


**C-404 Hazardous Waste Landfill  
May 2014 Semiannual  
Groundwater Report  
(October 2013–March 2014),  
Paducah Gaseous Diffusion Plant,  
Paducah, Kentucky**

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LATA Kentucky Classification Support

  
Date



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May 2014 Semiannual  
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(October 2013–March 2014)  
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Date Issued—May 2014

Prepared for the  
U.S. Department of Energy  
Office of Environmental Management

Prepared by  
LATA ENVIRONMENTAL SERVICES OF KENTUCKY, LLC  
managing the  
Environmental Remediation Activities at the  
Paducah Gaseous Diffusion Plant  
under contract DE-AC30-10CC40020

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## ACRONYMS

AKGWA	Assembled Kentucky Groundwater Database
ANOVA	Analysis of Variance
KDWM	Kentucky Division of Waste Management
LOD	level of detection
MCL	maximum contaminant level
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 2014 Semiannual Groundwater Report (October 2013—March 2014), Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, PAD-ENM-0091/V1, is being submitted by the U.S. Department of Energy (DOE) in accordance with requirements in the Kentucky Division of Waste Management Hazardous Waste Facility Permit, KY8-890-008-982. The reporting period covers October 2013 through March 2014 and includes analytical data from the January 2014 sampling of compliance monitoring wells (MWs) located in the vicinity of the closed C-404 Hazardous Waste Landfill (C-404 Landfill). This unit was closed as a landfill in May 1986.

The groundwater monitoring results were subjected to statistical analyses to fulfill the requirements of the Hazardous Waste Facility Permit. The nonparametric analysis of variance test (Statistical Test 3 of the permit-required statistics) for dissolved arsenic indicated that concentrations in the downgradient compliance wells (compliance wells) were different from concentrations in the upgradient background wells (background wells).

The indication of above-background dissolved arsenic concentration in compliance well MW84 (see Figure 1, C-404 Landfill Monitoring Well Map on page 3) using Statistical Test 3 is not considered evidence of contamination from the C-404 Landfill. Supporting evidence includes the following:

- The maximum concentration of dissolved arsenic in MW84 (0.00412 mg/L) is less than the drinking water standard maximum contaminant level (MCL) for arsenic (0.010 mg/L), shown in Figure 2.
- Dissolved arsenic concentrations are increasing only in upgradient well MW93; concentrations in downgradient wells MW84 and MW87 are stable; this condition is similar to the pattern of TCE concentrations seen in these same wells and attributed to a source upgradient of C-404 as documented in the Alternate Source Demonstration (PRS 2007).
- There is no significant difference in arsenic (total) concentrations between background well MW93 (0.00656 mg/L) and compliance well MW84 (0.00514 mg/L).

Statistical analysis for all other parameters indicates that concentrations in compliance wells are not statistically different from the concentrations in background wells.

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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 (KDWM) Hazardous Waste Facility Permit, KY8-890-008-982 (the permit), GSTR2 Part II, Condition T-47—Detection Monitoring Program—Recordkeeping, Reporting, and Response. The period covered by this report is October 2013 through March 2014.

Groundwater analytical results are provided in Appendix A. The statistical analyses and qualification statement are provided in Appendix B. Landfill leachate information and analytical data are 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 solid uranium-contaminated wastes. 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 and treated as needed.

In 1986, the disposal of waste at C-404 Landfill was halted, and a portion of the disposed of waste was found to be 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 a RCRA postclosure permit issued in 1992.

Previous groundwater monitoring documented that concentrations in compliance wells were statistically different from background wells for trichloroethene (TCE). The *C-404 Landfill Source Demonstration, Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, 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/cross-gradient of the C-404 Landfill.

## 1.2 MONITORING PERIOD ACTIVITIES

### 1.2.1 Groundwater Monitoring

Groundwater sampling was conducted in January 2014 using LATA Environmental Services of Kentucky, LLC, procedure PAD-ENM-2101, *Groundwater Sampling*. Appropriate sample containers and preservatives were used. The laboratories 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

**Table 1. Monitoring Well Locations**

<b>UCRS</b>	
Located south of C-404, adjacent to upgradient Regional Gravel Aquifer (RGA) background well MW93	MW94
Located north of C-404, adjacent to downgradient RGA compliance wells	MW85, MW88, MW91
<b>URGA</b>	
Upgradient background wells	MW93, MW420
Downgradient compliance wells	MW84, MW87, MW90A*

\*MW90 was abandoned in 2001 and replaced with MW90A.

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).

The conceptual model for the site demonstrates 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.

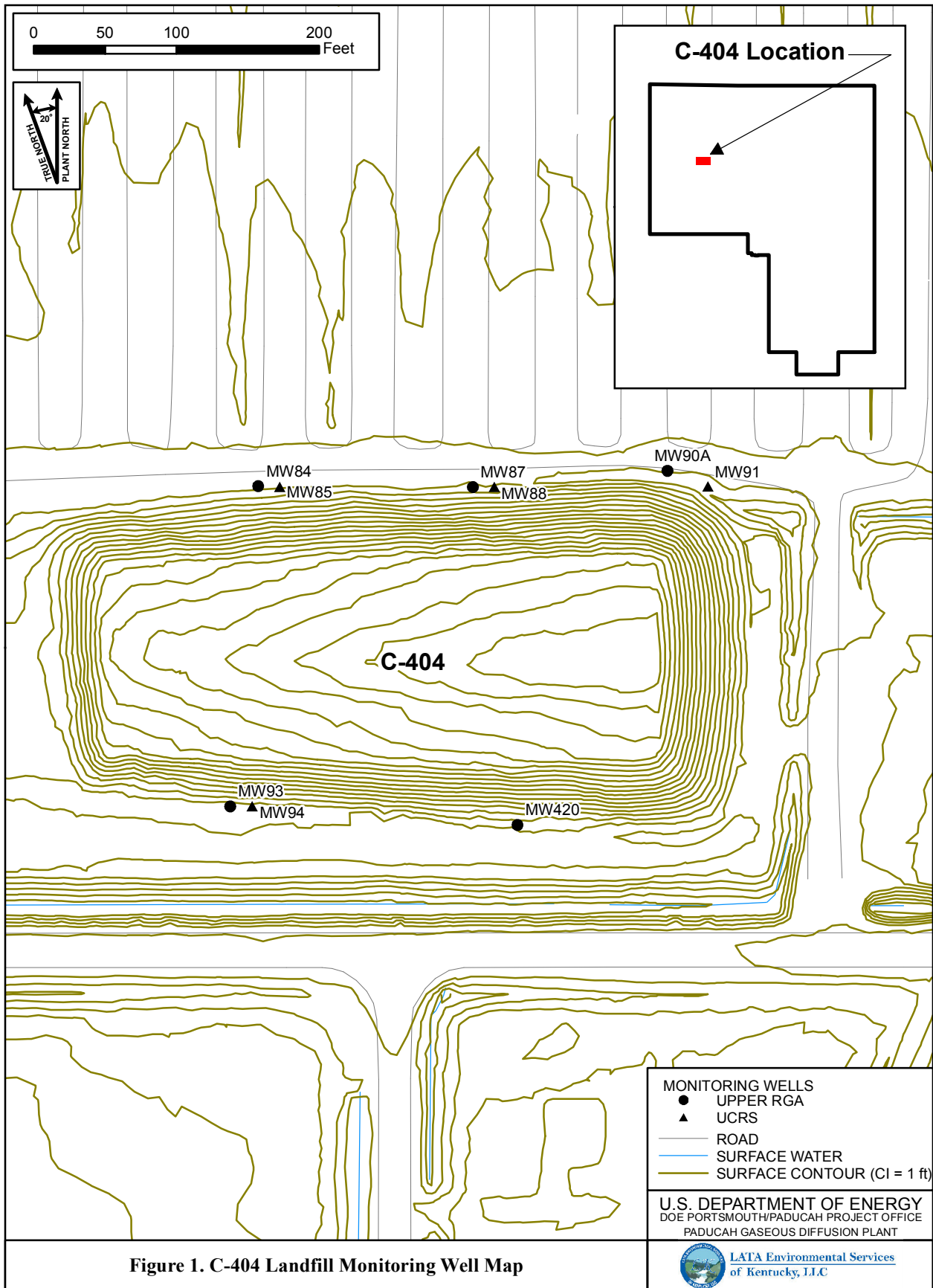
Table 2 presents the Assembled Kentucky Groundwater Database (AKGWA) numbers for each MW. A map of the MW locations is provided in Figure 1. All of the MWs listed in Tables 1 and 2 were sampled during this reporting period, and the samples were analyzed for the required parameters.

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

<b>PGDP Well Number</b>	<b>AKGWA Number</b>
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

Appendix A of this report contains the analytical results from the nine wells that were sampled during the January 2014 semiannual sampling event. The parameters specified in Hazardous Waste Facility Permit, Attachment E, Groundwater Monitoring, were analyzed for all locations sampled. Appendix B of this report contains the statistical analyses.

Per Permit Condition GSTR2, T-37, the groundwater flow rate and direction are evaluated annually and reported in the November report. For this May report, a potentiometric map has been included in Appendix D using data from sampling performed in January as supplemental information. Depth-to-water was measured on January 30, 2014, 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. Groundwater flow direction beneath the C-404 Landfill generally trends northward, but commonly varies from northeast to northwest.



**Figure 1. C-404 Landfill Monitoring Well Map**

### **1.2.2 Landfill Leachate**

The C-404 General Inspection Records and the Quarterly Landfill Inspection Results are included in Appendix C. In accordance with 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 was 1,200 gal. Once the leachate reached 3 ft, the leachate was sampled and removed using a mobile tank. Then, the leachate was transferred to a permitted hazardous waste storage and treatment facility on-site prior to characterization and transfer off-site for treatment. Analytical results from leachate sampling conducted for this removal event (February 2014) are included in Appendix C.

Arsenic was detected in one of two leachate samples (0.00112 mg/L) slightly above the detection limit (0.001 mg/L) but at concentrations below those found in both upgradient and downgradient URGA wells. Technetium-99 (Tc-99) was detected in leachate at a maximum concentration of 334 pCi/L.



## 2. STATISTICAL SYNOPSIS

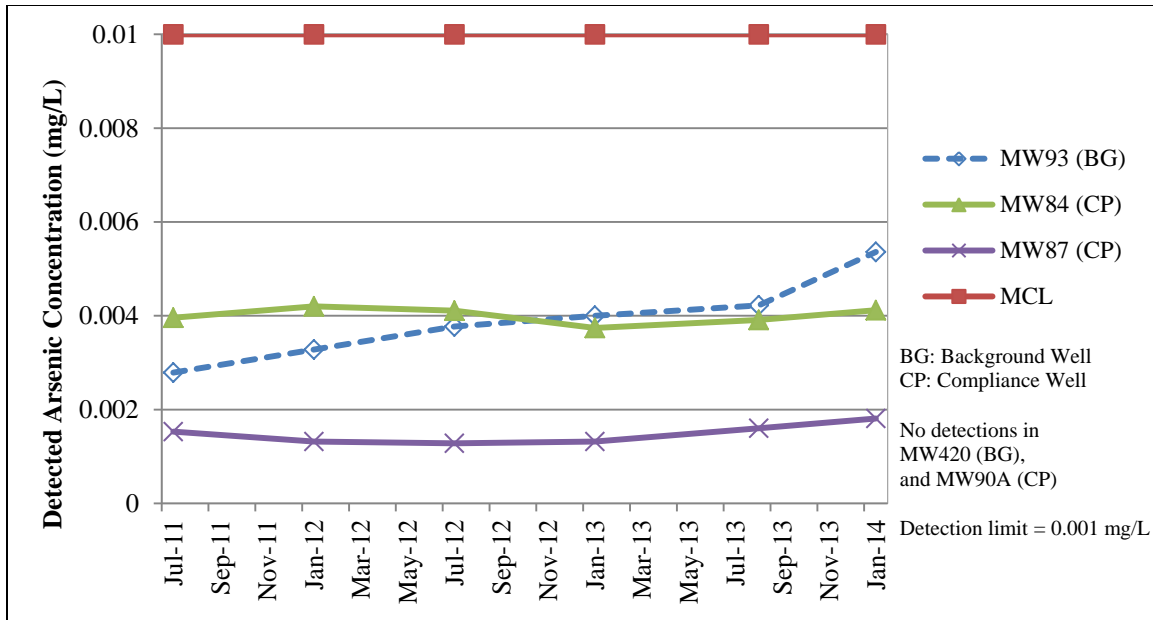
The statistical analyses conducted on the data collected from C-404 Landfill were performed in accordance with procedures in the approved Hazardous Waste Facility Permit, Attachment Part E. Appendix B of this report contains the statistical analyses performed for this reporting period. Data utilized for statistical analyses included data from the URGA background wells, MW93 and MW420, and URGA compliance wells, MW84, MW87, and MW90A. For this report, the reporting period data set includes data from the most current sampling event, January 2014, and from July 2011, January 2012, July 2012, January 2013, and August 2013.

The statistical test, Level of Detection (LOD), was performed for seven of the thirteen parameters (cadmium, mercury, selenium, uranium, uranium-234, uranium-235, and uranium-238). LOD values are presented in Appendix B. Statistical test, Test of Proportions, was performed for three of the thirteen parameters (chromium, lead, and Tc-99). Statistical test, nonparametric Analysis of Variance (ANOVA), was performed for arsenic and dissolved arsenic. Statistical test, parametric ANOVA, was performed for TCE.

The nonparametric ANOVA test for dissolved arsenic (Appendix B) indicated that concentrations in compliance well MW84 were different from concentrations in the background wells. Statistical analysis in Appendix B indicates that concentrations in compliance wells are not statistically different from the concentrations in background wells, except for dissolved arsenic.

The indication of above-background dissolved arsenic concentrations in compliance well MW84 using Statistical Test 3 is not considered evidence of contamination from the C-404 Landfill. Supporting evidence includes the following:

- The maximum concentration of dissolved arsenic in MW84 (0.00412 mg/L) is less than the drinking water standard maximum contaminant level (MCL) for arsenic (0.010 mg/L), shown in Figure 2.
- Dissolved arsenic concentrations are increasing only in upgradient well MW93; concentrations in downgradient wells MW84 and MW87 are stable; this condition is similar to the pattern of TCE concentrations seen in these same wells and attributed to a source upgradient of C-404 as documented in the Alternate Source Demonstration (PRS 2007).
- There is no significant difference in arsenic (total) concentrations between background well MW93 (0.00656 mg/L) and compliance well MW84 (0.00514 mg/L).



**Figure 2. Detected Arsenic (Dissolved) in C-404 Wells**

URGA well MW420 (background) is the only URGA well with Tc-99 levels above the minimum detectable activity, and this activity is low (see Appendix B Attachment 5). The concentrations of Tc-99 in MW420 (background) and lack of detections in compliance wells demonstrates that the C-404 Landfill is not an apparent source of statistically quantifiable levels of Tc-99. Note: UCRS wells MW85, MW88, and MW94 have low detectable levels of Tc-99; UCRS well MW91 has a higher Tc-99 level. Historical Tc-99 concentrations in leachate are lower than GW concentrations.

### **3. DATA VALIDATION AND QA/QC SUMMARY**

The data and the data validation qualifiers for the January 2014 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 lab 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 2014 Semiannual Groundwater Report  
(October 2013–March 2014),  
Paducah Gaseous Diffusion Plant, Paducah, Kentucky  
(PAD-ENM-0091/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 28, 2014*  
Date

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## 5. REFERENCES

- EPA (U.S. Environmental Protection Agency) 1989. *EPA Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities*, Interim Final Guidance, Office of Resource Conservation and Recovery, U.S. Environmental Protection Agency, Washington, DC.
- EPA 2009. *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities*, Unified Guidance Document (UGD), EPA/530/R-09/007, U.S. Environmental Protection Agency, Washington, DC.
- 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	Date Collected	Counting Error (+/-)	TPU	Method	Validation
Arsenic	B	0.0051	mg/L	1/13/2014			SW846-6020	=
Arsenic, Dissolved		0.0041	mg/L	1/13/2014			SW846-6020	=
Barometric Pressure Reading		29.79	Inches/Hg	1/13/2014				X
Cadmium	U	0.001	mg/L	1/13/2014			SW846-6020	=
Cadmium, Dissolved	U	0.001	mg/L	1/13/2014			SW846-6020	=
Chromium	X	0.0921	mg/L	1/13/2014			SW846-6020	=
Chromium, Dissolved	U	0.01	mg/L	1/13/2014			SW846-6020	=
Conductivity		342	umho/cm	1/13/2014				X
Depth to Water		51.59	ft	1/13/2014				X
Dissolved Oxygen		2.8	mg/L	1/13/2014				X
Lead	U	0.0013	mg/L	1/13/2014			SW846-6020	=
Lead, Dissolved	UB	0.0013	mg/L	1/13/2014			SW846-6020	=
Mercury	U	0.0002	mg/L	1/13/2014			SW846-7470A	=
Mercury, Dissolved	U	0.0002	mg/L	1/13/2014			SW846-7470A	=
pH		5.91	Std Unit	1/13/2014				X
Redox		376	mV	1/13/2014				X
Selenium	B	0.0065	mg/L	1/13/2014			SW846-6020	=
Selenium, Dissolved	U	0.005	mg/L	1/13/2014			SW846-6020	=
Technetium-99	U	11.8	pCi/L	1/13/2014	11	11	RL-7100	=
Temperature		57.1	deg F	1/13/2014				X
Trichloroethene	D	1500	ug/L	1/13/2014			SW846-8260B	=
Turbidity		23.3	NTU	1/13/2014				X
Uranium	U	0.001	mg/L	1/13/2014			SW846-6020	=
Uranium-234	U	0.136	pCi/L	1/13/2014	0.0702	0.139	RL-7128	=
Uranium-235	U	0.0071	pCi/L	1/13/2014	0.0163	0.0696	RL-7128	=
Uranium-238	U	0.143	pCi/L	1/13/2014	0.0677	0.0851	RL-7128	=

Note: The procedure RL-7100 is a localized procedure which implements liquid scintillation for radionuclide analyses.

**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	Date Collected	Counting Error (+/-)	TPU	Method	Validation
Arsenic	B	0.0115	mg/L	1/13/2014			SW846-6020	=
Arsenic, Dissolved		0.0125	mg/L	1/13/2014			SW846-6020	=
Barometric Pressure Reading		29.79	Inches/Hg	1/13/2014				X
Cadmium	U	0.001	mg/L	1/13/2014			SW846-6020	=
Cadmium, Dissolved	U	0.001	mg/L	1/13/2014			SW846-6020	=
Chromium	UX	0.01	mg/L	1/13/2014			SW846-6020	=
Chromium, Dissolved	U	0.01	mg/L	1/13/2014			SW846-6020	=
Conductivity		391	umho/cm	1/13/2014				X
Depth to Water		11.48	ft	1/13/2014				X
Dissolved Oxygen		3.36	mg/L	1/13/2014				X
Lead	U	0.0013	mg/L	1/13/2014			SW846-6020	=
Lead, Dissolved	U	0.0013	mg/L	1/13/2014			SW846-6020	=
Mercury	U	0.0002	mg/L	1/13/2014			SW846-7470A	=
Mercury, Dissolved	U	0.0002	mg/L	1/13/2014			SW846-7470A	=
pH		6.37	Std Unit	1/13/2014				X
Redox		410	mV	1/13/2014				X
Selenium	UB	0.005	mg/L	1/13/2014			SW846-6020	=
Selenium, Dissolved	U	0.005	mg/L	1/13/2014			SW846-6020	=
Technetium-99		112	pCi/L	1/13/2014	14.2	14.4	RL-7100	=
Temperature		57.9	deg F	1/13/2014				X
Trichloroethene	X	4.6	ug/L	1/13/2014			SW846-8260B	J
Turbidity		9.2	NTU	1/13/2014				X
Uranium	U	0.001	mg/L	1/13/2014			SW846-6020	=
Uranium-234	U	0.182	pCi/L	1/13/2014	0.0716	0.142	RL-7128	=
Uranium-235	U	0.0215	pCi/L	1/13/2014	0.026	0.0725	RL-7128	=
Uranium-238		0.216	pCi/L	1/13/2014	0.0769	0.0974	RL-7128	=

Note: The procedure RL-7100 is a localized procedure which implements liquid scintillation for radionuclide analyses.

**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	Date Collected	Counting Error (+/-)	TPU	Method	Validation
Arsenic		0.0022	mg/L	1/9/2014			SW846-6020	J
Arsenic, Dissolved		0.0018	mg/L	1/9/2014			SW846-6020	=
Barometric Pressure Reading		30.4	Inches/Hg	1/9/2014				X
Cadmium	U	0.001	mg/L	1/9/2014			SW846-6020	=
Cadmium, Dissolved	U	0.001	mg/L	1/9/2014			SW846-6020	=
Chromium	UX	0.01	mg/L	1/9/2014			SW846-6020	UJ
Chromium, Dissolved	U	0.01	mg/L	1/9/2014			SW846-6020	=
Conductivity		294	umho/cm	1/9/2014				X
Depth to Water		52.24	ft	1/9/2014				X
Dissolved Oxygen		2.14	mg/L	1/9/2014				X
Lead	U	0.0013	mg/L	1/9/2014			SW846-6020	UJ
Lead, Dissolved	U	0.0013	mg/L	1/9/2014			SW846-6020	=
Mercury	U	0.0002	mg/L	1/9/2014			SW846-7470A	=
Mercury, Dissolved	U	0.0002	mg/L	1/9/2014			SW846-7470A	=
pH		6.43	Std Unit	1/9/2014				X
Redox		821	mV	1/9/2014				X
Selenium	U	0.005	mg/L	1/9/2014			SW846-6020	UJ
Selenium, Dissolved	U	0.005	mg/L	1/9/2014			SW846-6020	=
Technetium-99	U	10.1	pCi/L	1/9/2014	11	11	RL-7100	=
Temperature		54	deg F	1/9/2014				X
Trichloroethene	D	670	ug/L	1/9/2014			SW846-8260B	=
Turbidity		12.8	NTU	1/9/2014				X
Uranium	U	0.001	mg/L	1/9/2014			SW846-6020	UJ
Uranium-234	U	0.0614	pCi/L	1/9/2014	0.0516	0.129	RL-7128	=
Uranium-235	U	0.0071	pCi/L	1/9/2014	0.0162	0.0695	RL-7128	=
Uranium-238	U	0.0563	pCi/L	1/9/2014	0.0447	0.0608	RL-7128	=

Note: The procedure RL-7100 is a localized procedure which implements liquid scintillation for radionuclide analyses.

**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	Date Collected	Counting Error (+/-)	TPU	Method	Validation
Arsenic		0.0050	mg/L	1/9/2014			SW846-6020	=
Arsenic, Dissolved		0.0048	mg/L	1/9/2014			SW846-6020	=
Barometric Pressure Reading		30.4	Inches/Hg	1/9/2014				X
		29.92	Inches/Hg	1/21/2014				X
Cadmium	U	0.001	mg/L	1/9/2014			SW846-6020	=
Cadmium, Dissolved	U	0.001	mg/L	1/9/2014			SW846-6020	=
Chromium	UX	0.01	mg/L	1/9/2014			SW846-6020	=
Chromium, Dissolved	U	0.01	mg/L	1/9/2014			SW846-6020	=
Conductivity		608	umho/cm	1/9/2014				X
		589	umho/cm	1/21/2014				X
Depth to Water		11.67	ft	1/9/2014				X
		11.23	ft	1/21/2014				X
Dissolved Oxygen		1.64	mg/L	1/21/2014				X
		1.06	mg/L	1/9/2014				X
Lead	U	0.0013	mg/L	1/9/2014			SW846-6020	=
Lead, Dissolved	U	0.0013	mg/L	1/9/2014			SW846-6020	=
Mercury	U	0.0002	mg/L	1/9/2014			SW846-7470A	=
Mercury, Dissolved	U	0.0002	mg/L	1/9/2014			SW846-7470A	=
pH		5.84	Std Unit	1/21/2014				X
		6.11	Std Unit	1/9/2014				X
Redox		782	mV	1/21/2014				X
		636	mV	1/9/2014				X
Selenium	U	0.005	mg/L	1/9/2014			SW846-6020	=
Selenium, Dissolved	U	0.005	mg/L	1/9/2014			SW846-6020	=
Technetium-99		21.7	pCi/L	1/9/2014	11.4	11.4	RL-7100	=
Temperature		45.3	deg F	1/21/2014				X
		55.1	deg F	1/9/2014				X
Trichloroethene		4	ug/L	1/21/2014			SW846-8260B	=
Turbidity		39.4	NTU	1/9/2014				X
		36.7	NTU	1/21/2014				X

Uranium	U	0.001 mg/L	1/9/2014			SW846-6020	=
Uranium-234	U	0.14 pCi/L	1/9/2014	0.0706	0.14	RL-7128	=
Uranium-235	U	-0.008 pCi/L	1/9/2014	0.0138	0.069	RL-7128	=
Uranium-238	U	0.0542 pCi/L	1/9/2014	0.0573	0.0675	RL-7128	=

Note: The procedure RL-7100 is a localized procedure which implements liquid scintillation for radionuclide analyses.

**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	Date Collected	Counting Error (+/-)	TPU	Method	Validation
Arsenic	UB	0.001	mg/L	1/9/2014			SW846-6020	=
Arsenic, Dissolved	U	0.001	mg/L	1/9/2014			SW846-6020	=
Barometric Pressure Reading		30.4	Inches/Hg	1/9/2014				X
Cadmium	U	0.001	mg/L	1/9/2014			SW846-6020	=
Cadmium, Dissolved	U	0.001	mg/L	1/9/2014			SW846-6020	=
Chromium	UX	0.01	mg/L	1/9/2014			SW846-6020	=
Chromium, Dissolved	U	0.01	mg/L	1/9/2014			SW846-6020	=
Conductivity		208	umho/cm	1/9/2014				X
Depth to Water		50.65	ft	1/9/2014				X
Dissolved Oxygen		3.79	mg/L	1/9/2014				X
Lead	U	0.0013	mg/L	1/9/2014			SW846-6020	=
Lead, Dissolved	U	0.0013	mg/L	1/9/2014			SW846-6020	=
Mercury	U	0.0002	mg/L	1/9/2014			SW846-7470A	=
Mercury, Dissolved	U	0.0002	mg/L	1/9/2014			SW846-7470A	=
pH		6.14	Std Unit	1/9/2014				X
Redox		542	mV	1/9/2014				X
Selenium	UB	0.005	mg/L	1/9/2014			SW846-6020	=
Selenium, Dissolved	U	0.005	mg/L	1/9/2014			SW846-6020	=
Technetium-99	U	12.4	pCi/L	1/9/2014	11.1	11.1	RL-7100	=
Temperature		57	deg F	1/9/2014				X
Trichloroethene		25	ug/L	1/9/2014			SW846-8260B	=
Turbidity		4	NTU	1/9/2014				X
Uranium	U	0.001	mg/L	1/9/2014			SW846-6020	=
Uranium-234	U	0.122	pCi/L	1/9/2014	0.071	0.139	RL-7128	=
Uranium-235	U	0.0098	pCi/L	1/9/2014	0.0217	0.0765	RL-7128	=
Uranium-238		0.217	pCi/L	1/9/2014	0.0822	0.101	RL-7128	=

Note: The procedure RL-7100 is a localized procedure which implements liquid scintillation for radionuclide analyses.



**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	Date Collected	Counting Error (+/-)	TPU	Method	Validation
Arsenic	B	0.0047	mg/L	1/13/2014			SW846-6020	=
Arsenic, Dissolved		0.0025	mg/L	1/13/2014			SW846-6020	=
Barometric Pressure Reading		29.79	Inches/Hg	1/13/2014				X
Cadmium	U	0.001	mg/L	1/13/2014			SW846-6020	=
Cadmium, Dissolved	U	0.001	mg/L	1/13/2014			SW846-6020	=
Chromium	X	0.469	mg/L	1/13/2014			SW846-6020	=
Chromium, Dissolved		0.0183	mg/L	1/13/2014			SW846-6020	=
Conductivity		544	umho/cm	1/13/2014				X
Depth to Water		11.58	ft	1/13/2014				X
Dissolved Oxygen		3.37	mg/L	1/13/2014				X
Lead		0.0018	mg/L	1/13/2014			SW846-6020	=
Lead, Dissolved	U	0.0013	mg/L	1/13/2014			SW846-6020	=
Mercury	U	0.0002	mg/L	1/13/2014			SW846-7470A	=
Mercury, Dissolved	U	0.0002	mg/L	1/13/2014			SW846-7470A	=
pH		5.65	Std Unit	1/13/2014				X
Redox		436	mV	1/13/2014				X
Selenium	B	0.0151	mg/L	1/13/2014			SW846-6020	=
Selenium, Dissolved		0.0059	mg/L	1/13/2014			SW846-6020	=
Technetium-99		2490	pCi/L	1/13/2014	45.4	76.7	RL-7100	=
Temperature		59.2	deg F	1/13/2014				X
Trichloroethene		92	ug/L	1/13/2014			SW846-8260B	=
Turbidity		90	NTU	1/13/2014				X
Uranium	U	0.001	mg/L	1/13/2014			SW846-6020	=
Uranium-234		0.4	pCi/L	1/13/2014	0.111	0.176	RL-7128	=
Uranium-235	U	0.0002	pCi/L	1/13/2014	0.00245	0.0713	RL-7128	=
Uranium-238		0.338	pCi/L	1/13/2014	0.101	0.126	RL-7128	=

Note: The procedure RL-7100 is a localized procedure which implements liquid scintillation for radionuclide analyses.

**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	Date Collected	Counting Error (+/-)	TPU	Method	Validation
Arsenic	B	0.0066	mg/L	1/9/2014			SW846-6020	=
Arsenic, Dissolved		0.0054	mg/L	1/9/2014			SW846-6020	=
Barometric Pressure Reading		30.4	Inches/Hg	1/9/2014				X
Cadmium	U	0.001	mg/L	1/9/2014			SW846-6020	=
Cadmium, Dissolved	U	0.001	mg/L	1/9/2014			SW846-6020	=
Chromium	UX	0.01	mg/L	1/9/2014			SW846-6020	=
Chromium, Dissolved	U	0.01	mg/L	1/9/2014			SW846-6020	=
Conductivity		402	umho/cm	1/9/2014				X
Depth to Water		53.82	ft	1/9/2014				X
Dissolved Oxygen		0.86	mg/L	1/9/2014				X
Lead	U	0.0013	mg/L	1/9/2014			SW846-6020	=
Lead, Dissolved	U	0.0013	mg/L	1/9/2014			SW846-6020	=
Mercury	U	0.0002	mg/L	1/9/2014			SW846-7470A	=
Mercury, Dissolved	U	0.0002	mg/L	1/9/2014			SW846-7470A	=
pH		6.1	Std Unit	1/9/2014				X
Redox		445	mV	1/9/2014				X
Selenium	B	0.006	mg/L	1/9/2014			SW846-6020	=
Selenium, Dissolved	U	0.005	mg/L	1/9/2014			SW846-6020	=
Technetium-99	U	7.52	pCi/L	1/9/2014	10.9	10.9	RL-7100	=
Temperature		55.8	deg F	1/9/2014				X
Trichloroethene	D	2900	ug/L	1/9/2014			SW846-8260B	=
Turbidity		50.7	NTU	1/9/2014				X
Uranium	U	0.001	mg/L	1/9/2014			SW846-6020	=
Uranium-234	U	0.0443	pCi/L	1/9/2014	0.0529	0.129	RL-7128	=
Uranium-235	U	-0.001	pCi/L	1/9/2014	0	0.0956	RL-7128	=
Uranium-238	U	0.089	pCi/L	1/9/2014	0.0511	0.069	RL-7128	=

Note: The procedure RL-7100 is a localized procedure which implements liquid scintillation for radionuclide analyses.

**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	Date Collected	Counting Error (+/-)	TPU	Method	Validation
Arsenic	B	0.0016	mg/L	1/9/2014			SW846-6020	=
Arsenic, Dissolved	U	0.001	mg/L	1/9/2014			SW846-6020	=
Barometric Pressure Reading		30.4	Inches/Hg	1/9/2014				X
Cadmium	U	0.001	mg/L	1/9/2014			SW846-6020	=
Cadmium, Dissolved	U	0.001	mg/L	1/9/2014			SW846-6020	=
Chromium	X	0.0105	mg/L	1/9/2014			SW846-6020	=
Chromium, Dissolved	U	0.01	mg/L	1/9/2014			SW846-6020	=
Conductivity		537	umho/cm	1/9/2014				X
Depth to Water		15.29	ft	1/9/2014				X
Dissolved Oxygen		1.31	mg/L	1/9/2014				X
Lead		0.0020	mg/L	1/9/2014			SW846-6020	=
Lead, Dissolved	U	0.0013	mg/L	1/9/2014			SW846-6020	=
Mercury	U	0.0002	mg/L	1/9/2014			SW846-7470A	=
Mercury, Dissolved	U	0.0002	mg/L	1/9/2014			SW846-7470A	=
pH		6.31	Std Unit	1/9/2014				X
Redox		445	mV	1/9/2014				X
Selenium	UB	0.005	mg/L	1/9/2014			SW846-6020	=
Selenium, Dissolved	U	0.005	mg/L	1/9/2014			SW846-6020	=
Technetium-99		700	pCi/L	1/9/2014	25.6	31	RL-7100	=
Temperature		55.8	deg F	1/9/2014				X
Trichloroethene		2.8	ug/L	1/9/2014			SW846-8260B	=
Turbidity		43	NTU	1/9/2014				X
Uranium		0.0026	mg/L	1/9/2014			SW846-6020	=
Uranium-234		0.906	pCi/L	1/9/2014	0.17	0.259	RL-7128	=
Uranium-235	U	0.0028	pCi/L	1/9/2014	0.00765	0.0789	RL-7128	=
Uranium-238		0.777	pCi/L	1/9/2014	0.153	0.207	RL-7128	=

Note: The procedure RL-7100 is a localized procedure which implements liquid scintillation for radionuclide analyses.

**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	Date Collected	Counting Error (+/-)	TPU	Method	Validation
Arsenic	B	0.0011	mg/L	1/9/2014			SW846-6020	=
Arsenic, Dissolved	U	0.001	mg/L	1/9/2014			SW846-6020	=
Barometric Pressure Reading		30.4	Inches/Hg	1/9/2014				X
Cadmium	U	0.001	mg/L	1/9/2014			SW846-6020	=
Cadmium, Dissolved	U	0.001	mg/L	1/9/2014			SW846-6020	=
Chromium	UX	0.01	mg/L	1/9/2014			SW846-6020	=
Chromium, Dissolved	U	0.01	mg/L	1/9/2014			SW846-6020	=
Conductivity		293	umho/cm	1/9/2014				X
Depth to Water		53.82	ft	1/9/2014				X
Dissolved Oxygen		1.84	mg/L	1/9/2014				X
Lead	U	0.0013	mg/L	1/9/2014			SW846-6020	=
Lead, Dissolved	U	0.0013	mg/L	1/9/2014			SW846-6020	=
Mercury	U	0.0002	mg/L	1/9/2014			SW846-7470A	=
Mercury, Dissolved	U	0.0002	mg/L	1/9/2014			SW846-7470A	=
pH		5.95	Std Unit	1/9/2014				X
Redox		725	mV	1/9/2014				X
Selenium	UB	0.005	mg/L	1/9/2014			SW846-6020	=
Selenium, Dissolved	U	0.005	mg/L	1/9/2014			SW846-6020	=
Technetium-99	U	15.2	pCi/L	1/9/2014	11.2	11.2	RL-7100	UJ
Temperature		53.9	deg F	1/9/2014				X
Trichloroethene	D	280	ug/L	1/9/2014			SW846-8260B	=
Turbidity		2.3	NTU	1/9/2014				X
Uranium	U	0.001	mg/L	1/9/2014			SW846-6020	=
Uranium-234	U	0.0198	pCi/L	1/9/2014	0.0538	0.129	RL-7128	=
Uranium-235	U	-0.001	pCi/L	1/9/2014	0	0.0956	RL-7128	=
Uranium-238	U	0.0381	pCi/L	1/9/2014	0.0452	0.0566	RL-7128	=

Note: The procedure RL-7100 is a localized procedure which implements liquid scintillation for radionuclide analyses.

**Paducah OREIS  
GROUNDWATER MONITORING REPORT**

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

Sampling Point: MW420 FR Upgradient URGA Period: Semiannual Report

AKGWA Well Tag #: 8005-3263

Parameter	Qualifier	Result	Units	Date Collected	Counting Error (+/-)	TPU	Method	Validation
Arsenic	B	0.0010	mg/L	1/9/2014			SW846-6020	=
Arsenic, Dissolved	U	0.001	mg/L	1/9/2014			SW846-6020	=
Barometric Pressure Reading		30.4	Inches/Hg	1/9/2014				X
Cadmium	U	0.001	mg/L	1/9/2014			SW846-6020	=
Cadmium, Dissolved	U	0.001	mg/L	1/9/2014			SW846-6020	=
Chromium	UX	0.01	mg/L	1/9/2014			SW846-6020	=
Chromium, Dissolved	U	0.01	mg/L	1/9/2014			SW846-6020	=
Conductivity		293	umho/cm	1/9/2014				X
Depth to Water		53.82	ft	1/9/2014				X
Dissolved Oxygen		1.84	mg/L	1/9/2014				X
Lead	U	0.0013	mg/L	1/9/2014			SW846-6020	=
Lead, Dissolved	U	0.0013	mg/L	1/9/2014			SW846-6020	=
Mercury	U	0.0002	mg/L	1/9/2014			SW846-7470A	=
Mercury, Dissolved	U	0.0002	mg/L	1/9/2014			SW846-7470A	=
pH		5.95	Std Unit	1/9/2014				X
Redox		725	mV	1/9/2014				X
Selenium	UB	0.005	mg/L	1/9/2014			SW846-6020	=
Selenium, Dissolved	U	0.005	mg/L	1/9/2014			SW846-6020	=
Technetium-99		16.8	pCi/L	1/9/2014	11.2	11.2	RL-7100	J
Temperature		53.9	deg F	1/9/2014				X
Trichloroethene	D	290	ug/L	1/9/2014			SW846-8260B	=
Turbidity		2.3	NTU	1/9/2014				X
Uranium	U	0.001	mg/L	1/9/2014			SW846-6020	=
Uranium-234	U	0.008	pCi/L	1/9/2014	0.0515	0.128	RL-7128	=
Uranium-235	U	0.0089	pCi/L	1/9/2014	0.0198	0.0735	RL-7128	=
Uranium-238	U	0.0191	pCi/L	1/9/2014	0.0335	0.0423	RL-7128	=

Note: The procedure RL-7100 is a localized procedure which implements liquid scintillation for radionuclide analyses.

**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

<b>Parameter</b>	<b>Qualifier</b>	<b>Result</b>	<b>Units</b>	<b>Date Collected</b>	<b>Counting Error (+/-)</b>	<b>TPU</b>	<b>Method</b>	<b>Validation</b>
Arsenic	UB	0.001	mg/L	1/9/2014			SW846-6020	=
Cadmium	U	0.001	mg/L	1/9/2014			SW846-6020	=
Chromium	UX	0.01	mg/L	1/9/2014			SW846-6020	=
Lead	U	0.0013	mg/L	1/9/2014			SW846-6020	=
Mercury	U	0.0002	mg/L	1/9/2014			SW846-7470A	=
Selenium	UB	0.005	mg/L	1/9/2014			SW846-6020	=
Technetium-99	U	12.2	pCi/L	1/9/2014	11	11	RL-7100	=
Trichloroethene	U	1	ug/L	1/9/2014			SW846-8260B	=
Uranium	U	0.001	mg/L	1/9/2014			SW846-6020	=
Uranium-234	U	0.176	pCi/L	1/9/2014	0.0746	0.143	RL-7128	=
Uranium-235	U	0.023	pCi/L	1/9/2014	0.0333	0.0755	RL-7128	=
Uranium-238	U	0.114	pCi/L	1/9/2014	0.0576	0.0755	RL-7128	=

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Note: The procedure RL-7100 is a localized procedure which implements liquid scintillation for radionuclide analyses.

**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

<b>Parameter</b>	<b>Qualifier</b>	<b>Result</b>	<b>Units</b>	<b>Date Collected</b>	<b>Counting Error (+/-)</b>	<b>TPU</b>	<b>Method</b>	<b>Validation</b>
Arsenic	UB	0.001	mg/L	1/9/2014			SW846-6020	=
Cadmium	U	0.001	mg/L	1/9/2014			SW846-6020	=
Chromium	UX	0.01	mg/L	1/9/2014			SW846-6020	=
Lead	U	0.0013	mg/L	1/9/2014			SW846-6020	=
Mercury	U	0.0002	mg/L	1/9/2014			SW846-7470A	=
Selenium	UB	0.005	mg/L	1/9/2014			SW846-6020	=
Technetium-99	U	14.8	pCi/L	1/9/2014	11.1	11.1	RL-7100	=
Trichloroethene	U	1	ug/L	1/9/2014			SW846-8260B	=
Uranium	U	0.001	mg/L	1/9/2014			SW846-6020	=
Uranium-234	U	0.0599	pCi/L	1/9/2014	0.0557	0.131	RL-7128	=
Uranium-235	U	0.0002	pCi/L	1/9/2014	0.00244	0.0712	RL-7128	=
Uranium-238	U	0.116	pCi/L	1/9/2014	0.0639	0.0798	RL-7128	=

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Note: The procedure RL-7100 is a localized procedure which implements liquid scintillation for radionuclide analyses.

**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

<b>Parameter</b>	<b>Qualifier</b>	<b>Result</b>	<b>Units</b>	<b>Date Collected</b>	<b>Counting Error (+/-)</b>	<b>TPU</b>	<b>Method</b>	<b>Validation</b>
Trichloroethene	U	1	ug/L	1/13/2014			SW846-8260B	=
	U	1	ug/L	1/21/2014			SW846-8260B	=
	U	1	ug/L	1/9/2014			SW846-8260B	=
	U	1	ug/L	1/9/2014			SW846-8260B	=

Note: The procedure RL-7100 is a localized procedure which implements liquid scintillation for radionuclide analyses.



### **MEDIA Codes**

WG Groundwater

### **QUALIFIER Codes**

- B Applies when the analyte is found in the associated blank.
- D Compounds identified in an analysis at a secondary dilution factor.
- U Analyte analyzed for, but not detected at or below the lowest concentration reported.
- X Other specific flags and footnotes may be required to properly define the results.

### **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, which is detected and unqualified.
- 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.

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**APPENDIX B**

**C-404 HAZARDOUS WASTE LANDFILL STATISTICAL ANALYSES**

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## GROUNDWATER STATISTICAL SUMMARY

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### 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 the approved Attachment VIII, Appendix C, of the C-404 Hazardous Waste Management Permit. The percent of censored (nondetected) data points for individual parameters was calculated for the combined analytical data. 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. For this report, the reporting period data set includes data from July 2011, January 2012, July 2012, January 2013, August 2013, and January 2014.

### Statistical Analysis Process

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.

## 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.

For this report, the reporting period data set from July 2011 through January 2014 consists of six sets of data.

**Table B.1. Monitoring Well Locations**

<b>UCRS</b>	
Located South of C-404; adjacent to upgradient Regional Gravel Aquifer (RGA) background well MW93	MW94
Located North of C-404, adjacent to downgradient RGA compliance wells	MW85, MW88, MW91
<b>URGA</b>	
Upgradient background wells	MW93, MW420
Downgradient compliance wells	MW84, MW87, MW90A*

\*MW90 was abandoned in 2001 and replaced with MW90A.

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

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

<b>Parameters</b>	<b>Observations</b>	<b>Missing Observations*</b>	<b>Censored Observations</b>	<b>Uncensored Observations</b>
<b>URGA</b>				
Arsenic	30	0	11	19
Arsenic, Dissolved	30	0	12	18
Cadmium	30	0	29	1
Cadmium, Dissolved	30	0	30	0
Chromium	30	0	18	12
Chromium, Dissolved	30	0	30	0
Lead	30	0	25	5
Lead, Dissolved	30	0	30	0
Mercury	30	0	30	0
Mercury, Dissolved	30	0	30	0
Selenium	30	0	28	2
Selenium, Dissolved	30	0	30	0
Technetium-99	30	0	20	10
Trichloroethene	30	0	0	30
Uranium (Metals)	30	0	30	0
Uranium, Dissolved	30	0	30	0
Uranium-234	30	0	30	0
Uranium-235	30	0	30	0
Uranium-238	30	0	29	1

\*Missing parameters that were dissolved metals were not analyzed when the parent total metals were not detected.

## 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.3. Percent Censored Report and Statistical Test Set Selected**

<b>Parameter</b>	<b>Total Samples (Nonmissing)</b>	<b>Detects</b>	<b>Nondetects</b>	<b>Percent Censored</b>	<b>Statistical Test Set</b>
<b>URGA</b>					
Arsenic	30	19	11	37 %	3
Arsenic, Dissolved	30	18	12	40 %	3
Cadmium	30	1	29	97 %	1
Chromium	30	12	18	60 %	2
Lead	30	5	25	83 %	2
Mercury	30	0	30	100 %	1
Selenium	30	2	28	93 %	1
Technetium-99	30	10	20	67 %	2
Trichloroethene	30	30	0	0%	4
Uranium	30	0	30	100 %	1
Uranium-234	30	0	30	100 %	1
Uranium-235	30	0	30	100 %	1
Uranium-238	30	1	29	97 %	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.



## SUMMARY OF CONCLUSIONS

The results for 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 6.

In summary, Statistical Test 2, Test of Proportions, for chromium, lead, and Tc-99 and Statistical Test 3, Nonparametric ANOVA, for total arsenic in the URGA indicated no statistical evidence of releases of these contaminants from the C-404 Landfill.

Statistical Test 3, Nonparametric ANOVA, for dissolved arsenic in the URGA, indicated concentrations were elevated relative to background in MW84; however no statistical evidence of elevated dissolved arsenic in the other two compliance wells (MW87 and MW90A) was found. Dissolved arsenic concentrations in background wells ranged from nondetect (DL = 0.001 mg/L) to 0.0054 mg/L, and were of the same order of magnitude in MW84, with concentrations ranging from 0.0039 to 0.0042 mg/L. Statistical Test 4, Parametric ANOVA, could not be used for TCE in the URGA because there was no evidence of equality of variance. An analysis of TCE data in the URGA indicated that 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 evidence of contamination of TCE in any compliance well.

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

<b>Parameter</b>	<b>LOD Values</b>	<b>½ LOD Values</b>
<b>URGA</b>		
Cadmium (mg/L)	0.001	0.0005
Mercury (mg/L)	0.0002	0.0001
Selenium (mg/L)	0.005	0.0025
Uranium (mg/L)	0.001	0.0005
Uranium-234 (pCi/L)	0.30	0.15
Uranium-235 (pCi/L)	0.18	0.09
Uranium-238 (pCi/L)	0.15	0.08

LOD = Limit of Detection; mg/L = milligrams per liter; pCi/L = picocuries per liter

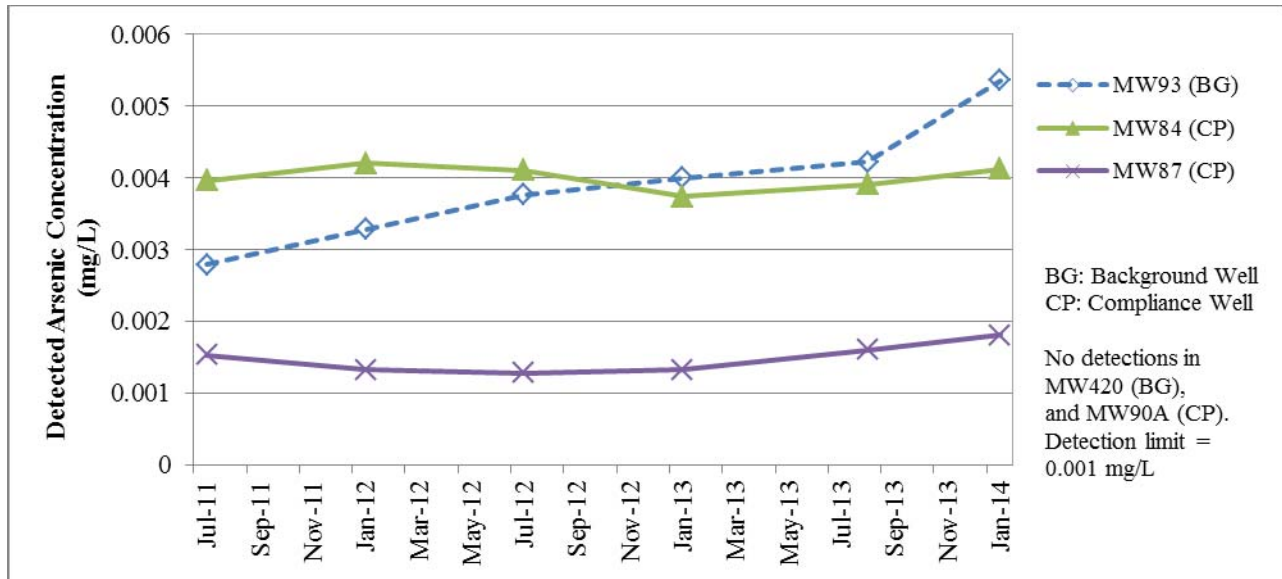
**Table B.5. Summary of Conclusions from the Statistical Analyses for the C-404 Hazardous Waste Landfill for the January 2014 Data Set**

<b>Attachment</b>	<b>RGA Well Type</b>	<b>Parameter</b>	<b>Applied Statistical Test</b>	<b>Results</b>
1	URGA	Arsenic	Statistical Test 3, Nonparametric ANOVA	No statistically significant evidence of contamination from the C-404 Landfill in compliance wells.
2	URGA	Arsenic, Dissolved	Statistical Test 3, Nonparametric ANOVA	There is statistically significant evidence that dissolved arsenic is higher in MW84 when compared to background wells. There is no statistically significant evidence of contamination from the C-404 Landfill in other compliance wells (MW87 and MW90A). (See Figure B.1 for graph of detected arsenic concentrations in monitoring wells versus time).
3	URGA	Chromium	Statistical Test 2, Test of Proportions	No statistically significant evidence of contamination from the C-404 Landfill in compliance wells.
4	URGA	Lead	Statistical Test 2, Test of Proportions	No statistically significant evidence of contamination from the C-404 Landfill in compliance wells.
5	URGA	Technetium-99	Statistical Test 2 Test of Proportions	No statistically significant evidence of contamination from the C-404 Landfill in compliance wells.
6	URGA	Trichloroethene	Statistical Test 4 Parametric ANOVA	Because equality of variance could not be confirmed, Statistical Test 4 was abandoned and Statistical Test 3, Non-parametric ANOVA, was performed. No statistically significant evidence of contamination in compliance wells.

RGA = Regional Gravel Aquifer; URGA = Upper Regional Gravel Aquifer

The concentrations of dissolved arsenic in the URGA wells were plotted against time, as shown in Figure B.1. The dissolved arsenic concentrations in MW84 in the three most recent monitoring events were lower or comparable to the concentrations measured during the three previous semiannual events. None of the concentrations exceeded the U.S. Environmental Protection Agency drinking water standard maximum contaminant level (MCL) for arsenic (0.010 mg/L). The dissolved arsenic concentrations in the upgradient well MW93 exceeded the concentrations in MW84 for the last three events. As noted in Figure B.1, the detection limit for dissolved arsenic concentrations in C-404 monitoring wells was 0.001 mg/L.

As a result of this analysis, it does not appear that the C-404 Landfill is a source of dissolved arsenic contamination of the URGA.



**Figure B.1. Detected Dissolved Arsenic Concentrations in C-404 Monitoring Wells**

**Attachment 1: Statistical Test 3, Nonparametric ANOVA, January 2014 Arsenic (Total) URG**

Arsenic (Total) (mg/L)					
Date	Background	Background	Compliance	Compliance	Compliance
	MW93	MW420	MW84	MW87	MW90A
Jul-11	<b>0.00255</b>	0.0005	<b>0.00422</b>	<b>0.00103</b>	0.0005
Jan-12	<b>0.00535</b>	0.0005	<b>0.00434</b>	<b>0.00187</b>	0.0005
Jul-12	<b>0.00412</b>	0.0005	<b>0.00425</b>	<b>0.00133</b>	0.0005
Jan-13	<b>0.00652</b>	0.0005	<b>0.00572</b>	<b>0.00183</b>	0.0005
Aug-13	<b>0.00472</b>	0.0005	<b>0.00441</b>	<b>0.0015</b>	0.0005
Jan-14	<b>0.00656</b>	<b>0.0011</b>	<b>0.00514</b>	<b>0.00218</b>	0.0005
Sum	0.0334		0.02808	0.00974	0.0030
n <sub>i</sub>	12		6	6	6
(x <sub>i</sub> ) <sub>avg</sub>	0.00278		0.00468	0.00162	0.0005

mg/L = milligrams per liter

BG=background

DL=detection limit

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

**Bolded values indicate a detected result.**

Overall mean  $\bar{x} = 0.00247$

N = 30

p = 4

$\bar{x} = 0.07$

**Attachment 1: Statistical Test 3, Nonparametric ANOVA, January 2014 Arsenic (Total) URGA**

**Statistical Test 3, Non-parametric ANOVA**

**Ranking of Observations**

Sequence	Arsenic (mg/L)	Adjusted Rank	Tie Number
1	0.0005	6	Tie 1
2	0.0005	6	
3	0.0005	6	
4	0.0005	6	
5	0.0005	6	
6	0.0005	6	
7	0.0005	6	
8	0.0005	6	
9	0.0005	6	
10	0.0005	6	
11	0.0005	6	
12	<b>0.00103</b>	12	
13	<b>0.0011</b>	13	
14	<b>0.00133</b>	14	
15	<b>0.0015</b>	15	
16	<b>0.00183</b>	16	
17	<b>0.00187</b>	17	
18	<b>0.00218</b>	18	
19	<b>0.00255</b>	19	
20	<b>0.00412</b>	20	
21	<b>0.00422</b>	21	
22	<b>0.00425</b>	22	
23	<b>0.00434</b>	23	
24	<b>0.00441</b>	24	
25	<b>0.00472</b>	25	
26	<b>0.00514</b>	26	
27	<b>0.00535</b>	27	
28	<b>0.00572</b>	28	
29	<b>0.00652</b>	29	
30	<b>0.00656</b>	30	

mg/L = milligrams per liter

BG=background

DL=detection limit

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

**Bolded values indicate a detected result.**

Adjustment for Ties:

$$\text{Tie 1} = (11^3 - 11) = 1320$$

$$\sum T_i = 1320$$

## Attachment 1: Statistical Test 3, Nonparametric ANOVA, January 2014 Arsenic (Total) URGA

### Sums of Ranks and Averages

Arsenic (mg/L)					
Date	Background	Background	Compliance	Compliance	Compliance
	MW93	MW420	MW84	MW87	MW90A
Jul-11	<b>0.00255</b>	0.0005	<b>0.00422</b>	<b>0.00103</b>	0.0005
Jan-12	<b>0.00535</b>	0.0005	<b>0.00434</b>	<b>0.00187</b>	0.0005
Jul-12	<b>0.00412</b>	0.0005	<b>0.00425</b>	<b>0.00133</b>	0.0005
Jan-13	<b>0.00652</b>	0.0005	<b>0.00572</b>	<b>0.00183</b>	0.0005
Aug-13	<b>0.00472</b>	0.0005	<b>0.00441</b>	<b>0.0015</b>	0.0005
Jan-14	<b>0.00656</b>	<b>0.0011</b>	<b>0.00514</b>	<b>0.00218</b>	0.0005

Observation Ranks for Arsenic					
Date	Background	Background	Compliance	Compliance	Compliance
	MW93	MW420	MW84	MW87	MW90A
Jul-10	19	6	21	12	6
Jan-11	27	6	23	17	6
Jul-11	20	6	22	14	6
Jan-12	29	6	28	16	6
Jul-12	25	6	24	15	6
Jan-13	30	13	26	18	6
R <sub>i</sub>	193		144	92	36
(R <sub>i</sub> ) <sub>avg</sub>	16.1		24.0	15.3	6.0
R <sub>i</sub> <sup>2</sup> /n <sub>i</sub>	3104.1		3456.0	1410.7	216.0

$$\Sigma R_i^2/n_i = 8186.8$$

mg/L = milligrams per liter

BG=background

DL=detection limit

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

**Bolded values indicate a detected result.**

$$K = 4$$

$$N = 30$$

### Calculation of Kruskal-Wallis Statistic

$$H = 12.635 \quad \text{Kruskal-Wallis Statistic} \quad H = [12/N(N+1) * \Sigma R_i^2/n_i] - 3(N+1)$$

$$H' = 13.286 \quad \text{Corrected Kruskal-Wallis} \quad H' = H/[1 - (\Sigma T_i/N^3 - N)]$$

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

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 1: Statistical Test 3, Nonparametric ANOVA, January 2014 Arsenic (Total) URG**

**Calculate Critical Values**

Average Background Ranking = 16.083

	Well No.	C <sub>i</sub>	(R <sub>i</sub> ) <sub>avg</sub> - (R <sub>b</sub> ) <sub>avg</sub>	Conclusion
BG Well	MW93			
BG Well	MW420			
	MW84	9.367	7.92	not contaminated
	MW87	9.367	-0.75	not contaminated
	MW90A	9.367	-10.08	not contaminated

mg/L = milligrams per liter

BG=background

DL=detection limit

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

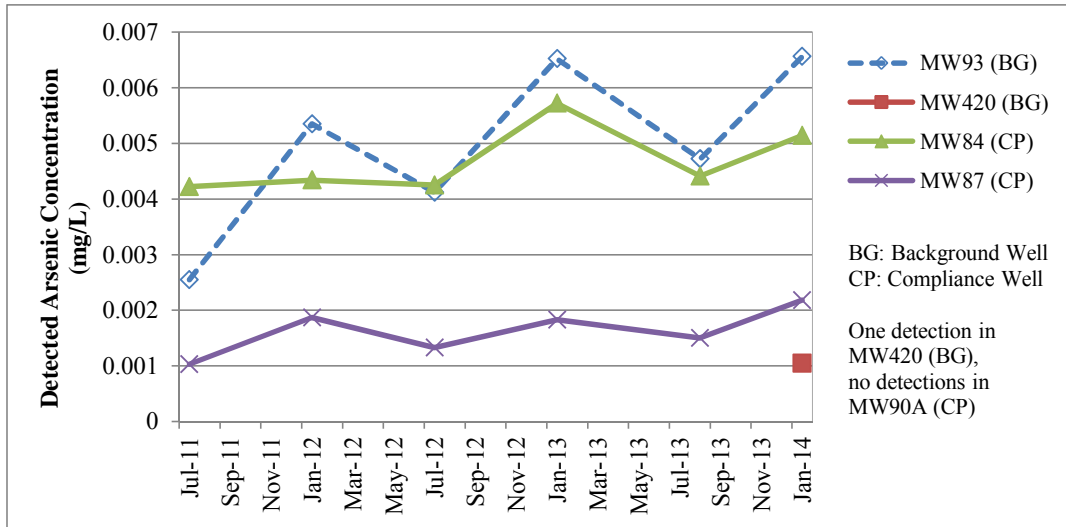
**Bolded values indicate a detected result.**

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 MW84, MW87 and MW90A, there is no statistically significant evidence of contamination 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

**Detected Arsenic (Total) in C-404 Wells**



\*Detection limit was 0.001 mg/L for all samples included in the graph.

**Attachment 2: Statistical Test 3, Nonparametric ANOVA, January 2014 Arsenic (Dissolved) URG**

Arsenic (Dissolved) (mg/L)					
Date	Background	Background	Compliance	Compliance	Compliance
	MW93	MW420	MW84	MW87	MW90A
Jul-11	<b>0.00279</b>	0.0005	<b>0.00396</b>	<b>0.00153</b>	0.0005
Jan-12	<b>0.00328</b>	0.0005	<b>0.0042</b>	<b>0.00132</b>	0.0005
Jul-12	<b>0.00377</b>	0.0005	<b>0.00411</b>	<b>0.00128</b>	0.0005
Jan-13	<b>0.004</b>	0.0005	<b>0.00374</b>	<b>0.00132</b>	0.0005
Aug-13	<b>0.00422</b>	0.0005	<b>0.00391</b>	<b>0.0016</b>	0.0005
Jan-14	<b>0.00536</b>	0.0005	<b>0.00412</b>	<b>0.00181</b>	0.0005
Sum	0.0234	0.0030	0.02404	0.00886	0.0030
n <sub>i</sub>	12		6	6	6
(x <sub>i</sub> ) <sub>avg</sub>	0.00220		0.00401	0.00148	0.0005

mg/L = milligrams per liter

BG=background

DL=detection limit

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

**Bolded values indicate a detected result.**

Overall mean x.. = 0.00208

N = 30

p = 4

x..= 0.06



**Attachment 2: Statistical Test 3, Nonparametric ANOVA, January 2014 Arsenic (Dissolved) URGA**

**Statistical Test 3, Non-parametric ANOVA**

**Ranking of Observations**

Sequence	Arsenic (mg/L)	Adjusted Rank	Tie Number
1	0.0005	6.5	Tie 1
2	0.0005	6.5	
3	0.0005	6.5	
4	0.0005	6.5	
5	0.0005	6.5	
6	0.0005	6.5	
7	0.0005	6.5	
8	0.0005	6.5	
9	0.0005	6.5	
10	0.0005	6.5	
11	0.0005	6.5	
12	0.0005	6.5	
13	<b>0.00128</b>	13	Tie 2
14	<b>0.00132</b>	14.5	
15	<b>0.00132</b>	14.5	
16	<b>0.00153</b>	16	
17	<b>0.0016</b>	17	
18	<b>0.00181</b>	18	
19	<b>0.00279</b>	19	
20	<b>0.00328</b>	20	
21	<b>0.00374</b>	21	
22	<b>0.00377</b>	22	
23	<b>0.00391</b>	23	
24	<b>0.00396</b>	24	
25	<b>0.004</b>	25	
26	<b>0.00411</b>	26	
27	<b>0.00412</b>	27	
28	<b>0.0042</b>	28	
29	<b>0.00422</b>	29	
30	<b>0.00536</b>	30	

mg/L = milligrams per liter

BG=background

DL=detection limit

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

**Bolded values indicate a detected result.**

Adjustment for Ties:

$$\text{Tie 1} = (12^3 - 12) = 1716$$

$$\text{Tie 2} = (2^3 - 2) = 6$$

$$\sum T_i = 1722$$

## Attachment 2: Statistical Test 3, Nonparametric ANOVA, January 2014 Arsenic (Dissolved) URGA

### Sums of Ranks and Averages

Arsenic (mg/L)					
Date	Background	Background	Compliance	Compliance	Compliance
	MW93	MW420	MW84	MW87	MW90A
Jul-11	<b>0.00279</b>	0.0005	<b>0.00396</b>	<b>0.00153</b>	0.0005
Jan-12	<b>0.00328</b>	0.0005	<b>0.0042</b>	<b>0.00132</b>	0.0005
Jul-12	<b>0.00377</b>	0.0005	<b>0.00411</b>	<b>0.00128</b>	0.0005
Jan-13	<b>0.004</b>	0.0005	<b>0.00374</b>	<b>0.00132</b>	0.0005
Aug-13	<b>0.00422</b>	0.0005	<b>0.00391</b>	<b>0.0016</b>	0.0005
Jan-14	<b>0.00536</b>	0.0005	<b>0.00412</b>	<b>0.00181</b>	0.0005

Observation Ranks for Arsenic					
Date	Background	Background	Compliance	Compliance	Compliance
	MW93	MW420	MW84	MW87	MW90A
Jul-11	19	6.5	24	16	6.5
Jan-12	20	6.5	28	14.5	6.5
Jul-12	22	6.5	26	13	6.5
Jan-13	25	6.5	21	14.5	6.5
Aug-13	29	6.5	23	17	6.5
Jan-14	30	6.5	27	18	6.5
R <sub>i</sub>	184		149	93	39
(R <sub>i</sub> ) <sub>avg</sub>	15.3		24.8	15.5	6.5
R <sub>i</sub> <sup>2</sup> /n <sub>i</sub>	2821.3		3700.2	1441.5	253.5

$$\sum R_i^2/n_i = 8216.5$$

mg/L = milligrams per liter

BG=background

DL=detection limit

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

**Bolded values indicate a detected result.**

$$K = 4$$

$$N = 30$$

### Calculation of Kruskal-Wallis Statistic

$$H = 13.019 \quad \text{Kruskal-Wallis Statistic} \quad H = [12/N(N+1) * \sum R_i^2/n_i] - 3(N+1)$$

$$H' = 13.907 \quad \text{Corrected Kruskal-Wallis} \quad H' = H/[1 - (\sum T_i/N^3 - N)]$$

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

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.

$$\begin{array}{llll} K-1 = & 3 & \alpha/(K-1) = & 0.01667 & Z(\alpha/(K-1))^{**} = & 2.1280 \\ \alpha = & 0.05 & 1-(\alpha/(K-1)) = & 0.983 & & \end{array}$$

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 2: Statistical Test 3, Nonparametric ANOVA, January 2014 Arsenic (Dissolved) URGA

### Calculate Critical Values

Average Background Ranking = 15.333

	Well No.	$C_i$	$(R_i)_{avg} - (R_b)_{avg}$	Conclusion
BG Well	MW93			
BG Well	MW420			
	MW84	9.367	9.50	evidence of contamination
	MW87	9.367	0.17	not contaminated
	MW90A	9.367	-8.83	not contaminated

mg/L = milligrams per liter

BG=background

DL=detection limit

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

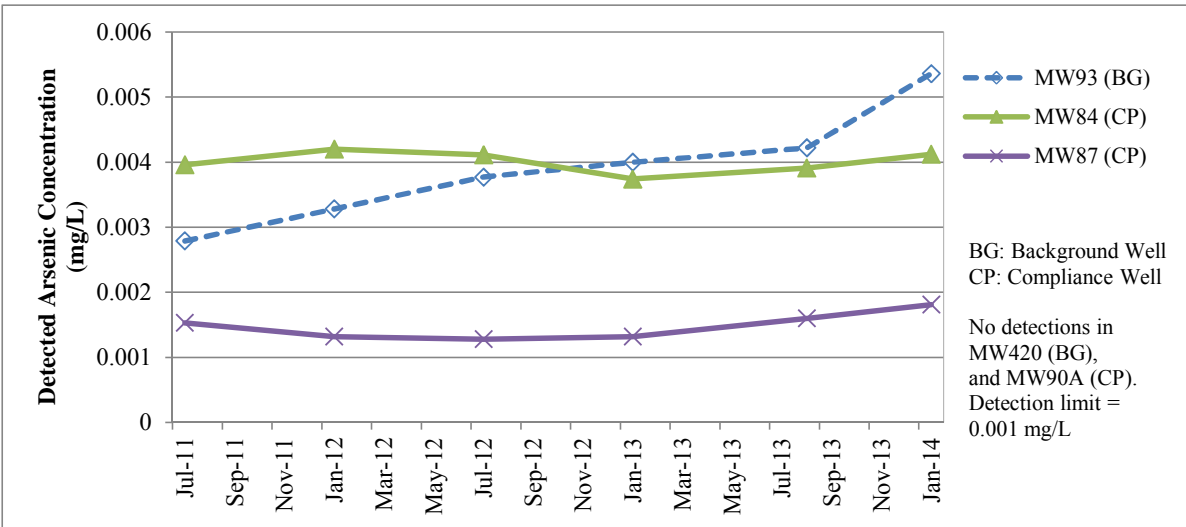
**Bolded values indicate a detected result.**

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 MW87 and MW90A, there is no statistically significant evidence of contamination from C-404 in these downgradient compliance test wells; however, there is statistically evidence that compliance well MW84 is contaminated.

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

### Detected Arsenic (Dissolved) in C-404 Wells



### Attachment 3: Statistical Test 2, Test of Proportions, January 2014 Chromium URGA

Chromium (mg/L)					
Date	Background	Background	Compliance	Compliance	Compliance
	MW93	MW420	MW84	MW87	MW90A
Jul-11	0.005	0.005	<b>0.0232</b>	<b>0.0357</b>	0.005
Jan-12	<b>0.0214</b>	0.005	0.005	<b>0.0792</b>	0.005
Jul-12	0.005	0.005	0.005	<b>0.0218</b>	0.005
Jan-13	<b>0.224</b>	0.005	<b>0.0604</b>	<b>0.177</b>	0.005
Aug-13	<b>0.0288</b>	0.005	<b>0.0639</b>	<b>0.0691</b>	0.005
Jan-14	0.005	0.005	<b>0.0921</b>	0.005	0.005

mg/L = milligrams per liter

BG=background

DL=detection limit

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

**Bolded values indicate a detected result.**

#### <sup>1</sup>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=	9	Y=number of samples above DL in compliance wells
n <sub>b</sub> =	12	n <sub>b</sub> =count of background well results/samples analyzed
n <sub>c</sub> =	18	n <sub>c</sub> =count of compliance well results/samples analyzed
n=	30	n=total number of samples

P =	0.400	$P=(x+y)/n$
nP =	12	$n=n_b+n_c$
n(1-P) =	18	

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

P <sub>b</sub> =	0.250	P <sub>b</sub> =proportion of detects in background wells
P <sub>c</sub> =	0.500	P <sub>c</sub> =proportion of detects in compliance wells
S <sub>D</sub> =	0.183	S <sub>D</sub> =standard error of difference in proportions
Z =	-1.369	$Z = (P_b - P_c)/S_D$
absolute value of Z =	1.369	

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.

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

## Attachment 4: Statistical Test 2, Test of Proportions, January 2014 Lead URGA

Lead (mg/L)					
Date	Background	Background	Compliance	Compliance	Compliance
	MW93	MW420	MW84	MW87	MW90A
Jul-11	0.00065	0.00065	0.00065	0.00065	0.00065
Jan-12	<b>0.00229</b>	0.00065	0.00065	<b>0.00279</b>	0.00065
Jul-12	0.00065	0.00065	0.00065	0.00065	0.00065
Jan-13	<b>0.00256</b>	0.00065	<b>0.00164</b>	<b>0.0117</b>	0.00065
Aug-13	0.00065	0.00065	0.00065	0.00065	0.00065
Jan-14	0.00065	0.00065	0.00065	0.00065	0.00065

mg/L = milligrams per liter

BG=background

DL=detection limit

Nondetect values are 1/2DL.

**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=	3	Y=	number of samples above DL in compliance wells
n <sub>b</sub> =	12	n <sub>b</sub> =	count of background well results/samples analyzed
n <sub>c</sub> =	18	n <sub>c</sub> =	count of compliance well results/samples analyzed
n=	30	n=	total number of samples

P =	0.167	P=(x+y)/n
nP =	5	n=n <sub>b</sub> +n <sub>c</sub>
n(1-P) =	25	

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

P <sub>b</sub> =	0.167	P <sub>b</sub> =	proportion of detects in background wells
P <sub>c</sub> =	0.167	P <sub>c</sub> =	proportion of detects in compliance wells
S <sub>D</sub> =	0.139	S <sub>D</sub> =	standard error of difference in proportions
Z =	0.000	Z =	(P <sub>b</sub> -P <sub>c</sub> )/S <sub>D</sub>
absolute value of Z =	0.000		

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.

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

**Attachment 5: Statistical Test 2, Test of Proportions, January 2014 Technetium-99 URGA**

Technetium-99 (pCi/L)					
Date	Background	Background	Compliance	Compliance	Compliance
	MW93	MW420	MW84	MW87	MW90A
Jul-11	<b>12.9</b>	<b>35.3</b>	<b>12.5</b>	<b>13.6</b>	6.20
Jan-12	7.90	<b>32.6</b>	7.90	7.90	7.90
Jul-12	9.25	9.25	<b>22.3</b>	9.25	9.25
Jan-13	7.4	<b>49.1</b>	7.4	7.4	7.4
Aug-13	3.165	<b>17.9</b>	<b>18.8</b>	4.88	7.25
Jan-14	8.1	<b>16.8</b>	8.1	8.1	8.1

pCi/L = picocuries per liter

BG=background

DL=detection limit

Data represent 1/2DL values for nondetects.

**Bolded values indicate a detected result.**

**†Test of Proportions**

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

X= 6 X=number of samples above DL in background wells  
 Y= 4 Y=number of samples above DL in compliance wells  
 n<sub>b</sub>= 12 n<sub>b</sub>=count of background well results/samples analyzed  
 n<sub>c</sub>= 18 n<sub>c</sub>=count of compliance well results/samples analyzed  
 n= 30 n=total number of samples

P = 0.333 P=(x+y)/n  
 nP = 10 n=n<sub>b</sub>+n<sub>c</sub>  
 n(1-P) = 20

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

P<sub>b</sub> = 0.500 P<sub>b</sub> =proportion of detects in background wells  
 P<sub>c</sub> = 0.222 P<sub>c</sub> =proportion of detects in compliance wells  
 S<sub>D</sub> = 0.176 S<sub>D</sub>=standard error of difference in proportions  
 Z = 1.581 Z = (P<sub>b</sub>-P<sub>c</sub>)/S<sub>D</sub>  
 absolute value of Z = 1.581

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.

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

**Attachment 6: Statistical Test 4, Parametric ANOVA, January 2014 Trichloroethene URGA**

Trichloroethene (TCE, µg/L)					
Date	Background	Background	Compliance	Compliance	Compliance
	MW93	MW420	MW84	MW87	MW90A
Jul-11	<b>990</b>	<b>290</b>	<b>1000</b>	<b>420</b>	<b>26</b>
Jan-12	<b>1200</b>	<b>280</b>	<b>1300</b>	<b>540</b>	<b>24</b>
Jul-12	<b>1500</b>	<b>210</b>	<b>1100</b>	<b>450</b>	<b>14</b>
Jan-13	<b>1900</b>	<b>190</b>	<b>1100</b>	<b>470</b>	<b>17</b>
Aug-13	<b>2200</b>	<b>230</b>	<b>1300</b>	<b>760</b>	<b>35</b>
Jan-14	<b>2900</b>	<b>290</b>	<b>1500</b>	<b>670</b>	<b>25</b>
n <sub>i</sub>	12		6	6	6
Sum	12180		7300	3310	141.00
(x <sub>i</sub> )avg	1015.00		1216.67	551.67	23.50

µg/L = micrograms per liter

**Bolded values indicate a detected result.**

Overall mean  $\bar{x} = 764.37$   
 $N = 30$   
 $p = 4$   
 $\bar{x} = 22931.00$

**Determine Normality of Dataset**

**Coefficient of Variability Test**

Table of Residuals

Date	Background	Background	Compliance	Compliance	Compliance
	MW93	MW420	MW84	MW87	MW90A
Jul-11	-25.00	-725.00	-216.67	-131.67	2.50
Jan-12	185.00	-735.00	83.33	-11.67	0.50
Jul-12	485.00	-805.00	-116.67	-101.67	-9.50
Jan-13	885.00	-825.00	-116.67	-81.67	-6.50
Aug-13	1185.00	-785.00	83.33	208.33	11.50
Jan-14	1885.00	-725.00	283.33	118.33	1.50

X: Mean Value =  $-1.14E-14$   
 S: Standard Deviation = 581.5  
 $K^*$  Factor = 2.22 (for  $n = 30$ )  
 $CV = S/X = -5.12E+16 < 1$ , residuals are normal

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

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

**Attachment 6: Statistical Test 4, Parametric ANOVA, January 2014 Trichloroethene URGA**

**Determine Equality of Variance of Dataset**

p = number of wells	$x_{..} = 22931.00$
$n_i$ = number of data points per well	$(x_{avg})_{..} = 764.37$
N = total sample size	
$S^2$ = the square of the standard deviation	p = 4
$\ln(S_i^2)$ = natural logarithm of each variance	N = 30
f = total sample size minus the number of wells (groups)	
$f_i = n_i - 1$	

Calculations for Equality of Variance: Bartlett's Test

$S_i$	$S_i^2$	$\ln(S_i^2)$	$n_i$	$f_i S_i^2$	$f_i \ln(S_i^2)$
931.621	867918.182	13.674	12	9547100.000	150.4
183.485	33666.667	10.424	6	168333.333	52.1
135.561	18376.667	9.819	6	91883.333	49.1
7.396	54.700	4.002	6	273.500	20.0

$\Sigma(S_i^2) =$	920016.22	$\Sigma f_i \ln(S_i^2) =$	271.6
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Equality of Variance: Bartlett's Test

f =	26		
$Sp^2 =$	377215.006		
$\ln Sp^2 =$	12.841		
$\chi^2 =$	62.218	(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*, USEPA, 1989.



**Attachment 6: Statistical Test 4, Parametric ANOVA, January 2014 Trichloroethene URGA**

**Lognormal Data for TCE**

Date	ln[TCE (µg/L)]				
	Background MW93	Background MW420	Compliance MW84	Compliance MW87	Compliance MW90A
Jul-11	6.90	5.67	6.91	6.04	3.26
Jan-12	7.09	5.63	7.17	6.29	3.18
Jul-12	7.31	5.35	7.00	6.11	2.64
Jan-13	7.55	5.25	7.00	6.15	2.83
Aug-13	7.70	5.44	7.17	6.63	3.56
Jan-14	7.97	5.67	7.31	6.51	3.22
$x_i$	77.53		42.57	37.73	18.68
$(x_i)_{avg}$	6.46		7.09	6.29	3.11

µg/L = micrograms per liter

**Determine Normality of Dataset**

**Coefficient of Variability Test**

Table of residuals

Date	Background MW93	Background MW420	Compliance MW84	Compliance MW87	Compliance MW90A
Jan-11	0.44	-0.79	-0.19	-0.25	0.14
Jul-11	0.63	-0.83	0.08	0.00	0.06
Jan-12	0.85	-1.11	-0.09	-0.18	-0.47
Jul-12	1.09	-1.21	-0.09	-0.14	-0.28
Jan-13	1.24	-1.02	0.08	0.34	0.44
Aug-13	1.51	-0.79	0.22	0.22	0.11

X: Mean Value = 0.00  
 S: Standard Deviation = 0.7  
 K\* Factor = 2.22 (for n = 30)  
 CV = S/X = -1.96E+15 <1, residuals of log-transformed data are normally distributed

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

## Attachment 6: Statistical Test 4, Parametric ANOVA, January 2014 Trichloroethene URGA

### Determine Equality of Variance of Dataset

$p$  = number of wells (background wells considered as one group)  $\bar{x} = 176.51$   
 $n_i$  = number of data points per well  $(\bar{x}_{avg}) = 5.88$   
 $N$  = total sample size  
 $S^2$  = the square of the standard deviation  $p = 4$   
 $\ln(S_i^2)$  = natural logarithm of each variance  $N = 30$   
 $f$  = total sample size minus the number of wells (groups)  
 $f_i = n_i - 1$

#### Calculations for Equality of Variance: Bartlett's Test

$S_i$	$S_i^2$	$\ln(S_i^2)$	$n_i$	$f_i S_i^2$	$f_i \ln(S_i^2)$
1.045	1.091	0.087	12	12.003	1.0
0.149	0.022	-3.809	6	0.111	-19.0
0.236	0.056	-2.886	6	0.279	-14.4
0.327	0.107	-2.235	6	0.535	-11.2

$$\sum(S_i^2) = 1.28 \qquad \sum f_i \ln(S_i^2) = -43.7$$

#### Equality of Variance: Bartlett's Test

$f = 26$   
 $S_p^2 = 0.497$   
 $\ln S_p^2 = -0.699$   
 $\chi^2 = 25.523$  (If calculated  $\chi^2 \leq$  tabulated  $\chi^2$ , 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*, USEPA, 1989.

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

**Attachment 6: Statistical Test 4, Parametric ANOVA, January 2014 Trichloroethene URGA**

**Statistical Test 3, Nonparametric ANOVA**

TCE (µg/L)					
Date	Background	Background	Compliance	Compliance	Compliance
	MW93	MW420	MW84	MW87	MW90A
Jul-11	<b>990</b>	<b>290</b>	<b>1000</b>	<b>420</b>	<b>26</b>
Jan-12	<b>1200</b>	<b>280</b>	<b>1300</b>	<b>540</b>	<b>24</b>
Jul-12	<b>1500</b>	<b>210</b>	<b>1100</b>	<b>450</b>	<b>14</b>
Jan-13	<b>1900</b>	<b>190</b>	<b>1100</b>	<b>470</b>	<b>17</b>
Aug-13	<b>2200</b>	<b>230</b>	<b>1300</b>	<b>760</b>	<b>35</b>
Jan-14	<b>2900</b>	<b>290</b>	<b>1500</b>	<b>670</b>	<b>25</b>
n <sub>i</sub>	12		6	6	6
x <sub>i</sub>	12180		7300	3310	141.00
(x <sub>i</sub> )avg	1015.00		1216.67	551.67	23.50

Overall mean  $\bar{x}.. = 764.37$

N = 30  
 p = 4  
 $\bar{x}.. = 22931.00$

µg/L = micrograms per liter

**Attachment 6: Statistical Test 4, Parametric ANOVA, January 2014 Trichloroethene URGA**

**Non-Parametric ANOVA**

**Ranking of Observations**

Sequence	TCE (µg/L)	Adjusted Rank	Tie Number
1	14	1	
2	17	2	
3	24	3	
4	25	4	
5	26	5	
6	35	6	
7	190	7	
8	210	8	
9	230	9	
10	280	10	
11	290	11.5	Tie 1
12	290	11.5	
13	420	13	
14	450	14	
15	470	15	
16	540	16	
17	670	17	
18	760	18	
19	990	19	
20	1000	20	
21	1100	21.5	Tie 2
22	1100	21.5	
23	1200	23	
24	1300	24.5	Tie 3
25	1300	24.5	
26	1500	26.5	Tie 4
27	1500	26.5	
28	1900	28	
29	2200	29	
30	2900	30	

Adjustment for Ties:

No. of Ties: Tie 1	2	Tie 1 =	$2^3 - 2 =$	6
Tie 2	2	Tie 2 =	$2^3 - 2 =$	6
Tie 3	2	Tie 3 =	$2^3 - 2 =$	6
Tie 4	2	Tie 4 =	$2^3 - 2 =$	6

$$\sum T_i = 24$$

**Attachment 6: Statistical Test 4, Parametric ANOVA, January 2014 Trichloroethene URGA**

**Sums of Ranks and Averages**

TCE (µg/L)					
Date	Background	Background	Compliance	Compliance	Compliance
	MW93	MW420	MW84	MW87	MW90A
Jul-11	990	290	1000	420	26
Jan-12	1200	280	1300	540	24
Jul-12	1500	210	1100	450	14
Jan-13	1900	190	1100	470	17
Aug-13	2200	230	1300	760	35
Jan-14	2900	290	1500	670	25

Observation Ranks for TCE					
Date	Background	Background	Compliance	Compliance	Compliance
	MW93	MW420	MW84	MW87	MW90A
Jul-11	19	11.5	20	13	5
Jan-12	23	10	24.5	16	3
Jul-12	26.5	8	21.5	14	1
Jan-13	28	7	21.5	15	2
Aug-13	29	9	24.5	18	6
Jan-14	30	11.5	26.5	17	4
R <sub>i</sub>	212.5		138.5	93	21
(R <sub>i</sub> ) <sub>avg</sub>	17.7		23.1	15.5	3.5
R <sub>i</sub> <sup>2</sup> /n <sub>i</sub>	3763.0		3197.0	1441.5	73.5

$$\Sigma R_i^2/n_i = 8475.1$$

$$K = 4$$

$$N = 30$$

**Calculation of Kruskal-Wallis Statistic**

$$H = 16.356 \quad \text{Kruskal-Wallis Statistic} \quad H = [12/N(N+1) * \Sigma R_i^2/n_i] - 3(N+1)$$

$$H' = 16.370 \quad \text{Corrected Kruskal-Wallis} \quad H' = H/[1 - (\Sigma T_i/N^3 - N)]$$

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

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

**Attachment 6: Statistical Test 4, Parametric ANOVA, January 2014 Trichloroethene URGA**

**Calculate Critical Values**

Average Background Ranking = 17.7

	Well No.	$C_i$	$(R_i)_{avg} - (R_b)_{avg}$	Conclusion
BG Well	MW93			
BG Well	MW420			
	MW84	9.367	5.38	not contaminated
	MW87	9.367	-2.21	not contaminated
	MW90A	9.367	-14.21	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*, USEPA, 1989

April 22, 2014  
LKYBA10836-14-0011

Mr. Mark Legier  
LATA Kentucky  
P.O. Box 280,  
Kevil, KY 42053

Subject: Statistical analysis of groundwater data for C-404 landfill

Dear Mr. Legier:

I am submitting this statement in response to your request that it be provided 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 Senior Environmental Engineer, with a doctorate in Civil Engineering and Professional Engineer license with the State of Tennessee, I have twenty-two years of experience in the analysis and interpretation of environmental data.

For this project, the statistical analyses on groundwater data from July 2011 through January 2014 were performed in accordance with the C-404 Hazardous Waste Landfill Permit, Appendix C using Microsoft Excel 2010. The Excel files were saved in a format compatible with Microsoft Excel 1997-2003. I used the Excel files from the previous reporting period (November 2013) and modified these as appropriate for this reporting period. This approach was used so that the format for the spreadsheets would be familiar to you and would facilitate your review. 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).

Please feel free to contact me at (865) 671-4401, Jeff Douthitt, or Vanessa Pineda at (270) 462-3882 if you have any questions.

Sincerely,



Olivia R. West, Ph.D., P.E.

OW:vp

cc: GEO Kevil DMC

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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**

The leachate information in this document includes the monthly and quarterly inspections; volumes of leachate removed during this reporting period; and analytical results of leachate sampling.

## Paducah OREIS Report for 404L13-03

**L1404L3-13**

from: C404L

on 12/9/2013

Media: WW

SmpMethod: GR

Comments: F039

Analysis	Results	Counting Error	Units	Result Qual	Foot Note	Reporting Limit	TPU	Method	V/V/A*
<b>ANION</b>									
Fluoride	12		mg/L	X		1		SW846-9056	IS / X /
<b>FS</b>									
Conductivity	642		umho/cm					FS	//
Dissolved Oxygen	5.77		mg/L					FS	//
pH	7.7		Std Unit					FS	//
Redox	460		mV					FS	//
Temperature	67.6		deg F					FS	//
<b>METAL</b>									
Arsenic	0.00112		mg/L			0.001		SW846-6020	/ X /
Barium	0.088		mg/L			0.005		SW846-6020	S / X /
Cadmium	0.00742		mg/L			0.001		SW846-6020	/ X /
Chromium	0.0103		mg/L			0.01		SW846-6020	/ X /
Copper	0.195		mg/L			0.1		SW846-6020	/ X /
Iron	0.1		mg/L	U		0.1		SW846-6010B	/ X /
Lead	0.0153		mg/L			0.0013		SW846-6020	/ X /
Mercury	0.0002		mg/L	UW		0.0002		SW846-7470A	/ X /
Nickel	0.0242		mg/L			0.005		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	141		mg/L			2		SW846-6020	IS / X /
Zinc	0.139		mg/L			0.02		SW846-6020	/ X /
<b>PCCB</b>									
PCB-1016	0.17		ug/L	U		0.17		SW846-8082	/ X /
PCB-1221	0.18		ug/L	U		0.18		SW846-8082	/ X /
PCB-1232	0.14		ug/L	U		0.14		SW846-8082	/ X /
PCB-1242	0.1		ug/L	U		0.1		SW846-8082	/ X /
PCB-1248	0.12		ug/L	U		0.12		SW846-8082	/ X /
PCB-1254	0.07		ug/L	U		0.07		SW846-8082	/ X /
PCB-1260	0.05		ug/L	U		0.05		SW846-8082	/ X /
PCB-1268	0.09		ug/L	U		0.09		SW846-8082	/ X /
Polychlorinated biphenyl	0.18		ug/L	U		0.18		SW846-8082	/ X /
<b>RADS</b>									
Cesium-137	6.98	14	pCi/L	U		19.6	14	RL-7124	/ X /
Neptunium-237	0.912	0.508	pCi/L	U		1.29	0.686	RL-7128	/ X /
Plutonium-239/240	-0.0521	0.0887	pCi/L	U		2.31	0.929	RL-7128	/ X /
Technetium-99	215	16.4	pCi/L			15.5	17.2	RL-7100	/ X /
Thorium-230	1.99	0.975	pCi/L	U		2.83	1.51	RL-7128	/ X /
Uranium-234	2790	149	pCi/L	T		27	720	RL-7128	/ X /
Uranium-235	418	64.2	pCi/L	T		17.4	124	RL-7128	S / X /
Uranium-238	31100	496	pCi/L	T		16	7870	RL-7128	/ X /
<b>VOA</b>									
Trichloroethene	1		ug/L	U		1		SW846-8260B	/ X /
<b>WETCHEM</b>									
Ammonia as Nitrogen	0.2		mg/L	U		0.2		EPA-350.3	/ X /

### Paducah OREIS Report for 404L13-03

**TB404L3-13**

from: QC

on 12/9/2013

Media: WQ

SmpMethod:

Comments:

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

**Paducah OREIS Report for 404L13-03**

**L1404L4-13**

from: C404L

on 12/9/2013

Media: WW

SmpMethod: GR

Comments: F039

Analysis	Results	Counting Error	Units	Result Qual	Foot Note	Reporting Limit	TPU	Method	V/V/A*
<b>ANION</b>									
Fluoride	8.5		mg/L	X		1		SW846-9056	I / X /
<b>FS</b>									
Conductivity	620		umho/cm					FS	//
Dissolved Oxygen	9.86		mg/L					FS	//
pH	8.25		Std Unit					FS	//
Redox	431		mV					FS	//
Temperature	67.5		deg F					FS	//
<b>METAL</b>									
Arsenic	0.001		mg/L	U		0.001		SW846-6020	/ X /
Barium	0.069		mg/L			0.005		SW846-6020	/ X /
Cadmium	0.00228		mg/L			0.001		SW846-6020	/ X /
Chromium	0.01		mg/L	U		0.01		SW846-6020	/ X /
Copper	0.02		mg/L	U		0.02		SW846-6020	/ X /
Iron	0.1		mg/L	U		0.1		SW846-6010B	/ X /
Lead	0.00436		mg/L			0.0013		SW846-6020	/ X /
Mercury	0.0002		mg/L	UW		0.0002		SW846-7470A	/ X /
Nickel	0.005		mg/L	U		0.005		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	124		mg/L			2		SW846-6020	IS / X /
Zinc	0.02		mg/L	U		0.02		SW846-6020	/ X /
<b>PCCB</b>									
PCB-1016	0.16		ug/L	U		0.16		SW846-8082	/ X /
PCB-1221	0.17		ug/L	U		0.17		SW846-8082	/ X /
PCB-1232	0.14		ug/L	U		0.14		SW846-8082	/ X /
PCB-1242	0.1		ug/L	U		0.1		SW846-8082	/ X /
PCB-1248	0.12		ug/L	U		0.12		SW846-8082	/ X /
PCB-1254	0.07		ug/L	U		0.07		SW846-8082	/ X /
PCB-1260	0.05		ug/L	U		0.05		SW846-8082	/ X /
PCB-1268	0.09		ug/L	U		0.09		SW846-8082	/ X /
Polychlorinated biphenyl	0.17		ug/L	U		0.17		SW846-8082	/ X /
<b>RADS</b>									
Cesium-137	0.854	1.71	pCi/L	U		19	10.6	RL-7124	/ X /
Neptunium-237	0.59	0.459	pCi/L	U		1.64	0.639	RL-7128	/ X /
Plutonium-239/240	0.104	0.157	pCi/L	U		2.31	0.938	RL-7128	/ X /
Technetium-99	334	18.9	pCi/L			15.5	20.7	RL-7100	/ X /
Thorium-230	0.327	0.483	pCi/L	U		2.78	1.2	RL-7128	/ X /
Uranium-234	2970	160	pCi/L	T		31.1	801	RL-7128	/ X /
Uranium-235	424	67.4	pCi/L	T		21.6	131	RL-7128	S / X /
Uranium-238	33200	533	pCi/L	T		18.8	8790	RL-7128	/ X /
<b>VOA</b>									
Trichloroethene	1		ug/L	U		1		SW846-8260B	/ X /
<b>WETCHEM</b>									
Ammonia as Nitrogen	0.2		mg/L	U		0.2		EPA-350.3	/ X /

**C-404 Monthly Inspection Summary<sup>1, 2, 3, 4</sup>**

Period of Inspection: January, February, March 2014

Leachate Level	Date (M/D/YY)	Level (inches deep)*	Inspector(s)
First monthly leachate level determination	1-30-14	32"	Jeff Boulton <i>Jeff Boulton</i>
Second monthly leachate level determination	2-17-14	38"	Jeff Boulton <i>Jeff Boulton</i>
Third monthly leachate level determination	3-18-14	16"	Jeff Boulton <i>Jeff Boulton</i>

\* 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."

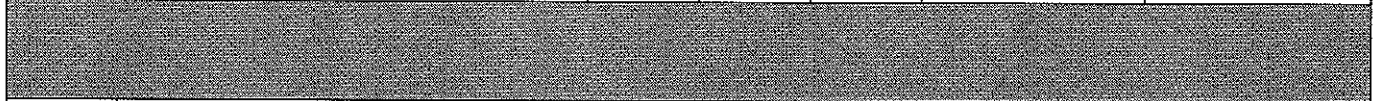
**NOTES:**

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 Inspection Checklist for Leachate Removal<sup>1, 2, 3</sup>**

Leachate Removal Inspection	YES	NO	N/A	Date (M/D/YY)	Volume (gallons)
Was any removal necessary during the quarter?	✓			2-19-14	1200
Has any leachate removed during the quarter been sampled?	✓			2-27-14	↓
Date of superficial inspection upon removal of leachate.	✓			2-19-14	
Date of sampling of leachate after removal.	✓			2-27-14	



Item No.	Inspection Item	Item Description	Inspection Results		Comments
			A	U	
A	Leachate Pit	Interior malformations	✓		
		Exterior malformations	✓		

Inspector: <u>Jeff Boulton</u> (Printed Name)	Signature: <u><i>Jeff Boulton</i></u> Date: <u>2-19-14</u> Time: <u>1426</u>
--	---

A=Acceptable  
U=Unacceptable

**NOTES:**

1. This form is completed if the leachate level in the sump is at **3 feet (36 inches)** and is being removed. Ensure the appropriate personnel have been contacted and complete the information above.
2. 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.
3. The original forms shall be kept on file in the facility operating record.

*Leachate was sampled at C-752-A from poly container RFD 118261-01. Jeff Boulton 2-27-14*



### C-404 Quarterly Inspection Checklist<sup>1, 5</sup>

Item No.	Inspection Item	Item Description	Inspection Results		Comments/Observations
			A	U	
A	Warning Signs	Four signs around landfill	✓		
B	Vegetative Cover <sup>2</sup>	Gully erosion depth > 6 inches	✓		
		Vegetative die-off	✓		
		Varmint intrusion/burrowing from animals	✓		
		Overgrowth	✓		
		Depressions	✓		
C	Ditches <sup>3</sup>	Debris in ditches	✓		
		Excessive sediment	✓		
		Drainage	✓		
		Erosion	✓		
D	Anchor Trench <sup>4</sup>	Washouts or depressions	✓		
		Lack of discharge	✓		
		Unusual volume or color	✓		
		Drainage (4 drains from landfill)	✓		
E	Leachate System	Level	✓		
		Cracks or damage	✓		
Inspector: <u>Jeff Boulton</u> (Printed Name)			Signature: <u>Jeff Boulton</u> Date: <u>3-18-14</u> Time: <u>1322</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.

**C-404 Monthly Inspection Summary<sup>1, 2, 3, 4</sup>**

Period of Inspection: October, November, December

Leachate Level	Date (M/D/YY)	Level (inches deep)*	Inspector(s)
First monthly leachate level determination	10/8/13	16"	<i>Rouitoyu</i>
Second monthly leachate level determination	11/5/13	17"	<i>Rouitoyu</i>
Third monthly leachate level determination	12/5/13	17"	<i>Rouitoyu</i>

\* 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<sup>1,5</sup>**

Item No.	Inspection Item	Item Description	Inspection Results		Comments/Observations
			A	U	
A	Warning Signs	Four signs around landfill	✓		
B	Vegetative Cover <sup>2</sup>	Gully erosion depth > 6 inches	✓		
		Vegetative die-off	✓		
		Varmint intrusion/burrowing from animals	✓		
		Overgrowth	✓		
		Depressions	✓		
C	Ditches <sup>3</sup>	Debris in ditches	✓		
		Excessive sediment	✓		
		Drainage	✓		
		Erosion	✓		
D	Anchor Trench <sup>4</sup>	Washouts or depressions	✓		
		Lack of discharge	✓		
		Unusual volume or color	✓		
		Drainage (4 drains from landfill)	✓		
E	Leachate System	Level	✓		
		Cracks or damage	✓		
Inspector: <u>Ronnie Poyner</u> (Printed Name)			Signature: <u>Ronnie Poyner</u> Date: <u>4/19/13</u> Time: <u>1330</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 Checklist for a 24-Hour Rain Event<sup>1,2,3</sup>**

Item No.	Inspection Item	Item Description	Inspection Results		Comments/Observations
			A	U	
A	Vegetative Cover	Gully erosion depth > 6 inches	✓		
		Vegetative die-off	✓		
		Varmint intrusion/burrowing from animals	✓		
		Overgrowth	✓		
		Depressions	✓		
B	Ditches	Debris in ditches	✓		
		Excessive sediment	✓		
		Drainage	✓		
		Erosion	✓		
C	Anchor Trench	Washouts or depressions	✓		
		Lack of discharge	✓		
		Unusual volume or color	✓		
		Drainage (4 drains from landfill)	✓		
Inspector: <u>Jeff Boulton</u> (Printed Name)		Signature: <u>Jeff Boulton</u> Date: <u>12-22-13</u> Time: <u>1842</u>			

A=Acceptable  
U=Unacceptable

**NOTES:**

1. This checklist is used after a major storm in the event that 5.8 inches falls in 24 hours.
2. 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.
3. The original forms shall be kept on file in the facility operating record.

ENM-F-0004 (8-17-10)  
PAD-ENM-0022

**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 30, 2014) 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 2014 sampling event. As indicated in previous reports, flow direction beneath the C-404 Landfill generally trends northward, but commonly varies from northeast to northwest.

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 each sampling event.

The January potentiometric surface data of the upper RGA are presented in Table D.1, and potentiometric surface maps are presented in Figures D.1.

**Table D.1. Barometric Pressure Corrections**

<b>C-404 Landfill (January 2014) Water Levels</b>									
Date	Time	Well	Datum Elev (ft amsl)	BP (in Hg)	Delta BP (ft Hg)	Raw Data		*Corrected Data	
						DTW (ft H <sub>2</sub> O)	Elev (ft amsl)	DTW (ft)	Elev (ft amsl)
1/30/2014	8:07	MW67	374.95	30.19	0.00	50.77	324.18	50.77	324.18
1/30/2014	7:40	MW76	376.86	30.19	0.00	52.45	324.41	52.45	324.41
1/30/2014	8:21	MW84	375.91	30.19	0.00	51.70	324.21	51.70	324.21
1/30/2014	8:05	MW87	375.79	30.19	0.00	51.64	324.15	51.64	324.15
1/30/2014	8:00	MW90A	374.28	30.19	0.00	50.15	324.13	50.15	324.13
1/30/2014	7:48	MW93	377.59	30.19	0.00	53.14	324.45	53.14	324.45
1/30/2014	7:36	MW227	378.74	30.19	0.00	54.23	324.51	54.23	324.51
1/30/2014	7:55	MW333	377.27	30.19	0.00	52.77	324.50	52.77	324.50
1/30/2014	8:16	MW337	374.59	30.19	0.00	50.26	324.33	50.26	324.33
1/30/2014	8:19	MW338	374.77	30.19	0.00	50.54	324.23	50.54	324.23
1/30/2014	7:43	MW420	377.59	30.19	0.00	53.24	324.35	53.24	324.35
Initial Barometric Pressure			<b>30.19</b>						
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									

