2024			SW846-7470A	UJ
Mercury, Dissolved	U	0.0002	mg/L	0.0002	7/9/2024			SW846-7470A	UJ
pH		5.78	Std Unit		7/9/2024				X
Selenium	U	0.005	mg/L	0.005	7/9/2024			SW846-6020B	=
Selenium, Dissolved	U	0.005	mg/L	0.005	7/9/2024			SW846-6020B	UJ
Sulfate		6.57	mg/L	0.4	7/9/2024			SW846-9056A	=
Technetium-99	U	14.2	pCi/L	19.6	7/9/2024	11.8	11.9	HASL 300, Tc-02-RC M	=
Temperature		64.9	deg F		7/9/2024				X
Trichloroethene		1000	ug/L	50	7/9/2024			SW846-8260D	=
Turbidity		2.34	NTU		7/9/2024				X
Uranium	U	0.0002	mg/L	0.0002	7/9/2024			SW846-6020B	=
Uranium-234	U	0.0601	pCi/L	1.26	7/9/2024	0.6	0.6	HASL 300, U-02-RC M	=
Uranium-235	U	-0.0865	pCi/L	0.998	7/9/2024	0.382	0.383	HASL 300, U-02-RC M	=
Uranium-238	U	0.7	pCi/L	1.02	7/9/2024	0.774	0.78	HASL 300, U-02-RC M	=

Paducah OREIS
GROUNDWATER MONITORING REPORT

Facility: C-404 Landfill **County:** McCracken **Permit #:** KY8-890-008-982

Sampling Point: MW88 REG Downgradient UCRS **Period:** Semiannual Report

AKGWA Well Tag #: 8000-5237

Parameter	Qualifier	Result	Units	Reporting Limit	Date Collected	Counting Error (+/-)	TPU	Method	Validation
Arsenic		0.00735	mg/L	0.005	7/11/2024			SW846-6020B	=
	U	0.03	mg/L	0.03	7/11/2024			SW846-6010D	=
Arsenic, Dissolved		0.00605	mg/L	0.005	7/11/2024			SW846-6020B	J
	U	0.03	mg/L	0.03	7/11/2024			SW846-6010D	UJ
Barometric Pressure Reading		30.06	Inches/Hg		7/11/2024				X
Cadmium	U	0.001	mg/L	0.001	7/11/2024			SW846-6020B	=
Cadmium, Dissolved	U	0.001	mg/L	0.001	7/11/2024			SW846-6020B	UJ
Chromium	U	0.01	mg/L	0.01	7/11/2024			SW846-6020B	=
Chromium, Dissolved	U	0.01	mg/L	0.01	7/11/2024			SW846-6020B	UJ
Conductivity		593	µmhos/cm		7/11/2024				X
Depth to Water		10.11	ft		7/11/2024				X
Dissolved Oxygen		0.83	mg/L		7/11/2024				X
Eh (approx)		400	mV		7/11/2024				X
Lead	U	0.002	mg/L	0.002	7/11/2024			SW846-6020B	=
Lead, Dissolved	U	0.002	mg/L	0.002	7/11/2024			SW846-6020B	UJ
Mercury	J	0.000071	mg/L	0.0002	7/11/2024			SW846-7470A	=
Mercury, Dissolved	U	0.0002	mg/L	0.0002	7/11/2024			SW846-7470A	UJ
pH		5.81	Std Unit		7/11/2024				X
Selenium	U	0.005	mg/L	0.005	7/11/2024			SW846-6020B	=
Selenium, Dissolved	U	0.005	mg/L	0.005	7/11/2024			SW846-6020B	UJ
Sulfate		97.3	mg/L	4	7/11/2024			SW846-9056A	=
Technetium-99	U	14.7	pCi/L	20.7	7/11/2024	12.4	12.5	HASL 300, Tc-02-RC M	=
Temperature		69	deg F		7/11/2024				X
Trichloroethene		1.2	ug/L	1	7/11/2024			SW846-8260D	=
Turbidity		101	NTU		7/11/2024				X
Uranium	J	0.000099	mg/L	0.0002	7/11/2024			SW846-6020B	=
Uranium-234	U	0.48	pCi/L	1.06	7/11/2024	0.699	0.704	HASL 300, U-02-RC M	=
Uranium-235	U	-0.0426	pCi/L	0.851	7/11/2024	0.367	0.368	HASL 300, U-02-RC M	=
Uranium-238	U	0.0115	pCi/L	1.16	7/11/2024	0.528	0.528	HASL 300, U-02-RC M	=

Paducah OREIS
GROUNDWATER MONITORING REPORT

Facility: C-404 Landfill **County:** McCracken **Permit #:** KY8-890-008-982

Sampling Point: MW90A REG Downgradient URGA **Period:** Semiannual Report

AKGWA Well Tag #: 8004-0357

Parameter	Qualifier	Result	Units	Reporting Limit	Date Collected	Counting Error (+/-)	TPU	Method	Validation
Arsenic	J	0.00327	mg/L	0.005	7/9/2024			SW846-6020B	=
	U	0.03	mg/L	0.03	7/9/2024			SW846-6010D	UJ
Arsenic, Dissolved	U	0.03	mg/L	0.03	7/9/2024			SW846-6010D	UJ
	J	0.00244	mg/L	0.005	7/9/2024			SW846-6020B	J
Barometric Pressure Reading		29.86	Inches/Hg		7/9/2024				X
Cadmium	U	0.001	mg/L	0.001	7/9/2024			SW846-6020B	=
Cadmium, Dissolved	U	0.001	mg/L	0.001	7/9/2024			SW846-6020B	UJ
Chromium	U	0.01	mg/L	0.01	7/9/2024			SW846-6020B	=
Chromium, Dissolved	U	0.01	mg/L	0.01	7/9/2024			SW846-6020B	UJ
Conductivity		229	µmhos/cm		7/9/2024				X
Depth to Water		50.31	ft		7/9/2024				X
Dissolved Oxygen		4.81	mg/L		7/9/2024				X
Eh (approx)		408	mV		7/9/2024				X
Lead	U	0.002	mg/L	0.002	7/9/2024			SW846-6020B	=
Lead, Dissolved	U	0.002	mg/L	0.002	7/9/2024			SW846-6020B	UJ
Mercury	U	0.0002	mg/L	0.0002	7/9/2024			SW846-7470A	UJ
Mercury, Dissolved	U	0.0002	mg/L	0.0002	7/9/2024			SW846-7470A	UJ
pH		5.77	Std Unit		7/9/2024				X
Selenium	U	0.005	mg/L	0.005	7/9/2024			SW846-6020B	=
Selenium, Dissolved	U	0.005	mg/L	0.005	7/9/2024			SW846-6020B	UJ
Sulfate		4.06	mg/L	0.4	7/9/2024			SW846-9056A	=
Technetium-99		45.3	pCi/L	20.2	7/9/2024	13.1	14	HASL 300, Tc-02-RC M	=
Temperature		67.2	deg F		7/9/2024				X
Trichloroethene		177	ug/L	5	7/9/2024			SW846-8260D	=
Turbidity		8.25	NTU		7/9/2024				X
Uranium	U	0.0002	mg/L	0.0002	7/9/2024			SW846-6020B	=
Uranium-234	U	0.26	pCi/L	1.42	7/9/2024	0.763	0.765	HASL 300, U-02-RC M	=
Uranium-235	U	0.364	pCi/L	0.993	7/9/2024	0.716	0.718	HASL 300, U-02-RC M	=
Uranium-238	U	0.174	pCi/L	1.1	7/9/2024	0.595	0.596	HASL 300, U-02-RC M	=

Paducah OREIS
GROUNDWATER MONITORING REPORT

Facility: C-404 Landfill **County:** McCracken **Permit #:** KY8-890-008-982

Sampling Point: MW91A REG Downgradient UCRS **Period:** Semiannual Report

AKGWA Well Tag #: 8007-2917

Parameter	Qualifier	Result	Units	Reporting Limit	Date Collected	Counting Error (+/-)	TPU	Method	Validation
Arsenic		0.00625	mg/L	0.005	7/11/2024			SW846-6020B	=
	U	0.03	mg/L	0.03	7/11/2024			SW846-6010D	=
Arsenic, Dissolved	U	0.03	mg/L	0.03	7/11/2024			SW846-6010D	UJ
	J	0.00453	mg/L	0.005	7/11/2024			SW846-6020B	J
Barometric Pressure Reading		30.06	Inches/Hg		7/11/2024				X
Cadmium	U	0.001	mg/L	0.001	7/11/2024			SW846-6020B	=
Cadmium, Dissolved	U	0.001	mg/L	0.001	7/11/2024			SW846-6020B	UJ
Chromium	U	0.01	mg/L	0.01	7/11/2024			SW846-6020B	=
Chromium, Dissolved	U	0.01	mg/L	0.01	7/11/2024			SW846-6020B	UJ
Conductivity		777	µmhos/cm		7/11/2024				X
Depth to Water		13.41	ft		7/11/2024				X
Dissolved Oxygen		0.27	mg/L		7/11/2024				X
Eh (approx)		278	mV		7/11/2024				X
Lead	U	0.002	mg/L	0.002	7/11/2024			SW846-6020B	=
Lead, Dissolved	U	0.002	mg/L	0.002	7/11/2024			SW846-6020B	UJ
Mercury	U	0.0002	mg/L	0.0002	7/11/2024			SW846-7470A	=
Mercury, Dissolved	U	0.0002	mg/L	0.0002	7/11/2024			SW846-7470A	UJ
pH		6.04	Std Unit		7/11/2024				X
Selenium	U	0.005	mg/L	0.005	7/11/2024			SW846-6020B	=
Selenium, Dissolved	U	0.005	mg/L	0.005	7/11/2024			SW846-6020B	UJ
Sulfate		72.5	mg/L	2	7/11/2024			SW846-9056A	=
Technetium-99		137	pCi/L	20.1	7/11/2024	15.4	21.7	HASL 300, Tc-02-RC M	=
Temperature		66.7	deg F		7/11/2024				X
Trichloroethene		16.5	ug/L	1	7/11/2024			SW846-8260D	=
Turbidity		83.62	NTU		7/11/2024				X
Uranium	U	0.0002	mg/L	0.0002	7/11/2024			SW846-6020B	=
Uranium-234	U	0.822	pCi/L	0.913	7/11/2024	0.754	0.764	HASL 300, U-02-RC M	=
Uranium-235	U	0	pCi/L	0.472	7/11/2024	0.317	0.318	HASL 300, U-02-RC M	=
Uranium-238	U	0.448	pCi/L	0.705	7/11/2024	0.568	0.57	HASL 300, U-02-RC M	=

Paducah OREIS
GROUNDWATER MONITORING REPORT

Facility: C-404 Landfill **County:** McCracken **Permit #:** KY8-890-008-982

Sampling Point: MW93A REG Upgradient URGA **Period:** Semiannual Report

AKGWA Well Tag #: 8007-4851

Parameter	Qualifier	Result	Units	Reporting Limit	Date Collected	Counting Error (+/-)	TPU	Method	Validation
Arsenic		0.00739	mg/L	0.005	7/9/2024			SW846-6020B	=
	J	0.0068	mg/L	0.03	7/9/2024			SW846-6010D	J
Arsenic, Dissolved	J	0.00504	mg/L	0.03	7/9/2024			SW846-6010D	J
		0.00542	mg/L	0.005	7/9/2024			SW846-6020B	J
Barometric Pressure Reading		29.71	Inches/Hg		7/9/2024				X
Cadmium	U	0.001	mg/L	0.001	7/9/2024			SW846-6020B	=
Cadmium, Dissolved	U	0.001	mg/L	0.001	7/9/2024			SW846-6020B	UJ
Chromium	U	0.01	mg/L	0.01	7/9/2024			SW846-6020B	=
Chromium, Dissolved	U	0.01	mg/L	0.01	7/9/2024			SW846-6020B	UJ
Conductivity		353	µmhos/cm		7/9/2024				X
Depth to Water		54.04	ft		7/9/2024				X
Dissolved Oxygen		2.7	mg/L		7/9/2024				X
Eh (approx)		403	mV		7/9/2024				X
Lead	U	0.002	mg/L	0.002	7/9/2024			SW846-6020B	=
Lead, Dissolved	U	0.002	mg/L	0.002	7/9/2024			SW846-6020B	UJ
Mercury	U	0.0002	mg/L	0.0002	7/9/2024			SW846-7470A	UJ
Mercury, Dissolved	U	0.0002	mg/L	0.0002	7/9/2024			SW846-7470A	UJ
pH		5.8	Std Unit		7/9/2024				X
Selenium	U	0.005	mg/L	0.005	7/9/2024			SW846-6020B	=
Selenium, Dissolved	U	0.005	mg/L	0.005	7/9/2024			SW846-6020B	UJ
Sulfate		7.49	mg/L	0.4	7/9/2024			SW846-9056A	=
Technetium-99	U	9.87	pCi/L	19.9	7/9/2024	11.8	11.9	HASL 300, Tc-02-RC M	=
Temperature		69.9	deg F		7/9/2024				X
Trichloroethene		554	ug/L	50	7/9/2024			SW846-8260D	=
Turbidity		2.48	NTU		7/9/2024				X
Uranium	U	0.0002	mg/L	0.0002	7/9/2024			SW846-6020B	=
Uranium-234	U	0.00359	pCi/L	2.14	7/9/2024	0.958	0.96	HASL 300, U-02-RC M	=
Uranium-235	U	0.213	pCi/L	2.27	7/9/2024	1.18	1.19	HASL 300, U-02-RC M	=
Uranium-238	U	-0.0796	pCi/L	1.59	7/9/2024	0.687	0.689	HASL 300, U-02-RC M	=

Paducah OREIS
GROUNDWATER MONITORING REPORT

Facility: C-404 Landfill **County:** McCracken **Permit #:** KY8-890-008-982

Sampling Point: MW94 REG Upgradient UCRS **Period:** Semiannual Report

AKGWA Well Tag #: 8000-5103

Parameter	Qualifier	Result	Units	Reporting Limit	Date Collected	Counting Error (+/-)	TPU	Method	Validation
Arsenic	J	0.00248	mg/L	0.005	7/11/2024			SW846-6020B	=
	U	0.03	mg/L	0.03	7/11/2024			SW846-6010D	=
Arsenic, Dissolved	U	0.005	mg/L	0.005	7/11/2024			SW846-6020B	UJ
	U	0.03	mg/L	0.03	7/11/2024			SW846-6010D	UJ
Barometric Pressure Reading		30.06	Inches/Hg		7/11/2024				X
Cadmium	U	0.001	mg/L	0.001	7/11/2024			SW846-6020B	=
Cadmium, Dissolved	U	0.001	mg/L	0.001	7/11/2024			SW846-6020B	UJ
Chromium	J	0.00551	mg/L	0.01	7/11/2024			SW846-6020B	=
Chromium, Dissolved	U	0.01	mg/L	0.01	7/11/2024			SW846-6020B	UJ
Conductivity		731	µmhos/cm		7/11/2024				X
Depth to Water		14.4	ft		7/11/2024				X
Dissolved Oxygen		1.34	mg/L		7/11/2024				X
Eh (approx)		292	mV		7/11/2024				X
Lead	U	0.002	mg/L	0.002	7/11/2024			SW846-6020B	=
Lead, Dissolved	U	0.002	mg/L	0.002	7/11/2024			SW846-6020B	UJ
Mercury	U	0.0002	mg/L	0.0002	7/11/2024			SW846-7470A	=
Mercury, Dissolved	U	0.0002	mg/L	0.0002	7/11/2024			SW846-7470A	UJ
pH		6.22	Std Unit		7/11/2024				X
Selenium	U	0.005	mg/L	0.005	7/11/2024			SW846-6020B	=
Selenium, Dissolved	U	0.005	mg/L	0.005	7/11/2024			SW846-6020B	UJ
Sulfate		62.5	mg/L	2	7/11/2024			SW846-9056A	=
Technetium-99		2150	pCi/L	22.2	7/11/2024	44.9	243	HASL 300, Tc-02-RC M	=
Temperature		68.4	deg F		7/11/2024				X
Trichloroethene		1.55	ug/L	1	7/11/2024			SW846-8260D	=
Turbidity		19.24	NTU		7/11/2024				X
Uranium		0.00104	mg/L	0.0002	7/11/2024			SW846-6020B	=
Uranium-234	U	-0.0364	pCi/L	1.88	7/11/2024	0.821	0.822	HASL 300, U-02-RC M	=
Uranium-235	U	0.441	pCi/L	1.57	7/11/2024	0.996	0.998	HASL 300, U-02-RC M	=
Uranium-238	U	0.601	pCi/L	1.68	7/11/2024	1.05	1.05	HASL 300, U-02-RC M	=

Paducah OREIS
GROUNDWATER MONITORING REPORT

Facility: C-404 Landfill **County:** McCracken **Permit #:** KY8-890-008-982

Sampling Point: MW420 REG Upgradient URGA **Period:** Semiannual Report

AKGWA Well Tag #: 8005-3263

Parameter	Qualifier	Result	Units	Reporting Limit	Date Collected	Counting Error (+/-)	TPU	Method	Validation
Arsenic	J	0.013	mg/L	0.03	7/9/2024			SW846-6010D	J
		0.0135	mg/L	0.005	7/9/2024			SW846-6020B	=
Arsenic, Dissolved		0.00953	mg/L	0.005	7/9/2024			SW846-6020B	J
	U	0.03	mg/L	0.03	7/9/2024			SW846-6010D	UJ
Barometric Pressure Reading		29.77	Inches/Hg		7/9/2024				X
Cadmium	U	0.001	mg/L	0.001	7/9/2024			SW846-6020B	=
Cadmium, Dissolved	U	0.001	mg/L	0.001	7/9/2024			SW846-6020B	UJ
Chromium	U	0.01	mg/L	0.01	7/9/2024			SW846-6020B	=
Chromium, Dissolved	U	0.01	mg/L	0.01	7/9/2024			SW846-6020B	UJ
Conductivity		388	µmhos/cm		7/9/2024				X
Depth to Water		53.72	ft		7/9/2024				X
Dissolved Oxygen		1.68	mg/L		7/9/2024				X
Eh (approx)		418	mV		7/9/2024				X
Lead	U	0.002	mg/L	0.002	7/9/2024			SW846-6020B	=
Lead, Dissolved	U	0.002	mg/L	0.002	7/9/2024			SW846-6020B	UJ
Mercury	U	0.0002	mg/L	0.0002	7/9/2024			SW846-7470A	UJ
Mercury, Dissolved	U	0.0002	mg/L	0.0002	7/9/2024			SW846-7470A	UJ
pH		5.74	Std Unit		7/9/2024				X
Selenium	U	0.005	mg/L	0.005	7/9/2024			SW846-6020B	=
Selenium, Dissolved	U	0.005	mg/L	0.005	7/9/2024			SW846-6020B	UJ
Sulfate		6.25	mg/L	0.4	7/9/2024			SW846-9056A	=
Technetium-99	U	7.33	pCi/L	19.6	7/9/2024	11.6	11.6	HASL 300, Tc-02-RC M	=
Temperature		70.6	deg F		7/9/2024				X
Trichloroethene		1790	ug/L	50	7/9/2024			SW846-8260D	=
Turbidity		5.74	NTU		7/9/2024				X
Uranium	U	0.0002	mg/L	0.0002	7/9/2024			SW846-6020B	=
Uranium-234	U	-0.146	pCi/L	2.28	7/9/2024	0.961	0.962	HASL 300, U-02-RC M	=
Uranium-235	U	0.0905	pCi/L	1.97	7/9/2024	0.946	0.948	HASL 300, U-02-RC M	=
Uranium-238	U	0.46	pCi/L	1.25	7/9/2024	0.905	0.908	HASL 300, U-02-RC M	=

Paducah OREIS
GROUNDWATER MONITORING REPORT

Facility: C-404 Landfill **County:** McCracken **Permit #:** KY8-890-008-982

Type of Sample: FB **Period:** Semiannual Report QC Samples

AKGWA Well Tag #: 0000-0000

Parameter	Qualifier	Result	Units	Reporting Limit	Date Collected	Counting Error (+/-)	TPU	Method	Validation
Arsenic	U	0.005	mg/L	0.005	7/9/2024			SW846-6020B	=
	U	0.03	mg/L	0.03	7/9/2024			SW846-6010D	UJ
Cadmium	U	0.001	mg/L	0.001	7/9/2024			SW846-6020B	=
Chromium	U	0.01	mg/L	0.01	7/9/2024			SW846-6020B	=
Lead	U	0.002	mg/L	0.002	7/9/2024			SW846-6020B	=
Mercury	U	0.0002	mg/L	0.0002	7/9/2024			SW846-7470A	UJ
Selenium	U	0.005	mg/L	0.005	7/9/2024			SW846-6020B	=
Technetium-99	U	7.71	pCi/L	19	7/9/2024	11.2	11.3	HASL 300, Tc-02-RC M	=
Trichloroethene	U	1	ug/L	1	7/9/2024			SW846-8260D	=
Uranium	U	0.0002	mg/L	0.0002	7/9/2024			SW846-6020B	=
Uranium-234	U	0.42	pCi/L	1.44	7/9/2024	0.827	0.83	HASL 300, U-02-RC M	=
Uranium-235	U	0.0985	pCi/L	1.05	7/9/2024	0.547	0.548	HASL 300, U-02-RC M	=
Uranium-238	U	0.386	pCi/L	0.849	7/9/2024	0.614	0.616	HASL 300, U-02-RC M	=

Paducah OREIS
GROUNDWATER MONITORING REPORT

Facility: C-404 Landfill **County:** McCracken **Permit #:** KY8-890-008-982

Type of Sample: RI **Period:** Semiannual Report QC Samples

AKGWA Well Tag #: 0000-0000

Parameter	Qualifier	Result	Units	Reporting Limit	Date Collected	Counting Error (+/-)	TPU	Method	Validation
Arsenic	U	0.005	mg/L	0.005	7/9/2024			SW846-6020B	=
	U	0.03	mg/L	0.03	7/9/2024			SW846-6010D	UJ
Cadmium	U	0.001	mg/L	0.001	7/9/2024			SW846-6020B	=
Chromium	U	0.01	mg/L	0.01	7/9/2024			SW846-6020B	=
Lead	U	0.002	mg/L	0.002	7/9/2024			SW846-6020B	=
Mercury	U	0.0002	mg/L	0.0002	7/9/2024			SW846-7470A	UJ
Selenium	U	0.005	mg/L	0.005	7/9/2024			SW846-6020B	=
Technetium-99	U	0.884	pCi/L	19.8	7/9/2024	11.5	11.5	HASL 300, Tc-02-RC M	=
Trichloroethene	U	1	ug/L	1	7/9/2024			SW846-8260D	=
Uranium	U	0.0002	mg/L	0.0002	7/9/2024			SW846-6020B	=
Uranium-234	U	0.00326	pCi/L	1.3	7/9/2024	0.583	0.584	HASL 300, U-02-RC M	=
Uranium-235	U	0.203	pCi/L	0.609	7/9/2024	0.57	0.571	HASL 300, U-02-RC M	=
Uranium-238	U	0.125	pCi/L	0.787	7/9/2024	0.468	0.468	HASL 300, U-02-RC M	=

Paducah OREIS
GROUNDWATER MONITORING REPORT

Facility: C-404 Landfill **County:** McCracken **Permit #:** KY8-890-008-982

Type of Sample: TB **Period:** Semiannual Report QC Samples

AKGWA Well Tag #: 0000-0000

Parameter	Qualifier	Result	Units	Reporting Limit	Date Collected	Counting Error (+/-)	TPU	Method	Validation
Trichloroethene	U	1	ug/L	1	7/11/2024			SW846-8260D	=
	U	1	ug/L	1	7/9/2024			SW846-8260D	=

QUALIFIER Codes

U Not detected.
J Estimated quantitation.

SAMPLING POINT Codes

UCRS Upper Continental Recharge System
URGA Upper Regional Gravel Aquifer

SAMPLE TYPE Codes

FB Field Blank
FR Field Duplicate as defined in sampling procedure.
REG Regular
RI QC Equipment Rinseate/Decon
TB Trip Blank

VALIDATION Codes

= Validated result, no qualifier is necessary.
J The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
U The analyte was analyzed for, but was not detected above the reported sample quantitation limit.
UJ Analyte, compound or nuclide not detected above the reported detection limit, and the reported detection limit is approximated due to quality deficiency.
X Not validated.

APPENDIX B

C-404 HAZARDOUS WASTE LANDFILL STATISTICAL ANALYSES

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GROUNDWATER STATISTICAL SUMMARY

INTRODUCTION

The statistical analyses conducted on the data collected from the C-404 Hazardous Waste Landfill (C-404 Landfill) were performed in accordance with procedures provided in Appendix E of the Hazardous Waste Management Facility Permit, reissued by the Kentucky Division of Waste Management in February 2020. The percent of censored (nondetected) data points for individual parameters was calculated for the combined analytical data from the most recent five sampling events. The percent of censored data was used to select the types of statistical analyses to determine whether compliance well concentrations differed from background well concentrations. Data points were used in the statistical analysis for analyte results close to the sample quantitation limit that were judged to be below that limit by the data validator.

Quarterly compliance monitoring groundwater sampling for radiological constituents was initiated in third quarter 2021 (July 2021) and was continued through November 2022. The additional quarters of groundwater data for radiological constituents alters the available data sets for the statistical analyses. For the second reporting period 2024 semiannual report, the reporting period data set includes nonradiological data from July–August 2022, January 2023, July 2023, January 2024, and July 2024. The reporting period data set for radiological constituents includes November 2022, January 2023, July 2023, January 2024, and July 2024.

STATISTICAL ANALYSIS PROCESS

Utilizing the current data set and four previous data sets, the type of statistical test conducted for each chemical data set is a function of the number of samples and proportion of censored data (nondetects) to uncensored data (detects) in each group. The percent of censored (nondetected) data points for individual parameters was calculated for the combined analytical data. The statistical procedures applied to the data are summarized below.

- Determine the percentage of the censored data using the reporting period data set.
- Group by percentage of censored data where the following apply:
  - — If censored data are greater than or equal to 90%, determine the limit of detection (LOD) and half of the LOD (½ LOD). This is Statistical Test 1.
  - — If censored data are between 50% and 90%, perform a Test of Proportions. If the analysis indicates a significant proportional difference in compliance wells, further analyze through nonparametric Analysis of Variance (ANOVA) Test. This is Statistical Test 2.
  - — If censored data are between 15% and 50%, perform nonparametric ANOVA Test. If results exceed the critical value, compute the critical difference used to identify individual well concentrations, which are significantly elevated compared with background. This is Statistical Test 3.

— If censored data are less than 15%, actual data values are analyzed using parametric ANOVA procedures. If the wells exhibit equal variances, then the data are used as presented. If the wells do not exhibit equal variances, then the log of the data is taken and then used in the calculations. Where statistical testing indicates elevated compliance well concentrations, Bonferroni's Test of Contrasts is performed. This is Statistical Test 4. Statistical Test 4 is found in Section 5.2.1 of EPA guidance document, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Final Guidance* (April 1989).

If the statistical method above indicates no statistical difference between concentrations in downgradient wells and concentrations in background wells, then there are no indications of statistically significant impacts on the groundwater from the C-404 Landfill. If the tiered statistical method above identifies a statistically significant difference between concentrations in downgradient wells and concentrations in background wells, then the data will be evaluated further to determine if the concentrations in downgradient wells are within the statistically developed upper tolerance limit (UTL) for background concentrations or are consistent with the findings of the 2007 alternate source demonstration (ASD), as follows:

(1) Compare the most recent downgradient sample results to a 95% UTL using the five most recent sets of data for each upgradient well as described below. If downgradient concentrations are lower than the UTL for the paired upgradient concentrations, then there is no confirmed exceedance.

(2) Evaluate results using paired ANOVA of wells in the same direction relative to the landfill (e.g., compare upgradient westernmost well results to downgradient westernmost well results). If ANOVA does not identify a statistically significant difference between upgradient and downgradient wells, then the results are consistent with the historical ASD.

(3) If results show downgradient wells have statistically significant higher concentrations than upgradient wells, even when evaluated with respect to the ASD, additional intra-well evaluation of trend will be performed using the Mann-Kendall test for trend. If concentrations do not show an increasing trend, then there is no confirmed exceedance attributable to C-404.

(4) Review other Regional Gravel Aquifer (RGA) well results in vicinity to determine if they are consistent with the ASD.

If the statistical analysis identifies downgradient well concentrations that are increasing, are higher than UTL, are higher than the upgradient well concentrations even when the ASD results are taken into account, this evaluation will identify a confirmed, statistically significant exceedance (in a compliance well) over background.

DATA ANALYSIS

Data from the upgradient background wells in the Upper Regional Gravel Aquifer (URGA) are included for comparison with three downgradient URGA wells. Figure 1 of this C-404 Landfill Groundwater Report provides a map of the well locations associated with the C-404 Landfill. Upper Continental Recharge System (UCRS) wells in Figure 1 are provided for reference only. Data from wells that are in the UCRS are not included in the statistical analyses.

Table B.1 presents the C-404 Landfill upgradient or background wells and downgradient or compliance wells from the URGA. Data from the URGA compliance wells were compared with data from the URGA background wells.

Table B.1. Monitoring Well Locations

URGA	
Upgradient background wells	MW93A*, MW420
Downgradient compliance wells	MW84A*, MW87A*, MW90A*

*MW90 was abandoned in 2001 and replaced with MW90A. MW84, MW87, and MW93 were abandoned in 2019 and replaced with MW84A, MW87A, and MW93A, respectively.

For this reporting period, the data set includes nonradionuclide data from July–August 2022, January 2023, July 2023, January 2024, and July 2024 and consists of five sets of data. The reporting period data set for radiological data is from November 2022 through July 2024 and also consists of five sets of data.

Table B.2 lists the number of analyses (observations), nondetects (censored observations), detects (uncensored observations), and missing observations by parameter. When field duplicate data are available from a well, the higher of the two readings was retained for further evaluation.

Table B.2. Summary of Missing, Censored, and Uncensored Data Collected

Parameters	Observations	Missing Observations	Censored Observations (Nondetects)	Uncensored Observations (Detects)
URGA				
Arsenic	25	0	1	24
Cadmium	25	0	25	0
Chromium	25	0	22	3
Lead	25	0	25	0
Mercury	25	0	25	0
Selenium	25	0	25	0
Technetium-99	25	0	13	12
Trichloroethene	25	0	0	25
Uranium (Metals)	25	0	23	2
Uranium-234	25	0	25	0
Uranium-235	25	0	25	0
Uranium-238	25	0	25	0

CENSORING PERCENTAGE AND STATISTICAL ANALYSIS

The type of statistical test set applied to the data is a function of the number of nondetects (censored) versus detects (uncensored) in each of the parameter groups and among the wells. Table B.3 presents the percentage of censored data and type of statistical test chosen for each of the parameters required by Part VIII.E of the Hazardous Waste Management Facility Permit.

Table B.3. Percent Censored Report and Statistical Test Set Selected

Parameter	Total Samples (Nonmissing)	Uncensored (Detects)	Censored (Nondetects)	Percent Censored	Statistical Test Set*
URGA					
Arsenic	25	24	1	4	4
Cadmium	25	0	25	100	1
Chromium	25	3	22	88	2
Lead	25	0	25	100	1
Mercury	25	0	25	100	1
Selenium	25	0	25	100	1
Technetium-99	25	12	13	52	2
Trichloroethene	25	25	0	0	4
Uranium (Metals)	25	2	23	92	1
Uranium-234	25	0	25	100	1
Uranium-235	25	0	25	100	1
Uranium-238	25	0	25	100	1

*A list of the constituents with ≥ 90% censored data is included in Table B.4, which summarizes the results of Statistical Test 1.

SUMMARY OF CONCLUSIONS

The results for Statistical Test 1, LOD, are summarized in Table B.4. Table B.5 provides the summary of conclusions for the C-404 Landfill statistical analyses for the first reporting period 2024, including the statistical tests performed, the attachment number, well type, parameter, and results of each statistical test. Results of Statistical Test 2, Statistical Test 3, and Statistical Test 4 are presented in Attachments B1 through B5. The statistician qualification statement is presented in Attachment B6.

Table B.4. Statistical Test 1: Limit of Detection

Parameter	LOD Values	½ LOD Values
URGA		
Cadmium (mg/L)	0.001	0.0005
Lead (mg/L)	0.002	0.001
Mercury (mg/L)	0.0002	0.0001
Selenium (mg/L)	0.005	0.0025
Uranium (mg/L)	0.0002	0.0001
Uranium-234 (pCi/L)	2.28	1.14
Uranium-235 (pCi/L)	2.27	1.14
Uranium-238 (pCi/L)	1.59	0.795

Table B.5. Summary of Conclusions from the C-404 Hazardous Waste Landfill Statistical Analyses for the First Reporting Period 2024

Attachment	RGA Well Type	Parameter	Applied Statistical Test	Results
B1	URGA	Arsenic	Statistical Test 4, parametric ANOVA (abandoned) and Statistical Test 3, nonparametric ANOVA.	Because equality of variance could not be confirmed, Statistical Test 4 was abandoned and Statistical Test 3, nonparametric ANOVA, was performed. Nonparametric ANOVA did not indicate a statistically significant difference between concentrations in downgradient wells and concentrations in background wells.
B2	URGA	Chromium	Statistical Test 2, Test of Proportions	No statistically significant difference was detected between concentrations in downgradient wells and concentrations in background wells.
B3	URGA	Technetium-99	Statistical Test 2, Test of Proportions, nonparametric ANOVA, 95% UTL, paired (parametric) ANOVA, paired (nonparametric) ANOVA, and Mann-Kendall.	Because the test of proportions indicated statistically significant evidence that the proportion of detects in one group of data exceeded the proportion of detects in the other group, nonparametric ANOVA was performed. Nonparametric ANOVA indicated a statistically significant difference between concentrations in downgradient wells and the concentrations in background wells for compliance wells MW84A and MW90A. Comparisons to the 95% UTL identified statistically significant differences between compliance wells MW84A and MW90A and the background wells. Paired (parametric) ANOVA (MW84A vs. MW93A and MW90A vs. MW93A) were performed and determined the equality of variances were not confirmed for both MW84A and MW90A. Paired (nonparametric) ANOVA was also performed. Paired (nonparametric) ANOVA identified a significant difference between upgradient (MW93A) and downgradient (MW84A and MW90A) wells. The Mann-Kendall trend analysis did not identify statistically significant trends for technetium-99 in either MW84A or MW90A.
B4	URGA	Trichloroethene (TCE)	Statistical Test 4, parametric ANOVA, with 95% UTL, paired (parametric) ANOVA, and Mann-Kendall trend analysis.	Because parametric ANOVA indicated a statistically significant difference between concentrations in background wells and compliance well MW84A, a comparison to the 95% UTL was performed. The 95% UTL indicated a statistically significant difference between concentrations in compliance well MW84A and concentrations in background wells; therefore, a paired (parametric) ANOVA (MW84A vs. MW93A) was performed that indicated a statistically significant difference between the wells. The Mann-Kendall trend analysis did not identify a statistically significant trend for TCE in MW84A.

In summary, Statistical Test 2, Test of Proportions, for technetium-99 in the URGA identified a statistically significant difference between background and downgradient wells. As a result, an evaluation by nonparametric ANOVA was performed and identified statistically significant exceedances in downgradient wells MW84A and MW90A as compared to background wells. The MW84A and MW90A technetium-99 concentrations exceeded the 95% UTL. Because equality of variance could not be confirmed on either MW84A or MW90A, paired (parametric) ANOVA was abandoned and a paired (nonparametric) was performed. Paired (nonparametric) ANOVA identified a significant difference between upgradient (MW93A) and downgradient (MW84A and MW90A) wells. Mann-Kendall trend analysis was performed and did not indicate a statistically significant trend for either MW84A or MW90A.

Statistical Test 2, Test of Proportions, for chromium in the URGA indicated no statistically significant difference between concentrations in downgradient wells and concentrations in background wells.

Statistical Test 4, because equality of variance by parametric ANOVA for arsenic could not be confirmed, the test was abandoned. Statistical Test 3, nonparametric ANOVA, did not identify a statistically significant difference between concentrations in downgradient wells and concentrations in background wells.

Statistical Test 4, parametric ANOVA, for TCE in the URGA indicated a statistically significant difference between concentrations in downgradient well MW84A and concentrations in background wells; therefore, the data were evaluated further by comparing results to the UTL. The 95% UTL indicated a statistically significant difference between concentrations in downgradient well MW84A and concentrations in background wells; therefore, paired (parametric) ANOVA was performed on upgradient well MW93A and downgradient well MW84A. Paired (parametric) ANOVA identified a statistically significant difference between the upgradient and downgradient wells. Mann-Kendall trend analysis was performed and did not indicate a statistically significant trend.

ATTACHMENT B1

ARSENIC
STATISTICAL TEST 4

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Attachment B1: Arsenic URGA, Statistical Test 4, Parametric ANOVA, Second Reporting Period 2024

Arsenic (As, mg/L)					
Date	Background	Background	Compliance	Compliance	Compliance
	MW93A	MW420	MW84A	MW87A	MW90A
Jul-22	**1.11E-02**	**1.03E-02**	**3.60E-02**	**8.27E-03**	2.50E-03
Jan-23	**1.11E-02**	**1.10E-02**	**3.43E-02**	**8.57E-03**	**2.78E-03**
Jul-23	**8.63E-03**	**1.14E-02**	**3.51E-02**	**8.63E-03**	**2.60E-03**
Jan-24	**8.19E-03**	**1.28E-02**	**3.76E-02**	**8.20E-03**	**2.72E-03**
Jul-24	**7.39E-03**	**1.35E-02**	**3.79E-02**	**7.80E-03**	**3.27E-03**
n_i	10		5	5	5
Sum	1.05E-01		1.81E-01	4.15E-02	1.39E-02
(x_i)avg	1.05E-02		3.62E-02	8.29E-03	2.77E-03

mg/L = milligrams per liter
Bolded values indicate a detected result.

Overall mean x.. =	1.37E-02	
N =	25	N = the total number of samples
p =	4	p = the number of n_i groups
x.. =	3.42E-01	x.. = the sum of the total number of samples

Determine Normality of Dataset

Coefficient of Variability Test

Table of Residuals

Date	Background	Background	Compliance	Compliance	Compliance
	MW93A	MW420	MW84A	MW87A	MW90A
Jul-22	5.59E-04	-2.41E-04	-1.80E-04	-2.40E-05	-2.74E-04
Jan-23	5.59E-04	4.59E-04	-1.88E-03	2.76E-04	6.00E-06
Jul-23	-1.91E-03	8.59E-04	-1.08E-03	3.36E-04	-1.74E-04
Jan-24	-2.35E-03	2.26E-03	1.42E-03	-9.40E-05	-5.40E-05
Jul-24	-3.15E-03	2.96E-03	1.72E-03	-4.94E-04	4.96E-04

X: Mean Value =	-6.25E-19	
S: Standard Deviation =	1.37E-03	
CV = S/X =	-2.20E+15	<1, data are normally distributed

Data are normally distributed (i.e.,<1)

If the coefficient of variation is < 1, the data are normally distributed.
If the coefficient of variation is > or = 1, data are not normally distributed.

Attachment B1: Arsenic URGA, Statistical Test 4, Parametric ANOVA,
Second Reporting Period 2024

Determine Equality of Variance of Dataset

p = number of well groups
n_i = number of data points per well
N = total sample size
S^2 = the square of the standard deviation
$\ln(S_i^2)$ = natural logarithm of each variance
f = total sample size minus the number of wells (groups)
$f_i = n_i - 1$
x.. = the sum of the total number of samples
$(x_{avg})_{..}$ = the mean of the total number of samples

$x_{..} =$ 3.42E-01
$(x_{avg})_{..} =$ 1.37E-02

p = 4
N = 25

Calculations for Equality of Variance: Bartlett's Test

S_i	S_i^2	$\ln(S_i^2)$	n_i	$f_iS_i^2$	$f_i\ln(S_i^2)$
1.96E-03	3.84E-06	-1.25E+01	10	3.46E-05	-1.12E+02
1.56E-03	2.43E-06	-1.29E+01	5	9.71E-06	-5.17E+01
3.33E-04	1.11E-07	-1.60E+01	5	4.43E-07	-6.41E+01
2.98E-04	8.86E-08	-1.62E+01	5	3.54E-07	-6.50E+01

$\sum(S_i^2) =$ 6.47E-06 $\sum f_i\ln(S_i^2) =$ -2.93E+02

Equality of Variance: Bartlett's Test

f = 21
$Sp^2 =$ 2.15E-06
$\ln Sp^2 =$ -1.31E+01
$c^2 =$ 1.89E+01 (If $c^2 \leq c^2_{crit}$, then variances are equal at the given significance level).
c^2_{crit} * = 7.81E+00 at a 5% significance level with 3 degrees of freedom

NOTE: The variances are NOT equal. **(i.e., $c^2 > c^2_{crit}$)**

Variances are not equal, transform the original data to lognormal (i.e., since $c^2 > c^2_{crit}$).

*Table 1, Appendix B, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance* (EPA 1989).

Attachment B1: Arsenic URGA, Statistical Test 4, Parametric ANOVA, Second Reporting Period 2024

Lognormal Data for Arsenic

ln[As (mg/L)]					
Date	Background	Background	Compliance	Compliance	Compliance
	MW93A	MW420	MW84A	MW87A	MW90A
Jul-22	-4.50E+00	-4.58E+00	-3.32E+00	-4.80E+00	-5.99E+00
Jan-23	-4.50E+00	-4.51E+00	-3.37E+00	-4.76E+00	-5.89E+00
Jul-23	-4.75E+00	-4.47E+00	-3.35E+00	-4.75E+00	-5.95E+00
Jan-24	-4.80E+00	-4.36E+00	-3.28E+00	-4.80E+00	-5.91E+00
Jul-24	-4.91E+00	-4.31E+00	-3.27E+00	-4.85E+00	-5.72E+00
Mean x_i	-4.69E+00	-4.44E+00	-3.32E+00	-4.79E+00	-5.89E+00
Background Mean	-4.57E+00		NA	NA	NA
Grand Mean	-4.63E+00				
x_i^2	2.03E+01	2.09E+01	1.11E+01	2.30E+01	3.59E+01
	2.03E+01	2.03E+01	1.14E+01	2.27E+01	3.46E+01
These values needed for ANOVA	2.26E+01	2.00E+01	1.12E+01	2.26E+01	3.54E+01
	2.31E+01	1.90E+01	1.08E+01	2.31E+01	3.49E+01
	2.41E+01	1.85E+01	1.07E+01	2.36E+01	3.28E+01
Sum x_i^2	5.53E+02				

mg/L = milligrams per liter

Determine Normality of Dataset

Coefficient of Variability Test

Table of ln[As (mg/L)] Data

Date	Background	Background	Compliance	Compliance	Compliance
	MW93A	MW420	MW84A	MW87A	MW90A
Jul-22	-4.50E+00	-4.58E+00	-3.32E+00	-4.80E+00	-5.99E+00
Jan-23	-4.50E+00	-4.51E+00	-3.37E+00	-4.76E+00	-5.89E+00
Jul-23	-4.75E+00	-4.47E+00	-3.35E+00	-4.75E+00	-5.95E+00
Jan-24	-4.80E+00	-4.36E+00	-3.28E+00	-4.80E+00	-5.91E+00
Jul-24	-4.91E+00	-4.31E+00	-3.27E+00	-4.85E+00	-5.72E+00

X: Mean Value = -4.63E+00
S: Standard Deviation = 8.44E-01
CV = S/X = -1.82E-01 <1, data are normally distributed

Data are normally distributed (i.e.,<1)

Determine Equality of Variance of Dataset for Lognormal Data

p = number of wells (background wells considered as one group)
n_i = number of data points per well
N = total sample size
S^2 = the square of the standard deviation
$\ln(S_i^2)$ = natural logarithm of each variance
f = total sample size minus the number of wells (groups)
$f_i = n_i - 1$
x.. = the sum of the total lognormal dataset
$(x_{avg})_{..}$ = the mean of the lognormal dataset

$x_{..} =$ -1.16E+02
$(x_{avg})_{..} =$ -4.63E+00
$n_i =$ 5
p = 4
N = 25

Calculations for Equality of Variance: Bartlett's Test

S_i	S_i^2	$\ln(S_i^2)$	ni	$f_iS_i^2$	$f_i\ln(S_i^2)$
1.94E-01	3.78E-02	-3.28E+00	10	3.40E-01	-2.95E+01
4.31E-02	1.86E-03	-6.29E+00	5	7.43E-03	-2.52E+01
4.05E-02	1.64E-03	-6.41E+00	5	6.56E-03	-2.57E+01
1.03E-01	1.06E-02	-4.55E+00	5	4.24E-02	-1.82E+01

$\sum(S_i^2) =$ 5.18E-02 $\sum f_i\ln(S_i^2) =$ -9.85E+01

Equality of Variance: Bartlett's Test

f = 2.10E+01
$Sp^2 =$ 1.89E-02
$\ln Sp^2 =$ -3.97E+00
$c^2 =$ 1.51E+01 (If $c^2 \le c^2_{crit}$, then variances are equal at the given significance level).
c^2_{crit} * = 7.81E+00 at a 5% significance level with 3 degrees of freedom

NOTE: The variances are NOT equal. (i.e., $c^2 \ge c^2_{crit}$)

Because variances are not equal, Statistical Test 3, Nonparametric ANOVA is performed.**

*Table 1, Appendix B, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance* (EPA 1989)].

**Section 5.2, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance* (EPA 1989)].

Attachment B1: Arsenic URGA, Statistical Test 4, Parametric ANOVA,
Second Reporting Period 2024

Nonparametric ANOVA

Arsenic (mg/L)					
Date	Background	Background	Compliance	Compliance	Compliance
	MW93A	MW420	MW84A	MW87A	MW90A
Jul-22	**1.11E-02**	**1.03E-02**	**3.60E-02**	**8.27E-03**	2.50E-03
Jan-23	**1.11E-02**	**1.10E-02**	**3.43E-02**	**8.57E-03**	**2.78E-03**
Jul-23	**8.63E-03**	**1.14E-02**	**3.51E-02**	**8.63E-03**	**2.60E-03**
Jan-24	**8.19E-03**	**1.28E-02**	**3.76E-02**	**8.20E-03**	**2.72E-03**
Jul-24	**7.39E-03**	**1.35E-02**	**3.79E-02**	**7.80E-03**	**3.27E-03**
Sum	1.05E-01		1.81E-01	4.15E-02	1.39E-02
n_i	10		5	5	5
$(x_i)_{avg}$	1.05E-02		3.62E-02	8.29E-03	2.77E-03

mg/L = milligrams per liter
DL = detection limit
All data sets represent 1/2 DL values for nondetects.
Bolded values indicate a detected result.

Overall mean x.. = 1.37E-02

N =	25	N = the total number of samples
p =	4	p = the number of n_i groups
x.. =	3.42E-01	x.. = the sum of the total number of samples

Attachment B1: Arsenic URGA, Statistical Test 4, Parametric ANOVA,
Second Reporting Period 2024

Nonparametric ANOVA

Ranking of Observations

Sequence	Arsenic (mg/L)	Adjusted Rank	Tie Number
1	0	1	
2	**2.60E-03**	2	
3	**2.72E-03**	3	
4	**2.78E-03**	4	
5	**3.27E-03**	5	
6	**7.39E-03**	6	
7	**7.80E-03**	7	
8	**8.19E-03**	8	
9	**8.20E-03**	9	
10	**8.27E-03**	10	
11	**8.57E-03**	11	
12	**8.63E-03**	12.5	Tie 1
13	**8.63E-03**	12.5	
14	**1.03E-02**	14	
15	**1.10E-02**	15	
16	**1.11E-02**	16.5	Tie 2
17	**1.11E-02**	16.5	
18	**1.14E-02**	18	
19	**1.28E-02**	19	
20	**1.35E-02**	20	
21	**3.43E-02**	21	
22	**3.51E-02**	22	
23	**3.60E-02**	23	
24	**3.76E-02**	24	
25	**3.79E-02**	25	

mg/L = milligrams per liter
DL = detection limit
Bolded values indicate a detected result.
NOTE: For this method, observations below the detection limit that are considered nondetects (i.e., U qualified data) are reported as a concentration of 0.

n_{tie}		
2	Tie 1 =	6
2	Tie 2 =	6
	$\sum T_i$ =	12

Attachment B1: Arsenic URGA, Statistical Test 4, Parametric ANOVA, Second Reporting Period 2024

Sums of Ranks and Averages

Arsenic (mg/L)					
Date	Background	Background	Compliance	Compliance	Compliance
	MW93A	MW420	MW84A	MW87A	MW90A
Jul-22	**1.11E-02**	**1.03E-02**	**3.60E-02**	**8.27E-03**	0
Jan-23	**1.11E-02**	**1.10E-02**	**3.43E-02**	**8.57E-03**	**2.78E-03**
Jul-23	**8.63E-03**	**1.14E-02**	**3.51E-02**	**8.63E-03**	**2.60E-03**
Jan-24	**8.19E-03**	**1.28E-02**	**3.76E-02**	**8.20E-03**	**2.72E-03**
Jul-24	**7.39E-03**	**1.35E-02**	**3.79E-02**	**7.80E-03**	**3.27E-03**

Observation Ranks for Arsenic					
Date	Background	Background	Compliance	Compliance	Compliance
	MW93A	MW420	MW84A	MW87A	MW90A
Jul-22	16.5	14	23	10	1
Jan-23	16.5	15	21	11	4
Jul-23	12.5	18	22	12.5	2
Jan-24	8	19	24	9	3
Jul-24	6	20	25	7	5
R_i	145.5		115	49.5	15
$(R_i)_{avg}$	14.6		23.0	9.9	3.0
R_i^2/n_i	2117.0		2645.0	490.1	45.0

$\Sigma R_i^2/n_i$ = 5.30E+03

mg/L = milligrams per liter
DL = detection limit

K = the number of n_i groups
N = the total number of samples

K = 4
N = 25

Bolded values indicate a detected result.
NOTE: For this method, observations below the detection limit that are considered nondetects (i.e., U qualified data) are reported as a concentration of 0.

Calculation of Kruskal-Wallis Statistic

H =	1.98E+01	Kruskal-Wallis Statistic	$H = [12/N(N+1)*\Sigma R_i^2/n_i] - 3(N+1)$
H' =	1.98E+01	Corrected Kruskal-Wallis	$H' = H/[1-(\sum T_i/N^3-N)]$
χ^2_{crit}* =	7.81E+00	3	degrees of freedom at the 5% significance level

NOTE: $H' > \chi^2_{crit}$

If $H' \leq \chi^2_{crit}$, the data from each well come from the same continuous distribution and hence have the same median concentrations of a specific constituent.

If $H' > \chi^2_{crit}$, reject the null hypothesis and calculate the critical difference for well comparisons to the background.

K-1 =	3	α/(K-1) =	1.67E-02	Z(α/(K-1))** =	2.13E+00
α =	0.05	1-(α/K-1) =	9.83E-01		

NOTE: *Table 1, Appendix B, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance* (EPA 1989).
**Table 4, Appendix B, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance* (EPA 1989).

Attachment B1: Arsenic URGA, Statistical Test 4, Parametric ANOVA,
Second Reporting Period 2024

Calculate Critical Values

Average Background Ranking = 14.6

	Well No.	C_i	$(R_i)_{avg} - (R_b)_{avg}$	Conclusion
BG Well	MW93A			
BG Well	MW420			
	MW84A	8.58E+00	8.45E+00	not contaminated
	MW87A	8.58E+00	-4.65E+00	not contaminated
	MW90A	8.58E+00	-1.16E+01	not contaminated

CONCLUSION: If $(R_i)_{avg} - (R_b)_{avg} > C_i$, then there is evidence that the compliance well is contaminated.

If $(R_i)_{avg} - (R_b)_{avg} < C_i$ for wells, there is no evidence of a statistically significant difference between concentrations in downgradient compliance test wells and background wells.

Since $(R_i)_{avg} - (R_b)_{avg} < C_i$ for MW84A, MW87A, and MW90A, there is no statistically significant difference between background wells and these downgradient compliance test wells; however, the negative value indicates that background wells have elevated concentrations.

Section 5.2.2, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance* (EPA 1989).

ATTACHMENT B2

CHROMIUM
STATISTICAL TEST 2

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Attachment B2: Chromium URGA, Statistical Test 2, Test of Proportions,
Second Reporting Period 2024

Chromium (mg/L)					
Date	Background	Background	Compliance	Compliance	Compliance
	MW93A	MW420	MW84A	MW87A	MW90A
Jul-22	**5.27E-03**	5.00E-03	5.00E-03	5.00E-03	5.00E-03
Jan-23	5.00E-03	5.00E-03	5.00E-03	5.00E-03	5.00E-03
Jul-23	5.00E-03	5.00E-03	5.00E-03	5.00E-03	5.00E-03
Jan-24	**3.82E-03**	5.00E-03	5.00E-03	**4.16E-03**	5.00E-03
Jul-24	5.00E-03	5.00E-03	5.00E-03	5.00E-03	5.00E-03

mg/L = milligrams per liter
DL = detection limit
All data sets represent 1/2 DL values for nondetects.
Bolded values indicate a detected result.

[!]Test of Proportions

Calculate the number of detections in background wells vs. compliance wells.

X =	2	X = number of samples above DL in background wells
Y =	1	Y = number of samples above DL in compliance wells
n_b =	10	n_b = count of background well results/samples analyzed
n_c =	15	n_c = count of compliance well results/samples analyzed
n =	25	n = total number of samples

P =	0.12	P = (x+y)/n
nP =	3	$n = n_b+n_c$
n(1-P) =	22	

NOTE: If nP and n(1-P) are both >= 5, then the normal approximation may be used; however, because nP < 5 and/or n(1-P) < 5, the test was continued to determine if the conclusion, along with a simple evaluation of the data would be similar.

P_b =	0.20	P_b = proportion of detects in background wells
P_c =	0.07	P_c = proportion of detects in compliance wells
S_D =	0.13	S_D = standard error of difference in proportions
Z =	1.01	$Z = (P_b-P_c)/S_D$
absolute value of Z =	1.01	

If the absolute value of Z exceeds the 97.5th percentile value of 1.96 from the standard normal distribution, this provides statistically significant evidence at the 5% significance level that the proportion of detects in one group of data exceeds the proportion of detects in the other group.

CONCLUSION: **Because the absolute value of Z is less than or equal to 1.96, there is no statistical evidence that the proportion of samples with detected results differs between the background wells and compliance well samples.**

[!] Section 8.1.2, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Final Guidance* (EPA 1989).

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ATTACHMENT B3

TECHNETIUM-99
STATISTICAL TEST 2

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Attachment B3: Technetium-99 URGA, Statistical Test 2, Test of Proportions, Second Reporting Period 2024

Technetium-99 (pCi/L)					
Date	**Background**	**Background**	**Compliance**	**Compliance**	**Compliance**
	MW93A	**MW420**	**MW84A**	**MW87A**	**MW90A**
Nov-22	8.65E+00	8.30E+00	**6.40E+01**	8.40E+00	**2.23E+01**
Jan-23	9.15E+00	8.85E+00	**2.02E+02**	**2.44E+01**	1.19E+01
Jul-23	9.35E+00	9.75E+00	**6.42E+01**	**3.33E+01**	**2.47E+01**
Jan-24	8.30E+00	8.15E+00	**8.60E+01**	**1.92E+01**	**4.35E+01**
Jul-24	9.95E+00	9.80E+00	**9.35E+01**	9.80E+00	**4.53E+01**

pCi/L = picocuries per liter
DL= detection limit
Nondetect values are 1/ DL
Bolded values indicate a detected result.

[l]**Test of Proportions**

Calculate the number of detections in background wells vs. compliance wells.

X =	0	X = number of samples above DL in background wells
Y =	12	Y = number of samples above DL in compliance wells
n_b =	10	n_b = count of background well results/samples analyzed
n_c =	15	n_c = count of compliance well results/samples analyzed
n =	25	n = total number of samples

P =	4.80E-01	P = (x+y)/n
nP =	12	$n = n_b+n_c$
n(1-P) =	13	

NOTE: If nP and n(1-P) are both >= 5, then the normal approximation may be used.

P_b =	0.00	P_b = proportion of detects in background wells
P_c =	0.80	P_c = proportion of detects in compliance wells
S_D =	0.20	S_D = standard error of difference in proportions
Z =	-3.92	$Z = (P_b-P_c)/S_D$
absolute value of Z =	3.92	

If the absolute value of Z exceeds the 97.5th percentile value of 1.96 from the standard normal distribution, this provides statistically significant evidence at the 5% significance level that the proportion of detects in one group of data exceeds the proportion of detects in the other group.

CONCLUSION: Because the absolute value of Z is greater than 1.96, Nonparametric ANOVA was performed.

[l]Section 8.1.2, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Final Guidance* (EPA 1989).

Attachment B3: Technetium-99 URGA, Statistical Test 2, Test of Proportions, Second Reporting Period 2024

Nonparametric ANOVA

Technetium-99 (pCi/L)					
Date	**Background**	**Background**	**Compliance**	**Compliance**	**Compliance**
	MW93A	**MW420**	**MW84A**	**MW87A**	**MW90A**
Nov-22	8.65E+00	8.30E+00	**6.40E+01**	8.40E+00	**2.23E+01**
Jan-23	9.15E+00	8.85E+00	**2.02E+02**	**2.44E+01**	1.19E+01
Jul-23	9.35E+00	9.75E+00	**6.42E+01**	**3.33E+01**	**2.47E+01**
Jan-24	8.30E+00	8.15E+00	**8.60E+01**	**1.92E+01**	**4.35E+01**
Jul-24	9.95E+00	9.80E+00	**9.35E+01**	9.80E+00	**4.53E+01**
Sum	9.03E+01		5.10E+02	9.51E+01	1.48E+02
n_i	10		5	5	5
$(x_i)_{avg}$	9.03E+00		1.02E+02	1.90E+01	2.95E+01

pCi/L = picocuries per liter
All data sets represent 1/2 detection limit values for nondetects.
Bolded values indicate a detected result.

Overall mean x.. = 3.37E+01

N =	25	N = the total number of samples
p =	4	p = the number of n_i groups
x.. =	8.43E+02	x.. = the sum of the total number of samples

Attachment B3: Technetium-99 URGA, Statistical Test 2, Test of Proportions, Second Reporting Period 2024

Nonparametric ANOVA

Ranking of Observations

Sequence	Technetium-99 (pCi/L)	Adjusted Rank	Tie Number
1	0	7	Tie 1
2	0	7	
3	0	7	
4	0	7	
5	0	7	
6	0	7	
7	0	7	
8	0	7	
9	0	7	
10	0	7	
11	0	7	
12	0	7	
13	0	7	
14	**1.92E+01**	14	
15	**2.23E+01**	15	
16	**2.44E+01**	16	
17	**2.47E+01**	17	
18	**3.33E+01**	18	
19	**4.35E+01**	19	
20	**4.53E+01**	20	
21	**6.40E+01**	21	
22	**6.42E+01**	22	
23	**8.60E+01**	23	
24	**9.35E+01**	24	
25	**2.02E+02**	25	

pCi/L = picocuries per liter
Bolded values indicate a detected result.

NOTE: For this method, observations below the detection limit that are considered nondetects (i.e., U qualified data) are reported as a concentration of 0.

n_{tie}

13 Tie 1 = 2184.00

$\sum T_i$ = 2184.00

Attachment B3: Technetium-99 URGA, Statistical Test 2, Test of Proportions, Second Reporting Period 2024

Nonparametric ANOVA

Sums of Ranks and Averages

Technetium-99 (pCi/L)					
Date	Background	Background	Compliance	Compliance	Compliance
	MW93A	MW420	MW84A	MW87A	MW90A
Nov-22	0	0	**6.40E+01**	0	**2.23E+01**
Jan-23	0	0	**2.02E+02**	**2.44E+01**	0
Jul-23	0	0	**6.42E+01**	**3.33E+01**	**2.47E+01**
Jan-24	0	0	**8.60E+01**	**1.92E+01**	**4.35E+01**
Jul-24	0	0	**9.35E+01**	0	**4.53E+01**

Observation Ranks for Technetium-99					
Date	Background	Background	Compliance	Compliance	Compliance
	MW93A	MW420	MW84A	MW87A	MW90A
Nov-22	7	7	21	7	15
Jan-23	7	7	25	16	7
Jul-23	7	7	22	18	17
Jan-24	7	7	23	14	19
Jul-24	7	7	24	7	20
R_i	70.00		115.00	62.00	78.00
$(R_i)_{avg}$	7.00		23.00	12.40	15.60
R_i^2/n_i	490.00		2645.00	768.80	1216.80

$\Sigma R_i^2/n_i$ = 5.12E+03

pCi/L = picocuries per liter

K = the number of n_i groups

N = the total number of samples

Bolded values indicate a detected result.

K = 4

N = 25

NOTE: For this method, observations below the detection limit that are considered nondetects (i.e., U qualified data) are reported as a concentration of 0.

Calculation of Kruskal-Wallis Statistic

H = 1.65E+01 Kruskal-Wallis Statistic $H = [12/N(N+1)*\Sigma R_i^2/n_i] - 3(N+1)$

H' = 1.92E+01 Corrected Kruskal-Wallis $H' = H/[1-(\sum T_i/N^3-N)]$

χ^2_{crit}* = 7.81E+00 3 degrees of freedom at the 5% significance level

NOTE: H' > χ^2_{crit}

If H' ≤ χ^2_{crit}, the data from each well come from the same continuous distribution and hence have the same median concentrations of a specific constituent.

If H' > χ^2_{crit}, reject the null hypothesis and calculate the critical difference for well comparisons to the background.

K-1 = 3 α/(K-1) = 1.67E-02 /(K-1))** = 2.13E+00

α = 0.05 1-(α/K-1) = 9.83E-01

NOTE: *Table 1, Appendix B, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance* (EPA 1989).

**Table 4, Appendix B, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance* (EPA 1989).

Attachment B3: Technetium-99 URGA, Statistical Test 2, Test of Proportions, Second Reporting Period 2024

Nonparametric ANOVA

Calculate Critical Values

Average Background Ranking = 7.0

	Well No.	C_i	$(R_i)_{avg} - (R_b)_{avg}$	Conclusion
BG Well	MW93A			
BG Well	MW420			
	MW84A	8.58E+00	1.60E+01	**evidence of contamination**
	MW87A	8.58E+00	5.40E+00	not contaminated
	MW90A	8.58E+00	8.60E+00	**evidence of contamination**

pCi/L = picocuries per liter
BG = background

CONCLUSION:
If $(R_i)_{avg} - (R_b)_{avg} > C_i$, then there is evidence that the compliance well is contaminated.

If $(R_i)_{avg} - (R_b)_{avg} < C_i$ for wells, there is no evidence of a statistically significant difference between concentrations in downgradient compliance test wells and background wells.

Since $(R_i)_{avg} - (R_b)_{avg} > C_i$ for MW84A and MW90A, there is a statistically significant difference between background wells and downgradient compliance test wells in MW84A and MW90A from the C-404 Land

Because nonparametric ANOVA indicated a statistically significant difference between compliance test wells and background wells at the C-404 Landfill in compliance well MW84A and MW90A, the 95% UTL was performed.

Since $(R_i)_{avg} - (R_b)_{avg} < C_i$ for MW87A, there is no statistically significant difference between background wells and these downgradient compliance test wells.

Section 5.2.2, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance* (EPA 1989).

Attachment B3: Technetium-99 URGA, Statistical Test 2, Test of Proportions, Second Reporting Period 2024

95% Upper Tolerance Limit (UTL)

Compare the most recent downgradient sample results to a calculated 95% UTL using the five most recent sets of data for each upgradient well, as described below. If downgradient concentration is less than the UTL for the paired upgradient concentrations, then there is no confirmed exceedance.

July 2024 Data, Second Reporting Period
Technetium-99 Observations (pCi/L)

Well No.						
MW93A	**8.65E+00**	**9.15E+00**	**9.35E+00**	**8.30E+00**	**9.95E+00**	**Upgradient Well[!]**
MW420	**8.30E+00**	**8.85E+00**	**9.75E+00**	**8.15E+00**	**9.80E+00**	**Upgradient Well[!]**
						Current Data
MW84A						**9.35E+01**
MW90A						**4.53E+01**
	X: Mean Value =		9.03E+00			
	S: Standard Deviation =		6.74E-01			
	K* factor =		2.911	(for n = 10)		
	CV = S/X		7.47E-02	<1, assume normal distribution		
	Upper Tolerance Interval: TL = X +(KxS) =			**1.10E+01**	(pCi/L)	

! = Data from previous 5 sampling events.
Nondetect values are 1/2 DL.
CV = coefficient of variation
* = Table 5, Appendix B, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance* (EPA 1989).

Result: **MW84A and MW90A exceeded the UTL, which is statistically significant evidence that these compliance wells have elevated concentration with respect to background data.**

Conclusion: **Because the 95% UTL indicated a statistically significant difference between compliance test wells and background wells at the C-404 Landfill in compliance wells MW84A and MW90A, the paired (parametric) ANOVA was performed for each downgradient well.**

Paired (Parametric) ANOVA - MW93A and MW84A

Evaluate results using paired ANOVA of wells in the same direction relative to the landfill [e.g., compare upgradient westernmost well results to downgradient westernmost well results]. If ANOVA does not identify a statistically significant difference between upgradient and downgradient wells, then the results are consistent with the historical ASD.

Technetium-99 (pCi/L)				
Date	Background	Compliance		
	MW93A	MW84A	n_i^2	
Nov-22	8.65E+00	**6.40E+01**	7.48E+01	4.10E+03
Jan-23	9.15E+00	**2.02E+02**	8.37E+01	4.08E+04
Jul-23	9.35E+00	**6.42E+01**	8.74E+01	4.12E+03
Jan-24	8.30E+00	**8.60E+01**	6.89E+01	7.40E+03
Jul-24	9.95E+00	**9.35E+01**	9.90E+01	8.74E+03
Sum (x_i)	4.54E+01	5.10E+02	5.55E+02	Total Sum (x..)
n_i	5	5		
$(x_i)_{avg}$	9.08E+00	1.02E+02		
$(x_i)^2$	2.06E+03	2.60E+05		

pCi/L = picocuries per liter
Nondetect values are 1/2 DL.
Bolded values indicate a detected result.

Overall mean x.. =	5.55E+01	
N =	10	N = the total number of samples
p =	2	p = the number of n_i groups
$x_{..} =$	5.55E+02	x.. = the sum of the total number of samples

Determine Normality of Dataset

Coefficient of Variability Test

Table of Residuals ($x_i - x_{iavg}$)

Date	Background	Compliance
	MW93A	MW84A
Nov-22	-4.30E-01	-3.79E+01
Jan-23	7.00E-02	1.00E+02
Jul-23	2.70E-01	-3.77E+01
Jan-24	-7.80E-01	-1.59E+01
Jul-24	8.70E-01	-8.44E+00

X: Mean Value =	0.00E+00	
S: Standard Deviation =	3.83E+01	
K* Factor =	2.911	(for n = 10)
CV = S/X =	#ΔIç/0!	#DIV/0!

The Coefficient of Variability Test was not performed due to mean = 0 (i.e., division by 0 is not possible).

*Table 5, Appendix B, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance* (EPA 1989).

If the coefficient of variation is < 1, the data are normally distributed.
If the coefficient of variation is > or = 1, data are not normally distributed.

Determine Equality of Variance of Dataset

p = number of wells	$x_{..} =$ 5.55E+02
n_i = number of data points per well	$(x_{avg})_{..} =$ 5.55E+01
N = total sample size	$n_{i} =$ 5
S^2 = the square of the standard deviation	p = 2
$\ln(S_i^2)$ = natural logarithm of each variance	N = 10
f = total sample size minus the number of wells (groups)	f_i = 4
$f_i = n_i - 1$	

Calculations for Equality of Variance: Bartlett's Test

S_i	S_i^2	$\ln(S_i^2)$†	n_i	$f_iS_i^2$	$f_i\ln(S_i^2)$†
6.38E-01	4.07E-01	-8.99E-01	5	1.63E+00	-3.60E+00
5.74E+01	3.30E+03	8.10E+00	5	1.32E+04	3.24E+01

$\sum(S_i^2) =$ 3.30E+03 $\sum f_i\ln(S_i^2) =$ 2.88E+01

Equality of Variance: Bartlett's Test

f =	8	
Sp^2 =	1.65E+03	
ln Sp^2 =	7.41E+00	
χ^2 =	3.05E+01	(If calculated $\chi^2 \leq$ tabulated χ^2_{crit}, then variances are equal at the given significance level).
χ^2_{crit} * =	3.84E+00	at a 5% significance level witl 1 degrees of freedom (p-1)

NOTE: The variances are NOT equal. (i.e., calculated $\chi^2 > \chi^2_{crit}$)

Variances are not equal, transform the original data to lognormal (i.e., since calculated $\chi^2 > \chi^2_{crit}$).

*Table 1, Appendix B, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance* (EPA 1989).

Paired (Parametric) ANOVA—Lognormal Data

ln[Technetium-99 (pCi/L)]				
Date	Background	Compliance		
	MW93A	MW84A	n_i^2	
Nov-22	2.16E+00	**4.16E+00**	4.66E+00	1.73E+01
Jan-23	2.21E+00	**5.31E+00**	4.90E+00	2.82E+01
Jul-23	2.24E+00	**4.16E+00**	5.00E+00	1.73E+01
Jan-24	2.12E+00	**4.45E+00**	4.48E+00	1.98E+01
Jul-24	2.30E+00	**4.54E+00**	5.28E+00	2.06E+01
Sum (x_i)	1.10E+01	2.26E+01	3.36E+01	Total Sum (x..)
n_i	5	5		
$(x_i)_{avg}$	2.20E+00	4.52E+00		
$(x_i)^2$	1.21E+02	5.12E+02		

pCi/L = picocuries per liter **Bolded values indicate a detected result.**

Overall mean x.. =	3.36E+00	
N =	10	N = the total number of samples
p =	2	p = the number of n_i groups
$x_{..}$ =	3.36E+01	x.. = the sum of the total number of samples

Determine Normality of Dataset

Coefficient of Variability Test—Lognormal Data

Table of Residuals (x_i-$x_i$avg) for Lognormal Data

Date	Background	Compliance
	MW93A	MW84A
Nov-22	-4.65E-02	-3.65E-01
Jan-23	9.65E-03	7.84E-01
Jul-23	3.13E-02	-3.62E-01
Jan-24	-8.78E-02	-6.99E-02
Jul-24	9.35E-02	1.37E-02

X: Mean Value =	3.55E-16	
S: Standard Deviation =	3.17E-01	
K* Factor =	2.911	(for n = 10)
CV = S/X =	8.92E+14	≥1, data are NOT normally distributed

Data are not normally distributed (i.e., < or =1)

*Table 5, Appendix B, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance* (EPA 1989).

If the coefficient of variation is < 1, the residuals are normally distributed.
If the coefficient of variation is > or = 1, the residuals are not normally distributed.

Determine Equality of Variance—Lognormal Data

p = number of wells	$x_{..} =$ 3.36E+01
n_i = number of data points per well	$(x_{avg})_{..} =$ 3.36E+00
N = total sample size	$n_i =$ 5
S^2 = the square of the standard deviation	p = 2
$\ln(S_i^2)$ = natural logarithm of each variance	N = 10
f = total sample size minus the number of wells (groups)	f_i = 4
$f_i = n_i - 1$	

Calculations for Equality of Variance: Bartlett's Test

S_i	S_i^2	$\ln(S_i^2)$	n_i	$f_i S_i^2$	$f_i \ln(S_i^2)$
7.02E-02	4.92E-03	-5.31E+00	5	1.97E-02	-2.13E+01
4.70E-01	2.21E-01	-1.51E+00	5	8.84E-01	-6.04E+00

$\sum(S_i^2) =$ 2.26E-01 $\sum f_i \ln(S_i^2) =$ -2.73E+01

Equality of Variance: Bartlett's Test

f =	8	
Sp^2 =	1.13E-01	
ln Sp^2 =	-2.18E+00	
χ^2 =	9.85E+00	(If calculated $\chi^2 \leq$ tabulated χ^2_{crit}, then variances are equal at the given significance level).
χ^2_{crit} * =	3.84E+00	at a 5% significance level with 1 degrees of freedom (p-1)

NOTE: The variances are NOT equal. (i.e., calculated $\chi^2 \leq \chi^2_{crit}$)

Since the variances are not equal, paired (nonparametric) ANOVA is performed.

*Table 1, Appendix B, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance* (EPA 1989).

**Section 5.2, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance* (EPA 1989)].

Attachment B3: Technetium-99 URGA, Statistical Test 2, Test of Proportions, Second Reporting Period 2024

Paired (Parametric) ANOVA - MW93A and MW90A

Evaluate results using paired ANOVA of wells in the same direction relative to the landfill (e.g., compare upgradient westernmost well results to downgradient westernmost well results). If ANOVA does not identify a statistically significant difference between upgradient and downgradient wells, then the results are consistent with the historical ASD.

Technetium-99 (pCi/L)				
Date	**Background**	**Compliance**		
	MW93A	MW90A	n_i^2	
Nov-22	8.65E+00	**2.23E+01**	7.48E+01	4.97E+02
Jan-23	9.15E+00	1.19E+01	8.37E+01	1.40E+02
Jul-23	9.35E+00	**2.47E+01**	8.74E+01	6.10E+02
Jan-24	8.30E+00	**4.35E+01**	6.89E+01	1.89E+03
Jul-24	9.95E+00	**4.53E+01**	9.90E+01	2.05E+03
Sum (x_i)	4.54E+01	1.48E+02	1.93E+02	Total Sum (x..)
n_i	5	5		
$(x_i)_{avg}$	9.08E+00	2.95E+01		
$(x_i)^2$	2.06E+03	2.18E+04		

pCi/L = picocuries per liter
Nondetect values are 1/2 DL.
Bolded values indicate a detected result.

Overall mean x.. =	1.93E+01	
N =	10	N = the total number of samples
p =	2	p = the number of n_i groups
$x_{..}$ =	1.93E+02	x.. = the sum of the total number of samples

Determine Normality of Dataset

Coefficient of Variability Test

Table of Residuals ($x_i - x_{iavg}$)

Date	**Background**	**Compliance**
	MW93A	**MW90A**
Nov-22	-4.30E-01	-7.23E+00
Jan-23	7.00E-02	-1.77E+01
Jul-23	2.70E-01	-4.83E+00
Jan-24	-7.80E-01	1.40E+01
Jul-24	8.70E-01	1.58E+01

X: Mean Value =	1.78E-15	
S: Standard Deviation =	9.62E+00	
K* Factor =	2.911	(for n = 10)
CV = S/X =	5.42E+15	≥1, data are NOT normally distributed

*Table 5, Appendix B, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance* (EPA 1989).

If the coefficient of variation is < 1, the data are normally distributed.
If the coefficient of variation is > or = 1, data are not normally distributed.

Attachment B3: Technetium-99 URGA, Statistical Test 2, Test of Proportions, Second Reporting Period 2024

Determine Equality of Variance of Dataset

p = number of wells
n_i = number of data points per well
N = total sample size
S^2 = the square of the standard deviation
$\ln(S_i^2)$ = natural logarithm of each variance
f = total sample size minus the number of wells (groups)
$f_i = n_i - 1$

$x_{..} =$ 1.93E+02
$(x_{avg})_{..} =$ 1.93E+01
$n_i =$ 5
p = 2
N = 10
f_i = 4

Calculations for Equality of Variance: Bartlett's Test

S_i	S_i^2	$\ln(S_i^2)$†	n_i	$f_iS_i^2$	$f_i\ln(S_i^2)$†
6.38E-01	4.07E-01	-8.99E-01	5	1.63E+00	-3.60E+00
1.44E+01	2.08E+02	5.34E+00	5	8.32E+02	2.14E+01

$\sum(S_i^2) =$ 2.08E+02 $\sum f_i\ln(S_i^2) =$ 1.78E+01

Equality of Variance: Bartlett's Test

f = 8
$Sp^2 =$ 1.04E+02
$\ln Sp^2 =$ 4.65E+00
$\chi^2 =$ 1.94E+01 (If calculated $\chi^2 \leq$ tabulated χ^2_{crit}, then variances are equal at the given significance level.)
χ^2_{crit} * = 3.84E+00 at a 5% significance level with 1 degree of freedom (p-1)

NOTE: The variances are NOT equal.") (i.e., calculated $\chi^2 > \chi^2_{crit}$)

Variances are not equal, transform the original data to lognormal
(i.e., since calculated c2 > c2crit).
*Table 1, Appendix B, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance* (EPA 1989).

Attachment B3: Technetium-99 URGA, Statistical Test 2, Test of Proportions, Second Reporting Period 2024

Paired (Parametric) ANOVA—Lognormal Data

ln[Technetium-99 (pCi/L)]				
Date	Background	Compliance		
	MW93A	MW90A	n_i^2	
Nov-22	2.16E+00	**3.10E+00**	4.66E+00	9.64E+00
Jan-23	2.21E+00	2.47E+00	4.90E+00	6.11E+00
Jul-23	2.24E+00	**3.21E+00**	5.00E+00	1.03E+01
Jan-24	2.12E+00	**3.77E+00**	4.48E+00	1.42E+01
Jul-24	2.30E+00	**3.81E+00**	5.28E+00	1.45E+01
Sum (x_i)	1.10E+01	1.64E+01	2.74E+01	Total Sum (x..)
n_i	5	5		
$(x_i)_{avg}$	2.20E+00	3.27E+00		
$(x_i)^2$	1.21E+02	2.68E+02		

pCi/L = picocuries per liter **Bolded values indicate a detected result.**

Overall mean x.. =	2.74E+00	
N =	10	N = the total number of samples
p =	2	p = the number of n_i groups
$x_{..}$ =	2.74E+01	x.. = the sum of the total number of samples

Determine Normality of Dataset

Coefficient of Variability Test—Lognormal Data

Table of Residuals (x_i-$x_i$avg) for Lognormal Data

Date	Background	Compliance
	MW93A	MW90A
Nov-22	-4.65E-02	-1.69E-01
Jan-23	9.65E-03	-8.02E-01
Jul-23	3.13E-02	-6.72E-02
Jan-24	-8.78E-02	4.99E-01
Jul-24	9.35E-02	5.39E-01

X: Mean Value =	-8.88E-17	
S: Standard Deviation =	3.70E-01	
K* Factor =	2.911	(for n = 10)
CV = S/X =	–4.17E+15	<1, data are normally distributed

Data are normally distributed (i.e., < or =1)

*Table 5, Appendix B, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance* (EPA 1989).

If the coefficient of variation is < 1, the residuals are normally distributed.
If the coefficient of variation is > or = 1, the residuals are not normally distributed.

Attachment B3: Technetium-99 URGA, Statistical Test 2, Test of Proportions, Second Reporting Period 2024

Determine Equality of Variance—Lognormal Data

p = number of wells	$x_{..} =$ 2.74E+01
n_i = number of data points per well	$(x_{avg})_{..} =$ 2.74E+00
N = total sample size	$n_{i} =$ 5
S^2 = the square of the standard deviation	p = 2
$\ln(S_i^2)$ = natural logarithm of each variance	N = 10
f = total sample size minus the number of wells (groups)	f_i = 4
$f_i = n_i - 1$	

Calculations for Equality of Variance: Bartlett's Test

S_i	S_i^2	$\ln(S_i^2)$	n_i	$f_iS_i^2$	$f_i\ln(S_i^2)$
7.02E-02	4.92E-03	-5.31E+00	5	1.97E-02	-2.13E+01
5.51E-01	3.04E-01	-1.19E+00	5	1.22E+00	-4.76E+00

$\sum(S_i^2) =$ 3.09E-01 $\sum f_i\ln(S_i^2) =$ -2.60E+01

Equality of Variance: Bartlett's Test

f =	8	
Sp^2 =	1.54E-01	
ln Sp^2 =	-1.87E+00	
χ^2 =	1.11E+01	(If calculated $\chi^2 \leq$ tabulated χ^2_{crit}, then variances are equal at the given significance level).
χ^2_{crit} * =	3.84E+00	at a 5% significance level with 1 degrees of freedom (p-1)

NOTE: The variances are NOT equal. (i.e., calculated $\chi^2 \leq \chi^2_{crit}$)

Since the variances are not equal, paired (nonparametric) ANOVA is performed.

*Table 1, Appendix B, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance* (EPA 1989).

**Section 5.2, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance* (EPA 1989)].

Paired Nonparametric ANOVA - MW93A vs MW84A

Technetium-99 (pCi/L)		
Date	Background	Compliance
	MW93A	MW84A
Nov-22	8.65E+00	**6.40E+01**
Jan-23	9.15E+00	**2.02E+02**
Jul-23	9.35E+00	**6.42E+01**
Jan-24	8.30E+00	**8.60E+01**
Jul-24	9.95E+00	**9.35E+01**
Sum	4.54E+01	5.10E+02
n_i	5	5
$(x_i)_{avg}$	9.08E+00	1.02E+02

pCi/L = picocuries per liter
DL = detection limit
All data sets represent 1/2 DL values for nondetects.
Bolded values indicate a detected result.

Overall mean x.. = 5.55E+01
N = 10
p = 2
x.. = 5.55E+02

Ranking of Observations

Sequence	Technetium-99	Adjusted	Tie Number
1	0	3	
2	0	3	
3	0	3	Tie 1
4	0	3	
5	0	3	
6	**6.40E+01**	6	
7	**6.42E+01**	7	
8	**8.60E+01**	8	
9	**9.35E+01**	9	
10	**2.02E+02**	10	

pCi/L = picocuries per liter
Bolded values indicate a detected result.

n_{tie}	Adjustment for Ties: $(n_{tie}^3 - n_{tie})$	
5	Tie 1 =	120
	$\sum T_i$ =	120

Note: for this method, observations below the detection that are considered non-detects (i.e., U qualified data) are reported as a concentration 0.

Sums of Ranks and Averages

Observation Ranks for Tc-99		
Date	Background	Compliance
	MW93A	MW84A
Nov-22	3	6
Jan-23	3	10
Jul-23	3	7
Jan-24	3	8
Jul-24	3	9
R_i	15	40
$(R_i)_{avg}$	3.0	8
R_i^2/n_i	45.0	320.0

$\Sigma R_i^2/n_i$ = 365
K = 2
N = 10

K = the number of n_i groups
N = the total number of samples

Attachment B3: Technetium-99 URGA, Statistical Test 2, Test of Proportions, Second Reporting Period 2024

Calculation of Kruskal-Wallis Statistic

H =	6.82E+00	Kruskal-Wallis Statistic	$H = [12/N(N+1)*\Sigma R_i^2/n_i] - 3(N+1)$
H' =	7.76E+00	Corrected Kruskal-Wallis	$H' = H/[1-(\sum T_i/N^3-N)]$
χ^2_{crit} * =	3.84E+00	1	degrees of freedom at the 5% significance level

NOTE: $H' > \chi^2_{crit}$

If $H' \leq \chi^2_{crit}$, the data from each well comes from the same continuous distribution and hence have the same median concentrations of a specific constituent.
If $H' > \chi^2_{crit}$, reject the null hypothesis and calculate the critical difference for well comparisons to the background.

K-1 =	1	α/(K-1) =	5.00E-02	Z(α/(K-1))** =	1.64E+00
α =	0.05	1-(α/K-1) =	9.50E-01		

*Table 1, Appendix B, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance* (EPA 1989).
**Table 4, Appendix B, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance* (EPA 1989).

Calculate Critical Values

Average Background Ranking = 3.000

	Well No.	C_i	$(R_i)_{avg} - (R_b)_{avg}$	Conclusion
BG Well	MW93A			
	MW84A	3.15E+00	5.00E+00	**evidence of contamination**

pCi/L = picocuries per liter

CONCLUSION: If $(R_i)_{avg} - (R_b)_{avg} > C_i$, then there is evidence that the compliance well is contaminated.

If $(R_i)_{avg} - (R_b)_{avg} < C_i$ for wells, there is no evidence of a statistically significant difference between concentrations in downgradient compliance test wells and background wells.

Since (Ri)avg - (Rb)avg > Ci for MW84A, there is a statistically significant difference in this downgradient compliance test well.

Because the nonparametric ANOVA for the two wells indicated a statistically significant difference between compliance test wells and background wells at the C-404 Landfill in compliance well MW84A, a Mann Kendall statistical analysis was performed.

Section 5.2.2, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance* (EPA 1989).

Paired Nonparametric ANOVA - MW93A vs. MW90A

Technetium-99 (pCi/L)		
Date	Background	Compliance
	MW93A	MW90A
Nov-22	8.65E+00	**2.23E+01**
Jan-23	9.15E+00	1.19E+01
Jul-23	9.35E+00	**2.47E+01**
Jan-24	8.30E+00	**4.35E+01**
Jul-24	9.95E+00	**4.53E+01**
Sum	4.54E+01	1.48E+02
n_i	5	5
$(x_i)_{avg}$	9.08E+00	2.95E+01

pCi/L = picocuries per liter
DL = detection limit
All data sets represent 1/2 DL values for nondetects.
Bolded values indicate a detected result.

Overall mean x.. = 1.93E+01
N = 10
p = 2
x.. = 1.93E+02

Ranking of Observations

Sequence	Technetium-99	Adjusted	Tie Number
1	0	3.5	Tie 1
2	0	3.5	
3	0	3.5	
4	0	3.5	
5	0	3.5	
6	0	3.5	
7	**2.23E+01**	7	
8	**2.47E+01**	8	
9	**4.35E+01**	9	
10	**4.53E+01**	10	

pCi/L = picocuries per liter
Bolded values indicate a detected result.

n_{tie}	Adjustment for Ties: $(n_{tie}^3 - n_{tie})$	
6	Tie 1 =	210
	$\sum T_i$ =	210

Note: for this method, observations below the detection that are considered non-detects (i.e., U qualified data) are reported as a concentration 0.

Sums of Ranks and Averages

Observation Ranks for Tc-99		
Date	Background	Compliance
	MW93A	MW84A
Nov-22	3.5	7
Jan-23	3.5	3.5
Jul-23	3.5	8
Jan-24	3.5	9
Jul-24	3.5	10
R_i	17.5	37.5
$(R_i)_{avg}$	3.5	7.5
R_i^2/n_i	61.3	281.3

$\Sigma R_i^2/n_i$ = 342.5
K = 2
N = 10

K = the number of n_i groups
N = the total number of samples

Attachment B3: Technetium-99 URGA, Statistical Test 2, Test of Proportions, Second Reporting Period 2024

Calculation of Kruskal-Wallis Statistic

H =	4.36E+00	Kruskal-Wallis Statistic	$H = [12/N(N+1)*\Sigma R_i^2/n_i] - 3(N+1)$
H' =	5.54E+00	Corrected Kruskal-Wallis	$H' = H/[1-(\sum T_i/N^3-N)]$
χ^2_{crit} * =	3.84E+00	1	degrees of freedom at the 5% significance level

NOTE: $H' > \chi^2_{crit}$

If $H' \leq \chi^2_{crit}$, the data from each well comes from the same continuous distribution and hence have the same median concentrations of a specific constituent.
If $H' > \chi^2_{crit}$, reject the null hypothesis and calculate the critical difference for well comparisons to the background.

K-1 =	1	α/(K-1) =	5.00E-02	Z(α/(K-1))** =	1.64E+00
α =	0.05	1-(α/K-1) =	9.50E-01		

*Table 1, Appendix B, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance* (EPA 1989).
**Table 4, Appendix B, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance* (EPA 1989).

Calculate Critical Values

Average Background Ranking = 3.500

	Well No.	C_i	$(R_i)_{avg} - (R_b)_{avg}$	Conclusion
BG Well	MW93A			
	MW90A	3.15E+00	4.00E+00	**evidence of contamination**

pCi/L = picocuries per liter

CONCLUSION: If $(R_i)_{avg} - (R_b)_{avg} > C_i$, then there is evidence that the compliance well is contaminated.

If $(R_i)_{avg} - (R_b)_{avg} < C_i$ for wells, there is no evidence of a statistically significant difference between concentrations in downgradient compliance test wells and background wells.

Since (Ri)avg - (Rb)avg > Ci for MW90A, there is a statistically significant difference in this downgradient compliance test well.

Because the nonparametric ANOVA for the two wells indicated a statistically significant difference between compliance test wells and background wells at the C-404 Landfill in compliance well MW90A, a Mann Kendall statistical analysis was performed.

Section 5.2.2, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance* (EPA 1989).

Attachment B3: Technetium-99 URGA, Statistical Test 2, Test of Proportions, Second Reporting Period 2024

Mann-Kendall Trend Test Analysis

User Selected Options	
Date/Time of Computation	ProUCL 5.2 9/26/2024 4:02:35 PM
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

Input Data

Date Collected	Result (pCi/L)
Jan-22	2.25E+02
May-22	**4.79E+01**
Jul-22	**4.72E+01**
Nov-22	**6.40E+01**
Jan-23	2.02E+02
Jul-23	**6.42E+01**
Jan-24	**8.60E+01**
Jul-24	**9.35E+01**

Bolded values indicate a detected result.

MW84A_Tc-99_period_2_2024

General Statistics

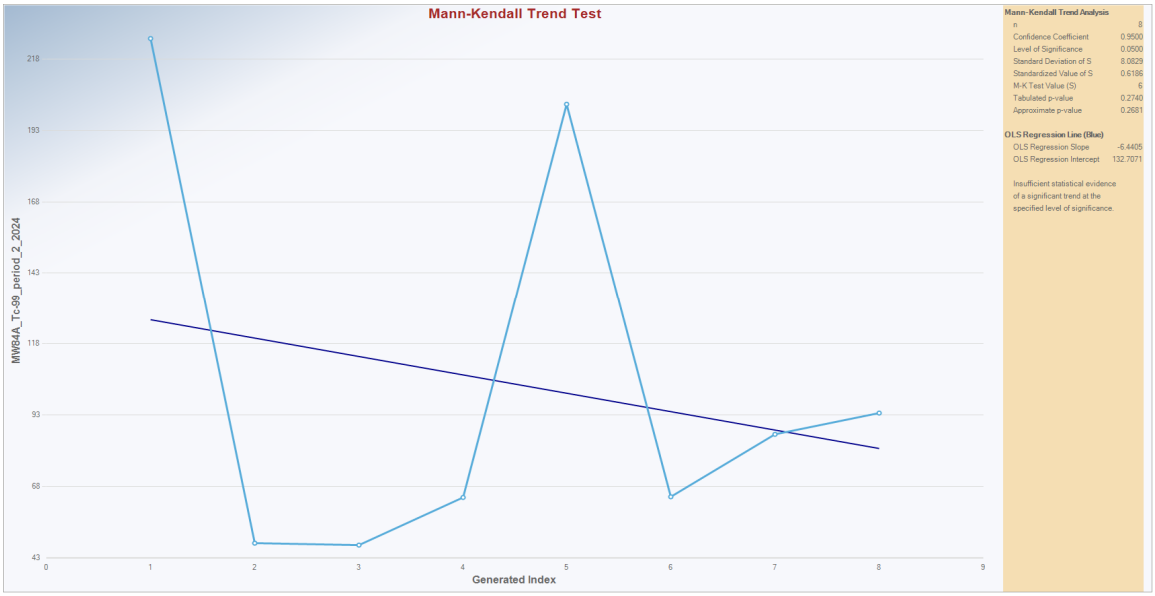
Number or Reported Events Not Used	0
Number of Generated Events	8
Number Values Reported (n)	8
Minimum	47.2
Maximum	225
Mean	103.7
Geometric Mean	87.37
Median	75.1
Standard Deviation	69.93
Coefficient of Variation	0.674

Mann-Kendall Test

M-K Test Value (S)	6
Tabulated p-value	0.274
Standard Deviation of S	8.083
Standardized Value of S	0.619
Approximate p-value	0.268

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis for Technetium-99 in MW84A



Attachment B3: Technetium-99 URGA, Statistical Test 2, Test of Proportions, Second Reporting Period 2024

Input Data

Date Collected	Result (pCi/L)
Jan-22	**7.36E+00**
May-22	**3.44E+01**
Jul-22	**2.57E+01**
Nov-22	**2.23E+01**
Jan-23	2.16E+01
Jul-23	**2.47E+01**
Jan-24	**4.35E+01**
Jul-24	**4.53E+01**

Bolded values indicate a detected result.

Mann-Kendall Trend Test Analysis

User Selected Options	
Date/Time of Computation	ProUCL 5.2 9/26/2024 4:21:32 PM
From File	WorkSheet_a.xls
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

MW90A_Tc-99_Period_2_2024

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	8
Number Values Reported (n)	8
Minimum	7.36
Maximum	45.3
Mean	28.11
Geometric Mean	25
Median	25.2
Standard Deviation	12.51
Coefficient of Variation	0.445

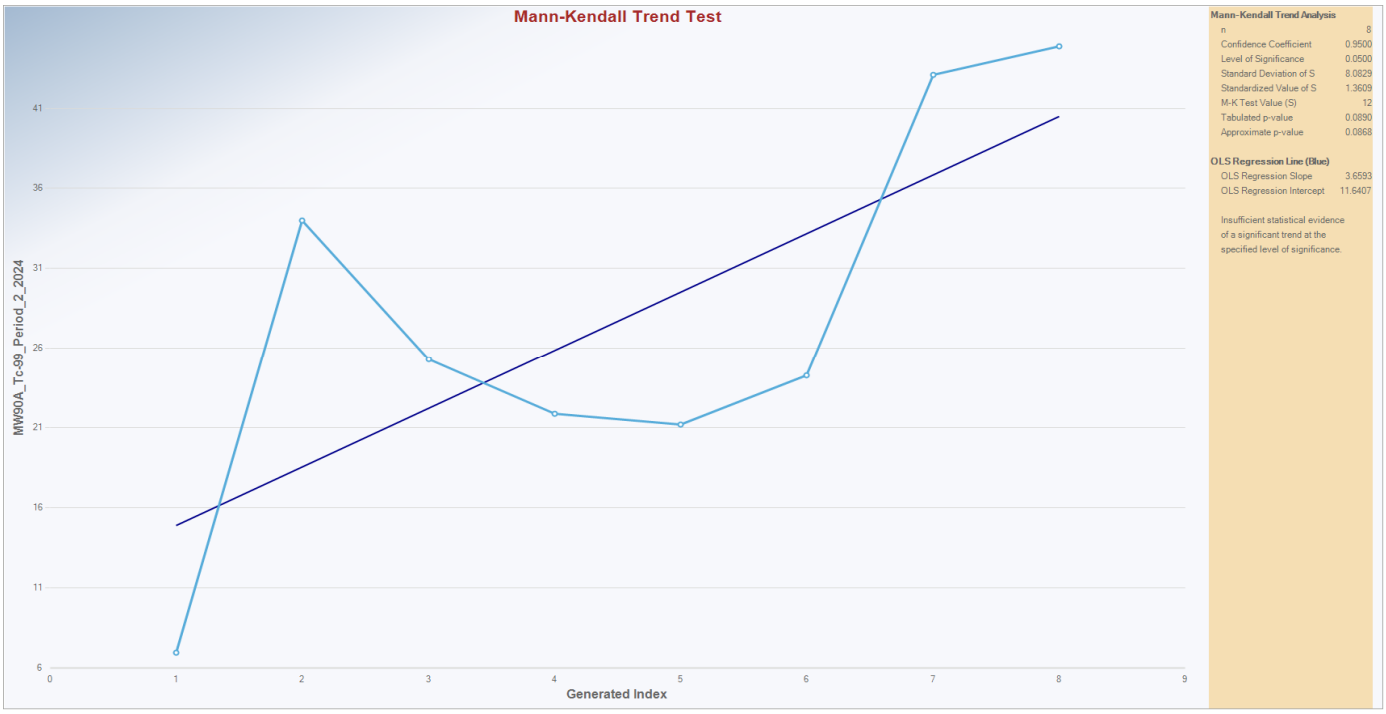
Mann-Kendall Test

M-K Test Value (S)	12
Tabulated p-value	0.089
Standard Deviation of S	8.083
Standardized Value of S	1.361
Approximate p-value	0.0868

Insufficient evidence to identify a significant trend at the specified level of significance.

Attachment B3: Technetium-99 URGA, Statistical Test 2, Test of Proportions, Second Reporting Period 2024

Mann-Kendall Trend Analysis for Technetium-99 in MW90A



ATTACHMENT B4

TRICHLOROETHENE
STATISTICAL TEST 4

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Attachment B4: Trichloroethene URGA, Statistical Test 4, Parametric ANOVA, Second Reporting Period 2024

Trichloroethene (TCE, µg/L)					
Date	Background	Background	Compliance	Compliance	Compliance
	MW93A	MW420	MW84A	MW87A	MW90A
Jul-Aug-22	**1.63E+03**	**1.62E+03**	**6.57E+03**	**1.40E+03**	**2.22E+02**
Jan-23	**1.96E+03**	**2.11E+03**	**7.00E+03**	**2.14E+03**	**2.96E+02**
Jul-23	**1.88E+03**	**2.09E+03**	**5.87E+03**	**2.16E+03**	**2.67E+02**
Jan-24	**1.32E+03**	**2.60E+03**	**6.09E+03**	**1.69E+03**	**3.13E+02**
Jul-24	**5.54E+02**	**1.79E+03**	**5.11E+03**	**1.00E+03**	**1.77E+02**
n_i	10		5	5	5
Sum	1.76E+04		3.06E+04	8.39E+03	1.28E+03
(x_i)avg	1.76E+03		6.13E+03	1.68E+03	2.55E+02

µg/L = micrograms per liter
Bolded values indicate a detected result.

Overall mean x.. =	2.31E+03	
N =	25	N = the total number of samples
p =	4	p = the number of n_i groups
x.. =	5.79E+04	x.. = the sum of the total number of samples

Determine Normality of Dataset

Coefficient of Variability Test

Table of Residuals

Date	Background	Background	Compliance	Compliance	Compliance
	MW93A	MW420	MW84A	MW87A	MW90A
Jul-Aug-22	-1.25E+02	-1.35E+02	4.42E+02	-2.78E+02	-3.30E+01
Jan-23	2.05E+02	3.55E+02	8.72E+02	4.62E+02	4.10E+01
Jul-23	1.25E+02	3.35E+02	-2.58E+02	4.82E+02	1.20E+01
Jan-24	-4.35E+02	8.45E+02	-3.80E+01	1.20E+01	5.80E+01
Jul-24	-1.20E+03	3.46E+01	-1.02E+03	-6.78E+02	-7.80E+01

X: Mean Value =	-3.64E-14	
S: Standard Deviation =	4.89E+02	
K* Factor =	2.292	(for n = 25)
CV = S/X =	-1.34E+16	

Conclusion: Since the coefficient of variability is less than 1, the data are normally distributed.

*K factor [from Table 5, Appendix B of *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance* (EPA 1989)].

If the coefficient of variation is < 1, the data are normally distributed.
If the coefficient of variation is > or = 1, data are not normally distributed.

Attachment B4: Trichloroethene URGA, Statistical Test 4, Parametric ANOVA, Second Reporting Period 2024

Determine Equality of Variance of Dataset

p = number of well groups
n_i = number of data points per well
N = total sample size
S^2 = the square of the standard deviation
$\ln(S_i^2)$ = natural logarithm of each variance
f = total sample size minus the number of wells (groups)
$f_i = n_i - 1$
x.. = the sum of the total number of samples
$(x_{avg})_{..}$ = the mean of the total number of samples

$x_{..} =$ 5.79E+04
$(x_{avg})_{..} =$ 2.31E+03
p = 4
N = 25

Calculations for Equality of Variance: Bartlett's Test

S_i	S_i^2	$\ln(S_i^2)$	n_i	$f_i S_i^2$	$f_i \ln(S_i^2)$
5.45E+02	2.97E+05	1.26E+01	10	2.68E+06	1.13E+02
7.18E+02	5.15E+05	1.32E+01	5	2.06E+06	5.26E+01
4.96E+02	2.46E+05	1.24E+01	5	9.83E+05	4.96E+01
5.56E+01	3.09E+03	8.04E+00	5	1.24E+04	3.21E+01

$\sum(S_i^2) =$ 1.06E+06 $\sum f_i \ln(S_i^2) =$ 2.48E+02

Equality of Variance: Bartlett's Test

f = 21
$Sp^2 =$ 2.73E+05
$\ln Sp^2 =$ 1.25E+01
$c^2 =$ 1.50E+01 (If $c^2 \leq c^2_{crit}$, then variances are equal at the given significance level).
c^2_{crit} * = 7.81E+00 at a 5% significance level with 3 degrees of freedom

NOTE: The variances are NOT equal. **(i.e., $c^2 > c^2_{crit}$)**

Variances are not equal, transform the original data to lognormal (i.e., since $c^2 > c^2_{crit}$).

*Table 1, Appendix B, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance* (EPA 1989).

Attachment B4: Trichloroethene URGA, Statistical Test 4, Parametric ANOVA, Second Reporting Period 2024

Lognormal Data for TCE

ln[TCE (µg/L)]					
Date	Background	Background	Compliance	Compliance	Compliance
	MW93A	MW420	MW84A	MW87A	MW90A
Jul-Aug-22	7.40E+00	7.39E+00	8.79E+00	7.24E+00	5.40E+00
Jan-23	7.58E+00	7.65E+00	8.85E+00	7.67E+00	5.69E+00
Jul-23	7.54E+00	7.64E+00	8.68E+00	7.68E+00	5.59E+00
Jan-24	7.19E+00	7.86E+00	8.71E+00	7.43E+00	5.75E+00
Jul-24	6.32E+00	7.49E+00	8.54E+00	6.91E+00	5.18E+00
Mean x_i	7.20E+00	7.61E+00	8.71E+00	7.39E+00	5.52E+00
Background Mean	7.41E+00		NA	NA	NA
Grand Mean	7.29E+00				
x_i^2	5.47E+01	5.46E+01	7.73E+01	5.25E+01	2.92E+01
	5.75E+01	5.86E+01	7.84E+01	5.88E+01	3.24E+01
These values needed for ANOVA	5.68E+01	5.84E+01	7.53E+01	5.89E+01	3.12E+01
	5.16E+01	6.18E+01	7.59E+01	5.52E+01	3.30E+01
	3.99E+01	5.61E+01	7.29E+01	4.77E+01	2.68E+01
Sum x_i^2	1.36E+03				

µg/L = micrograms per liter

Determine Normality of Dataset

Coefficient of Variability Test

Table of ln[TCE (µg/L)] Data

Date	Background	Background	Compliance	Compliance	Compliance
	MW93A	MW420	MW84A	MW87A	MW90A
Jul-Aug-22	7.40E+00	7.39E+00	8.79E+00	7.24E+00	5.40E+00
Jan-23	7.58E+00	7.65E+00	8.85E+00	7.67E+00	5.69E+00
Jul-23	7.54E+00	7.64E+00	8.68E+00	7.68E+00	5.59E+00
Jan-24	7.19E+00	7.86E+00	8.71E+00	7.43E+00	5.75E+00
Jul-24	6.32E+00	7.49E+00	8.54E+00	6.91E+00	5.18E+00

X: Mean Value = 7.29E+00
S: Standard Deviation = 1.09E+00
K* Factor = 2.292 (for n = 25)
CV = S/X = 1.49E-01 <1, data are normally distributed

Data are normally distributed (i.e.,<1)

*K factor [from Table 5, Appendix B of *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance* (EPA 1989)].

Attachment B4: Trichloroethene URGA, Statistical Test 4, Parametric ANOVA, Second Reporting Period 2024

Determine Equality of Variance of Dataset for Lognormal Data

p = number of wells (background wells considered as one group)
n_i = number of data points per well
N = total sample size
S^2 = the square of the standard deviation
$\ln(S_i^2)$ = natural logarithm of each variance
f = total sample size minus the number of wells (groups)
$f_i = n_i - 1$
x.. = the sum of the total lognormal dataset
$(x_{avg})_{..} =$ the mean of the lognormal dataset

$x_{..} =$ 1.82E+02
$(x_{avg})_{..} =$ 7.29E+00
$n_i =$ 5
p = 4
N = 25

Calculations for Equality of Variance: Bartlett's Test

S_i	S_i^2	$\ln(S_i^2)$	ni	$f_iS_i^2$	$f_i\ln(S_i^2)$
4.24E-01	1.80E-01	-1.72E+00	10	1.62E+00	-1.54E+01
1.20E-01	1.43E-02	-4.25E+00	5	5.73E-02	-1.70E+01
3.22E-01	1.04E-01	-2.26E+00	5	4.16E-01	-9.05E+00
2.33E-01	5.42E-02	-2.92E+00	5	2.17E-01	-1.17E+01

$\sum(S_i^2) =$ 3.52E-01 $\sum f_i\ln(S_i^2) =$ -5.31E+01

Equality of Variance: Bartlett's Test

f = 21
$Sp^2 =$ 1.10E-01
$\ln Sp^2 =$ -2.21E+00
$c^2 =$ 6.77E+00 (If $c^2 \le c^2_{crit}$, then variances are equal at the given significance level).
c^2_{crit} * = 7.81E+00 at a 5% significance level with 3 degrees of freedom

NOTE: The variances are equal. (i.e., $c^2 \le c^2_{crit}$)

Because variances are equal, the Parametric ANOVA for the lognormal dataset will proceed.

*Table 1, Appendix B, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance* (EPA 1989)].

**Section 5.2, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance* (EPA 1989)].

Attachment B4: Trichloroethene URGA, Statistical Test 4, Parametric ANOVA, Second Reporting Period 2024

Parametric ANOVA

Between Well Sum of Squares[1]

Source of Variation	Sums of Squares	df	Mean Squares	$F_{calculated}$
Between Wells (SS wells)	2.60E+01	3	8.66E+00	7.88E+01
Error within wells (SS error)	2.31E+00	21	1.10E-01	
Total (SS total)	2.83E+01	24		

If $F_{calculated} > F_{tabulated}$, then reject the hypothesis of equal well means. If $F_{calculated}$ is less than or equal to $F_{tabulated}$, it can be concluded that there is no significant difference between concentrations, therefore, there is no evidence of well contamination.

$F_{tabulated}$ = 3.07E+00**

CONCLUSION: **$F_{calculated} > F_{tabulated}$; therefore, evidence of well contamination. Additional comparisons must be made.**

NOTE: ** Table 2, Appendix B, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance* , USEPA, 1989. $F_{tabulated}$ taken at the 5% significance level.

Comparison of Compliance Wells to Background Wells (Bonferroni Test)

n_b =	10	N-p =	21	α =	0.05
$(x_b)_{avg}$ =	7.41E+00	m =	3	α/m =	1.67E-02

n_b = total sample size of all background wells

$(x_b)_{avg}$ = average concentration from all background wells

Well No.	Well Mean	Differences of Avg.	Standard Error	Bonferroni's t[2]	D_i	Conclusion
	$(x_b)_{avg}$	$(x_i)_{avg}-(x_b)_{avg}$	SE_i	$t_{(N-p),(\alpha/m)}$		
MW93A						
MW420						
MW84A	8.71E+00	1.31E+00	1.82E-01	2.27	0.41	**evidence of contamination**
MW87A	7.39E+00	-2.00E-02	1.82E-01	2.27	0.41	not contaminated
MW90A	5.52E+00	-1.89E+00	1.82E-01	2.27	0.41	not contaminated

CONCLUSION: **If the "Differences of Averages" is greater than D_i, then the well is contaminated. After performing Bonferroni's t calculation, the following can be concluded: MW84A shows statistically significantly levels of contamination as compared background wells. MW87A and MW90A do not show statistically significant levels of contamination.**

[1]Section 5.2.1, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Final Guidance* , (EPA, 1989).

[2]Appendix B, Table 3 (EPA, 1989).

A 95% UTL comparison is performed.

Attachment B4: Trichloroethene URGA, Statistical Test 4, Parametric ANOVA, Second Reporting Period 2024

95% Upper Tolerance Limit (UTL)

Compare the most recent downgradient sample results to a calculated 95% UTL using the five most recent sets of data for each upgradient well, as described below. If downgradient concentration is less than the UTL for the paired upgradient concentrations, then there is no confirmed exceedance.

July 2024 Data, Second Reporting Period
TCE Observations (µg/L)

Well No.						
MW93A	**1.63E+03**	**1.96E+03**	**1.88E+03**	**1.32E+03**	**5.54E+02**	**Upgradient Well!**
MW420	**1.62E+03**	**2.11E+03**	**2.09E+03**	**2.60E+03**	**1.79E+03**	**Upgradient Well!**
						Current Data
MW84A						**5.11E+03**
	X: Mean Value =		1.76E+03			
	S: Standard Deviation =		5.45E+02			
	K* factor =		2.911	(for n = 10)		
	CV = S/X		3.11E-01	<1, assume normal distribution		
	Upper Tolerance Interval: TL = X +(KxS) =		**3.34E+03**	(µg/L)		

! = Data from previous 5 sampling events.
CV = coefficient of variation
* = Table 5, Appendix B, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance* (EPA 1989).

Result: **MW84A exceeded the 95% UTL, which is statistically significant evidence that this compliance well has elevated TCE concentrations with respect to background data.**

Conclusion: **Because the 95% UTL indicated a statistically significant difference between compliance test wells and background wells at the C-404 Landfill in compliance well MW84A, the paired ANOVA was performed.**

Paired (Parametric) ANOVA - MW93A and MW84A

Evaluate results using paired ANOVA of wells in the same direction relative to the landfill [e.g., compare upgradient westernmost well results to downgradient westernmost well results]. If ANOVA does not identify a statistically significant difference between upgradient and downgradient wells, then the results are consistent with the historical ASD.

TCE (µg/L)				
Date	Background	Compliance		
	MW93A	MW84A	n_i^2	
Jul-Aug-22	**1.63E+03**	**6.57E+03**	2.66E+06	4.32E+07
Jan-23	**1.96E+03**	**7.00E+03**	3.84E+06	4.90E+07
Jul-23	**1.88E+03**	**5.87E+03**	3.53E+06	3.45E+07
Jan-24	**1.32E+03**	**6.09E+03**	1.74E+06	3.71E+07
Jul-24	**5.54E+02**	**5.11E+03**	3.07E+05	2.61E+07
Sum (x_i)	7.34E+03	3.06E+04	3.80E+04	Total Sum (x..)
n_i	5	5		
$(x_i)_{avg}$	1.47E+03	6.13E+03		
$(x_i)^2$	5.39E+07	9.39E+08		

µg/L = micrograms per liter
Bolded values indicate a detected result.

Overall mean x.. =	3.80E+03	
N =	10	N = the total number of samples
p =	2	p = the number of n_i groups
$x_{..}$ =	3.80E+04	x.. = the sum of the total number of samples

Determine Normality of Dataset

Coefficient of Variability Test

Table of Residuals (x_i-x_{iavg})

Date	Background	Compliance
	MW93A	MW84A
Jul-Aug-22	1.61E+02	4.42E+02
Jan-23	4.91E+02	8.72E+02
Jul-23	4.11E+02	-2.58E+02
Jan-24	-1.49E+02	-3.80E+01
Jul-24	-9.15E+02	-1.02E+03

X: Mean Value =	0.00E+00	
S: Standard Deviation =	6.11E+02	
K* Factor =	2.911	(for n = 10)
CV = S/X =	#DIV/0!	#DIV/0!

The Coefficient of Variability Test was not performed due to mean = 0 (i.e., division by 0 is not possible).

*Table 5, Appendix B, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance* (EPA 1989).

If the coefficient of variation is < 1, the data are normally distributed.
If the coefficient of variation is > or = 1, data are not normally distributed.

Determine Equality of Variance of Dataset

p = number of wells	$x_{..} =$ 3.80E+04
n_i = number of data points per well	$(x_{avg})_{..} =$ 3.80E+03
N = total sample size	$n_{i} =$ 5
S^2 = the square of the standard deviation	p = 2
$\ln(S_i^2)$ = natural logarithm of each variance	N = 10
f = total sample size minus the number of wells (groups)	f_i = 4
$f_i = n_i - 1$	

Calculations for Equality of Variance: Bartlett's Test

S_i	S_i^2	$\ln(S_i^2)$†	n_i	$f_iS_i^2$	$f_i\ln(S_i^2)$†
5.69E+02	3.24E+05	1.27E+01	5	1.30E+06	5.08E+01
7.18E+02	5.15E+05	1.32E+01	5	2.06E+06	5.26E+01

$\sum(S_i^2) =$ 8.39E+05 $\sum f_i\ln(S_i^2) =$ 1.03E+02

Equality of Variance: Bartlett's Test

f =	8	
Sp^2 =	4.19E+05	
ln Sp^2 =	1.29E+01	
c^2 =	2.13E-01	(If calculated $c^2 \leq$ tabulated c^2_{crit}, then variances are equal at the given significance level).
c^2_{crit} * =	3.84E+00	at a 5% significance level with 1 degrees of freedom (p-1)

NOTE: The variances are equal. (i.e., calculated $c^2 \leq c^2_{crit}$)

Since calculated $c^2 \leq c^2_{crit}$, then the analysis can proceed as normal.

*Table 1, Appendix B, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance* (EPA 1989).

Between Well Sum of Squares

Source of Variation	Sums of Squares		Degrees of Freedom	Mean Squares	Calculated F	F Statistic**
Between Wells	SS_{wells} =	5.43E+07	1	5.43E+07	1.29E+02	5.32E+00
Error	SS_{Error} =	3.36E+06	8	4.19E+05		
Total	SS_{Total} =	5.76E+07	9			

If calculated F > F statistic, then reject the hypothesis of equal well means. If calculated F is less than or equal to F statistic, it can be concluded that there is no significant difference between concentrations; therefore, there is no evidence of well contamination.

CONCLUSION: **Calculated F > F statistic; therefore, ANOVA has identified a significant difference between upgradient and downgradient wells.**

Mann-Kendall trend analysis was performed.

**Table 2, Appendix B, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance* (EPA 1989). F statistic taken at the 5% significance level.

Attachment B4: Trichloroethene URGA, Statistical Test 4, Parametric ANOVA, Second Reporting Period 2024

Mann-Kendall Trend Test Analysis

MW84A Trichloroethene Second Reporting Period 2024

Date/Time of Computation	ProUCL 5.2 9/30/2024 7:58:48 AM
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	0.95
Level of Significance	0.05

MW84A_TCE_Nov_2024

Input Data	
Date Collected	**Result (µg/L)**
Jan-21	**2.63E+03**
Jul-21	**5.29E+03**
Jan-22	**6.56E+03**
Jul-22	**6.57E+03**
Jan-23	**7.00E+03**
Jul-23	**5.87E+03**
Jan-24	**6.09E+03**
Jul-24	**5.11E+03**

Bolded values indicate a detected result.

General Statistics

Number or Reported Events Not Used	0
Number of Generated Events	8
Number Values Reported (n)	8
Minimum	2630
Maximum	7000
Mean	5640
Geometric Mean	5440
Median	5980
Standard Deviation	1377
Coefficient of Variation	0.244

Mann-Kendall Test

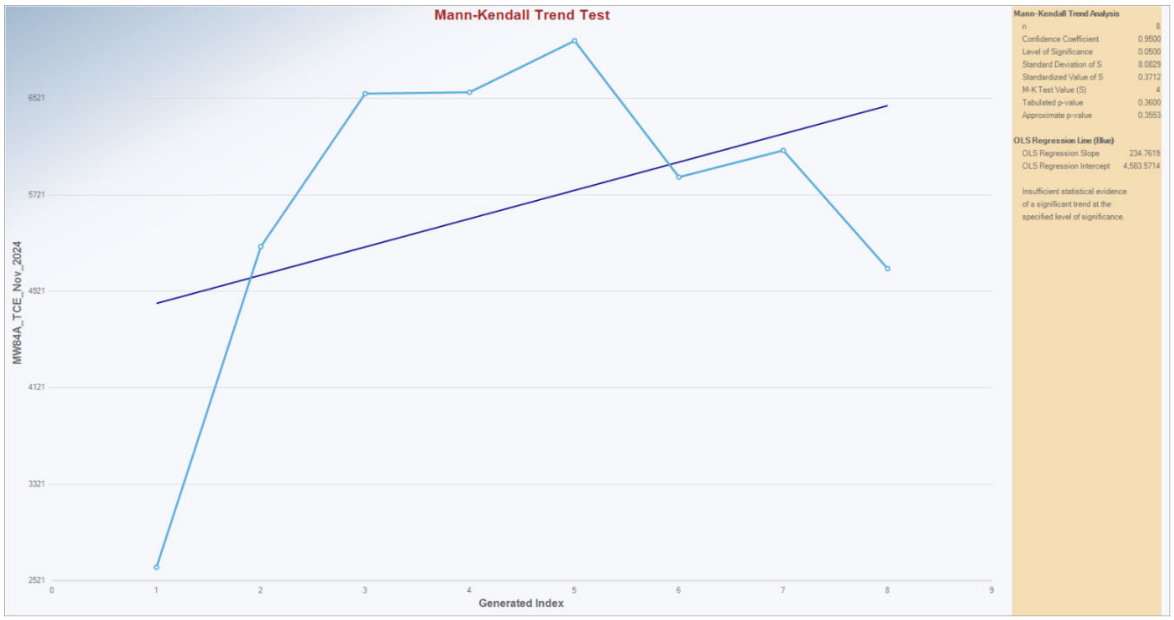
M-K Test Value (S)	4
Tabulated p-value	0.36
Standard Deviation of S	8.083
Standardized Value of S	0.371
Approximate p-value	0.355

Insufficient evidence to identify a significant trend at the specified level of significance.

Attachment B4: Trichloroethene URGA, Statistical Test 4, Parametric ANOVA, Second Reporting Period 2024

Mann-Kendall Trend Test Analysis

MW84A Trichloroethene November 2024



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ATTACHMENT B5

STATISTICIAN STATEMENT

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FOUR RIVERS
NUCLEAR PARTNERSHIP, LLC

Four Rivers Nuclear Partnership, LLC
5511 Hobbs Road
Kevil, KY 42053
www.fourriversnuclearpartnership.com

October 10, 2024

Mr. Dennis Greene
Four Rivers Nuclear Partnership, LLC
5511 Hobbs Road
Kevil, KY 42053

Dear Mr. Greene:

I am submitting this statement as a supplementary document to the completed statistical analysis I performed on the groundwater data for the C-404 Hazardous Waste Landfill at the Paducah Site.

As an Environmental Scientist, with a bachelor's degree in Earth Sciences/Geology, I have over 30 years of experience in reviewing and assessing laboratory analytical results associated with environmental sampling and investigation activities.

For this project, the statistical analyses on groundwater data from July–August 2022 through July 2024 were performed in accordance with the Hazardous Waste Management Facility Permit, Appendix E using Microsoft Excel 2016 and U.S. Environmental Protection Agency's (EPA's) ProUCL 5.2. The spreadsheets include the results for the following statistical tests:

- Test of Proportions
- Parametric Analysis of Variance (ANOVA)
- Nonparametric ANOVA
- 95% Upper Tolerance Limit
- Paired (parametric) ANOVA
- Paired (nonparametric) ANOVA
- Mann-Kendall

The statistical analyses procedures were based on EPA's *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Interim Final Guidance* (1989).

Sincerely,

Bryan Smith

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APPENDIX C

2024 ANNUAL REPORT OF THE C-404 LANDFILL HYDRAULIC FLOW RATE AND DIRECTION

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2024 ANNUAL REPORT OF THE C-404 LANDFILL HYDRAULIC FLOW RATE AND DIRECTION

The Hazardous Waste Management Facility Permit, KY8-890-008-982, (Permit) requires annual determination of average hydraulic flow rate and direction of flow in the uppermost aquifer at the C-404 Hazardous Waste Landfill (C-404 Landfill). The uppermost aquifer below C-404 Landfill is the Regional Gravel Aquifer (RGA). Water level measurements currently are taken from several wells at the perimeter of the C-404 Landfill on a semiannual basis. The water levels used for this analysis (taken on January 23, 2024, and July 24, 2024) were measured as closely as possible and within a 24-hour period to ensure the comparability of the data. Table C.1 documents the datums used for the water level measurements. These measurements were used to plot the potentiometric surface of the upper RGA for the January and July 2024 semiannual sampling events.

Table C.1. Measurement Control Datums Used for Upper Regional Gravel Aquifer C-404 Monitoring Wells During 2024

Well	Measurement Location	Datum Point Elevation (ft amsl)
MW84A	Top of Outside Casing	375.29
MW87A	Top of Outside Casing	375.30
MW90A	Top of Inside Casing	374.15
MW93A	Top of Outside Casing	378.67
MW420	Top of Inside Casing	377.55

Contours for each potentiometric surface were drawn after water level data were corrected for barometric pressure; groundwater hydraulic gradients then are calculated from the contours. The average of the gradients measured during this reporting period is the annual average groundwater hydraulic gradient for the upper RGA and is calculated at 1.17×10^{-3} ft/ft.

The hydraulic conductivity values reported in the *Resource Conservation and Recovery Act (RCRA) Part B Permit Modification for Inclusion of C-404 Low-Level Radioactive/Hazardous Waste Landfill* (June 1992) were determined by multi-well testing and range from 21 to 140 ft/day (7.41×10^{-3} to 4.94×10^{-2} cm/s).

Multiplication of the hydraulic gradient (i) and the hydraulic conductivity (K) yields the specific discharge (q) for a unit area of the RGA. Annual average linear-flow velocity (v) is calculated by multiplying the hydraulic conductivity by the gradient and dividing by the porosity (n). It is assumed that the porosity equals 25% in the RGA beneath the C-404 Landfill.

Table C.2 summarizes the annual average results of the calculations. Table C.3 presents the calculation information for the annual groundwater flow rate. The January 2024 and July 2024 potentiometric surface data of the upper RGA are presented in Tables C.4 and C.5, and potentiometric surface maps are presented in Figures C.1 and C.2.

The potentiometric contours depict the directions of hydraulic flow during each sampling event. Hydraulic flow direction beneath the C-404 Landfill generally trends northeastward, but commonly varies from northeast to north.

Table C.2. C-404 Landfill Annual Average Groundwater Flow Rate for 2024

Hydraulic Conductivity (K) Range	Annual Average Specific Discharge (q) ft/day (cm/s)	Annual Average Linear Flow Velocity (v) ft/day (cm/s)
Low K	2.45×10^{-2} (8.66×10^{-6})	9.85×10^{-2} (3.47×10^{-5})
High K	1.64×10^{-1} (5.77×10^{-5})	6.54×10^{-1} (2.31×10^{-4})

Table C.3. Calculation Information for the C-404 Landfill Annual Groundwater Flow Rate 2024

Upper RGA K = 21 ft/d					
	i (ft/ft)	**q (ft/d)**	**q (cm/s)**	**v (ft/d)**	**v (cm/s)**
January 2024	-1.23×10^{-3}	2.59×10^{-2}	9.15×10^{-6}	1.04×10^{-1}	3.66×10^{-5}
July 2024	-1.10×10^{-3}	2.31×10^{-2}	8.16×10^{-6}	9.30×10^{-2}	3.27×10^{-5}
Annual Average	$\mathbf{-1.17 \times 10^{-3}}$	$\mathbf{2.45 \times 10^{-2}}$	$\mathbf{8.66 \times 10^{-6}}$	$\mathbf{9.85 \times 10^{-2}}$	$\mathbf{3.47 \times 10^{-5}}$
Upper RGA K = 140 ft/d					
	i (ft/ft)	**q (ft/d)**	**q (cm/s)**	**v (ft/d)**	**v (cm/s)**
January 2024	-1.23×10^{-3}	1.73×10^{-1}	6.10×10^{-5}	6.91×10^{-1}	2.44×10^{-4}
July 2024	-1.10×10^{-3}	1.54×10^{-1}	5.44×10^{-5}	6.17×10^{-1}	2.18×10^{-4}
Annual Average	$\mathbf{-1.17 \times 10^{-3}}$	$\mathbf{1.64 \times 10^{-1}}$	$\mathbf{5.77 \times 10^{-5}}$	$\mathbf{6.54 \times 10^{-1}}$	$\mathbf{2.31 \times 10^{-4}}$

$q = K*I$

where:
q = specific discharge
v = average linear velocity
K = hydraulic conductivity

ft/ft = foot per foot
ft/d = foot per day
cm/s = centimeter/second

$v = q/n_e$

where:
q = specific discharge
i = hydraulic gradient (from potentiometric map)
n_e = porosity (assumed to be 25%)

Table C.4. January 2024 RGA Potentiometric Surface Data

C-404 Landfill (January 2024) Water Levels									
Date	Time	Well	Datum Elev (ft amsl)	BP (in Hg)	Delta BP (ft H_20)	Raw Data		*Corrected Data	
						DTW (ft)	Elev (ft amsl)	DTW (ft)	Elev (ft amsl)
January 23, 2024	9:33	MW67	374.95	30.23	0.00	52.87	322.08	52.87	322.04
January 23, 2024	9:44	MW76	376.56	30.23	0.00	54.43	322.13	54.43	322.13
January 23, 2024	9:31	MW84A	375.29	30.23	0.00	53.42	321.87	53.42	321.87
January 23, 2024	9:29	MW87A	375.30	30.23	0.00	53.49	321.81	53.49	321.81
January 23, 2024	9:24	MW90A	374.15	30.23	0.00	52.28	321.87	52.28	321.87
January 23, 2024	9:39	MW93A	378.67	30.23	0.00	56.40	322.27	56.40	322.27
January 23, 2024	9:47	MW227	378.81	30.23	0.00	56.42	322.39	56.42	322.39
January 23, 2024	9:41	MW333	377.20	30.23	0.00	54.84	322.36	54.84	322.35
January 23, 2024	9:10	MW337	374.45	30.23	0.00	52.22	322.23	52.22	322.19
January 23, 2024	9:11	MW338	374.76	30.23	0.00	52.56	322.20	52.56	322.16
January 23, 2024	9:35	MW420	377.55	30.23	0.00	55.48	322.07	55.48	322.07
January 23, 2024	9:42	MW548	377.62	30.23	0.00	55.28	322.34	55.28	322.34
Reference Barometric Pressure			**30.23**						

Elev = elevation
amsl = above mean sea level
BP = barometric pressure
DTW = depth to water in feet below datum
*Assumes a barometric efficiency of 1.0

Table C.5. July 2024 RGA Potentiometric Surface Data

C-404 Landfill (July 2024) Water Levels									
Date	Time	Well	Datum Elev (ft amsl)	BP (in Hg)	Delta BP (ft H_20)	Raw Data		*Corrected Data	
						DTW (ft)	Elev (ft amsl)	DTW (ft)	Elev (ft amsl)
July 24, 2024	7:50	MW67	374.95	30.14	0.01	50.72	324.23	50.73	324.18
July 24, 2024	8:12	MW76	376.56	30.15	0.00	52.36	324.20	52.36	324.20
July 24, 2024	7:56	MW84A	375.29	30.15	0.00	51.21	324.08	51.21	324.08
July 24, 2024	7:57	MW87A	375.30	30.15	0.00	51.31	323.99	51.31	323.99
July 24, 2024	12:20	MW90A	374.15	30.15	0.00	50.16	323.99	50.16	323.99
July 24, 2024	8:07	MW93A	378.67	30.15	0.00	54.29	324.38	54.29	324.38
July 24, 2024	8:17	MW227	378.81	30.15	0.00	54.32	324.49	54.32	324.49
July 24, 2024	12:28	MW333	377.20	30.15	0.00	52.69	324.51	52.69	324.50
July 24, 2024	7:39	MW337	374.45	30.14	0.01	50.06	324.39	50.07	324.34
July 24, 2024	7:41	MW338	374.76	30.14	0.01	50.46	324.30	50.47	324.25
July 24, 2024	8:03	MW420	377.55	30.15	0.00	53.28	324.27	53.28	324.27
July 24, 2024	8:10	MW548	377.62	30.15	0.00	53.13	324.49	53.13	324.49
Reference Barometric Pressure			**30.15**						

Elev = elevation
amsl = above mean sea level
BP = barometric pressure
DTW = depth to water in feet below datum
*Assumes a barometric efficiency of 1.0

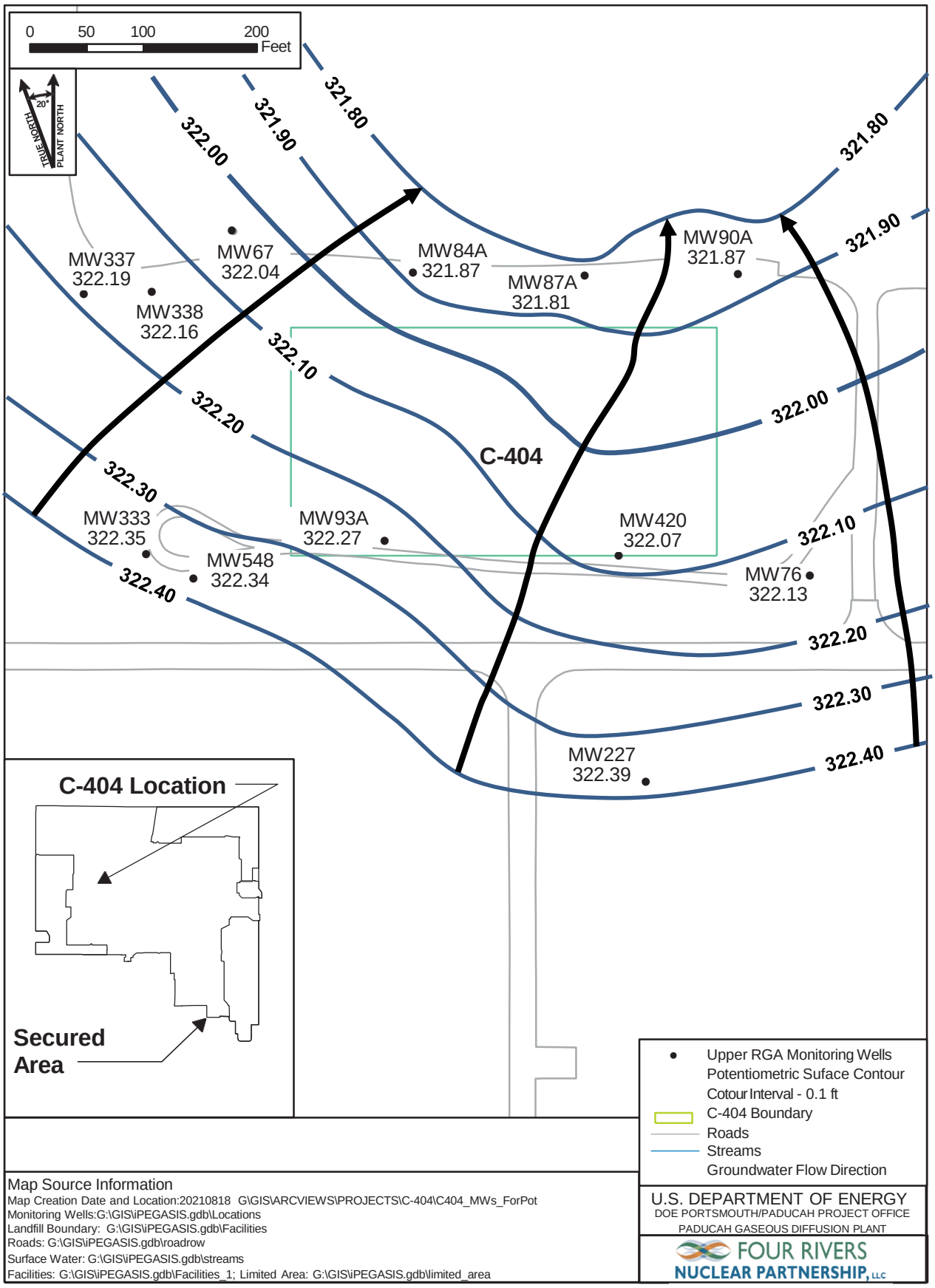

Figure C.1. Potentiometric Surface of the Upper Regional Gravel Aquifer, 23 Jan, 2024

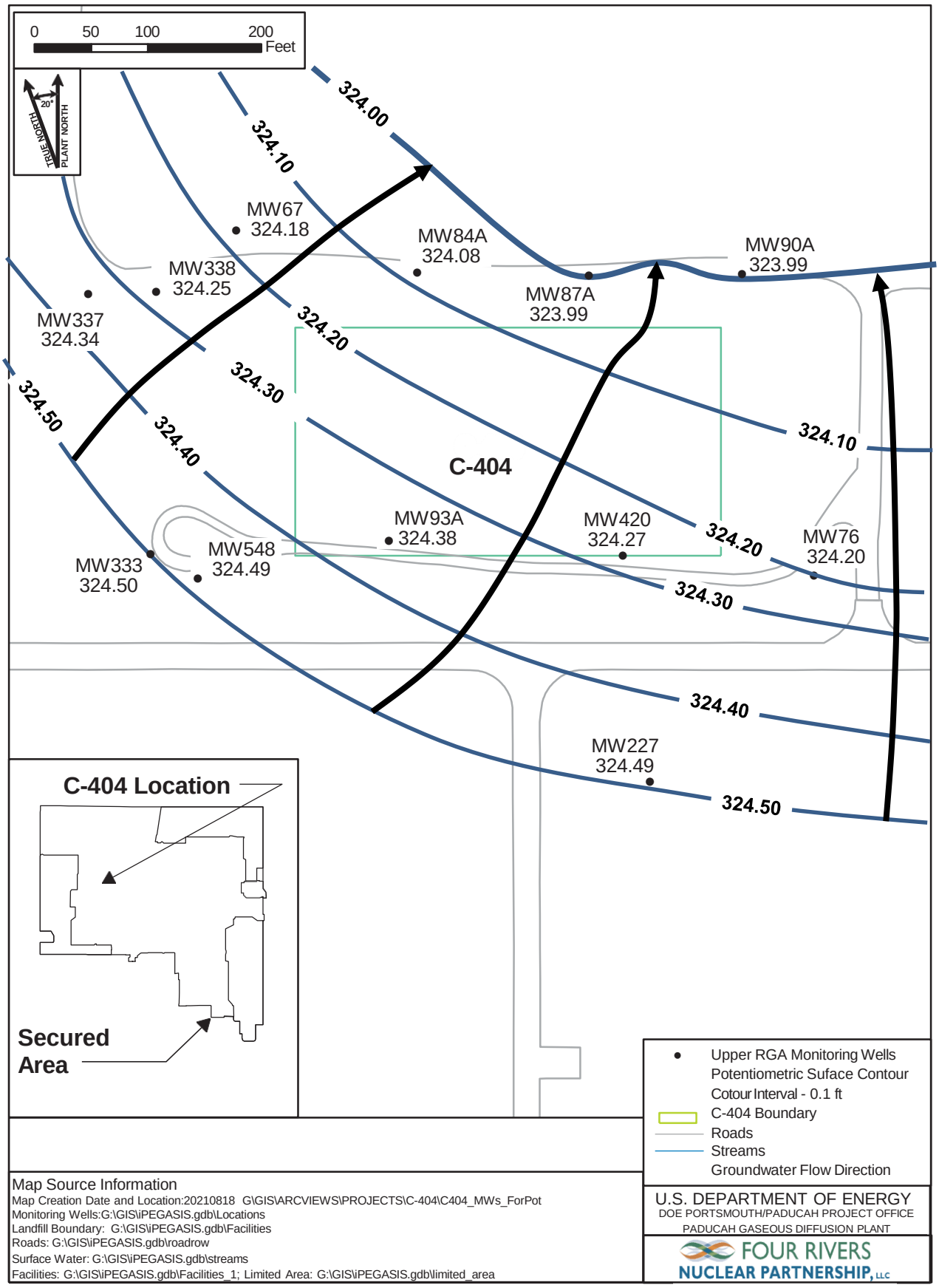

Figure C.2. Potentiometric Surface of the Upper Regional Gravel Aquifer, 24 July, 2024

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