



Department of Energy

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MAY 20 2016

PPPO-02-3543536-16

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Division of Waste Management
Kentucky Department for Environmental Protection
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Madisonville, Kentucky 42431

Ms. April Webb
Division of Waste Management
Kentucky Department for Environmental Protection
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Frankfort, Kentucky 40601

Dear Mr. Shingleton and Ms. Webb:

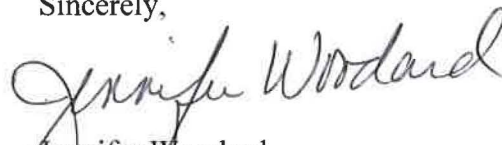
**TRANSMITTAL OF C-404 HAZARDOUS WASTE LANDFILL MAY 2016
SEMIANNUAL GROUNDWATER REPORT (OCTOBER 2015–MARCH 2016),
PADUCAH GASEOUS DIFFUSION PLANT, PADUCAH, KENTUCKY,
FPDP-RPT-0024/V1, PERMIT NUMBER KY8-890-008-982**

This report is submitted to comply with Part II Specific Condition II.K.6.d of the Hazardous Waste Management Facility Permit, Permit Number KY8-890-008-982. This report provides the groundwater analytical results and statistical analysis of those results for the semiannual sampling event conducted during January 2016 at the C-404 Hazardous Waste Landfill. This report also includes groundwater flow direction as supplemental information to the permit-required annual flow rate and direction.

Results of the statistical analyses indicate that compliance well concentrations of permit-required parameters are not statistically different from those in background wells; therefore, there is no indication that releases of contaminants from the C-404 Landfill have affected the underlying groundwater.

If you have any questions or require additional information, please contact David Dollins at (270) 441-6819.

Sincerely,


Jennifer Woodard
Paducah Site Lead
Portsmouth/Paducah Project Office

Enclosures:

1. Certification Page
2. C-404 Hazardous Waste Landfill May 2016 Semiannual Groundwater Report

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CERTIFICATION

Document Identification: *C-404 Hazardous Waste Landfill May 2016
Semiannual Groundwater Report (October 2015–March 2016),
Paducah Gaseous Diffusion Plant, Paducah, Kentucky,
FPDP-RPT-0024/V1, Permit Number KY8-890-008-982*

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to ensure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or 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.

Fluor Federal Services, Inc.

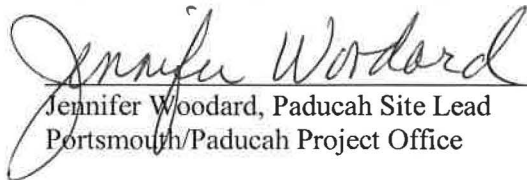


Mark J. Duff, Director, Environmental Management

5-20-16
Date Signed

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to ensure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or 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




Jennifer Woodard, Paducah Site Lead
Portsmouth/Paducah Project Office

5/20/16
Date Signed

**C-404 Hazardous Waste Landfill
May 2016 Semiannual
Groundwater Report
(October 2015–March 2016),
Paducah Gaseous Diffusion Plant,
Paducah, Kentucky**

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5/16/16
Date

**C-404 Hazardous Waste Landfill
May 2016 Semiannual
Groundwater Report
(October 2015–March 2016),
Paducah Gaseous Diffusion Plant,
Paducah, Kentucky**

Date Issued—May 2016

U.S. DEPARTMENT OF ENERGY
Office of Environmental Management

Prepared by
FLUOR FEDERAL SERVICES, INC.,
Paducah Deactivation Project
managing the
Deactivation Project at the
Paducah Gaseous Diffusion Plant
under Task Order DE-DT0007774

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ACRONYMS

AKGWA	Assembled Kentucky Groundwater
MW	monitoring well
PGDP	Paducah Gaseous Diffusion Plant
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 May 2016 Semiannual Groundwater Report (October 2015–March 2016), Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, FPDP-RPT-0024/V1, is being submitted by the U.S. Department of Energy in accordance with requirements in Kentucky Division of Waste Management Hazardous Waste Facility Permit, KY8-890-008-982. The reporting period covers October 2015 through March 2016 and includes analytical data from the January 2016 sampling of monitoring wells (MWs) located in the vicinity of the closed C-404 Hazardous Waste Landfill (C-404 Landfill). In 1986, disposal of waste at 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.

The groundwater monitoring analytical data were subjected to statistical analyses. The analyses were conducted in accordance with the Hazardous Waste Facility Permit, reissued in July 2015. There is no statistical evidence of releases from the C-404 Landfill because concentrations in the downgradient (compliance) wells are not statistically different from the concentrations in upgradient (background) wells.

On December 28, 2015, the leachate level was measured at 38 inches and 1,100 gal was removed on December 29, 2015. The sample for this leachate was collected on December 29, 2015, and analytical data are included in this semiannual report. On March 11, 2016, the leachate level was measured at 37 inches and 1,200 gal was removed on March 14, 2016. The sample for this leachate was collected on March 14, 2016; however, analytical data were not available for inclusion in this report by the regulatory deadline. The leachate analytical data for the March 14, 2016, leachate sample will be included in the next semiannual report. Required maintenance during this reporting period included MW maintenance (well wizard repair) and ground cover maintenance (animal burrow filled in). No well rehabilitation efforts were conducted during this reporting period.

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1. INTRODUCTION

This report contains the statistical evaluation of data from groundwater sampling and analysis for the C-404 Hazardous Waste Landfill (C-404 Landfill) at the Paducah Gaseous Diffusion Plant (PGDP), Paducah, Kentucky. This semiannual report is required by the Kentucky Division of Waste Management Hazardous Waste Facility Permit, KY8-890-008-982 (the permit) (KDWM 2015), Specific Condition II.K.6.d—Recordkeeping, Reporting, and Response. The period covered by this report is October 2015 through March 2016.

Groundwater analytical results are provided in Appendix A. The statistical analyses and qualification statement are provided in Appendix B. Landfill leachate information is provided in Appendix C. The groundwater flow direction determination is provided in Appendix D.

1.1 BACKGROUND

The C-404 Landfill is located in the west-central portion of the PGDP 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, and managed appropriately.

In 1986, the disposal of waste at 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 Facility Permit (KDWM 2015).

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

1.2 MONITORING PERIOD ACTIVITIES

1.2.1 Groundwater Monitoring

Groundwater sampling was conducted in January 2016 using Fluor Federal Services, Inc., procedure CP4-ES-2101, *Groundwater Sampling*. Appropriate sample containers and preservatives were used. The laboratory that performed analyses used U.S. Environmental Protection Agency-approved methods, as applicable. There are nine monitoring wells (MWs) sampled under this permit for the C-404 Landfill: four Upper Continental Recharge System (UCRS) wells and five Upper Regional Gravel Aquifer (URGA) wells. Table 1 presents the well numbers 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 these UCRS wells as being adjacent to an “upgradient” or “downgradient” URGA well location, identified relative to the URGA groundwater flow direction (see Figure 1).

Table 1. Monitoring Well Locations

UCRS	
Located south of C-404, adjacent to upgradient URGA background well MW93	MW94
Located north of C-404, adjacent to downgradient URGA compliance wells	MW85, MW88, MW91
URGA	
Upgradient background wells	MW93, MW420
Downgradient compliance wells	MW84, MW87, MW90A*

*MW90 was abandoned in 2001 and replaced with MW90A.

The conceptual model for the site indicates that groundwater in the UCRS wells flows vertically until it reaches the URGA; therefore, UCRS wells are not considered “upgradient” or “downgradient” of other wells in the area.

Table 2 presents the Assembled Kentucky Groundwater (AKGWA) numbers for each MW. A map of the MW locations is provided in Figure 1. All of the MWs listed in Tables 1 and 2 were sampled during this reporting period, and the samples were analyzed for parameters required by Attachment E of the Hazardous Waste Facility Permit.

Appendix A of this report contains the analytical results from the wells that were sampled during the January 2016 semiannual sampling event. Appendix B of this report contains the statistical analyses.

Per Permit Specific Condition II.K.4.a, the groundwater flow rate and direction are evaluated annually and reported in each November report. For this May report, a potentiometric map has been included in Appendix D as supplemental information, using data from sampling performed in January 2016. Depth-to-water was measured on January 26, 2016, from several wells at the perimeter of the C-404 Landfill (see Table D.1). Water level measurements in 11 vicinity well locations define the potentiometric surface for the URGA (see Table D.1). Groundwater flow direction beneath the C-404 Landfill generally trends northward, but commonly varies from northeast to northwest. On January 26, 2016, groundwater flow was toward the north-northeast (see Figure D.1).

1.2.2 Landfill Leachate

The C-404 General Inspection Records and the Monthly and Quarterly Landfill Inspection Results are included in Appendix C. In accordance with Section 1.2 of the Hazardous Waste Facility 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 three ft in depth.” The monthly leachate depths in the C-404 sump recorded for this reporting period are included in Appendix C.

The volume of leachate removed from the sump during this reporting period, October 2015 to March 2016, was 2,300 gal. Once the leachate depth reached 3 ft, the leachate was pumped into a mobile tank. Then the leachate was transferred to a permitted hazardous waste storage facility on-site prior to characterization and transfer off-site for treatment. Analytical results from leachate sampling conducted on December 29, 2015, are included in Appendix C. Because analytical results from leachate sampling conducted on March 14, 2016, were not available for inclusion in this report by the regulatory deadline, they will be included in the next semiannual report.

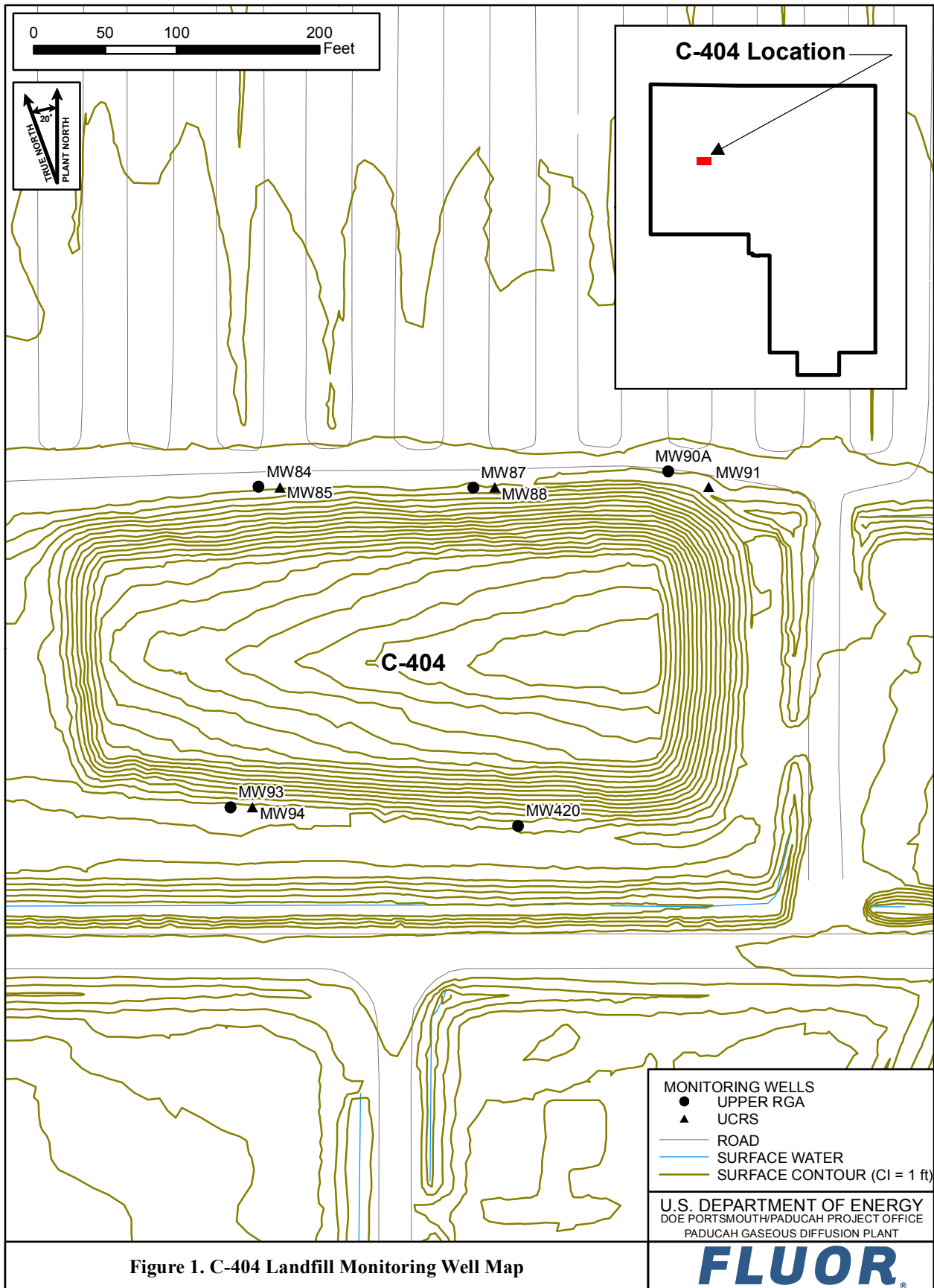


Figure 1. C-404 Landfill Monitoring Well Map

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 11/4/2013

**Table 2. Assembled Kentucky
Groundwater Database Numbers**

PGDP Well Number	AKGWA Number
MW84	8000-5233
MW85	8000-5234
MW87	8000-5236
MW88	8000-5237
MW90A	8004-0357
MW91	8000-5240
MW93	8000-5102
MW94	8000-5103
MW420	8005-3263

1.2.3 Maintenance

No well rehabilitation efforts were conducted during this reporting period.

Required maintenance during this reporting period included MW maintenance (well wizard repair) and ground cover maintenance (animal burrow filled in).

On October 23, 2015, MW89 was damaged during mowing activities. The mower contacted the MW and cracked the well wizard that is used for sampling purposes. The well wizard on MW89 was repaired on October 29, 2015.

During the quarterly inspection conducted on November 6, 2015, an animal burrow was discovered in the side of the northwest slope. The burrow had not affected the integrity of the landfill cap; the burrow was observed to be within the ground cover. The burrow was filled with top soil and seeded on December 18, 2015.

2. STATISTICAL SYNOPSIS

The statistical analyses conducted on the data collected from C-404 Landfill were performed in accordance with procedures in the Hazardous Waste Facility Permit, Attachment Part E, reissued in July 2015. Appendix B of this report contains the statistical analyses performed for this reporting period. Data utilized for statistical analyses included data from the URGA background wells, MW93 and MW420, and URGA compliance wells, MW84, MW87, and MW90A. For these statistical analyses, the reporting period data set includes data from January 2014, July 2014, January 2015, July 2015, and January 2016.

The statistical tests on all parameters showed no statistical difference between concentrations in the downgradient (compliance) and upgradient (background) wells, indicating no evidence of releases from the C-404 Landfill.

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3. DATA VALIDATION AND QA/QC SUMMARY

The data and the data validation qualifiers for the January 2016 data set are provided in Appendix A. All data for this data set were considered useable as reported.

Data validation was performed on the organic, inorganic, and radiochemical analytical data by an independent, third-party validator.

Field quality control samples are collected semiannually during each sampling event. Equipment rinseate blanks, field blanks, and trip blanks are obtained to ensure quality control and are reported in the Analytical Results in Appendix A. No contamination was detected in these samples. 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.

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4. PROFESSIONAL GEOLOGIST AUTHORIZATION

DOCUMENT IDENTIFICATION: *C-404 Hazardous Waste Landfill
May 2016 Semiannual Groundwater Report
(October 2015–March 2016),
Paducah Gaseous Diffusion Plant, Paducah, Kentucky
(FPDP-RPT-0024/V1)*

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



Kenneth R. Davis
Kenneth R. Davis

PG1194

May 16, 2016
Date

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5. REFERENCES

KDWM (Kentucky Division of Waste Management) 2015. Hazardous Waste Facility Permit for the U.S. Department of Energy, Paducah Gaseous Diffusion Plant, KY8-890-008-982, effective July 26.

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

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APPENDIX A

C-404 HAZARDOUS WASTE LANDFILL ANALYTICAL RESULTS

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**Paducah OREIS
GROUNDWATER MONITORING REPORT**

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

Sampling Point: MW84 REG Downgradient URGA **Period:** Semiannual Report

AKGWA Well Tag #: 8000-5233

Parameter	Qualifier	Result	Units	Reporting Limit	Date Collected	Counting Error (+/-)	TPU	Method	Validation
Arsenic		0.0103	mg/L	0.005	1/27/2016			SW846-6020	J
Arsenic, Dissolved	U	0.005	mg/L	0.005	1/27/2016			SW846-6020	=
Barometric Pressure Reading		30.33	Inches/Hg		1/27/2016				X
Cadmium	J	0.0002	mg/L	0.001	1/27/2016			SW846-6020	J
Cadmium, Dissolved	U	0.001	mg/L	0.001	1/27/2016			SW846-6020	=
Chromium		0.0393	mg/L	0.01	1/27/2016			SW846-6020	=
Chromium, Dissolved	J	0.0086	mg/L	0.01	1/27/2016			SW846-6020	U
Conductivity		344	umho/cm		1/27/2016				X
Depth to Water		48.72	ft		1/27/2016				X
Dissolved Oxygen		3.29	mg/L		1/27/2016				X
Lead	J	0.0011	mg/L	0.002	1/27/2016			SW846-6020	=
Lead, Dissolved	U	0.002	mg/L	0.002	1/27/2016			SW846-6020	=
Mercury	U	0.0002	mg/L	0.0002	1/27/2016			SW846-7470A	=
Mercury, Dissolved	U	0.0002	mg/L	0.0002	1/27/2016			SW846-7470A	=
pH		6.05	Std Unit		1/27/2016				X
Redox		396	mV		1/27/2016				X
Selenium	U	0.005	mg/L	0.005	1/27/2016			SW846-6020	=
Selenium, Dissolved	U	0.005	mg/L	0.005	1/27/2016			SW846-6020	=
Technetium-99		168	pCi/L	21.4	1/27/2016	16.7	25.1	HASL 300, Tc-02-RC M	=
Temperature		59.2	deg F		1/27/2016				X
Trichloroethene		1340	ug/L	20	1/27/2016			SW846-8260B	=
Turbidity		47.4	NTU		1/27/2016				X
Uranium		0.0002	mg/L	0.0002	1/27/2016			SW846-6020	U
Uranium-234	U	2.07	pCi/L	2.08	1/27/2016	1.97	1.99	HASL 300, U-02-RC M	=
Uranium-235	U	0.464	pCi/L	1.39	1/27/2016	1.31	1.31	HASL 300, U-02-RC M	=
Uranium-238	U	-0.090	pCi/L	1.8	1/27/2016	0.778	0.779	HASL 300, U-02-RC M	=

**Paducah OREIS
GROUNDWATER MONITORING REPORT**

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

Sampling Point: MW84 FR Downgradient URGA **Period:** Semiannual Report

AKGWA Well Tag #: 8000-5233

Parameter	Qualifier	Result	Units	Reporting Limit	Date Collected	Counting Error (+/-)	TPU	Method	Validation
Arsenic		0.0075	mg/L	0.005	1/27/2016			SW846-6020	J
Arsenic, Dissolved	U	0.005	mg/L	0.005	1/27/2016			SW846-6020	=
Barometric Pressure Reading		30.33	Inches/Hg		1/27/2016				X
Cadmium	J	0.0001	mg/L	0.001	1/27/2016			SW846-6020	J
Cadmium, Dissolved	U	0.001	mg/L	0.001	1/27/2016			SW846-6020	=
Chromium		0.0352	mg/L	0.01	1/27/2016			SW846-6020	=
Chromium, Dissolved	J	0.0080	mg/L	0.01	1/27/2016			SW846-6020	U
Conductivity		344	umho/cm		1/27/2016				X
Depth to Water		48.72	ft		1/27/2016				X
Dissolved Oxygen		3.29	mg/L		1/27/2016				X
Lead	J	0.0010	mg/L	0.002	1/27/2016			SW846-6020	=
Lead, Dissolved	U	0.002	mg/L	0.002	1/27/2016			SW846-6020	=
Mercury	U	0.0002	mg/L	0.0002	1/27/2016			SW846-7470A	=
Mercury, Dissolved	U	0.0002	mg/L	0.0002	1/27/2016			SW846-7470A	=
pH		6.05	Std Unit		1/27/2016				X
Redox		396	mV		1/27/2016				X
Selenium	U	0.005	mg/L	0.005	1/27/2016			SW846-6020	=
Selenium, Dissolved	U	0.005	mg/L	0.005	1/27/2016			SW846-6020	=
Technetium-99		170	pCi/L	21.5	1/27/2016	16.8	25.2	HASL 300, Tc-02-RC M	=
Temperature		59.2	deg F		1/27/2016				X
Trichloroethene		1350	ug/L	20	1/27/2016			SW846-8260B	=
Turbidity		47.4	NTU		1/27/2016				X
Uranium	J	0.0002	mg/L	0.0002	1/27/2016			SW846-6020	U
Uranium-234	U	0.78	pCi/L	1.72	1/27/2016	1.24	1.24	HASL 300, U-02-RC M	=
Uranium-235	U	0	pCi/L	1.15	1/27/2016	0.772	0.773	HASL 300, U-02-RC M	=
Uranium-238	U	0	pCi/L	0.929	1/27/2016	0.624	0.626	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		0.0101	mg/L	0.005	1/27/2016			SW846-6020	=
Arsenic, Dissolved		0.0064	mg/L	0.005	1/27/2016			SW846-6020	=
Barometric Pressure Reading		30.33	Inches/Hg		1/27/2016				X
Cadmium	U	0.001	mg/L	0.001	1/27/2016			SW846-6020	=
Cadmium, Dissolved	U	0.001	mg/L	0.001	1/27/2016			SW846-6020	=
Chromium		0.0105	mg/L	0.01	1/27/2016			SW846-6020	U
Chromium, Dissolved	J	0.0084	mg/L	0.01	1/27/2016			SW846-6020	U
Conductivity		415	umho/cm		1/27/2016				X
Depth to Water		10.48	ft		1/27/2016				X
Dissolved Oxygen		2.6	mg/L		1/27/2016				X
Lead	U	0.002	mg/L	0.002	1/27/2016			SW846-6020	=
Lead, Dissolved	U	0.002	mg/L	0.002	1/27/2016			SW846-6020	=
Mercury	U	0.0002	mg/L	0.0002	1/27/2016			SW846-7470A	=
Mercury, Dissolved	U	0.0002	mg/L	0.0002	1/27/2016			SW846-7470A	=
pH		6.37	Std Unit		1/27/2016				X
Redox		421	mV		1/27/2016				X
Selenium	U	0.005	mg/L	0.005	1/27/2016			SW846-6020	=
Selenium, Dissolved	U	0.005	mg/L	0.005	1/27/2016			SW846-6020	=
Technetium-99		84.2	pCi/L	20	1/27/2016	13.9	16.7	HASL 300, Tc-02-RC M	=
Temperature		60	deg F		1/27/2016				X
Trichloroethene		6.65	ug/L	1	1/27/2016			SW846-8260B	=
Turbidity		36.5	NTU		1/27/2016				X
Uranium		0.0004	mg/L	0.0002	1/27/2016			SW846-6020	U
Uranium-234	U	-0.736	pCi/L	4.3	1/27/2016	1.4	1.4	HASL 300, U-02-RC M	=
Uranium-235	U	-0.182	pCi/L	3.64	1/27/2016	1.57	1.58	HASL 300, U-02-RC M	=
Uranium-238	U	0.172	pCi/L	3.75	1/27/2016	1.8	1.8	HASL 300, U-02-RC M	=

**Paducah OREIS
GROUNDWATER MONITORING REPORT**

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

Sampling Point: MW87 REG Downgradient URGA **Period:** Semiannual Report

AKGWA Well Tag #: 8000-5236

Parameter	Qualifier	Result	Units	Reporting Limit	Date Collected	Counting Error (+/-)	TPU	Method	Validation
Arsenic	J	0.0048	mg/L	0.005	1/25/2016			SW846-6020	=
Arsenic, Dissolved	U	0.005	mg/L	0.005	1/25/2016			SW846-6020	=
Barometric Pressure Reading		29.94	Inches/Hg		1/25/2016				X
Cadmium	J	0.0001	mg/L	0.001	1/25/2016			SW846-6020	=
Cadmium, Dissolved	U	0.001	mg/L	0.001	1/25/2016			SW846-6020	=
Chromium	B	0.0266	mg/L	0.01	1/25/2016			SW846-6020	=
Chromium, Dissolved	BJ	0.0037	mg/L	0.01	1/25/2016			SW846-6020	U
Conductivity		355	umho/cm		1/25/2016				X
Depth to Water		49.15	ft		1/25/2016				X
Dissolved Oxygen		2.11	mg/L		1/25/2016				X
Lead	J	0.0011	mg/L	0.002	1/25/2016			SW846-6020	=
Lead, Dissolved	U	0.002	mg/L	0.002	1/25/2016			SW846-6020	=
Mercury	U	0.0002	mg/L	0.0002	1/25/2016			SW846-7470A	=
Mercury, Dissolved	U	0.0002	mg/L	0.0002	1/25/2016			SW846-7470A	=
pH		6.17	Std Unit		1/25/2016				X
Redox		487	mV		1/25/2016				X
Selenium	U	0.005	mg/L	0.005	1/25/2016			SW846-6020	=
Selenium, Dissolved	J	0.002	mg/L	0.005	1/25/2016			SW846-6020	=
Technetium-99	U	0.827	pCi/L	21.1	1/25/2016	12.3	12.3	HASL 300, Tc-02-RC M	=
Temperature		61.3	deg F		1/25/2016				X
Trichloroethene		1230	ug/L	20	1/25/2016			SW846-8260B	=
Turbidity		10.8	NTU		1/25/2016				X
Uranium		0.0003	mg/L	0.0002	1/25/2016			SW846-6020	U
Uranium-234	U	2.28	pCi/L	3.83	1/25/2016	2.97	3	HASL 300, U-02-RC M	=
Uranium-235	U	0.73	pCi/L	3.49	1/25/2016	2.32	2.32	HASL 300, U-02-RC M	=
Uranium-238	U	1.02	pCi/L	3.63	1/25/2016	2.31	2.31	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		0.0068	mg/L	0.005	1/25/2016			SW846-6020	=
Arsenic, Dissolved	J	0.0033	mg/L	0.005	1/25/2016			SW846-6020	=
Barometric Pressure Reading		29.92	Inches/Hg		1/25/2016				X
Cadmium	U	0.001	mg/L	0.001	1/25/2016			SW846-6020	=
Cadmium, Dissolved	U	0.001	mg/L	0.001	1/25/2016			SW846-6020	=
Chromium	B	0.0115	mg/L	0.01	1/25/2016			SW846-6020	U
Chromium, Dissolved	BJ	0.0039	mg/L	0.01	1/25/2016			SW846-6020	U
Conductivity		545	umho/cm		1/25/2016				X
Depth to Water		10.01	ft		1/25/2016				X
Dissolved Oxygen		1.5	mg/L		1/25/2016				X
Lead		0.0027	mg/L	0.002	1/25/2016			SW846-6020	=
Lead, Dissolved	U	0.002	mg/L	0.002	1/25/2016			SW846-6020	=
Mercury	J	9E-05	mg/L	0.0002	1/25/2016			SW846-7470A	=
Mercury, Dissolved	U	0.0002	mg/L	0.0002	1/25/2016			SW846-7470A	=
pH		5.89	Std Unit		1/25/2016				X
Redox		484	mV		1/25/2016				X
Selenium	U	0.005	mg/L	0.005	1/25/2016			SW846-6020	=
Selenium, Dissolved	J	0.002	mg/L	0.005	1/25/2016			SW846-6020	=
Technetium-99		37	pCi/L	22.5	1/25/2016	14.1	14.7	HASL 300, Tc-02-RC M	=
Temperature		62.5	deg F		1/25/2016				X
Trichloroethene		2.21	ug/L	1	1/25/2016			SW846-8260B	=
Turbidity		92.7	NTU		1/25/2016				X
Uranium		0.0003	mg/L	0.0002	1/25/2016			SW846-6020	U
Uranium-234	U	2.09	pCi/L	4.74	1/25/2016	3.18	3.2	HASL 300, U-02-RC M	=
Uranium-235	U	1.56	pCi/L	4.16	1/25/2016	3.03	3.04	HASL 300, U-02-RC M	=
Uranium-238	U	-0.773	pCi/L	4.74	1/25/2016	1.5	1.51	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	U	0.005	mg/L	0.005	1/25/2016			SW846-6020	=
Arsenic, Dissolved	U	0.005	mg/L	0.005	1/25/2016			SW846-6020	=
Barometric Pressure Reading		29.92	Inches/Hg		1/25/2016				X
Cadmium	U	0.001	mg/L	0.001	1/25/2016			SW846-6020	=
Cadmium, Dissolved	U	0.001	mg/L	0.001	1/25/2016			SW846-6020	=
Chromium	BJ	0.0053	mg/L	0.01	1/25/2016			SW846-6020	U
Chromium, Dissolved	BJ	0.0062	mg/L	0.01	1/25/2016			SW846-6020	U
Conductivity		239	umho/cm		1/25/2016				X
Depth to Water		47.5	ft		1/25/2016				X
Dissolved Oxygen		3.68	mg/L		1/25/2016				X
Lead	U	0.002	mg/L	0.002	1/25/2016			SW846-6020	=
Lead, Dissolved	U	0.002	mg/L	0.002	1/25/2016			SW846-6020	=
Mercury	U	0.0002	mg/L	0.0002	1/25/2016			SW846-7470A	=
Mercury, Dissolved	U	0.0002	mg/L	0.0002	1/25/2016			SW846-7470A	=
pH		6.03	Std Unit		1/25/2016				X
Redox		486	mV		1/25/2016				X
Selenium	J	0.0023	mg/L	0.005	1/25/2016			SW846-6020	=
Selenium, Dissolved	J	0.002	mg/L	0.005	1/25/2016			SW846-6020	=
Technetium-99	U	0.615	pCi/L	20.6	1/25/2016	12	12	HASL 300, Tc-02-RC M	=
Temperature		62.3	deg F		1/25/2016				X
Trichloroethene		39.8	ug/L	1	1/25/2016			SW846-8260B	=
Turbidity		5.7	NTU		1/25/2016				X
Uranium	U	0.0002	mg/L	0.0002	1/25/2016			SW846-6020	=
Uranium-234	U	2.42	pCi/L	5.9	1/25/2016	4.53	4.56	HASL 300, U-02-RC M	=
Uranium-235	U	1.55	pCi/L	6.3	1/25/2016	4.57	4.58	HASL 300, U-02-RC M	=
Uranium-238	U	1.25	pCi/L	5.09	1/25/2016	3.69	3.71	HASL 300, U-02-RC M	=

**Paducah OREIS
GROUNDWATER MONITORING REPORT**

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

Sampling Point: MW91 REG Downgradient UCRS **Period:** Semiannual Report

AKGWA Well Tag #: 8000-5240

Parameter	Qualifier	Result	Units	Reporting Limit	Date Collected	Counting Error (+/-)	TPU	Method	Validation
Arsenic		0.0065	mg/L	0.005	1/27/2016			SW846-6020	=
Arsenic, Dissolved	U	0.005	mg/L	0.005	1/27/2016			SW846-6020	=
Barometric Pressure Reading		30.33	Inches/Hg		1/27/2016				X
Cadmium	U	0.001	mg/L	0.001	1/27/2016			SW846-6020	=
Cadmium, Dissolved	U	0.001	mg/L	0.001	1/27/2016			SW846-6020	=
Chromium		2.83	mg/L	0.5	1/27/2016			SW846-6020	=
Chromium, Dissolved		0.0245	mg/L	0.01	1/27/2016			SW846-6020	U
Conductivity		493	umho/cm		1/27/2016				X
Depth to Water		10.11	ft		1/27/2016				X
Dissolved Oxygen		2.56	mg/L		1/27/2016				X
Lead		0.0052	mg/L	0.002	1/27/2016			SW846-6020	=
Lead, Dissolved	U	0.002	mg/L	0.002	1/27/2016			SW846-6020	=
Mercury	U	0.0002	mg/L	0.0002	1/27/2016			SW846-7470A	=
Mercury, Dissolved	U	0.0002	mg/L	0.0002	1/27/2016			SW846-7470A	=
pH		5.94	Std Unit		1/27/2016				X
Redox		462	mV		1/27/2016				X
Selenium	J	0.0034	mg/L	0.005	1/27/2016			SW846-6020	=
Selenium, Dissolved	J	0.0031	mg/L	0.005	1/27/2016			SW846-6020	=
Technetium-99		2540	pCi/L	23.6	1/27/2016	52.5	287	HASL 300, Tc-02-RC M	=
Temperature		60.6	deg F		1/27/2016				X
Trichloroethene		84.9	ug/L	1	1/27/2016			SW846-8260B	=
Turbidity		325	NTU		1/27/2016				X
Uranium		0.0018	mg/L	0.0002	1/27/2016			SW846-6020	=
Uranium-234	U	1.21	pCi/L	1.97	1/27/2016	1.47	1.48	HASL 300, U-02-RC M	=
Uranium-235	U	0.931	pCi/L	2.05	1/27/2016	1.48	1.48	HASL 300, U-02-RC M	=
Uranium-238	U	1.28	pCi/L	1.83	1/27/2016	1.46	1.47	HASL 300, U-02-RC M	=

**Paducah OREIS
GROUNDWATER MONITORING REPORT**

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

Sampling Point: MW93 REG Upgradient URGA **Period:** Semiannual Report

AKGWA Well Tag #: 8000-5102

Parameter	Qualifier	Result	Units	Reporting Limit	Date Collected	Counting Error (+/-)	TPU	Method	Validation
Arsenic		0.0074	mg/L	0.005	1/25/2016			SW846-6020	=
Arsenic, Dissolved	U	0.005	mg/L	0.005	1/25/2016			SW846-6020	=
Barometric Pressure Reading		29.94	Inches/Hg		1/25/2016				X
Cadmium	J	0.0002	mg/L	0.001	1/25/2016			SW846-6020	=
Cadmium, Dissolved	U	0.001	mg/L	0.001	1/25/2016			SW846-6020	=
Chromium	B	0.0401	mg/L	0.01	1/25/2016			SW846-6020	=
Chromium, Dissolved	BJ	0.0032	mg/L	0.01	1/25/2016			SW846-6020	U
Conductivity		405	umho/cm		1/25/2016				X
Depth to Water		52.47	ft		1/25/2016				X
Dissolved Oxygen		1.42	mg/L		1/25/2016				X
Lead	J	0.0014	mg/L	0.002	1/25/2016			SW846-6020	=
Lead, Dissolved	U	0.002	mg/L	0.002	1/25/2016			SW846-6020	=
Mercury	U	0.0002	mg/L	0.0002	1/25/2016			SW846-7470A	=
Mercury, Dissolved	U	0.0002	mg/L	0.0002	1/25/2016			SW846-7470A	=
pH		6.11	Std Unit		1/25/2016				X
Redox		483	mV		1/25/2016				X
Selenium	J	0.0017	mg/L	0.005	1/25/2016			SW846-6020	=
Selenium, Dissolved	J	0.0023	mg/L	0.005	1/25/2016			SW846-6020	=
Technetium-99	U	4.09	pCi/L	20.9	1/25/2016	12.3	12.3	HASL 300, Tc-02-RC M	=
Temperature		62.7	deg F		1/25/2016				X
Trichloroethene		2490	ug/L	50	1/25/2016			SW846-8260B	=
Turbidity		82	NTU		1/25/2016				X
Uranium		0.0002	mg/L	0.0002	1/25/2016			SW846-6020	U
Uranium-234	U	0.319	pCi/L	4.55	1/25/2016	2.26	2.27	HASL 300, U-02-RC M	=
Uranium-235	U	-0.237	pCi/L	4.64	1/25/2016	1.98	1.98	HASL 300, U-02-RC M	=
Uranium-238	U	0.607	pCi/L	3.76	1/25/2016	2.24	2.24	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	0.0047	mg/L	0.005	1/25/2016			SW846-6020	=
Arsenic, Dissolved	U	0.005	mg/L	0.005	1/25/2016			SW846-6020	=
Barometric Pressure Reading		29.94	Inches/Hg		1/25/2016				X
Cadmium	U	0.001	mg/L	0.001	1/25/2016			SW846-6020	=
Cadmium, Dissolved	U	0.001	mg/L	0.001	1/25/2016			SW846-6020	=
Chromium	B	0.0757	mg/L	0.01	1/25/2016			SW846-6020	=
Chromium, Dissolved	BJ	0.0025	mg/L	0.01	1/25/2016			SW846-6020	U
Conductivity		880	umho/cm		1/25/2016				X
Depth to Water		13.67	ft		1/25/2016				X
Dissolved Oxygen		1.58	mg/L		1/25/2016				X
Lead		0.0061	mg/L	0.002	1/25/2016			SW846-6020	=
Lead, Dissolved	U	0.002	mg/L	0.002	1/25/2016			SW846-6020	=
Mercury	U	0.0002	mg/L	0.0002	1/25/2016			SW846-7470A	=
Mercury, Dissolved	U	0.0002	mg/L	0.0002	1/25/2016			SW846-7470A	=
pH		6.26	Std Unit		1/25/2016				X
Redox		471	mV		1/25/2016				X
Selenium	U	0.005	mg/L	0.005	1/25/2016			SW846-6020	=
Selenium, Dissolved	J	0.0020	mg/L	0.005	1/25/2016			SW846-6020	=
Technetium-99		658	pCi/L	22.3	1/25/2016	25.8	77.4	HASL 300, Tc-02-RC M	=
Temperature		61	deg F		1/25/2016				X
Trichloroethene		2.76	ug/L	1	1/25/2016			SW846-8260B	=
Turbidity		255	NTU		1/25/2016				X
Uranium		0.0029	mg/L	0.0002	1/25/2016			SW846-6020	U
Uranium-234	U	1.14	pCi/L	2.85	1/25/2016	1.84	1.85	HASL 300, U-02-RC M	=
Uranium-235	U	0.643	pCi/L	3.07	1/25/2016	1.77	1.77	HASL 300, U-02-RC M	=
Uranium-238	U	0.927	pCi/L	2.48	1/25/2016	1.64	1.64	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	U	0.005	mg/L	0.005	1/25/2016			SW846-6020	=
Arsenic, Dissolved	U	0.005	mg/L	0.005	1/25/2016			SW846-6020	=
Barometric Pressure Reading		29.94	Inches/Hg		1/25/2016				X
Cadmium	U	0.001	mg/L	0.001	1/25/2016			SW846-6020	=
Cadmium, Dissolved	U	0.001	mg/L	0.001	1/25/2016			SW846-6020	=
Chromium	U	0.01	mg/L	0.01	1/25/2016			SW846-6020	U
Chromium, Dissolved	BJ	0.0025	mg/L	0.01	1/25/2016			SW846-6020	U
Conductivity		338	umho/cm		1/25/2016				X
Depth to Water		50.98	ft		1/25/2016				X
Dissolved Oxygen		1.56	mg/L		1/25/2016				X
Lead	U	0.002	mg/L	0.002	1/25/2016			SW846-6020	=
Lead, Dissolved	U	0.002	mg/L	0.002	1/25/2016			SW846-6020	=
Mercury	U	0.0002	mg/L	0.0002	1/25/2016			SW846-7470A	=
Mercury, Dissolved	U	0.0002	mg/L	0.0002	1/25/2016			SW846-7470A	=
pH		5.95	Std Unit		1/25/2016				X
Redox		451	mV		1/25/2016				X
Selenium	U	0.005	mg/L	0.005	1/25/2016			SW846-6020	=
Selenium, Dissolved	U	0.005	mg/L	0.005	1/25/2016			SW846-6020	=
Technetium-99	U	-3.91	pCi/L	18.6	1/25/2016	10.6	10.6	HASL 300, Tc-02-RC M	=
Temperature		57.8	deg F		1/25/2016				X
Trichloroethene		222	ug/L	5	1/25/2016			SW846-8260B	=
Turbidity		37.7	NTU		1/25/2016				X
Uranium	U	0.0002	mg/L	0.0002	1/25/2016			SW846-6020	=
Uranium-234	U	2.4	pCi/L	2.61	1/25/2016	2.72	2.75	HASL 300, U-02-RC M	=
Uranium-235	U	1.35	pCi/L	3.6	1/25/2016	2.62	2.63	HASL 300, U-02-RC M	=
Uranium-238	U	0.941	pCi/L	3.35	1/25/2016	2.13	2.13	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	1/27/2016			SW846-6020	=
Cadmium	U	0.001	mg/L	0.001	1/27/2016			SW846-6020	=
Chromium	J	0.0058	mg/L	0.01	1/27/2016			SW846-6020	=
Lead	U	0.002	mg/L	0.002	1/27/2016			SW846-6020	=
Mercury	U	0.0002	mg/L	0.0002	1/27/2016			SW846-7470A	=
Selenium	U	0.005	mg/L	0.005	1/27/2016			SW846-6020	=
Technetium-99	U	-2.37	pCi/L	19.2	1/27/2016	11.1	11.1	HASL 300, Tc-02-RC M	=
Trichloroethene	U	1	ug/L	1	1/27/2016			SW846-8260B	=
Uranium	U	0.0002	mg/L	0.0002	1/27/2016			SW846-6020	=
Uranium-234	U	0.803	pCi/L	3.13	1/27/2016	1.82	1.83	HASL 300, U-02-RC M	=
Uranium-235	U	-0.265	pCi/L	3.05	1/27/2016	1.17	1.17	HASL 300, U-02-RC M	=
Uranium-238	U	1.12	pCi/L	2.47	1/27/2016	1.79	1.79	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	1/27/2016			SW846-6020	=
Cadmium	U	0.001	mg/L	0.001	1/27/2016			SW846-6020	=
Chromium	J	0.0053	mg/L	0.01	1/27/2016			SW846-6020	U
Lead	U	0.002	mg/L	0.002	1/27/2016			SW846-6020	=
Mercury	U	0.0002	mg/L	0.0002	1/27/2016			SW846-7470A	=
Selenium	U	0.005	mg/L	0.005	1/27/2016			SW846-6020	=
Technetium-99	U	1.61	pCi/L	19.2	1/27/2016	11.2	11.2	HASL 300, Tc-02-RC M	=
Trichloroethene	U	1	ug/L	1	1/27/2016			SW846-8260B	=
Uranium	U	0.0002	mg/L	0.0002	1/27/2016			SW846-6020	=
Uranium-234	U	0.297	pCi/L	2.97	1/27/2016	1.48	1.48	HASL 300, U-02-RC M	=
Uranium-235	U	-0.21	pCi/L	2.42	1/27/2016	0.928	0.93	HASL 300, U-02-RC M	=
Uranium-238	U	0.283	pCi/L	2.48	1/27/2016	1.27	1.27	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	1/25/2016			SW846-8260B	=
	U	1	ug/L	1	1/27/2016			SW846-8260B	=

MEDIA Codes

WG Groundwater

QUALIFIER Codes

- U Analyte analyzed for, but not detected at or below the lowest concentration reported.
- J Estimated quantitation.
- B Compound found in blank as well as sample.

SAMPLE METHOD Codes

GR Grab

SAMPLING POINT Codes

- UCRS Upper Continental Recharge System
- URGA Upper Regional Gravel Aquifer

SAMPLE TYPE Codes

- FB Field Blank
- FR Field Replicate (Code used for Field Duplicate)
- REG Regular
- RI QC Equipment Rinseate/Decon
- TB Trip Blank

VALIDATION Code

- = 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.
- 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 C-404 Hazardous Waste Landfill (C-404 Landfill) were performed in accordance with procedures provided in Appendix E of the C-404 Hazardous Waste Management Permit, reissued by the Kentucky Division of Waste Management (KDWM) in July 2015. 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. For this report, the reporting period data set includes data from January 2014, July 2014, January 2015, July 2015, and January 2016.

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 (1/2 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. If variances are found to be unequal even for log-transformed concentrations, Statistical Test 4 is abandoned and Statistical Test 3 is used to compare

compliance wells with background wells. 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 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 RGA well results in vicinity to determine if they are consistent with 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	MW93, MW420
Downgradient compliance wells	MW84, MW87, MW90A*

*MW90 was abandoned in 2001 and replaced with MW90A.

For this report, the reporting period data set from January 2014 through January 2016 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.

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 and uncensored data and type of statistical test chosen for each of the parameters.

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

Parameters	Observations	Missing Observations*	Censored Observations	Uncensored Observations
URGA				
Arsenic	25	0	9	16
Arsenic, Dissolved	25	0	17	8
Cadmium	25	0	19	6
Cadmium, Dissolved	25	0	25	0
Chromium	25	0	10	15
Chromium, Dissolved	25	0	16	9
Lead	25	0	17	8
Lead, Dissolved	25	0	25	0
Mercury	25	0	25	0
Mercury, Dissolved	25	0	25	0
Selenium	25	0	19	6
Selenium, Dissolved	25	0	22	3
Technetium-99	25	0	23	2
Trichloroethene	25	0	0	25
Uranium (Metals)	25	0	14	11
Uranium-234	25	0	25	0
Uranium-235	25	0	25	0
Uranium-238	25	0	24	1

*Missing parameters that were dissolved metals were not analyzed when the parent total metals were not detected in prior sampling events.

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

Parameter	Total Samples (Nonmissing)	Uncensored	Censored	Percent Censored	Statistical Test Set*
URGA					
Arsenic	25	16	9	36	3
Arsenic, Dissolved	25	8	17	68	2
Cadmium	25	6	19	76	2
Cadmium, Dissolved	25	0	25	100	1
Chromium	25	15	10	40	3
Chromium, Dissolved	25	9	16	64	2
Lead	25	8	17	68	2
Lead, Dissolved	25	0	25	100	1
Mercury	25	0	25	100	1
Mercury, Dissolved	25	0	25	100	1
Selenium	25	6	19	76	2
Selenium, Dissolved	25	3	22	88	2
Technetium-99	25	2	23	92	1
Trichloroethene	25	25	0	0	4/3**
Uranium (Metals)	25	11	14	56	2
Uranium-234	25	0	25	100	1
Uranium-235	25	0	25	100	1
Uranium-238	25	1	24	96	1

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

**Because equality of variance could not be confirmed, Statistical Test 4, Parametric ANOVA, was abandoned, and Statistical Test 3, Nonparametric ANOVA, was performed.

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 statistical analyses for the C-404 Landfill, 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 1 through 10.

In summary, Statistical Test 2, Test of Proportions, for dissolved arsenic, cadmium, dissolved chromium, lead, selenium, dissolved selenium, and uranium, as well as Statistical Test 3, Nonparametric ANOVA, for arsenic in the URGA indicated no statistical evidence of releases of these contaminants from the C-404 Landfill.

Statistical Test 3, Nonparametric ANOVA, for chromium in the URGA identified a statistically significant difference between concentrations in downgradient wells and concentrations in background wells; therefore, the data was evaluated further by comparing results to the UTL. The comparison indicated there was no statistical evidence of a release from the C-404 Landfill.

Statistical Test 4, Parametric ANOVA, could not be used for trichloroethene in the URGA because there was no evidence of equality of variance. Thus, Statistical Test 4 was abandoned and Statistical Test 3, Nonparametric ANOVA, was performed. Statistical Test 3 showed there was no statistical evidence of releases of trichloroethene from the C-404 Landfill.

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

Parameter	LOD Values	½ LOD Values
URGA		
Cadmium, Dissolved (mg/L)	0.001	0.0005
Lead, Dissolved (mg/L)	0.002	0.001
Mercury (mg/L)	0.0002	0.0001
Mercury, Dissolved (mg/L)	0.0002	0.0001
Technetium-99 (pCi/L)	21.1	10.55
Uranium-234 (pCi/L)	5.9	2.95
Uranium-235 (pCi/L)	6.3	3.15
Uranium-238 (pCi/L)	5.09	2.545

Table B.5. Summary of Conclusions from the Statistical Analyses for the C-404 Hazardous Waste Landfill for the January 2016 Data Set

Attachment	RGA Well Type	Parameter	Applied Statistical Test	Results
B1	URGA	Arsenic	Statistical Test 3, Nonparametric ANOVA	No statistical evidence of releases from the C-404 Landfill in compliance wells.
B2	URGA	Arsenic, Dissolved	Statistical Test 2, Test of Proportions	No statistical evidence of releases from the C-404 Landfill in compliance wells.
B3	URGA	Cadmium	Statistical Test 2, Test of Proportions	No statistical evidence of releases from the C-404 Landfill in compliance wells.
B4	URGA	Chromium	Statistical Test 3, Nonparametric ANOVA/95% UTL	Because Nonparametric ANOVA indicated a statistical evidence of a release from the C-404 Landfill in compliance well MW84, comparison to the 95% UTL was performed, as required by the Hazardous Waste Facility Permit. Results of the comparison showed no statistical evidence of releases from the C-404 Landfill in compliance wells.
B5	URGA	Chromium Dissolved	Statistical Test 2, Test of Proportions	No statistical evidence of releases from the C-404 Landfill in compliance wells.
B6	URGA	Lead	Statistical Test 2, Test of Proportions	No statistical evidence of releases from the C-404 Landfill in compliance wells.
B7	URGA	Selenium	Statistical Test 2, Test of Proportions	No statistical evidence of releases from the C-404 Landfill in compliance wells.
B8	URGA	Selenium, Dissolved	Statistical Test 2 Test of Proportions	No statistical evidence of releases from the C-404 Landfill in compliance wells.
B9	URGA	Trichloroethene	Statistical Test 4 Parametric ANOVA/ Statistical Test 3, Nonparametric ANOVA	Because equality of variance could not be confirmed, Statistical Test 4 was abandoned and Statistical Test 3, Non-parametric ANOVA, was performed. Results of this analysis showed no statistical evidence of releases from the C-404 Landfill in compliance wells.
B10	URGA	Uranium	Statistical Test 2 Test of Proportions	No statistical evidence of releases from the C-404 Landfill in compliance wells.

ATTACHMENT B1

ARSENIC (TOTAL)
STATISTICAL TEST 3

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Attachment B1: Statistical Test 3, Nonparametric ANOVA, January 2016 Arsenic (Total) URG

Arsenic (Total) (mg/L)					
Date	Background	Background	Compliance	Compliance	Compliance
	MW93	MW420	MW84	MW87	MW90A
Jan-14	0.00656	0.00105	0.00514	0.00218	0.0005
Jul-14	0.0058	0.0025	0.00511	0.00302	0.0025
Jan-15	0.00185	0.0025	0.0073	0.00174	0.0025
Jul-15	0.00702	0.0025	0.00922	0.00447	0.0025
Jan-16	0.00743	0.0025	0.0103	0.00481	0.0025
Sum	0.0397		0.03707	0.01622	0.0105
n _i	10		5	5	5
(x _i) _{avg}	0.00397		0.00741	0.00324	0.0021

mg/L = milligrams per liter

BG=background

DL=detection limit

All data sets represent 1/2 DL values for nondetects.

Bolded values indicate a detected result.

$$\text{Overall mean } x.. = 0.00414$$

$$\begin{aligned} N &= 25 \\ p &= 4 \\ x.. &= 0.10 \end{aligned}$$

Attachment B1: Statistical Test 3, Nonparametric ANOVA, January 2016 Arsenic (Total) URGA

Statistical Test 3, Nonparametric ANOVA

Ranking of Observations

Sequence	Arsenic (mg/L)	Adjusted Rank	Tie Number
1	0.0005	1	
2	0.0011	2	
3	0.00174	3	
4	0.00185	4	
5	0.00218	5	
6	0.0025	9.5	Tie 1
7	0.0025	9.5	
8	0.0025	9.5	
9	0.0025	9.5	
10	0.0025	9.5	
11	0.0025	9.5	
12	0.0025	9.5	
13	0.0025	9.5	
14	0.00302	14	
15	0.00447	15	
16	0.00481	16	
17	0.00511	17	
18	0.00514	18	
19	0.0058	19	
20	0.00656	20	
21	0.00702	21	
22	0.0073	22	
23	0.00743	23	
24	0.00922	24	
25	0.0103	25	

mg/L = milligrams per liter

BG=background

DL=detection limit

All data sets represent 1/2 DL values for nondetects.

Bolded values indicate a detected result.

$$n_{tie} = \frac{\text{Adjustment for Ties: } (n_{tie}^3 - n_{tie})}{8}$$

$$\text{Tie 1} = 504$$

$$\sum T_i = 504$$

Attachment B1: Statistical Test 3, Nonparametric ANOVA, January 2016 Arsenic (Total) URGA

Sums of Ranks and Averages

Arsenic (mg/L)					
Date	Background	Background	Compliance	Compliance	Compliance
	MW93	MW420	MW84	MW87	MW90A
Jan-14	0.00656	0.0011	0.00514	0.00218	0.0005
Jul-14	0.0058	0.0025	0.00511	0.00302	0.0025
Jan-15	0.00185	0.0025	0.0073	0.00174	0.0025
Jul-15	0.00702	0.0025	0.00922	0.00447	0.0025
Jan-16	0.00743	0.0025	0.0103	0.00481	0.0025

Observation Ranks for Arsenic					
Date	Background	Background	Compliance	Compliance	Compliance
	MW93	MW420	MW84	MW87	MW90A
Jan-14	20	2	18	5	1
Jul-14	19	9.5	17	14	9.5
Jan-15	4	9.5	22	3	9.5
Jul-15	21	9.5	24	15	9.5
Jan-16	23	9.5	25	16	9.5
R _i	127		106	53	39
(R _i) _{avg}	12.7		21.2	10.6	7.8
R _i ² /n _i	1612.9		2247.2	561.8	304.2

$$\Sigma R_i^2/n_i = 4726.1$$

mg/L = milligrams per liter

BG=background

DL=detection limit

All data sets represent 1/2 DL values for nondetects.

Bolded values indicate a detected result.

$$K = 4$$

$$N = 25$$

Calculation of Kruskal-Wallis Statistic

$$H = 9.251 \quad \text{Kruskal-Wallis Statistic} \quad H = [12/N(N+1) * \Sigma R_i^2/n_i] - 3(N+1)$$

$$H' = 9.560 \quad \text{Corrected Kruskal-Wallis} \quad H' = H/[1 - (\Sigma T_i/N^3 - N)]$$

$$\chi^2_{crit} = 7.815 \quad 3 \quad \text{degrees of freedom at the 5\% significance level}$$

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.

$$K-1 = 3 \quad \alpha/(K-1) = 0.01667 \quad Z(\alpha/(K-1))^{**} = 2.1280$$

$$\alpha = 0.05 \quad 1 - (\alpha/(K-1)) = 0.983$$

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

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

Attachment B1: Statistical Test 3, Nonparametric ANOVA, January 2016 Arsenic (Total) URGAs

Calculate Critical Values

Average Background Ranking = 12.700

	Well No.	C_i	$(R_i)_{avg} - (R_b)_{avg}$	Conclusion
BG Well	MW93			
BG Well	MW420			
	MW84	8.578	8.50	not contaminated
	MW87	8.578	-2.10	not contaminated
	MW90A	8.578	-4.90	not contaminated

mg/L = milligrams per liter

BG=background

DL=detection limit

All data sets represent 1/2 DL values for nondetects.

Bolded values indicate a detected result.

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

CONCLUSION: Since $(R_i)_{avg} - (R_b)_{avg} < C_i$ for all wells, MW84, MW87 and MW90A, there is no statistical evidence of releases from C-404 in these downgradient compliance test wells.

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

ATTACHMENT B2

**ARSENIC (DISSOLVED)
STATISTICAL TEST 2**

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Attachment B2: Statistical Test 2, Test of Proportions, January 2016 Arsenic, Dissolved URGA

Arsenic, Dissolved (mg/L)					
Date	Background	Background	Compliance	Compliance	Compliance
	MW93	MW420	MW84	MW87	MW90A
Jan-14	0.00536	0.0005	0.00412	0.00181	0.0005
Jul-14	0.0025	0.0025	0.0025	0.0025	0.0025
Jan-15	0.0035	0.0025	0.00245	0.0025	0.0025
Jul-15	0.00478	0.0025	0.00544	0.00273	0.0025
Jan-16	0.0025	0.0025	0.0025	0.0025	0.0025

mg/L = milligrams per liter

BG=background

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= 3 X=number of samples above DL in background wells
 Y= 5 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 = 0.320 P=(x+y)/n
 nP = 8 n=n_b+n_c
 n(1-P) = 17

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

P_b = 0.300 P_b =proportion of detects in background wells
 P_c = 0.333 P_c =proportion of detects in compliance wells
 S_D = 0.190 S_D=standard error of difference in proportions
 Z = -0.175 Z = (P_b-P_c)/S_D
 absolute value of Z = 0.175

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 1.96, there is no statistical evidence that the proportion of samples with detected results differs between the background well and compliance well samples.

¹ 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

CADMIUM
STATISTICAL TEST 2

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Attachment B3: Statistical Test 2, Test of Proportions, January 2016 Cadmium URGA

Cadmium (mg/L)					
Date	Background	Background	Compliance	Compliance	Compliance
	MW93	MW420	MW84	MW87	MW90A
Jan-14	0.0005	0.0005	0.0005	0.0005	0.0005
Jul-14	0.0005	0.0005	0.0005	0.0005	0.0005
Jan-15	0.0005	0.0005	0.00018	0.00014	0.0005
Jul-15	0.0005	0.0005	0.00012	0.0005	0.0005
Jan-16	0.000152	0.0005	0.000179	0.000121	0.0005

mg/L = milligrams per liter

BG=background

DL=detection limit

All data sets represent 1/2 DL values for nondetects.

Bolded values indicate a detected result.

¹Test of Proportions

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

X= 1 X=number of samples above DL in background wells
 Y= 5 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 = 0.240 P=(x+y)/n
 nP = 6 n=n_b+n_c
 n(1-P) = 19

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

P_b = 0.100 P_b =proportion of detects in background wells
 P_c = 0.333 P_c =proportion of detects in compliance wells
 S_D = 0.174 S_D=standard error of difference in proportions
 Z = -1.338 Z = (P_b-P_c)/S_D
 absolute value of Z = 1.338

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 1.96, there is no statistical evidence that the proportion of samples with detected results differs between the background well and compliance well samples.

¹ Section 8.1.2, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Final Guidance* (EPA, 1989).

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ATTACHMENT B4

CHROMIUM
STATISTICAL TEST 3

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Attachment B4: Statistical Test 3, Nonparametric ANOVA, January 2016 Chromium (Total) URG

Chromium (mg/L)					
Date	Background	Background	Compliance	Compliance	Compliance
	MW93	MW420	MW84	MW87	MW90A
Jan-14	0.005	0.005	0.0921	0.005	0.005
Jul-14	0.011	0.005	0.331	0.00903	0.00227
Jan-15	0.0273	0.005	0.442	0.031	0.005
Jul-15	0.00473	0.005	0.0347	0.00809	0.005
Jan-16	0.0401	0.005	0.0393	0.0266	0.00525
Sum	0.1131		0.93910	0.07972	0.0225
n _i	10		5	5	5
(x _i) _{avg}	0.01131		0.18782	0.01594	0.0045

mg/L = milligrams per liter

BG=background

DL=detection limit

All data sets represent 1/2 DL values for nondetects.

Bolded values indicate a detected result.

Overall mean $\bar{x} = 0.04618$

N = 25

p = 4

$\bar{x} = 1.15$

Attachment B4: Statistical Test 3, Nonparametric ANOVA, January 2016 Chromium (Total) URGA

Statistical Test 3, Nonparametric ANOVA

Ranking of Observations

Sequence	Chromium (mg/L)	Adjusted Rank	Tie Number
1	0.00227	1	
2	0.00473	2	
3	0.005	7.5	Tie 1
4	0.005	7.5	
5	0.005	7.5	
6	0.005	7.5	
7	0.005	7.5	
8	0.005	7.5	
9	0.005	7.5	
10	0.005	7.5	
11	0.005	7.5	
12	0.005	7.5	
13	0.00525	13	
14	0.00809	14	
15	0.00903	15	
16	0.011	16	
17	0.0266	17	
18	0.0273	18	
19	0.031	19	
20	0.0347	20	
21	0.0393	21	
22	0.0401	22	
23	0.0921	23	
24	0.331	24	
25	0.442	25	

mg/L = milligrams per liter

BG=background

DL=detection limit

All data sets represent 1/2 DL values for nondetects.

Bolded values indicate a detected result.

n_{tie} Adjustment for Ties: $(n_{tie}^3 - n_{tie})$

10 Tie 1 = 990

$\sum T_i =$ 990

Attachment B4: Statistical Test 3, Nonparametric ANOVA, January 2016 Chromium (Total) URGA

Sums of Ranks and Averages

Chromium (mg/L)					
Date	Background	Background	Compliance	Compliance	Compliance
	MW93	MW420	MW84	MW87	MW90A
Jan-14	0.005	0.005	0.0921	0.005	0.005
Jul-14	0.011	0.005	0.331	0.00903	0.00227
Jan-15	0.0273	0.005	0.442	0.031	0.005
Jul-15	0.00473	0.005	0.0347	0.00809	0.005
Jan-16	0.0401	0.005	0.0393	0.0266	0.00525

Observation Ranks for Chromium					
Date	Background	Background	Compliance	Compliance	Compliance
	MW93	MW420	MW84	MW87	MW90A
Jan-14	7.5	7.5	23	7.5	7.5
Jul-14	16	7.5	24	15	1
Jan-15	18	7.5	25	19	7.5
Jul-15	2	7.5	20	14	7.5
Jan-16	22	7.5	21	17	13
R _i	103		113	72.5	36.5
(R _i) _{avg}	10.3		22.6	14.5	7.3
R _i ² /n _i	1060.9		2553.8	1051.3	266.5

$$\Sigma R_i^2/n_i = 4932.4$$

mg/L = milligrams per liter

BG=background

DL=detection limit

All data sets represent 1/2 DL values for nondetects.

Bolded values indicate a detected result.

$$K = 4$$

$$N = 25$$

Calculation of Kruskal-Wallis Statistic

$$H = 13.060 \quad \text{Kruskal-Wallis Statistic} \quad H = [12/N(N+1) * \Sigma R_i^2/n_i] - 3(N+1)$$

$$H' = 13.945 \quad \text{Corrected Kruskal-Wallis} \quad H' = H/[1 - (\Sigma T_i/N^3 - N)]$$

$$\chi^2_{crit} = 7.815 \quad 3 \quad \text{degrees of freedom at the 5\% significance level}$$

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.

$$K-1 = 3 \quad \alpha/(K-1) = 0.01667 \quad Z(\alpha/(K-1))^{**} = 2.1280$$

$$\alpha = 0.05 \quad 1 - (\alpha/(K-1)) = 0.983$$

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

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

Attachment B4: Statistical Test 3, Nonparametric ANOVA, January 2016 Chromium (Total) URGA

Calculate Critical Values

Average Background Ranking = 10.300

	Well No.	C_i	$(R_i)_{avg} - (R_b)_{avg}$	Conclusion
BG Well	MW93			
BG Well	MW420			
	MW84	8.578	12.30	evidence of contamination
	MW87	8.578	4.20	not contaminated
	MW90A	8.578	-3.00	not contaminated

mg/L = milligrams per liter

BG=background

DL=detection limit

All data sets represent 1/2 DL values for nondetects.

Bolded values indicate a detected result.

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, MW87 and MW90A, there is no statistical evidence of releases from C-404 in these downgradient compliance test wells.

Since $(R_i)_{avg} - (R_b)_{avg} > C_i$ for MW84, there is statistical evidence of releases from C-404 in MW84.

Because nonparametric ANOVA indicated statistical evidence of a release from the C-404 Landfill in compliance well MW84, the 95% UTL was performed.

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

C-404 Landfill - URGA - Chromium (Upper Tolerance Interval Test)

January 2016 Data, First Reporting Period

Observations (mg/L)

Well No.					
MW93	0.01	0.011	0.0273	0.00473	0.0401
MW420	0.01	0.01	0.01	0.01	0.01
MW84	X: Mean Value = 0.0143				0.0393
MW87	S: Standard Deviation = 0.0108				0.0266
MW90A	K* factor = 2.911 (for n = 10)				0.01
	CV = S/X 0.7539 <1, assume normal distribution				
	Upper Tolerance Interval: TL = X +(KxS) = 0.0457 (mg/L)				

Upgradient Well (data from previous 5 sampling events)

Upgradient Well (data from previous 5 sampling events)

B4-7

* : K factor (From Table 5, Appendix B of Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Guidance, USEPA, 1989)

Result: None of the Test Wells had exceeded the Upper Tolerance level, which is statistically significant evidence that these wells have no elevated concentration with respect to background data.

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

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ATTACHMENT B5
CHROMIUM, DISSOLVED
STATISTICAL TEST 2

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Attachment B5: Statistical Test 2, Test of Proportions, January 2016 Chromium, Dissolved URGA

Chromium, Dissolved (mg/L)					
Date	Background	Background	Compliance	Compliance	Compliance
	MW93	MW420	MW84	MW87	MW90A
Jan-14	0.005	0.005	0.005	0.005	0.005
Jul-14	0.005	0.005	0.00228	0.00205	0.00231
Jan-15	0.005	0.005	0.00405	0.005	0.005
Jul-15	0.005	0.005	0.005	0.005	0.005
Jan-16	0.00323	0.00252	0.00856	0.00370	0.00618

mg/L = milligrams per liter

BG=background

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= 7 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 = 0.360 P=(x+y)/n
 nP = 9 n=n_b+n_c
 n(1-P) = 16

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

P_b = 0.200 P_b =proportion of detects in background wells
 P_c = 0.467 P_c =proportion of detects in compliance wells
 S_D = 0.196 S_D=standard error of difference in proportions
 Z = -1.361 Z = (P_b-P_c)/S_D
 absolute value of Z = 1.361

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 1.96, there is no statistical evidence that the proportion of samples with detected results differs between the background well and compliance well samples.

¹ Section 8.1.2, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Final Guidance* (EPA, 1989).

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ATTACHMENT B6

LEAD
STATISTICAL TEST 2

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**Attachment B6: Statistical Test 2, Test of Proportions, January 2016
Lead URGA**

Lead (mg/L)					
Date	Background	Background	Compliance	Compliance	Compliance
	MW93	MW420	MW84	MW87	MW90A
Jan-14	0.00065	0.00065	0.00065	0.00065	0.00065
Jul-14	0.00066	0.001	0.001	0.001	0.001
Jan-15	0.0024	0.001	0.00189	0.0009	0.001
Jul-15	0.001	0.001	0.00088	0.001	0.001
Jan-16	0.00144	0.001	0.00108	0.00107	0.001

mg/L = milligrams per liter

BG=background

DL=detection limit

Nondetect values are 1/2 DL.

Bolded values indicate a detected result.

Test of Proportions

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

X= 3 X=number of samples above DL in background wells
 Y= 5 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 = 0.320 P=(x+y)/n
 nP = 8 n=n_b+n_c
 n(1-P) = 17

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

P_b = 0.300 P_b =proportion of detects in background wells
 P_c = 0.333 P_c =proportion of detects in compliance wells
 S_D = 0.190 S_D=standard error of difference in proportions
 Z = -0.175 Z = (P_b-P_c)/S_D
 absolute value of Z = 0.175

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 1.96, there is no statistical evidence that the proportion of samples with detected results differs between the background well and compliance well samples.

¹ Section 8.1.2, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Final Guidance* (EPA, 1989).

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ATTACHMENT B7

SELENIUM
STATISTICAL TEST 2

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**Attachment B7: Statistical Test 2, Test of Proportions, January 2016
Selenium URGA**

Selenium (mg/L)					
Date	Background	Background	Compliance	Compliance	Compliance
	MW93	MW420	MW84	MW87	MW90A
Jan-14	0.00596	0.0025	0.00652	0.0025	0.0025
Jul-14	0.0025	0.0025	0.0025	0.0025	0.00166
Jan-15	0.0025	0.0025	0.0025	0.0025	0.00182
Jul-15	0.0025	0.0025	0.0025	0.0025	0.0025
Jan-16	0.00165	0.0025	0.0025	0.0025	0.00231

mg/L = milligrams per liter

BG=background

DL=detection limit

Nondetect values are 1/2 DL.

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= 4 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 = 0.240 P=(x+y)/n
 nP = 6 n=n_b+n_c
 n(1-P) = 19

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

P_b = 0.200 P_b =proportion of detects in background wells
 P_c = 0.267 P_c =proportion of detects in compliance wells
 S_D = 0.174 S_D=standard error of difference in proportions
 Z = -0.382 Z = (P_b-P_c)/S_D
 absolute value of Z = 0.382

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 1.96, there is no statistical evidence that the proportion of samples with detected results differs between the background well and compliance well samples.

¹ Section 8.1.2, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Final Guidance* (EPA, 1989).

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ATTACHMENT B8

**SELENIUM, DISSOLVED
STATISTICAL TEST 2**

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**Attachment B8: Statistical Test 2, Test of Proportions, January 2016
Selenium, Dissolved URGA**

Selenium, Dissolved (mg/L)					
Date	Background	Background	Compliance	Compliance	Compliance
	MW93	MW420	MW84	MW87	MW90A
Jan-14	0.0025	0.0025	0.0025	0.0025	0.0025
Jul-14	0.0025	0.0025	0.0025	0.0025	0.0025
Jan-15	0.0025	0.0025	0.0025	0.0025	0.0025
Jul-15	0.0025	0.0025	0.0025	0.0025	0.0025
Jan-16	0.00225	0.0025	0.0025	0.00199	0.00197

mg/L = milligrams per liter

BG=background

DL=detection limit

Nondetect values are 1/2 DL.

Bolded values indicate a detected result.

¹Test of Proportions

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

X= 1 X=number of samples above DL in background wells
 Y= 2 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 = 0.120 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 = 0.100 P_b =proportion of detects in background wells
 P_c = 0.133 P_c =proportion of detects in compliance wells
 S_D = 0.133 S_D=standard error of difference in proportions
 Z = -0.251 Z = (P_b-P_c)/S_D
 absolute value of Z = 0.251

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 1.96, there is no statistical evidence that the proportion of samples with detected results differs between the background well and compliance well samples.

¹ Section 8.1.2, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Final Guidance* (EPA, 1989).

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ATTACHMENT B9

**TRICHLOROETHENE
STATISTICAL TESTS 4/3**

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**Attachment B9. Statistical Test 4, Parametric ANOVA,
January 2016 Trichloroethene URG**

Trichloroethene (TCE, µg/L)					
Date	Background	Background	Compliance	Compliance	Compliance
	MW93	MW420	MW84	MW87	MW90A
Jan-14	2900	290	1500	670	25
Jul-14	2710	203	1270	1030	46.2
Jan-15	2970	208	1380	1010	37.3
Jul-15	2520	191	1530	1250	37.9
Jan-16	2490	222	1350	1230	39.8
n _i	10		5	5	5
Sum	14704		7030	5190	186.20
(x _i)avg	1470.40		1406.00	1038.00	37.24

µg/L = micrograms per liter

Bolded values indicate a detected result.

Overall mean $\bar{x}..$ = 1084.41
 N = 25
 p = 4
 $\bar{x}..$ = 27110.20

Determine Normality of Dataset

Coefficient of Variability Test

Table of Residuals

Date	Background	Background	Compliance	Compliance	Compliance
	MW93	MW420	MW84	MW87	MW90A
Jan-14	1429.60	-1180.40	94.00	-368.00	-12.24
Jul-14	1239.60	-1267.40	-136.00	-8.00	8.96
Jan-15	1499.60	-1262.40	-26.00	-28.00	0.06
Jul-15	1049.60	-1279.40	124.00	212.00	0.66
Jan-16	1019.60	-1248.40	-56.00	192.00	2.56

X: Mean Value = -3.41E-14
 S: Standard Deviation = 817.1
 K* Factor = 2.292 (for n = 25)
 CV = S/X = -2.40E+16 ≤ 1, assume normal distribution

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

Because the coefficient of variation is < 1, the residuals appear to be normally distributed.

**Attachment B9. Statistical Test 4, Parametric ANOVA,
January 2016 Trichloroethene URGA**

Determine Equality of Variance of Dataset

p = number of wells $\bar{x}_{..} = 27110.20$
 n_i = number of data points per well $(x_{avg})_{..} = 1084.41$
 N = total sample size
 S^2 = the square of the standard deviation $p = 4$
 $\ln(S_i^2)$ = natural logarithm of each variance $N = 25$
 f = total sample size minus the number of wells (groups)
 $f_i = n_i - 1$

Calculations for Equality of Variance: Bartlett's Test

S_i	S_i^2	$\ln(S_i^2)$	n_i	$f_i S_i^2$	$f_i \ln(S_i^2)$
1323.257	1751008.49	14.376	10	15759076.4	129.4
107.842	11630.00	9.361	5	46520.000	37.4
233.495	54520.00	10.906	5	218080.000	43.6
7.699	59.27	4.082	5	237.092	16.3

$\sum(S_i^2) = 1817217.76$
 $\sum f_i \ln(S_i^2) = 226.8$

Equality of Variance: Bartlett's Test

$f = 21$
 $Sp^2 = 763043.500$
 $\ln Sp^2 = 13.545$
 $\chi^2 = 57.666$ (If calculated $\chi^2 \leq \chi^2_{crit}$, then variances are equal at the given significance level).
 $\chi^2_{crit} * = 7.815$ at a 5% significance level with 3 degrees of freedom

Variances are not equal, transform the original data to lognormal.

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

**Attachment B9. Statistical Test 4, Parametric ANOVA,
January 2016 Trichloroethene URG**

Lognormal Data for TCE

ln[TCE (µg/L)]					
Date	Background	Background	Compliance	Compliance	Compliance
	MW93	MW420	MW84	MW87	MW90A
Jan-14	7.97	5.67	7.31	6.51	3.22
Jul-14	7.90	5.31	7.15	6.94	3.83
Jan-15	8.00	5.34	7.23	6.92	3.62
Jul-15	7.83	5.25	7.33	7.13	3.63
Jan-16	7.82	5.40	7.21	7.11	3.68
x_i	66.50		36.23	34.61	17.99
$(x_i)_{avg}$	6.65		7.25	6.92	3.60

µg/L = micrograms per liter

Determine Normality of Dataset

Coefficient of Variability Test

Table of Residuals

Date	Background	Background	Compliance	Compliance	Compliance
	MW93	MW420	MW84	MW87	MW90A
Jan-14	1.32	-0.98	0.07	-0.41	-0.38
Jul-14	1.25	-1.34	-0.10	0.02	0.24
Jan-15	1.35	-1.31	-0.02	0.00	0.02
Jul-15	1.18	-1.40	0.09	0.21	0.04
Jan-16	1.17	-1.25	-0.04	0.19	0.09

X: Mean Value = 4.62E-16
 S: Standard Deviation = 0.83
 K* Factor = 2.292 (for n = 25)
 CV = S/X = 1.79E+15 > or = 1, log-transformed data are not normally distributed

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

**Attachment B9. Statistical Test 4, Parametric ANOVA,
January 2016 Trichloroethene URGA**

Determine Equality of Variance of Dataset

p = number of wells (background wells considered as one group) x_{..} = 155.33
 n_i = number of data points per well (x_{avg})_{..} = 6.21
 N = total sample size
 S² = the square of the standard deviation p = 4
 ln(S_i²) = natural logarithm of each variance N = 25
 f = total sample size minus the number of wells (groups)
 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)
1.328	1.765	0.568	10	15.882	5.1
0.077	0.006	-5.131	5	0.024	-20.5
0.252	0.063	-2.760	5	0.253	-11.0
0.228	0.052	-2.956	5	0.208	-11.8

$\sum(S_i^2) = 1.89$ $\sum f_i \ln(S_i^2) = -38.3$

Equality of Variance: Bartlett's Test

f = 21
 Sp² = 0.779
 ln Sp² = -0.249
 $\chi^2 = 33.041$ (If calculated $\chi^2 \leq$ tabulated χ^2 , then variances are equal at the given significance level).
 tabulated $\chi^2 * = 7.815$ at a 5% significance level with 3 degrees of freedom

Variances are not equal.

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

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

**Attachment B9. Statistical Test 3, Nonparametric ANOVA,
January 2016 Trichloroethene URGA**

Statistical Test 3, Nonparametric ANOVA

TCE ($\mu\text{g/L}$)					
Date	Background	Background	Compliance	Compliance	Compliance
	MW93	MW420	MW84	MW87	MW90A
Jan-14	2900	290	1500	670	25
Jul-14	2710	203	1270	1030	46.2
Jan-15	2970	208	1380	1010	37.3
Jul-15	2520	191	1530	1250	37.9
Jan-16	2490	222	1350	1230	39.8
n_i	10		5	5	5
x_i	14704		7030	5190	186.20
$(x_i)\text{avg}$	1470.40		1406.00	1038.00	37.24

Overall mean $x_{..}$ = 1084.41

N = 25

p = 4

$x_{..}$ = 27110.20

$\mu\text{g/L}$ = micrograms per liter

**Attachment B9. Statistical Test 3, Nonparametric ANOVA,
January 2016 Trichloroethene URGA**

Non-Parametric ANOVA

Ranking of Observations

Sequence	TCE (µg/L)	Adjusted Rank	Tie Number
1	25	1	
2	37.3	2	
3	37.9	3	
4	39.8	4	
5	46.2	5	
6	191	6	
7	203	7	
8	208	8	
9	222	9	
10	290	10	
11	670	11	
12	1010	12	
13	1030	13	
14	1230	14	
15	1250	15	
16	1270	16	
17	1350	17	
18	1380	18	
19	1500	19	
20	1530	20	
21	2490	21	
22	2520	22	
23	2710	23	
24	2900	24	
25	2970	25	

$$\text{Adjustment for Ties: } \frac{n_{\text{tie}}^3 - n_{\text{tie}}}{n_{\text{tie}}}$$

$$\sum T_i = 0$$

**Attachment B9. Statistical Test 3, Nonparametric ANOVA,
January 2016 Trichloroethene URGA**

Sums of Ranks and Averages

TCE (µg/L)					
Date	Background	Background	Compliance	Compliance	Compliance
	MW93	MW420	MW84	MW87	MW90A
Jan-14	2900	290	1500	670	25
Jul-14	2710	203	1270	1030	46.2
Jan-15	2970	208	1380	1010	37.3
Jul-15	2520	191	1530	1250	37.9
Jan-16	2490	222	1350	1230	39.8

Observation Ranks for TCE					
Date	Background	Background	Compliance	Compliance	Compliance
	MW93	MW420	MW84	MW87	MW90A
Jan-14	24	10	19	11	1
Jul-14	23	7	16	13	5
Jan-15	25	8	18	12	2
Jul-15	22	6	20	15	3
Jan-16	21	9	17	14	4
R _i	155		90	65	15
(R _i) _{avg}	15.5		18.0	13.0	3
R _i ² /n _i	2402.5		1620.0	845.0	45

$$\Sigma R_i^2/n_i = 4912.5$$

$$K = 4$$

$$N = 25$$

Calculation of Kruskal-Wallis Statistic

$$H = 12.692 \quad \text{Kruskal-Wallis Statistic} \quad H = [12/N(N+1)*\Sigma R_i^2/n_i] - 3(N+1)$$

$$H' = 12.692 \quad \text{Corrected Kruskal-Wallis} \quad H' = H/[1-(\Sigma T_i/N^3-N)]$$

$$\chi^2_{crit} = 7.815 \quad 3 \quad \text{degrees of freedom at the 5\% significance level}$$

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.

$$K-1 = 3 \quad \alpha/(K-1) = 0.01667 \quad Z(\alpha/(K-1))^{**} = 2.128$$

$$\alpha = 0.05 \quad 1-(\alpha/(K-1)) = 0.983$$

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 B9. Statistical Test 3, Nonparametric ANOVA,
January 2016 Trichloroethene URGA**

Calculate Critical Values

Average Background Ranking = 15.5

	Well No.	C_i	$(R_i)_{avg} - (R_b)_{avg}$	Conclusion
BG Well	MW93			
BG Well	MW420			
	MW84	8.578	2.50	not contaminated
	MW87	8.578	-2.50	not contaminated
	MW90A	8.578	-12.50	not contaminated

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

CONCLUSION: Since $(R_i)_{avg} - (R_b)_{avg} < C_i$, there is no statistically significant evidence that downgradient compliance test wells are contaminated; 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 B10

**URANIUM
STATISTICAL TEST 2**

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Attachment B10: Statistical Test 2, Test of Proportions, January 2016 Uranium URGA

Uranium (mg/L)					
Date	Background	Background	Compliance	Compliance	Compliance
	MW93	MW420	MW84	MW87	MW90A
Jan-14	0.0005	0.0005	0.0005	0.0005	0.0005
Jul-14	0.00093	0.0001	0.00011	0.00085	0.0001
Jan-15	0.00214	0.0001	0.00043	0.00019	0.0001
Jul-15	0.0001	0.0001	0.00018	0.00087	0.0001
Jan-16	0.000203	0.0001	0.000226	0.000273	0.0001

mg/L = milligrams per liter

BG=background

DL=detection limit

Nondetect values are 1/2 DL.

Bolded values indicate a detected result.

Test of Proportions

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

X=	3	X=number of samples above DL in background wells
Y=	8	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 =	0.440	P=(x+y)/n
nP =	11	n=n _b +n _c
n(1-P) =	14	

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

P _b =	0.300	P _b =proportion of detects in background wells
P _c =	0.533	P _c =proportion of detects in compliance wells
S _D =	0.203	S _D =standard error of difference in proportions
Z =	-1.151	Z = (P _b -P _c)/S _D
absolute value of Z =	1.151	

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 1.96, there is no statistical evidence that the proportion of samples with detected results differs between the background well and compliance well samples.

¹ Section 8.1.2, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Final Guidance* (EPA, 1989).

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ATTACHMENT B11
STATISTICIAN STATEMENT

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April 18, 2016

Ms. Myrna Redfield
Fluor Federal Services, Inc.
5511 Hobbs Road
Kevil, KY 42053

Dear Ms. Redfield:

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

As a Chemist, with a Bachelor of Science degree in chemistry and a minor in biology, I have over 20 years of experience in reviewing and assessing laboratory analytical results associated with environmental sampling and investigation activities. For the generation of these statistical analyses, my work was observed and reviewed by a senior chemist and geologist with Fluor Federal Services, Inc.

For this project, the statistical analyses on groundwater data from January 2014 through January 2016 were performed in accordance with the C-404 Hazardous Waste Landfill Permit, Appendix E using Microsoft Excel 2010. The spreadsheets include the results for the following statistical tests:

- Test of Proportions
- Parametric Analysis of Variance (ANOVA)
- Nonparametric ANOVA

The statistical analyses procedures were based on the U.S. Environmental Protection Agency (USEPA) *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Interim Final Guidance* (1989).

Sincerely,



Jennifer R. Blewett

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APPENDIX C

**C-404 HAZARDOUS WASTE LANDFILL
LEACHATE INFORMATION**

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**PADUCAH GASEOUS DIFFUSION PLANT
C-404 HAZARDOUS WASTE LANDFILL
PERMIT NUMBER KY8-890-008-982**

LEACHATE INFORMATION

This appendix includes the C-404 Landfill monthly and quarterly inspection checklists and volumes of leachate removed during this reporting period (1,100 gal on December 29, 2015, and 1,200 gal on March 14, 2016). The analytical results of the leachate sampling conducted on December 29, 2015, also are included. The analytical results of the leachate sampling conducted on March 14, 2016, will be included in the next semiannual report.

One item noted as an observation in the inspection checklists pertained to a landfill sign. A sign was on the ground on the west end of the C-404 Landfill. A replacement sign is being ordered in response to the noted inspection item; the fallen sign will be replaced as soon as practical.

Another item noted as an observation in the inspection checklists pertained to the drainage pipes. The drainage pipes were observed to be cracked; however, they continue to flow water without plugging. Cracks are caused by mowing activities and will continue to occur. The drainage pipes will continue to be monitored to ensure proper drainage; if it becomes necessary, options to protect the drainage pipes from the mowers will be evaluated. If implemented, most options to protect the drainage pipes potentially would require modification of the Post-closure Plan Permit Application.

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C-404 Monthly Inspection Summary^{1, 2, 3, 4}

Period of Inspection: OCTOBER 2015

Leachate Level	Date (M/D/YY)	Level (inches deep)*	Inspector(s)
First monthly leachate level determination	10/13/15	22"	Barry Kinsall
Second monthly leachate level determination		BK	
Third monthly leachate level determination		10/13/15	

* If the leachate level in the sump is at **3 feet (36 inches)**, then contact the appropriate personnel to initial removal and sampling of leachate AND when leachate is removed, complete the **"C-404 Inspection Checklist for Leachate Removal."**

NOTES:

1. If any item is found to be unacceptable and cannot be explained in the space available, the inspector must identify the specific observation and nature of the problem on the "C-404 Inspection Addendum" Form.
2. Third quarter of calendar year inspection includes the annual leachate collection system inspection.
3. The original forms shall be kept on file in the facility operating record.
4. Upon completing the monthly inspections, e-mail Environmental Compliance the leachate level and whether or not the leachate needs to be sampled or removed.

ENM-F-0001 (8/17/10)
PAD-ENM-0022

C-404 Quarterly Inspection Checklist^{1, 5}

Item No.	Inspection Item	Item Description	Inspection Results		Comments/Observations
			A	U	
A	Warning Signs	Four signs around landfill		✓	SEE PAGE #2
B	Vegetative Cover ²	Gully erosion depth > 6 inches	✓		SEE PAGE #2
		Vegetative die-off	✓		
		Varmint intrusion/burrowing from animals		✓	
		Overgrowth	✓		
		Depressions	✓		
C	Ditches ³	Debris in ditches	✓		
		Excessive sediment	✓		
		Drainage	✓		
		Erosion		✓	
D	Anchor Trench ⁴	Washouts or depressions	✓		ALL PVC DRAINS CRACKED / DAMAGED
		Lack of discharge	✓		
		Unusual volume or color	✓		
		Drainage (4 drains from landfill)		✓	
E	Leachate System	Level	✓		
		Cracks or damage	✓		
Inspector: <u>Barry Kinsall / Justin Riley</u> (Printed Name)			Signature: <u>[Signature]</u> Date: <u>11/6/15</u> Time: <u>0920</u>		

A=Acceptable
U=Unacceptable

NOTES:

1. If any item is found to be unacceptable, the inspector must identify the specific observation and nature of the problem on the "C-404 Inspection Addendum" Form.
2. For Item No. B, the vegetative cover shall be mowed regularly during the active growing season to discourage the growth of weeds, competitive species, or deep-rooted vegetation. Mowing shall be conducted using a sickle-type mower to prevent airborne contaminants. A radiation work permit will be required. Any erosion damage greater than 6 inches will be repaired by restoring to its original grade and reseeding. Differential settlement will be repaired by restoring site to its original grade and reseeding.
3. For Item No. C, blockage of or damage to the system shall be repaired by removing debris and accumulated sediment and restoring the ditch to its original grade. Ditches shall be reseeded and additional gravel shall be installed as needed.
4. For Item No. D, drainage pipe failures shall be repaired by removing the failed pipe, installing a new section, and replacing the fill material as necessary.
5. The original forms shall be kept on file in the facility operating record.

ENM-F-0002 (8-17-10)
PAD-ENM-0022

C-404 Inspection Addendum^{1,2,3}

Date	Item No.	Observation	Repairs Completed
11/6/15	A	C-404 SIGN ON WEST END OF LANDFILL IS DOWN. PVC SIGN POST IS BROKEN. NO WARNING SIGN PRESENT	
11/6/15	B	COYOTE DEN DISCOVERED IN SIDE OF NORTH WEST SLOPE. POSSIBLE OLD DEN (DEPRESSION FILLED IN) ON SOUTHEAST SLOPE.	
11/6/15	B	NUMEROUS MOLE/VOLE/MOUSE HOLES IN LANDFILL. APPEAR TO BE SHALLOW	
11/6/15	C	SIDE ROAD ENTRANCE OF ROAD ON SOUTHSIDE OF C-404 LANDFILL IS ERODING (GRAVEL)	
11/6/15	C	PONDED WATER IN DITCHES, ESPECIALLY SOUTHSIDE & NORTHEAST DITCHES.	
11/6/15	D	DRAINS ON NW, NE, SE & SOUTHSIDE ARE CRACKED AND DAMAGED.	

NOTES:

1. This form can be used if additional space is necessary to document the appropriate information.
2. If the notation is made by someone other than the inspector for the repairs completed, that person should sign the entry.
3. The original forms shall be kept on file in the facility operating record.

ENM-F-0006 (8-17-10)
PAD-ENM-0022

C-404 Leachate Pit Monthly Level Inspection

Calendar Quarter/Year: DECEMBER 2015

	Date (MM/DD/YY)	Depth* (inches)	Inspector(s) (Print/Sign)
First month of the quarter	_____	_____	_____
Second month of the quarter	_____	_____	_____
Third month of the quarter	12/1/15	24"	BARRY KINSALL

Comments: _____

* If the leachate level in the pit is **36 inches or more**, Waste Management is contacted to initiate removal and sampling of leachate.

NOTE: The third quarter calendar year inspection includes the annual leachate collection system inspection.

C-404 Inspection Addendum

Date	Inspection/ Item No.	Observation	Repairs Completed
12/28/15	BK 12/30/15	DUE TO THE AMOUNT OF RAINFALL THAT THE SITE HAS RECEIVED OVER THE PAST 5 DAYS, THE SUMP WAS CHECKED FOR LEACHATE LEVEL. THE LEVEL WAS 38" WHICH EXCEEDS THE 36" LIMIT. SUMP MUST BE PUMPED. BK 12/28/15	BK 12/30/15
12/28/15		EMAIL SENT TO WASTE MANAGEMENT REQUESTING LEACHATE REMOVAL. (EMAIL ATTACHED). BK 12/28/15	
12/29/15		- WASTE MANAGEMENT REMOVED 1100 GALLONS FROM PIT. - SAMPLE WAS COLLECTED PRIOR TO BEING PUMPED	
12/30/15		LEACHATE LEVEL AFTER PUMPING WAS 14".	
BK 12/30/15			

NOTES:

This form is used if additional space is necessary to document the appropriate information. Provide signature and date for all entries.

C-404 Leachate Pit Monthly Level Inspection

Calendar Quarter/Year: JAN - MARCH 2016

	Date (MM/DD/YY)	Depth* (inches)	Inspector(s) (Print/Sign)
First month of the quarter	1/14/16	21"	Barry Kinsall <i>[Signature]</i> Justin Riles <i>[Signature]</i>
Second month of the quarter		BK 11/14/16	
Third month of the quarter			

Comments: _____

BK
1/25/16

* If the leachate level in the pit is **36 inches or more**, Waste Management is contacted to initiate removal and sampling of leachate.

NOTE: The third quarter calendar year inspection includes the annual leachate collection system inspection.

C-404 Leachate Pit Monthly Level Inspection

Calendar Quarter/Year: JAN-MARCH 2016

	Date (MM/DD/YY)	Depth* (inches)	Inspector(s) (Print/Sign)
First month of the quarter	 	BK 2/11/16	
Second month of the quarter	2/11/16	25"	Barry Kinsall <i>BK</i>
Third month of the quarter	 	BK 2/11/16	

Comments: _____

 BK
2/11/16

* If the leachate level in the pit is 36 inches or more, Waste Management is contacted to initiate removal and sampling of leachate.

NOTE: The third quarter calendar year inspection includes the annual leachate collection system inspection.

C-404 Quarterly Inspection Checklist

Item	Inspection Item	Description	Inspection Results		Comments/Observations
			A	U	
A	Warning Signs	Four signs around landfill		✓	SEE ATTACHMENT. ITEM# A
B	Vegetative Cover ²	Gully erosion depth > 6 inches	✓		BK 2/23/16
		Vegetative die-off	✓		BK 2/23/16
		Varmint intrusion/burrowing from animals	✓		SEE ATTACHMENT ITEM# B
		Overgrowth	✓		BK 2/23/16
		Depressions	✓		BK 2/23/16
C	Ditches ³	Debris in ditches	✓		BK 2/23/16
		Excessive sediment	✓		BK 2/23/16
		Drainage	✓		BK 2/23/16
		Erosion	✓		ROAD EROSION ITEM# C
D	Anchor Trench ⁴	Washouts or depressions	✓		BK 2/23/16
		Lack of discharge	✓		BK 2/23/16
		Unusual volume or color	✓		BK 2/23/16
		Drainage (4 drains from landfill)		✓	SEE ATTACHMENT ITEM# D
E	Leachate System	Level	✓		25" on 2/11/16 BK 2/23/16
		Cracks or damage	✓		
Inspector: <u>Barry Kinsall / Justin Riley</u> (Printed Name)			Signature: <u>B. Kinsall / J. Riley</u> Date: <u>2/23/16</u> Time: <u>0923</u>		

A = Acceptable
U = Unacceptable

NOTES:

1. If any item is found to be unacceptable, the inspector documents the specific observation and nature of the problem. CP4-ES-0039-F06 Addendum is used if additional space is needed.
2. For Item B, the vegetative cover shall be mowed regularly during the active growing season to prevent the overgrowth of weeds, competitive species, or deep-rooted vegetation. Any erosion damage greater than 6 inches will be repaired by restoring to its original grade and reseeding. Depressions caused by settling will be repaired by restoring site to its original grade and reseeding.
3. For Item C, blockage of or damage to the ditch system shall be repaired by removing debris and accumulated sediment and restoring the ditch to its original grade. Ditches shall be reseeded and additional gravel shall be installed as needed.
4. For Item D, drainage pipe failures shall be repaired by removing the failed pipe, installing a new section, and replacing the fill material as necessary.

C-404 Inspection Addendum

Date	Inspection/ Item No.	Observation	Repairs Completed
2/23/16	A	C-404 SIGN ON WEST END OF LANDFILL IS DOWN. PVC SIGN IS BROKEN. NO WARNNG SIGN PRESENT.	
2/23/16	B	NUMEROUS VOLE/MOUSE HOLES IN LANDFILL. ALSO A COUPLE OF HOLES FROM COYOTES DIGGNG. ALL APPEAR TO BE SHALLOW.	
2/23/16	C	SIDE ROAD ENTRANCE ON SOUTHSIDE OF C-404 LANDFILL IS ERODING (GRAVEL).	
2/23/16	D	DRAWS ON NW, NE, SE & SOUTHSIDE ARE CRACKED AND DAMAGED.	
<p>BY 2/23/16</p>			

NOTES:

This form is used if additional space is necessary to document the appropriate information. Provide signature and date for all entries.

C-404 Leachate Pit Monthly Level Inspection

Calendar Quarter/Year: 3/1/16

	Date (MM/DD/YY)	Depth* (inches)	Inspector(s) (Print/Sign)
First month of the quarter			
Second month of the quarter			
Third month of the quarter	3/1/16	37"	Barry Kingall <i>[Signature]</i>

Comments: CONTACTED MIKE ZEISS TO SCHEDULE
LEACHATE PUMPING. CONTACTED JAIME MORROW
TO SETUP SAMPLES IN PEMS. BK 3/1/16

* If the leachate level in the pit is 36 inches or more, Waste Management is contacted to initiate removal and sampling of leachate.

NOTE: The third quarter calendar year inspection includes the annual leachate collection system inspection.

C-404 Inspection Checklist for Leachate Removal

Leachate Removal Inspection		YES	NO	N/A	Date (MM/DD/YY)	Volume (gallons)
Was any removal necessary during the quarter?		✓	BK 3/15/16		3/14/16	1200
Has leachate removed during the quarter been sampled?		✓			3/14/16	N/A
Item	Inspection Item	Description	Inspection Results		Comments	
			A	U		
A	Leachate Pit After Removal of Leachate	Interior defects	PPK 3-16-16 ✓		SEE COMMENT BK 3/15/16	
		Exterior defects	PPK 3-16-16 ✓			
Inspector: <u>Barry Kinsall / JUSTIN RILEY</u> (Printed Name)			Signature: <u>[Signature]</u> Date: <u>3/15/16</u> Time: <u>1401</u>			

A = Acceptable
U = Unacceptable

Comments: LEACHATE LEVEL AFTER PUMPING WAS MEASURED AT 8 INCHES ON 3/15/16. BK 3/15/16
* ANIMAL BURROW NEXT TO FRONT CONCRETE WALL.
3/15/16 BK

NOTES:

1. This form is completed if the leachate level in the pit is at 36 inches or more.
2. If any item is found to be unacceptable, the inspector documents the specific observation and nature of the problem. CP4-ES-0039-F06 Addendum is used if additional space is needed.

Paducah OREIS Report for 404L16-01

L1404L1-16

from: C404L

on 12/29/2015

Media: WW

SmpMethod: GR

Comments:

Analysis	Results	Counting Error	Units	Result Qual	Foot Note	Reporting Limit	TPU	Method	V/V/A*
ANION									
Fluoride	6.11		mg/L			0.2		SW846-9056	I / X /
FS									
Conductivity	498		umho/cm					FS	/ /
Dissolved Oxygen	7.48		mg/L					FS	/ /
pH	7.16		Std Unit					FS	/ /
Redox	400		mV					FS	/ /
Temperature	57.7		deg F					FS	/ /
METAL									
Arsenic	0.005		mg/L	U		0.005		SW846-6020	/ X /
Barium	0.0872		mg/L			0.002		SW846-6020	/ X /
Cadmium	0.001		mg/L	U		0.001		SW846-6020	/ X /
Chromium	0.01		mg/L	U		0.01		SW846-6020	/ X /
Copper	0.00607		mg/L			0.001		SW846-6020	/ X /
Iron	0.428		mg/L	X		0.1		SW846-6020	S / X /
Lead	0.002		mg/L	U		0.002		SW846-6020	/ X /
Mercury	0.00012		mg/L	J		0.0002		SW846-7470A	S / X /
Nickel	0.0033		mg/L			0.002		SW846-6020	S / X /
Selenium	0.005		mg/L	U		0.005		SW846-6020	/ X /
Silver	0.001		mg/L	U		0.001		SW846-6020	/ X /
Uranium	53.9		mg/L			0.2		SW846-6020	I / X /
Zinc	0.00569		mg/L	J		0.01		SW846-6020	S / X /
PPCB									
PCB-1016	0.098		ug/L	U		0.098		SW846-8082	/ X /
PCB-1221	0.098		ug/L	U		0.098		SW846-8082	/ X /
PCB-1232	0.098		ug/L	U		0.098		SW846-8082	/ X /
PCB-1242	0.098		ug/L	U		0.098		SW846-8082	/ X /
PCB-1248	0.676		ug/L			0.098		SW846-8082	/ X /
PCB-1254	0.098		ug/L	U		0.098		SW846-8082	/ X /
PCB-1260	0.098		ug/L	U		0.098		SW846-8082	/ X /
PCB-1268	0.098		ug/L	U		0.098		SW846-8082	/ X /
Polychlorinated biphenyl	0.676		ug/L			0.098		SW846-8082	I / X /
RADS									
Cesium-137	-1.07	3.96	pCi/L	U		7.03	3.99	EPA-901.1	/ X /
Neptunium-237	1.24	1.37	pCi/L	U		1.81	1.38	Alpha Spectroscopy	/ X /
Plutonium-239/240	-0.386	0.894	pCi/L	U		2.65	0.895	HASL 300, Pu-11-RC M	/ X /
Technetium-99	275	18.6	pCi/L			20.7	35.8	HASL 300, Tc-02-RC M	/ X /
Thorium-230	2.19	2.72	pCi/L	U		3.67	2.79	HASL 300, Th-01-RC M	/ X /
Uranium-234	1210	268	pCi/L			83.4	316	HASL 300, U-02-RC M	/ X /
Uranium-235	186	121	pCi/L			55.9	124	HASL 300, U-02-RC M	/ X /
Uranium-238	16200	967	pCi/L			72.2	2440	HASL 300, U-02-RC M	/ X /
VOA									
Trichloroethene	1		ug/L	U		1		SW846-8260B	/ X /
WETCHEM									
Ammonia as Nitrogen	0.134		mg/L			0.05		EPA-350.1	/ X /

Paducah OREIS Report for 404L16-01

L1404LD1-16

from: C404L

on 12/29/2015

Media: WW

SmpMethod: GR

Comments:

Analysis	Results	Counting Error	Units	Result Qual	Foot Note	Reporting Limit	TPU	Method	V/V/A*
ANION									
Fluoride	6.22		mg/L			0.2		SW846-9056	I / X /
FS									
Conductivity	498		umho/cm					FS	/ /
Dissolved Oxygen	7.48		mg/L					FS	/ /
pH	7.16		Std Unit					FS	/ /
Redox	400		mV					FS	/ /
Temperature	57.7		deg F					FS	/ /
METAL									
Arsenic	0.005		mg/L	U		0.005		SW846-6020	/ X /
Barium	0.0893		mg/L			0.002		SW846-6020	/ X /
Cadmium	0.001		mg/L	U		0.001		SW846-6020	/ X /
Chromium	0.01		mg/L	U		0.01		SW846-6020	/ X /
Copper	0.00645		mg/L			0.001		SW846-6020	/ X /
Iron	0.53		mg/L	X		0.1		SW846-6020	S / X /
Lead	0.002		mg/L	U		0.002		SW846-6020	/ X /
Mercury	0.000121		mg/L	J		0.0002		SW846-7470A	S / X /
Nickel	0.00332		mg/L			0.002		SW846-6020	S / X /
Selenium	0.005		mg/L	U		0.005		SW846-6020	/ X /
Silver	0.001		mg/L	U		0.001		SW846-6020	/ X /
Uranium	56.1		mg/L			0.2		SW846-6020	I / X /
Zinc	0.00854		mg/L	J		0.01		SW846-6020	S / X /
PPCB									
PCB-1016	0.099		ug/L	U		0.099		SW846-8082	/ X /
PCB-1221	0.099		ug/L	U		0.099		SW846-8082	/ X /
PCB-1232	0.099		ug/L	U		0.099		SW846-8082	/ X /
PCB-1242	0.099		ug/L	U		0.099		SW846-8082	/ X /
PCB-1248	0.665		ug/L			0.099		SW846-8082	/ X /
PCB-1254	0.099		ug/L	U		0.099		SW846-8082	/ X /
PCB-1260	0.099		ug/L	U		0.099		SW846-8082	/ X /
PCB-1268	0.099		ug/L	U		0.099		SW846-8082	/ X /
Polychlorinated biphenyl	0.665		ug/L			0.099		SW846-8082	I / X /
RADS									
Cesium-137	0.776	3.75	pCi/L	U		7.21	3.77	EPA-901.1	/ X /
Neptunium-237	0.525	1.16	pCi/L	U		2.04	1.16	Alpha Spectroscopy	/ X /
Plutonium-239/240	0.519	1.43	pCi/L	U		2.48	1.43	HASL 300, Pu-11-RC M	/ X /
Technetium-99	332	19.8	pCi/L			20.9	41.8	HASL 300, Tc-02-RC M	/ X /
Thorium-230	1.7	2.7	pCi/L	U		4.09	2.75	HASL 300, Th-01-RC M	/ X /
Uranium-234	1840	311	pCi/L			93.8	397	HASL 300, U-02-RC M	/ X /
Uranium-235	191	118	pCi/L			91.6	120	HASL 300, U-02-RC M	/ X /
Uranium-238	16900	933	pCi/L			64.2	2450	HASL 300, U-02-RC M	/ X /
VOA									
Trichloroethene	1		ug/L	U		1		SW846-8260B	/ X /
WETCHEM									
Ammonia as Nitrogen	0.296		mg/L			0.05		EPA-350.1	S / X /

Paducah OREIS Report for 404L16-01

FB404L1-16

from: QC

on 12/29/2015

Media: WQ

SmpMethod:

Comments:

Analysis	Results	Counting Error	Units	Result Qual	Foot Note	Reporting Limit	TPU	Method	V/V/A*
ANION									
Fluoride	0.1		mg/L	U		0.1		SW846-9056	/X/
METAL									
Arsenic	0.005		mg/L	U		0.005		SW846-6020	/X/
Barium	0.002		mg/L	U		0.002		SW846-6020	/X/
Cadmium	0.001		mg/L	U		0.001		SW846-6020	/X/
Chromium	0.01		mg/L	U		0.01		SW846-6020	/X/
Copper	0.00513		mg/L			0.001		SW846-6020	/X/
Iron	0.1		mg/L	UX		0.1		SW846-6020	/X/
Lead	0.002		mg/L	U		0.002		SW846-6020	/X/
Mercury	0.00012		mg/L	J		0.0002		SW846-7470A	/X/
Nickel	0.00308		mg/L			0.002		SW846-6020	/X/
Selenium	0.005		mg/L	U		0.005		SW846-6020	/X/
Silver	0.001		mg/L	U		0.001		SW846-6020	/X/
Uranium	0.000325		mg/L			0.0002		SW846-6020	/X/
Zinc	0.00533		mg/L	J		0.01		SW846-6020	/X/
PCCB									
PCB-1016	0.0971		ug/L	U		0.0971		SW846-8082	/X/
PCB-1221	0.0971		ug/L	U		0.0971		SW846-8082	/X/
PCB-1232	0.0971		ug/L	U		0.0971		SW846-8082	/X/
PCB-1242	0.0971		ug/L	U		0.0971		SW846-8082	/X/
PCB-1248	0.0971		ug/L	U		0.0971		SW846-8082	/X/
PCB-1254	0.0971		ug/L	U		0.0971		SW846-8082	/X/
PCB-1260	0.0971		ug/L	U		0.0971		SW846-8082	/X/
PCB-1268	0.0971		ug/L	U		0.0971		SW846-8082	/X/
Polychlorinated biphenyl	0.0971		ug/L	U		0.0971		SW846-8082	/X/
RADS									
Cesium-137	-0.683	3.52	pCi/L	U		5.63	3.54	EPA-901.1	/X/
Neptunium-237	-0.348	0.66	pCi/L	U		2.03	0.66	Alpha Spectroscopy	/X/
Plutonium-239/240	0.503	1.39	pCi/L	U		2.4	1.39	HASL 300, Pu-11-RC M	/X/
Technetium-99	-3.8	11.6	pCi/L	U		20.3	11.6	HASL 300, Tc-02-RC M	/X/
Thorium-230	0.968	2.74	pCi/L	U		5.1	2.77	HASL 300, Th-01-RC M	/X/
Uranium-234	1.88	4.24	pCi/L	U		6.68	4.26	HASL 300, U-02-RC M	/X/
Uranium-235	1.34	4.26	pCi/L	U		6.42	4.28	HASL 300, U-02-RC M	/X/
Uranium-238	3.41	4.87	pCi/L	U		5.81	4.93	HASL 300, U-02-RC M	/X/
VOA									
Trichloroethene	1		ug/L	U		1		SW846-8260B	/X/
WETCHEM									
Ammonia as Nitrogen	0.0333		mg/L	J		0.05		EPA-350.1	/X/

Paducah OREIS Report for 404L16-01

RI404L1-16	from: QC	on 12/29/2015	Media: WQ	SmpMethod:
Comments:				

Analysis	Results	Counting Error	Units	Result Qual	Foot Note	Reporting Limit	TPU	Method	V/V/A*
ANION									
Fluoride	0.1		mg/L	U		0.1		SW846-9056	/ X /
METAL									
Arsenic	0.005		mg/L	U		0.005		SW846-6020	/ X /
Barium	0.002		mg/L	U		0.002		SW846-6020	/ X /
Cadmium	0.001		mg/L	U		0.001		SW846-6020	/ X /
Chromium	0.01		mg/L	U		0.01		SW846-6020	/ X /
Copper	0.001		mg/L	U		0.001		SW846-6020	/ X /
Iron	0.1		mg/L	UX		0.1		SW846-6020	/ X /
Lead	0.002		mg/L	U		0.002		SW846-6020	/ X /
Mercury	0.00012		mg/L	J		0.0002		SW846-7470A	/ X /
Nickel	0.002		mg/L	U		0.002		SW846-6020	/ X /
Selenium	0.005		mg/L	U		0.005		SW846-6020	/ X /
Silver	0.001		mg/L	U		0.001		SW846-6020	/ X /
Uranium	0.0002		mg/L	U		0.0002		SW846-6020	/ X /
Zinc	0.01		mg/L	U		0.01		SW846-6020	/ X /
PCCB									
PCB-1016	0.099		ug/L	U		0.099		SW846-8082	/ X /
PCB-1221	0.099		ug/L	U		0.099		SW846-8082	/ X /
PCB-1232	0.099		ug/L	U		0.099		SW846-8082	/ X /
PCB-1242	0.099		ug/L	U		0.099		SW846-8082	/ X /
PCB-1248	0.099		ug/L	U		0.099		SW846-8082	/ X /
PCB-1254	0.099		ug/L	U		0.099		SW846-8082	/ X /
PCB-1260	0.099		ug/L	U		0.099		SW846-8082	/ X /
PCB-1268	0.099		ug/L	U		0.099		SW846-8082	/ X /
Polychlorinated biphenyl	0.099		ug/L	U		0.099		SW846-8082	/ X /
RADS									
Cesium-137	2.13	2.24	pCi/L	U		4.85	2.45	EPA-901.1	/ X /
Neptunium-237	-0.131	0.904	pCi/L	U		2.2	0.904	Alpha Spectroscopy	/ X /
Plutonium-239/240	-0.554	0.893	pCi/L	U		2.85	0.895	HASL 300, Pu-11-RC M	/ X /
Technetium-99	-4.1	12.2	pCi/L	U		21.2	12.2	HASL 300, Tc-02-RC M	/ X /
Thorium-230	-0.516	1.12	pCi/L	U		3.13	1.12	HASL 300, Th-01-RC M	/ X /
Uranium-234	2.26	2.44	pCi/L	U		2.77	2.46	HASL 300, U-02-RC M	/ X /
Uranium-235	-0.445	1.34	pCi/L	U		3.78	1.35	HASL 300, U-02-RC M	/ X /
Uranium-238	2.26	2.44	pCi/L	U		2.77	2.46	HASL 300, U-02-RC M	/ X /
VOA									
Trichloroethene	1		ug/L	U		1		SW846-8260B	/ X /
WETCHEM									
Ammonia as Nitrogen	0.085		mg/L			0.05		EPA-350.1	/ X /

TB404L1-16	from: QC	on 12/29/2015	Media: WQ	SmpMethod:
Comments:				

Analysis	Results	Counting Error	Units	Result Qual	Foot Note	Reporting Limit	TPU	Method	V/V/A*
VOA									
Trichloroethene	1		ug/L	U		1		SW846-8260B	/ X /

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APPENDIX D

**C-404 HAZARDOUS WASTE LANDFILL
GROUNDWATER FLOW RATE AND DIRECTION**

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C-404 LANDFILL FLOW DIRECTION

The C-404 Hazardous Waste Landfill (C-404 Landfill) Permit requires annual determination of average hydraulic flow rate and direction of flow in the uppermost aquifer. 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 flow direction information included in this report is supplemental to the permit-required annual flow rate and direction.

The water levels used for this analysis (taken on January 26, 2016) were measured as closely as possible and within a 24-hour period to ensure the comparability of the data. These measurements were used to plot the potentiometric surface of the upper RGA for the January 2016 sampling event. As indicated in previous reports, flow direction beneath the C-404 Landfill generally trends northward, but commonly varies from northeast to northwest. On January 26, 2016, groundwater flow was toward the north-northeast (see Figure D.1).

Contours for the potentiometric surface were drawn after water-level data were corrected for barometric efficiency. The potentiometric contours depict the directions of hydraulic flow during the sampling event.

The January potentiometric surface data of the upper RGA are presented in Table D.1, and a potentiometric surface map is presented in Figure D.1.

Table D.1. Barometric Pressure Corrections

C-404 Landfill (January 2016) Water Levels									
Date	Time	Well	Datum Elev (ft amsl)	BP (in Hg)	Delta BP (ft H ₂ O)	Raw Data		Corrected Data*	
						DTW (ft)	Elev (ft amsl)	DTW (ft)	Elev (ft amsl)
1/26/2016	8:28	MW67	374.95	30.17	0.00	48.53	326.42	48.53	326.42
1/26/2016	8:40	MW76	376.77	30.17	0.00	50.31	326.46	50.31	326.46
1/26/2016	8:14	MW84	376.01	30.17	0.00	49.50	326.51	49.50	326.51
1/26/2016	13:03	MW87	375.79	30.21	-0.05	49.44	326.35	49.39	326.40
1/26/2016	7:57	MW90A	374.20	30.17	0.00	47.88	326.32	47.88	326.32
1/26/2016	8:36	MW93	377.67	30.17	0.00	51.19	326.48	51.19	326.48
1/26/2016	8:45	MW227	378.81	30.17	0.00	52.35	326.46	52.35	326.46
1/26/2016	8:38	MW333	377.35	30.17	0.00	50.84	326.51	50.84	326.51
1/26/2016	8:10	MW337	374.67	30.17	0.00	48.16	326.51	48.16	326.51
1/26/2016	8:12	MW338	374.86	30.17	0.00	48.42	326.44	48.42	326.44
1/26/2016	8:31	MW420	377.70	30.17	0.00	51.21	326.49	51.21	326.49
Initial Barometric Pressure			30.17						
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									

