



**A & M Engineering and
Environmental Services, Inc.**
Consulting · Design · Construction · Remediation

January 31, 2018

Ms. Hillary Young, P.E.
Chief Engineer
Land Protection Division
Oklahoma Department of Environmental Quality
707 North Robinson
P.O. Box 1677
Oklahoma City, Oklahoma 73101-1677

**RE: Annual Groundwater Monitoring and
Corrective Action Report for Calendar Year 2017
Grand River Dam Authority
Grand River Energy Center
Chouteau, Oklahoma
A&M Engineering Project No. 1986-002**

Dear Ms. Young:

On behalf of our Client, the Grand River Dam Authority (GRDA), A&M Engineering and Environmental Services, Inc. (A&M Engineering) is pleased to submit the attached Annual Groundwater Monitoring and Corrective Action Report (Calendar Year 2017) for the Coal Combustion Residuals (CCR) Landfill at the above referenced GRDA Facility. As required by OAC 252:517, a copy of this document will be posted on the GRDA CCR Webpage and maintained in the facility operating records.

If you have any questions on this matter, or if you require any additional information, please do not hesitate to call.

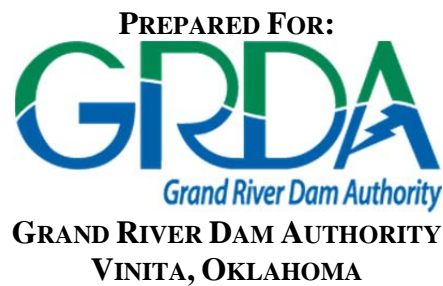
Sincerely,
A & M Engineering and Environmental Services, Inc.

Thomas A. Trebonik, P.G.
Senior Project Manager

Cc: Mike Bednar, GRDA
Travis Hinshaw, GRDA

**ANNUAL GROUNDWATER MONITORING
AND
CORRECTIVE ACTION REPORT
(CALENDAR YEAR 2017)**

**GRAND RIVER DAM AUTHORITY LANDFILL
GRAND RIVER ENERGY CENTER
MAYES COUNTY, OKLAHOMA
SOLID WASTE PERMIT NO. 3549012**



JANUARY 31, 2018

A&M PROJECT NO. 1986-002-

PREPARED BY:

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**ANNUAL GROUNDWATER MONITORING
AND
CORRECTIVE ACTION REPORT
GRAND RIVER DAM AUTHORITY LANDFILL
GRAND RIVER ENERGY CENTER
MAYES COUNTY, OKLAHOMA**

1.0 INTRODUCTION

The Grand River Dam Authority (GRDA) owns and operates the Grand River Energy Center (GREC), an electric power generating facility, located approximately three (3) miles east of the City of Chouteau in Mayes County, Oklahoma. Two (2) coal fired boilers are operated at GREC which produce Coal Combustion Residuals (CCRs) consisting of fly ash and bottom ash. Fly ash comprises greater than 80% of CCRs generated at the facility and is largely sold for beneficial use purposes. Excess fly ash and bottom ash is disposed within an on-site permitted coal ash landfill, herein referred to as the GRDA Landfill. The GRDA Landfill is located entirely within the GREC complex.

On June 9, 2016, the Governor of the State of Oklahoma approved by Declaration a final rule for the Disposal of CCRs from Electric Utilities. The new rule regulates the disposal of CCRs under OAC 252:517 Sections 1 through 19. The rule applies both to new and existing CCR landfills and surface impoundments at coal burning electric utility sites.

OAC 252:517-9-1(e) requires existing CCR landfill facilities to:

“No Later than January 31, 2018, and annually thereafter, the owner or operator must prepare an annual groundwater monitoring and corrective action report.”

For the preceding calendar year, the annual report must:

- (i) Document the status of the groundwater monitoring and corrective action program for the CCR unit;



- (ii) Summarize key actions completed;
- (iii) Describe any problems encountered;
- (iv) Discuss actions to resolve problems; and
- (v) Project key activities for the upcoming year.

Additional information to be included in the annual report includes a map, image or diagram showing the CCR landfill and monitoring wells; identification of wells installed or decommissioned during the previous year with a discussion of why those activities occurred; the results of analysis of groundwater collected during the previous year; and summary information on the number of groundwater samples collected, dates of sampling, and whether the sampling was required by detection or assessment monitoring programs.

This Annual Groundwater Monitoring and Corrective Action Report has been prepared to satisfy the requirements of OAC 252:517-9-1(e).

2.0 LANDFILL INFORMATION

The GRDA Landfill is permitted by the Oklahoma Department of Environmental Quality (DEQ) as a Non-Hazardous Industrial Waste Landfill that is allowed to accept fly ash, bottom ash and spent powdered activated carbon used to control flue gas emissions, generated at the GREC (DEQ, 2015). The GRDA Landfill is situated south of the coal-fired boiler units within the GREC complex, as shown in **Figure 1**, and has been in operation since 1981. The total landfill permit area consists of approximately 116 acres, of which only 47 acres have been utilized for CCR disposal. The GRDA Landfill remains active to date.

In October 2017, a request to modify the existing landfill permit was submitted to DEQ. The modification requested a *reduction* in landfill permit area from 116 acres to 67 acres with plans to only utilize a total of 48 acres for CCR landfiling purposes. The request for permit modification and design drawings (submitted with accompanying revised Closure Plan, Quality



Assurance and Quality Control Plan, Run-on and Run-off Control Plan, and Post-Closure Plan) is currently under review by DEQ.

The landfill is bordered by surface impoundments to the west and south. The surface impoundments to the south were created during construction of US Highway 412 by using the area for borrow material. These impoundments hold water continuously throughout the year and are connected in series. The impoundments are used for stormwater and process wastewater treatment permitted separately by DEQ under industrial wastewater permit OK0035149. Discharge from the ponds is to the Neosho River. A discharge station which is continually monitored is located at the southeastern corner of the property, near the intersection of Highways 412 and 412B. The water level in these impoundments fluctuates from about 592 to 596 feet above mean sea level (MSL). **Figure 1** depicts the GRDA Landfill and its relative location to the surface impoundments.

3.0 SITE HYDROGEOLOGY

The landfill is underlain by an unconsolidated clay, silt, sand and gravel layers ranging in total thickness from 9 feet to about 25 feet. The unconsolidated section is underlain by Pennsylvanian sandstone/limestone bedrock.

The uppermost aquifer at the site is in the unconsolidated section and is monitored for changes in groundwater quality. Five monitoring wells are used: one (1) upgradient well and four (4) downgradient wells. The locations of the monitoring wells are shown on **Figure 1**. MW93-1 is the upgradient well, and MW93-2, MW93-3, MW03-1 and MW03-2 are the downgradient wells. The wells, installed in 1993 and 2003, are monitored routinely in accordance with the non-Hazardous Industrial Waste Landfill Permit issued by DEQ.

Historical groundwater flow maps covering the time period from July, 2012 to December, 2017 have been prepared and previously submitted to DEQ. Data provided shows the fluctuations of the groundwater levels at each monitoring well and provides an indication of the direction of



groundwater flow. The maps were compiled semi-annually and include the elevation of the groundwater at each well, interpolated contours of the top of groundwater elevation across the site, and the direction of groundwater flow. The groundwater in the uppermost aquifer flows from the west-northwest to the east-southeast, generally following the surface terrain. The groundwater velocity in the uppermost aquifer is calculated to be about 3.39×10^{-6} cm/sec or 3.5 feet/year.

3.1 STATUS OF GROUNDWATER MONITORING AND CORRECTIVE ACTION

A groundwater monitoring system currently composed of one upgradient and four downgradient monitoring wells has been in place at the facility since 2003. Groundwater monitoring for the GRDA Landfill is conducted on a semi-annual basis (generally in May/June and November/December of each calendar year) and a separate Semi-annual Groundwater Sampling and Statistical Analysis Report is prepared and submitted to DEQ. The most recent sampling and analysis event occurred in November 2017. The 2017 Second Semi-Annual Groundwater Sampling and Statistical Analysis Report has been submitted to DEQ and is currently under review.

Groundwater samples from the monitoring wells are collected in accordance with the GRDA Groundwater Sampling and Analysis Program on file with DEQ and are analyzed by a third party State of Oklahoma Certified Laboratory. On occasion however, those constituents for which the GRDA Laboratory is approved for analysis may be analyzed at the facility.

Groundwater samples collected and analyzed during calendar year 2017 included, at a minimum, those constituents for Detection Monitoring as listed in Appendix A of OAC 252:517 (Boron, Calcium, Chloride, Fluoride, pH, Sulfate, and Total Dissolved Solids) as well as a variety of other general water quality parameters and metal constituents required by the DEQ issued Landfill Permit. The most recent Semi-Annual Groundwater Sampling and Statistical Analysis Report includes historical data for select parameters from June 2004 through November 2017.



Statistical evaluation of the laboratory analytical results is performed on the groundwater data in accordance with the GRDA Groundwater Sampling and Analysis Program. The evaluation of the analytical data includes utilizing a tolerance or prediction interval procedure. Under this procedure, an interval for each constituent determined from laboratory analysis is established from the background data (gathered from the upgradient monitoring well) and the level of each constituent in the downgradient (compliance) wells is compared to the upper tolerance or prediction limit.

The Shapiro-Francia Test of Normality, Levene's Test for Equal Variance and Prediction Limit Interval tests for inter-well analyses is utilized in the statistical evaluation of the parameters. In the event an inter-well statistical evaluation indicates the presence of an elevated parameter in the downgradient wells compared to historical data of the upgradient or background wells, an Intra-well Prediction Limit Interval test is conducted on the specific well or wells of interest. These intra-well comparisons are then utilized to determine whether a significant increase had occurred within a specific well in question. This method of statistical evaluation is consistent with OAC 252:517-9-4(g)(3) and is the method historically used by the GREC Complex in statistical analysis of groundwater data.

3.2 SUMMARY OF KEY ACTIONS COMPLETED

Key actions completed during the preceding year included the collection of additional groundwater samples from the monitoring wells to allow for laboratory analysis of boron and fluoride. Boron and fluoride are currently on the list of parameters for detection monitoring (OAC 252:517 Appendix A) but were not included on the original DEQ landfill permit required list of constituents. Completion of the collection of eight background samples for boron and fluoride now allows for statistical evaluation of groundwater data for these constituents. In addition to the normal list of constituents evaluated, the 2017 Second Semi-Annual Groundwater Sampling and Statistical Analysis Report submitted to DEQ included statistical evaluation of the boron and fluoride concentrations within the groundwater.



3.3 PROBLEMS ENCOUNTERED AND RESOLUTION OF PROBLEMS

During the preceding year, no problems were encountered in conducting the semi-annual groundwater monitoring activities at the GRDA Landfill facility and no corrective actions were required to be implemented.

3.4 KEY ACTIVITIES FOR THE UPCOMING YEAR

In response to a November 29, 2017 letter received from DEQ concerning the Groundwater Sampling and Analysis Program filed with DEQ on October 16, 2017, an updated Groundwater Sampling and Analysis Program was prepared and submitted to DEQ (January 3, 2018).

Updates made to the original document included modifying regulation citations from the Federal Coal Combustion Residual Regulations as contained in 40 CFR §257 to the State of Oklahoma Regulations as found in OAC 252:517.

In addition, and at the request of DEQ, a schedule had been prepared and submitted for the collection and analysis of groundwater samples for OAC 252:517 Appendix B constituents. The additional sampling and analysis would be conducted to gather eight background samples necessary for statistical evaluation of the Appendix B constituents should evaluation become necessary. The schedule prepared and submitted requested an accelerated period (over 6 months rather than quarterly) for the sampling and analysis. Approval for the accelerated schedule is pending. It is anticipated that this activity will be initiated and completed during the upcoming 2018 calendar year. Appendix B constituents for which monitoring will be conducted include:

Antimony	Lead
Arsenic	Lithium
Barium	Mercury
Beryllium	Molybdenum
Cadmium	Selenium
Chromium	Thallium
Cobalt	Radium 226 and 228 Combined
Fluoride	



3.5 ADDITIONAL REQUIRED INFORMATION

A figure showing the location of the GRDA Coal Combustion Residuals landfill is included as **Figure 1**. The figure clearly shows the locations and identification numbers of the monitoring wells used for the GRDA Landfill. As previously stated, MW93-1 is the upgradient well and MW93-2, MW93-3, MW03-1 and MW03-2 are the downgradient wells for the CCR landfill.

There were no new monitoring wells installed or decommissioned at the GRDA facility during the preceding calendar year (2017). The wells initially installed in 1993 and 2003 have been continuously utilized for groundwater monitoring at the facility.

During the preceding year, groundwater samples were collected and analyzed from all five monitoring wells on two separate, semi-annual occasions: June 6, 2017 and November 7, 2017. Analysis of samples collected during these events included the required constituents for detection monitoring (as required by OAC 252:517 and the DEQ issued landfill permit) as well as boron and fluoride concentrations.

In addition, separate sampling and analysis events were conducted during calendar year 2017 to ensure a sufficient number of background groundwater samples to allow for statistical evaluation of groundwater concentrations for boron and fluoride. The separate sampling and analysis events were conducted on February 16, 2017, March 8, 2017, May 9, 2017, August 22, 2017, and September 22, 2017. Two previous sampling and analysis events for boron and fluoride concentrations in the groundwater were conducted in calendar year 2016. **Appendix A** presents all of the monitoring data collected during calendar year 2017 for the upgradient and each downgradient monitoring well in use for the GRDA Landfill.

Tables 1 and **1a** present summaries of the groundwater data collected during the first and second semi-annual sampling events for calendar year 2017, respectively. **Tables 2** and **2a** present historical summaries of select groundwater data (collected during the first and second semi-annual sampling events, respectively). **Tables 3** and **3a** present historical data related to



additional monitoring of monitoring wells MW93-3 and MW03-2. The additional quarterly analysis conducted for MW93-3 (Sodium and Conductivity) and MW03-2 (Chloride) are required as a result of prior implementation of monitoring for these constituents in order to allow for assessment of whether an increasing trend in these constituents is occurring. Monitoring for these parameters has been ongoing since 2015. A summary table for calendar year 2017 which includes the number of groundwater samples that were collected for analysis, the dates the samples were collected and whether the individual sample collected was required by detection monitoring or assessment monitoring is included in **Table 4**.

During calendar year 2017, there was no transition between detection and assessment monitoring programs. Sampling and analysis of groundwater was conducted in accordance with the established detection monitoring requirements for the GRDA Landfill along with the additional monitoring required by DEQ. It is anticipated that detection monitoring with the additional monitoring required by DEQ will continue for calendar year 2018.

4.0 REFERENCES

Resources and references used in the preparation of this Annual Groundwater Monitoring and Corrective Action Report include:

Oklahoma State Department of Health (OSDH), Permit for a *Coal Ash Disposal Site*. January 13, 1981.

Oklahoma Department of Environmental Quality (DEQ), *Permit Modification to add an additional Solid Waste Stream, Grand River Dam Authority, Mayes County, Permit 3549012*. February 20, 2015.

Oklahoma Department of Environmental Quality (DEQ), *OAC 252:517*. September 15, 2016.

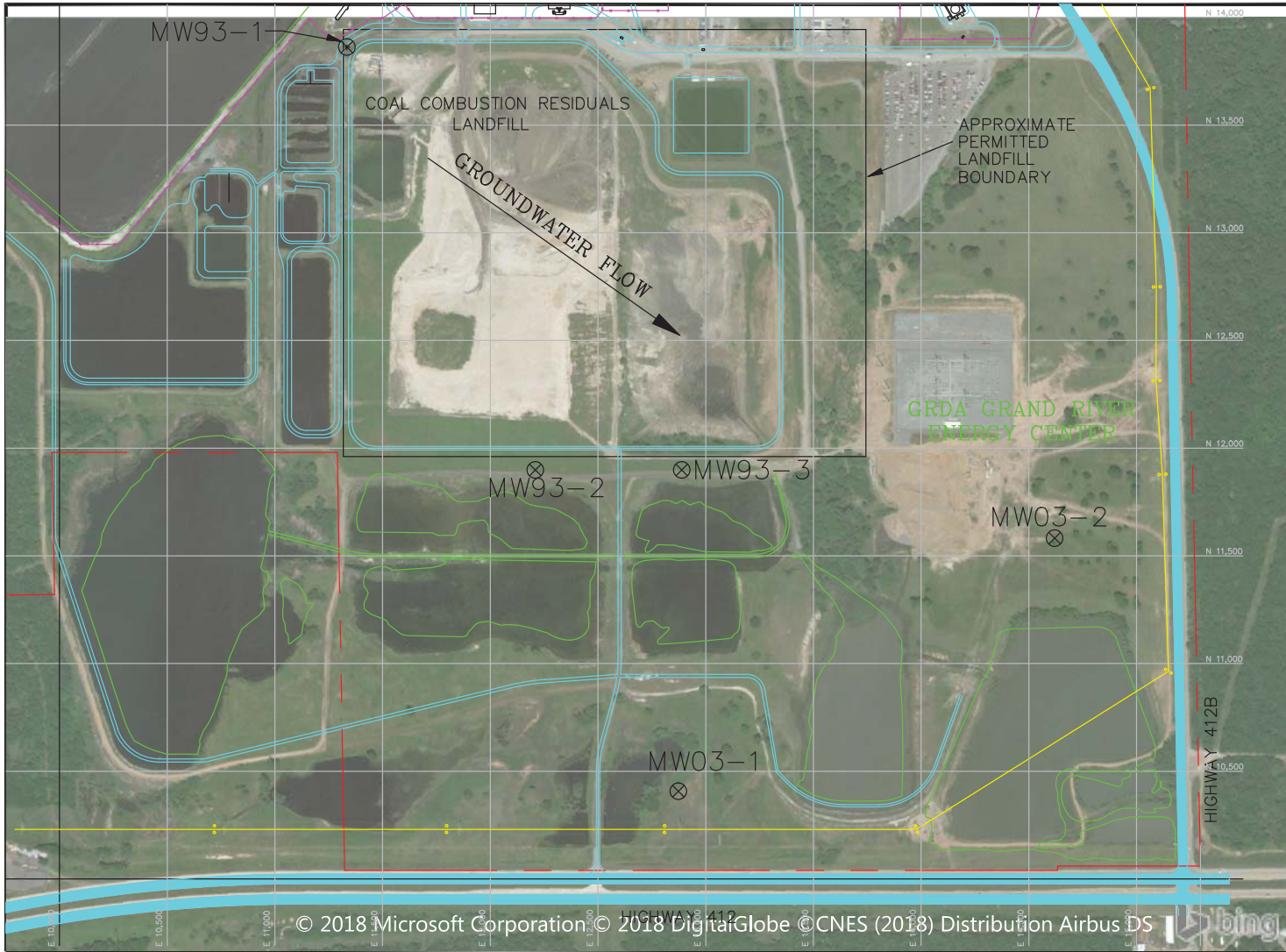
Grand River Dam Authority, *2017 First Semi-Annual Groundwater Sampling and Statistical Analysis Report*. June 2017.



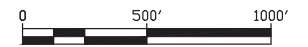
Grand River Dam Authority, *2017 Second Semi-Annual Groundwater Sampling and Statistical Analysis Report*. December 2017.



FIGURES



SCALE



LEGEND

⊗ MW93-1 GROUNDWATER MONITORING WELL

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DJR 4/13/06

GENERAL NOTES

1) AERIAL BACKGROUND FROM BING MAPS.

REVISIONS

NO.	DESCRIPTION	BY	CHECKED	DATE	NO.	DESCRIPTION	BY	CHECKED	DATE



A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.

ENGINEERING - ENVIRONMENTAL - CONSTRUCTION

DRAWN: OPC	CHECKED BY: TAT	MATERIALS BY:	ENGINEER:
DATE: 01/30/2018	DATE: 01/30/2018	DATE:	DATE:

APPROVED BY: TAT	SCALE: AS SHOWN	PROJECT NUMBER: 1986-002	DRAWING NUMBER: FIGURE 1	REV:
DATE: 01/30/2018				

CCR LANDFILL AND WELL LOCATION MAP
GRAND RIVER DAM AUTHORITY LANDFILL
CHOUTEAU, OK

TABLES

Table 1
First Semi-Annual 2017 Analytical Results
June 6, 2017
Grand River Dam Authority (GRDA) Landfill
Chouteau, Oklahoma

PARAMETER	Monitoring Well I.D.				
	MW 93-1 (upgradient)	MW 93-2 (downgradient)	MW 93-3 (downgradient)	MW 03-1 (downgradient)	MW 03-2 (downgradient)
Stabilized Water Level (msl)	609.53	599.92	596.60	594.87	593.82
Temperature °C	25.7	24.8	24.2	24.1	21.7
pH (S.U.)	6.69	9.29	6.65	6.64	6.73
Specific Conductivity (umhos/cm)	1,289	12,590	1,743	198	1,498
ORP mv	-113.0	-166.4	-174.1	-159.2	-158.1
Alkalinity (mg/L)	398	246	304	56	192.0
Chloride (mg/L)	16.1	1,580	113	0.887	117
Sulfate (mg/L)	265	3,630	18.2	8.92	332
Dissolved Arsenic (mg/L)	<0.005	0.038	<0.005	<0.005	<0.005
Dissolved Sodium (mg/L)	58.4	2,310	301	6.56	96.8
Hardness (mg/L)	568	114	192	NT	NT
Calcium (mg/L)	206	45.2	56.0	NT	NT
Dissolved Copper (mg/L)	<0.01	0.014	<0.01	NT	NT
Dissolved Iron (mg/L)	<0.075	<0.075	<0.075	NT	NT
Nitrate-Nitrogen (mg/L)	<0.25	<0.25	1.53	NT	NT
Total Phosphorus (mg/L)	<0.025	0.588	0.048	NT	NT
Total Residue (mg/L)	820	7,380	830	NT	NT
TDS (mg/L)	810	7,350	780	NT	NT
COD (mg/L)	<15.0	82.2	<15.0	NT	NT
TOC (mg/L)	3.31	12.1	2.54	NT	NT
Dissolved Potassium (mg/L)	0.45	241	4.37	NT	NT
Dissolved Barium (mg/L)	0.013	0.033	0.199	NT	NT
Dissolved Selenium (mg/L)	<0.005	0.015	0.005	NT	NT

NT = Not Tested
NS = Insufficient Sample for
analysis

Table 1a
Second Semi-Annual 2017 Analytical Results
November 07, 2017
Grand River Dam Authority (GRDA) Landfill
Chouteau, Oklahoma

PARAMETER	Monitoring Well I.D.				
	MW 93-1 (upgradient)	MW 93-2 (downgradient)	MW 93-3 (downgradient)	MW 03-1 (downgradient)	MW 03-2 (downgradient)
Stabilized Water Level (msl)	608.73	599.62	595.80	592.57	592.42
Temperature °C	18.5	18.7	17.3	16.5	15.9
pH (S.U.)	6.21	8.86	6.46	6.44	6.22
Specific Conductivity (umhos/cm)	1,458	10,520	2,121	444	2,042
ORP mv	-51.0	-44.5	-39.8	-42.2	-38.2
Alkalinity (mg/L)	394	430	409	217	192
Chloride (mg/L)	16.2	1,160	402	1.13	288
Sulfate (mg/L)	281	4,340	80.3	14.4	516
Dissolved Arsenic (mg/L)	<0.005	0.028	<0.005	<0.005	<0.005
Dissolved Sodium (mg/L)	45.2	2,750	368	17.60	120.0
Hardness (mg/L)	598	183	275	NT	NT
Calcium (mg/L)	212	68.5	80.2	NT	NT
Dissolved Copper (mg/L)	<0.01	<0.01	<0.01	NT	NT
Dissolved Iron (mg/L)	<0.075	<0.075	<0.075	NT	NT
Nitrate-Nitrogen (mg/L)	<0.25	<0.25	0.96	NT	NT
Total Phosphorus (mg/L)	<0.025	0.484	0.056	NT	NT
Total Residue (mg/L)	896	9,360	1,220	NT	NT
TDS (mg/L)	878	7,820	1,250	NT	NT
COD (mg/L)	<15.0	148	<15.0	NT	NT
TOC (mg/L)	3.46	12.3	3.15	NT	NT
Dissolved Potassium (mg/L)	<0.25	246	3.73	NT	NT
Dissolved Barium (mg/L)	0.015	0.061	0.227	NT	NT
Dissolved Selenium (mg/L)	<0.005	0.015	<0.005	NT	NT

NT = Not Tested
NS = Insufficient Sample for
analysis

**Table 2
Historical Monitoring Well Analytical Results
June 6, 2017
Grand River Dam Authority (GRDA) Landfill
Chouteau, Oklahoma**

PARAMETER	WELL ID																														
	MW 93-1 Upgradient																														
	6/24/04	9/15/04	12/15/04	3/16/05	6/15/05	9/21/05	12/21/05	3/15/06	6/21/06	12/20/06	6/12/07	12/17/07	6/11/08	12/3/08	6/17/09	12/9/09	6/17/10	12/22/10	6/29/11	12/7/11	6/6/12	12/12/12	6/19/13	12/11/13	6/11/14	12/3/14	6/17/15	12/1/15	6/22/16	12/20/16	6/6/17
pH (S.U.)	6.53	6.43	6.61	6.57	6.53	6.65	6.61	6.64	6.85	6.67	6.58	6.33	6.7	6.5	6.8	6.6	6.5	6.55	6.5	6.41	6.23	6.61	6.58	6.57	6.10	6.69	6.38	6.45	6.59	6.28	6.69
Specific Conductivity (umhos/cm)	1620	1618	1586	1521	1531	1441	1030	1318	1547	1370	1466	1327	1334	1352	1301	1218	1179	1270	1275	1236	1185	1227	1366	1329	1200	1230	1210	1230	1185	1186	1289
Alkalinity (mg/L)	348	332	327	340	330	347	340	320	314	300	310	330	370	344	350	370	380	370	366	370	384	330	360	358	342	368	380	383	390	395.4	398
Chloride (mg/L)	61	44	48	42	42	42	58	50	31	35	24	27	29	28	20	24	17	20	20.8	17.6	23.8	22.2	21.5	17.6	19.3	16.9	13	15.2	13	15.2	16.1
Sodium (mg/L)	94.7	71	92.3	86.3	77.4	92.8	81.9	99.7	82	85.1	74.9	81.8	56.5	75.2	67.4	76.9	55	70.5	55.4	69.1	55.6	58.9	70	72.9	56.5	69.4	69.7	57.5	66.9	54.8	58.4
Sulfate (mg/L)	500	475	558	880	22	467	475	375	420	330	260	300	375	340	650	160	290	304	306	255	275	301	409	306	316	292	286	299	250	275	265
Arsenic (mg/L)	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	0.0109	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.0068	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	

PARAMETER	WELL ID																																
	MW 93-2 Downgradient																																
	6/24/04	9/15/04	12/15/04	3/16/05	6/15/05	9/21/05	12/21/05	3/15/06	6/21/06	12/20/06	2/21/07	6/12/07	12/17/07	6/11/08	12/3/08	12/15/08	6/17/09	12/9/09	6/17/10	12/22/10	6/29/11	12/7/11	6/6/12	12/12/12	6/19/13	12/11/13	6/11/14	12/3/14	6/17/15	12/1/15	6/22/16	12/20/16	6/6/17
pH (S.U.)	9.24	9.32	9.26	9.23	9.10	9.25	9.31	9.47	9.4	9.18	9.20	9.10	9.30	9.4	9.7	9.6*	9.8	9.8	9.6	9.5	9.4	9.5	9.68	10.02/9.51*	9.4	9.46	8.55	8.95	9.13	9.37	9.28	9.72	9.29
Specific Conductivity (umhos/cm)	10494	10340	9940	9690	10010	9660	10000	8650	9830	8310	7660	9590	9100	9600	10520	9070*	10690	10050	10020	11230	11110	10770	10490	11460	10500	10650	9940	10900	1270	10560	6710	11400	12590
Alkalinity (mg/L)	329	272	288	240	246	228	232	250	290	356	340	312	210	240	280	280	250	236	252	240	266	288	256	248	364	328	342	296	384	226	176	162	246
Chloride (mg/L)	1892	1435	1600	1325	1400	1412	1550	1375	1500	1250	1250	1350	1399	1210	1584	1584	750	875	1500	1600	1670	1510	1610	1750	1390	1410	1360	1520	47.7	1760	1300	1690	1580
Sodium (mg/L)	2180	1800	2480	2490	2030	2520	2300	2720	2450	2170	1900	1980	2244	2649	2120	2120	2220	240	2100	2460	2190	2500	2060	2730	2230	2290	1940	2730	270	3140 / 2780 / 1890**	2700	2400	2310
Sulfate (mg/L)	2650	2700	2950	3200	2650	3200	3200	3000	2700	2500	2900	2400	3100	2350	3300	2400*	2300	2200	2900	3460	2630	2520	2360	3240	2510	2460	2790	2940	114	3600	2620	3800	3630
Arsenic (mg/L)	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	0.0343	0.0603	0.0510	0.0330	NT	0.0525	0.0635	0.0179	0.0215	0.0610	<0.005	0.0098	0.0562	0.0530	0.0353	0.0197	0.0274	<0.005	0.03	0.047	0.06	0.038	

*MW-93-2 was resampled for pH on 1/9/2013.

**MW-93-2 was resampled for Sodium on 3/4/2016 and 5/25/2016

PARAMETER	WELL ID																															
	MW 93-3 Downgradient																															
	6/24/04	9/15/04	12/15/04	3/16/05	6/15/05	9/21/05	12/21/05	3/15/06	6/21/06	12/20/06	6/12/07	12/17/07	6/11/08	12/3/08	6/17/09	12/9/09	6/17/10	12/22/10	6/29/11	12/7/11	6/6/12	12/12/12	6/19/13	12/11/13	12/11/13	6/11/14	12/3/14	6/7/15	12/1/15	6/22/16	12/20/16	6/6/17
pH (S.U.)	6.80	6.70	6.88	6.69	6.81	6.85	6.70	7.07	6.84	6.93	6.89	6.8	6.8	6.8	7.2	6.9	6.7	6.82	6.7	6.77	6.42	6.85	6.49	7.07	7.07	6.08	6.80	6.4	6.6	6.43	6.27	6.65
Specific Conductivity (umhos/cm)	1129	1068	972	1134	1080	1155	1140	1035	1226	1087	1031	910	1023	1073	1073	1038	1108	1090	1178	930	1203	1010	1438	1252	1252	1500	1200	1480	1807	2494	2200	1743
Alkalinity (mg/L)	309	264	254	290	268	264	246	227	253	250	280	290	300	226	240	214	296	230	256	244	288	226	316	262	262	338	262	388	480 / 462 / 440*	330	330.4	304
Chloride (mg/L)	160	139	122	180	150	215	180	221	210	210	110	131	144	152	120	175	150	170	170	98.9	194	168	194	173	173	254	194	168	280	518	475	113
Sodium (mg/L)	150	200	186	196	170	239	180	180	227	211	159	194	195	190	173	202	202	216	158	218	201	168	235	234	234	258	220	280	339 / 440 / 464*	449 / 368*	337	301
Sulfate (mg/L)	24	17	26	29	26	19	23	19	21	42	3	28	27	11	16	12	45	25.8	34.2	37.4	38.3	25.8	61.6	26.5	26.5	56.2	36.0	109	81	58.5	66.6	18.2
Arsenic (mg/L)	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005

*MW-93-3 was resampled for Sodium and Alkalinity on 3/4/2016 and 5/25/2016, and Sodium on 10/11/2016.

**Table 2 (continued)
Historical Monitoring Well Analytical Results
June 6, 2017
Grand River Dam Authority (GRDA) Landfill
Chouteau, Oklahoma**

PARAMETER	WELL ID																														
	MW 03-1 Downgradient																														
	6/24/04	9/15/04	12/15/04	3/16/05	6/15/05	9/21/05	12/21/05	3/15/06	6/21/06	12/20/06	6/12/07	12/17/07	6/11/08	12/3/08	6/7/09	12/9/09	6/17/10	12/22/10	6/29/11	12/7/11	6/6/12	12/12/12	6/19/13	12/11/13	6/11/14	12/3/14	6/7/15	12/1/15	6/22/16	12/20/16	6/6/17
pH (S.U.)	7.27	6.78	7.32	7.30	7.28	7.88	**	**	**	7	7	7	7.4	7.4	7.6	7.5	7.1	6.89	7.3	7.05	7.33	DRY	7.15	7.19	6.62	6.73	6.66	6.34	7.2	6.75	6.64
Specific Conductivity (umhos/cm)	497	687	514	422	465	517	**	**	**	447	630	540	467	649	519	469	500	504	463	501	457	DRY	373	476	826	409	267	385	320	NS	198
Alkalinity (mg/L)	209	220	184	160	252	180	**	**	**	204	200	190	200	206	204	216	232	216	210	222	216	DRY	144	212	222	194	134	150	130	211.6	56
Chloride (mg/L)	10	22	6	4	6	5	**	**	**	5	4	3	11	11	4	32	5	8.7	4.86	5.88	9.36	DRY	<5.0	<5.0	44	<5.0	<5.00	0.777	0.628	0.786	0.887
Sodium (mg/L)	10.2	42	8.04	5.99	7.3	14.1	**	**	**	8	8	10	5.71	7.01	7.34	6.77	9.31	7.11	7.04	8.87	7.94	DRY	10.3	9.78	55.9	9.80	9.7	12	8.59	7.94	6.56
Sulfate (mg/L)	42	76	62	22	23	17	**	**	**	55	88	120	23	90	21	15	16	22.9	21.6	18.1	14.3	DRY	16.2	29.1	127	19.7	7.86	12.1	10.3	30.9	332
Arsenic (mg/L)	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	DRY	0.008	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.0005	<0.05

NS = Insufficient sample for analysis

PARAMETER	WELL ID																														
	MW 03-2 Downgradient																														
	6/24/04	9/15/04	12/15/04	3/16/05	6/15/05	9/21/05	12/21/05	3/15/06	6/21/06	12/20/06	6/12/07	12/17/07	6/11/08	12/3/08	6/7/09	12/9/09	6/17/10	12/22/11	6/29/11	12/7/11	6/6/12	12/12/12	6/19/13	12/11/13	6/11/14	12/3/14	6/7/15	12/1/15	6/22/16	12/20/16	6/6/17
pH (S.U.)	6.84	7.17	6.86	6.80	6.87	6.87	6.83	6.88	6.78	6.88	6.87	6.7	6.9	6.8	7.3	6.8	6.8	7.2	6.7	6.69	6.73	6.82	6.88	6.72	7.00	7.14	6.45	6.39	6.75	6.36	6.73
Specific Conductivity (umhos/cm)	692	522	655	661	674	625	572	594	636	580	680	617	674	752	720	690	685	728	748	755	716	807	807	805	219	1540	965	967	1074	1454	1498
Alkalinity (mg/L)	235	200	222	220	252	224	230	220	228	220	228	200	200	210	200	208	216	230	224	236	230	242	232	230	92	76	220	214	204	199.4	192.0
Chloride (mg/L)	36	4	28	30	30	27	26	27	23	35	30	20	41	46	60	45	33	29	28.4	23.5	29.3	28.3	32.1	32.8	<5.00	51.2	54.7	67.8 / 69.6 / 80.1*	79.7 / 88.4*	126	117
Sodium (mg/L)	47.4	8.7	51.3	47	42.8	52.6	46.5	50.4	44.9	50.5	47	50.2	33.8	54.4	48.2	47.3	52.9	51.7	51	60.1	52	61.3	57.3	54	9.78	68	66.3	63.8	76.8	80.2	96.8
Sulfate (mg/L)	72	32	54	78	23	80	72	30	***	34	68	130	67	210	84	80	106	98.9	101	98.8	107	111	113	106	10.3	158	179	197	254	451	332
Arsenic (mg/L)	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.0005	<0.005	

*MW-03-2 was resampled for Chloride on 3/4/2016, 5/25/2016, and 10/11/2016.

**Table 2a
Historical Monitoring Well Analytical Results
November 7, 2017
Grand River Dam Authority (GRDA) Landfill
Chouteau, Oklahoma**

PARAMETER	WELL ID																															
	MW 93-1 Upgradient																															
	6/24/04	9/15/04	12/15/04	3/16/05	6/15/05	9/21/05	12/21/05	3/15/06	6/21/06	12/20/06	6/12/07	12/17/07	6/11/08	12/3/08	6/17/09	12/9/09	6/17/10	12/22/10	6/29/11	12/7/11	6/6/12	12/12/12	6/19/13	12/11/13	6/11/14	12/3/14	6/17/15	12/1/15	6/22/16	12/20/16	6/6/17	11/7/17
pH (S.U.)	6.53	6.43	6.61	6.57	6.53	6.65	6.61	6.64	6.85	6.67	6.58	6.33	6.7	6.5	6.8	6.6	6.5	6.55	6.5	6.41	6.23	6.61	6.58	6.57	6.10	6.69	6.38	6.45	6.59	6.28	6.69	6.21
Specific Conductivity (umhos/cm)	1620	1618	1586	1521	1531	1441	1030	1318	1547	1370	1466	1327	1334	1352	1301	1218	1179	1270	1275	1236	1185	1227	1366	1329	1200	1230	1210	1230	1185	1186	1289	1458
Alkalinity (mg/L)	348	332	327	340	330	347	340	320	314	300	310	330	370	344	350	370	380	370	366	370	384	330	360	358	342	368	380	383	390	395.4	398	394
Chloride (mg/L)	61	44	48	42	42	42	58	50	31	35	24	27	29	28	20	24	17	20	20.8	17.6	23.8	22.2	21.5	17.6	19.3	16.9	13	15.2	13	15.2	16.1	16.2
Sodium (mg/L)	94.7	71	92.3	86.3	77.4	92.8	81.9	99.7	82	85.1	74.9	81.8	56.5	75.2	67.4	76.9	55	70.5	55.4	69.1	55.6	58.9	70	72.9	56.5	69.4	69.7	57.5	66.9	54.8	58.4	45.2
Sulfate (mg/L)	500	475	558	880	22	467	475	375	420	330	260	300	375	340	650	160	290	304	306	255	275	301	409	306	316	292	286	299	250	275	265	281
Arsenic (mg/L)	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	0.0109	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.0068	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.0005	<0.005	<0.005	

PARAMETER	WELL ID																																	
	MW 93-2 Downgradient																																	
	6/24/04	9/15/04	12/15/04	3/16/05	6/15/05	9/21/05	12/21/05	3/15/06	6/21/06	12/20/06	2/21/07	6/12/07	12/17/07	6/11/08	12/3/08	12/15/08	6/17/09	12/9/09	6/17/10	12/22/10	6/29/11	12/7/11	6/6/12	12/12/12	6/19/13	12/11/13	6/11/14	12/3/14	6/17/15	12/1/15	6/22/16	12/20/16	6/6/17	11/7/17
pH (S.U.)	9.24	9.32	9.26	9.23	9.10	9.25	9.31	9.47	9.4	9.18	9.20	9.10	9.30	9.4	9.7	9.6*	9.8	9.8	9.6	9.5	9.4	9.5	9.68	10.02/9.51*	9.4	9.46	8.55	8.95	9.13	9.37	9.28	9.72	9.29	8.86
Specific Conductivity (umhos/cm)	10494	10340	9940	9690	10010	9660	10000	8650	9830	8310	7660	9590	9100	9600	10520	9070*	10690	10050	10020	11230	11110	10770	10490	11460	10500	10650	9940	10900	1270	10560	6710	11400	12590	10520
Alkalinity (mg/L)	329	272	288	240	246	228	232	250	290	356	340	312	210	240	280	280	250	236	252	240	266	288	256	248	364	328	342	296	384	226	176	162	246	430
Chloride (mg/L)	1892	1435	1600	1325	1400	1412	1550	1375	1500	1250	1250	1350	1399	1210	1584	1584	750	875	1500	1600	1670	1510	1610	1750	1390	1410	1360	1520	47.7	1760	1300	1690	1580	1160
Sodium (mg/L)	2180	1800	2480	2490	2030	2520	2300	2720	2450	2170	1900	1980	2244	2649	2120	2120	2220	240	2100	2460	2190	2500	2060	2730	2230	2290	1940	2730	270	3140 / 2780 / 1890**	2700	2400	2310	2750
Sulfate (mg/L)	2650	2700	2950	3200	2650	3200	3200	3000	2700	2500	2900	2400	3100	2350	3300	2400*	2300	2200	2900	3460	2630	2520	2360	3240	2510	2460	2790	2940	114	3600	2620	3800	3630	4340
Arsenic (mg/L)	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	0.0343	0.0603	0.0510	0.0330	NT	0.0525	0.0635	0.0179	0.0215	0.0610	<0.005	0.0098	0.0562	0.0530	0.0353	0.0197	0.0274	<0.005	0.03	0.047	0.06	0.038	0.028	

*MW-93-2 was resampled for pH on 1/9/2013.

**MW-93-2 was resampled for Sodium on 3/4/2016 and 5/25/2016

PARAMETER	WELL ID																																
	MW 93-3 Downgradient																																
	6/24/04	9/15/04	12/15/04	3/16/05	6/15/05	9/21/05	12/21/05	3/15/06	6/21/06	12/20/06	6/12/07	12/17/07	6/11/08	12/3/08	6/17/09	12/9/09	6/17/10	12/22/10	6/29/11	12/7/11	6/6/12	12/12/12	6/19/13	12/11/13	12/11/13	6/11/14	12/3/14	6/7/15	12/1/15	6/22/16	12/20/16	6/6/17	11/7/17
pH (S.U.)	6.80	6.70	6.88	6.69	6.81	6.85	6.70	7.07	6.84	6.93	6.89	6.8	6.8	6.8	7.2	6.9	6.7	6.82	6.7	6.77	6.42	6.85	6.49	7.07	7.07	6.08	6.80	6.4	6.6	6.43	6.27	6.65	6.46
Specific Conductivity (umhos/cm)	1129	1068	972	1134	1080	1155	1140	1035	1226	1087	1031	910	1023	1073	1073	1038	1108	1090	1178	930	1203	1010	1438	1252	1252	1500	1200	1480	1807	2494	2200	1743	2121
Alkalinity (mg/L)	309	264	254	290	268	264	246	227	253	250	280	290	300	226	240	214	296	230	256	244	288	226	316	262	262	338	262	388	480 / 462 / 440*	330	330.4	304	409
Chloride (mg/L)	160	139	122	180	150	215	180	221	210	210	110	131	144	152	120	175	150	170	170	98.9	194	168	194	173	173	254	194	168	280	518	475	113	402
Sodium (mg/L)	150	200	186	196	170	239	180	180	227	211	159	194	195	190	173	202	202	216	158	218	201	168	235	234	234	258	220	280	339 / 440 / 464*	449 / 368*	337	301	368
Sulfate (mg/L)	24	17	26	29	26	19	23	19	21	42	3	28	27	11	16	12	45	25.8	34.2	37.4	38.3	25.8	61.6	26.5	26.5	56.2	36.0	109	81	58.5	66.6	18.2	80.3
Arsenic (mg/L)	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.0005	<0.005	<0.005

*MW-93-3 was resampled for Sodium and Alkalinity on 3/4/2016 and 5/25/2016, and Sodium on 10/11/2016.

**Table 2 (continued)
Historical Monitoring Well Analytical Results
November 7, 2017
Grand River Dam Authority (GRDA) Landfill
Chouteau, Oklahoma**

PARAMETER	WELL ID																															
	MW 03-1 Downgradient																															
	6/24/04	9/15/04	12/15/04	3/16/05	6/15/05	9/21/05	12/21/05	3/15/06	6/21/06	12/20/06	6/12/07	12/17/07	6/11/08	12/3/08	6/7/09	12/9/09	6/17/10	12/22/10	6/29/11	12/7/11	6/6/12	12/12/12	6/19/13	12/11/13	6/11/14	12/3/14	6/7/15	12/1/15	6/22/16	12/20/16	6/6/17	11/7/17
pH (S.U.)	7.27	6.78	7.32	7.30	7.28	7.88	**	**	**	7	7	7	7.4	7.4	7.6	7.5	7.1	6.89	7.3	7.05	7.33	DRY	7.15	7.19	6.62	6.73	6.66	6.34	7.2	6.75	6.64	6.44
Specific Conductivity (umhos/cm)	497	687	514	422	465	517	**	**	**	447	630	540	467	649	519	469	500	504	463	501	457	DRY	373	476	826	409	267	385	320	NS	198	444
Alkalinity (mg/L)	209	220	184	160	252	180	**	**	**	204	200	190	200	206	204	216	232	216	210	222	216	DRY	144	212	222	194	134	150	130	211.6	56	217
Chloride (mg/L)	10	22	6	4	6	5	**	**	**	5	4	3	11	11	4	32	5	8.7	4.86	5.88	9.36	DRY	<5.0	<5.0	44	<5.0	<5.00	0.777	0.628	0.786	0.887	1.13
Sodium (mg/L)	10.2	42	8.04	5.99	7.3	14.1	**	**	**	8	8	10	5.71	7.01	7.34	6.77	9.31	7.11	7.04	8.87	7.94	DRY	10.3	9.78	55.9	9.80	9.7	12	8.59	7.94	6.56	17.6
Sulfate (mg/L)	42	76	62	22	23	17	**	**	**	55	88	120	23	90	21	15	16	22.9	21.6	18.1	14.3	DRY	16.2	29.1	127	19.7	7.86	12.1	10.3	30.9	332	14.4
Arsenic (mg/L)	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	DRY	0.008	<0.005	<0.005	<0.005	<0.005	<0.005	<0.0005	<0.05	<0.005	

NS = Insufficient sample for analysis

PARAMETER	WELL ID																															
	MW 03-2 Downgradient																															
	6/24/04	9/15/04	12/15/04	3/16/05	6/15/05	9/21/05	12/21/05	3/15/06	6/21/06	12/20/06	6/12/07	12/17/07	6/11/08	12/3/08	6/7/09	12/9/09	6/17/10	12/22/10	6/29/11	12/7/11	6/6/12	12/12/12	6/19/13	12/11/13	6/11/14	12/3/14	6/7/15	12/1/15	6/22/16	12/20/16	6/6/17	11/7/17
pH (S.U.)	6.84	7.17	6.86	6.80	6.87	6.87	6.83	6.88	6.78	6.88	6.87	6.7	6.9	6.8	7.3	6.8	6.8	7.2	6.7	6.69	6.73	6.82	6.88	6.72	7.00	7.14	6.45	6.39	6.75	6.36	6.73	6.22
Specific Conductivity (umhos/cm)	692	522	655	661	674	625	572	594	636	580	680	617	674	752	720	690	685	728	748	755	716	807	807	805	219	1540	965	967	1074	1454	1498	2042
Alkalinity (mg/L)	235	200	222	220	252	224	230	220	228	220	228	200	200	210	200	208	216	230	224	236	230	242	232	230	92	76	220	214	204	199.4	192.0	192
Chloride (mg/L)	36	4	28	30	30	27	26	27	23	35	30	20	41	46	60	45	33	29	28.4	23.5	29.3	28.3	32.1	32.8	<5.00	51.2	54.7	67.8 / 69.6 / 80.1*	79.7 / 88.4*	126	117	288
Sodium (mg/L)	47.4	8.7	51.3	47	42.8	52.6	46.5	50.4	44.9	50.5	47	50.2	33.8	54.4	48.2	47.3	52.9	51.7	51	60.1	52	61.3	57.3	54	9.78	68	66.3	63.8	76.8	80.2	96.8	17.6
Sulfate (mg/L)	72	32	54	78	23	80	72	30	***	34	68	130	67	210	84	80	106	98.9	101	98.8	107	111	113	106	10.3	158	179	197	254	451	332	516
Arsenic (mg/L)	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.0005	<0.005	<0.005	

Table 3
First Semi-Annual 2017 Additional Sampling Summary
Grand River Dam Authority (GRDA) Landfill
Chouteau, Oklahoma

Sample Date	MW93-3		MW03-2
	Sodium (mg/L)	Conductivity (uS/cm)	Chloride (mg/L)
12/1/2015	339*	1807	67.8*
3/4/2016	440*	N/A	69.6*
5/25/2016	464*	N/A	80.1*
6/22/2016	449*	2494*	79.7*
10/11/2016	368*	2005*	88.4*
12/20/2016	337	2200*	126*
3/8/2017	334*	2404*	146*
6/6/2017	301*	1743	117*

* Indicates a verified intra-well statistical exceedance for the specified sampling event.

Table 3a
Second Semi-Annual 2017 Additional Sampling Summary
Grand River Dam Authority (GRDA) Landfill
Chouteau, Oklahoma

Sample Date	MW93-3		MW03-2
	Sodium (mg/L)	Conductivity (uS/cm)	Chloride (mg/L)
12/1/2015	339*	1807	67.8*
3/4/2016	440*	N/A	69.6*
5/25/2016	464*	N/A	80.1*
6/22/2016	449*	2494*	79.7*
10/11/2016	368*	2005*	88.4*
12/20/2016	337	2200*	126*
3/8/2017	334*	2404*	146*
6/6/2017	301*	1743	117*
8/22/2017	281	14	198
11/7/2017	368	2121	288*

* Indicates a verified intra-well statistical exceedance for the specified sampling event.

Table 4: Sampling Summary Table (2017)
Grand River Dam Authority (GRDA) Landfill
Chouteau, Oklahoma

Well ID	# of Samples Collected	2017 Sampling Dates	Collected For:		Comments:
			Detection Monitoring	Assessment Monitoring	
MW93-1 (upgradient)	7	February 16 March 8 May 9 June 6 August 22 September 22 November 7	X		Includes additional samples for background concentrations of boron and fluoride.
MW93-2 (downgradient)	7	February 16 March 8 May 9 June 6 August 22 September 22 November 7	X	X	Includes additional samples for background concentrations of boron and fluoride. In assessment monitoring for pH only.
MW93-3 (downgradient)	7	February 16 March 8 May 9 June 6 August 22 September 22 November 7	X	X	Includes additional samples for background concentrations of boron and fluoride. In assessment monitoring for sodium and conductivity only.
MW03-1 (downgradient)	7	February 16 March 8 May 9 June 6 August 22 September 22 November 7	X		Includes additional samples for background concentrations of boron and fluoride.
MW03-2 (downgradient)	7	February 16 March 8 May 9 June 6 August 22 September 22 November 7	X	X	Includes additional samples for background concentrations of boron and fluoride. In assessment monitoring for chloride only.

APPENDIX A
Monitoring Data Collected

GRDA GROUNDWATER SAMPLING

DATE: 02/16/17

Logbook Entry By: wsh

Reviewed By: MB

Final Review By: _____

Well Number	Total Depth	TOC Elev.	Depth to Water Level	Stabilized Water Level
MW93-1	15.6'	619.83	11.3	608.53
MW93-2	22.2'	607.62	8.1	599.52
MW93-3	27.3'	608.10	13.3	594.80
MW03-1	12.3'	602.87	11.8	591.07
MW03-2	26.9'	607.82	15.8	592.02
F0-8				

Date Sampled	Time Sampled	Sampler
2/16/17	954	wsh/ev
2/16/17	1000	wsh/ev
2/16/17	1005	wsh/ev
2/16/17	1048	wsh/ev
2/16/17	1038	wsh/ev

Date Sample Analyzed	Time Sample Analyzed	Analyst	Temp. °F	pH	Specific Conductivity	ORP mv	Fluoride mg/L	Boron mg/L
2/16/17	1008	wsh/ev	16.70	6.6	978	-49.9	0.16	0.341
2/16/17	1012	wsh/ev	16.00	9.5	9,610	-100.9	0.68	2.09
2/16/17	1015	wsh/ev	17.90	6.4	1,886	-82.7	0.20	0.126
2/16/17	1054	wsh/ev	16.20	7.2	315	-57.4	0.13	<0.025
2/16/17	1052	wsh/ev	18.50	6.6	1,150	-65.6	0.12	<0.025

Well Number	Chloride mg/L	Nitrate-Nitrogen mg/L	Sulfate mg/L	Dissolved Arsenic mg/L	Dissolved Barium mg/L	Dissolved Calcium mg/L	Dissolved Copper mg/L	Dissolved Iron mg/L	Dissolved Potassium mg/L	Dissolved Selenium mg/L	Dissolved Sodium mg/L	Alkalinity mg/L	COD mg/L	Hardness mg/L	Total Phosphorus mg/L	TDS mg/L	TOC mg/L	Total Residue mg/L
MW93-1																		
MW93-2																		
MW93-3											324							
MW03-1																		
MW03-2	110																	

GRDA GROUNDWATER SAMPLING

DATE: 03/08/17

Logbook Entry By: wsh

Reviewed By: MB

Final Review By: _____

Well Number	Total Depth	TOC Elev.	Depth to Water Level	Stabilized Water Level
MW93-1	15.6'	619.83	11.3	608.53
MW93-2	22.2'	607.62	8.2	599.42
MW93-3	27.3'	608.10	13.3	594.80
MW03-1	12.3'	602.87	10.9	591.97
MW03-2	26.9'	607.82	15.4	592.42
F0-8				

Date Sampled	Time Sampled	Sampler
3/8/17	844	wsh/cb
3/8/17	856	wsh/cb
3/8/17	904	wsh/cb
3/8/17	934	wsh/cb
3/8/17	919	wsh/cb
3/8/17	940	wsh/cb

Date Sample Analyzed	Time Sample Analyzed	Analyst	Temp. ° C	pH	Specific Conductivity	ORP mv	Fluoride mg/L	Boron mg/L
3/8/17	844	wsh	17.0	6.8	1208	-50.7	0.19	0.348
3/8/17	856	wsh	16.70	9.6	11.50	-127.6	0.79	2.07
3/8/17	904	wsh	18.10	6.6	2,404	-128.4	0.22	0.09
3/8/17	934	wsh	15.80	7.3	444	-113.0	0.16	<0.025
3/8/17	919	wsh	17.20	6.8	1,514	-122.9	0.14	<0.025
3/8/17	940	wsh	14.20	8.2	1,102	-111.1		

Well Number	Chloride mg/L	Nitrate-Nitrogen mg/L	Sulfate mg/L	Dissolved Arsenic mg/L	Dissolved Barium mg/L	Dissolved Calcium mg/L	Dissolved Copper mg/L	Dissolved Iron mg/L	Dissolved Potassium mg/L	Dissolved Selenium mg/L	Dissolved Sodium mg/L	Alkalinity mg/L	COD mg/L	Hardness mg/L	Total Phosphorus mg/L	TDS mg/L	TOC mg/L	Total Residue mg/L
MW93-1																		
MW93-2																		
MW93-3											334							
MW03-1																		
MW03-2	146																	

GRDA GROUNDWATER SAMPLING

DATE: 05/09/17

Logbook Entry By: wsh

Reviewed By: _____

Final Review By: Matthew Butcher

Well Number	Total Depth	TOC Elev.	Depth to Water Level	Stabilized Water Level
MW93-1	15.6'	619.83	10.5	609.33
MW93-2	22.2'	607.62	8	599.62
MW93-3	27.3'	608.10	12.5	595.60
MW03-1	12.3'	602.87	8.1	594.77
MW03-2	26.9'	607.82	12.6	595.22
F0-8				

Date Sampled	Time Sampled	Sampler
5/9/17	1215	wsh/cb
5/9/17	1249	wsh/cb
5/9/17	1254	wsh/cb
5/9/17	1313	wsh/cb
5/9/17	1301	wsh/cb

Date Sample Analyzed	Time Sample Analyzed	Analyst	Temp. ° C	pH	Specific Conductivity	ORP mv	Fluoride mg/L	Boron mg/L
5/9/17	1216	wsh	22.8	6.7	1153	-202.3	0.13	0.366
5/9/17	1249	wsh	21.70	9.4	10.59	-308.6	0.7	1.97
5/9/17	1254	wsh	20.50	6.5	1,832	-269.3	0.18	0.139
5/9/17	1314	wsh	19.40	7.3	363	-248.1	0.1	0.041
5/9/17	1301	wsh	19.40	6.7	1,471	-252.4	<0.10	0.032

Well Number	Chloride mg/L	Nitrate-Nitrogen mg/L	Sulfate mg/L	Dissolved Arsenic mg/L	Dissolved Barium mg/L	Dissolved Calcium mg/L	Dissolved Copper mg/L	Dissolved Iron mg/L	Dissolved Potassium mg/L	Dissolved Selenium mg/L	Dissolved Sodium mg/L	Alkalinity mg/L	COD mg/L	Hardness mg/L	Total Phosphorus mg/L	TDS mg/L	TOC mg/L	Total Residue mg/L
MW93-1																		
MW93-2																		
MW93-3											266							
MW03-1																		
MW03-2	142																	

GRDA GROUNDWATER SAMPLING

DATE: 06/06/17

Logbook Entry By: wsh

Reviewed By: MB

Final Review By: _____

Well Number	Total Depth	TOC Elev.	Depth to Water Level	Stabilized Water Level
MW93-1	15.6'	619.83	10.3	609.53
MW93-2	22.2'	607.62	7.7	599.92
MW93-3	27.3'	608.10	11.5	596.60
MW03-1	12.3'	602.87	8.0	594.87
MW03-2	26.9'	607.82	14.0	593.82
F0-8				

Date Sampled	Time Sampled	Sampler
6/6/17	1402	wsh/dc
6/6/17	1415	wsh/dc
6/6/17	1419	wsh/dc
6/6/17	1452	wsh/dc
6/6/17	1435	wsh/dc
6/6/17	1508	wsh/dc

Date Sample Analyzed	Time Sample Analyzed	Analyst	Temp. ° C	pH	Specific Conductivity	ORP mv	Fluoride mg/L	Boron mg/L
6/6/17	1402	wsh	25.7	6.68	1289	-113.0	0.140	0.371
6/6/17	1415	wsh	24.80	9.29	12.59	-166.4	0.680	1.830
6/6/17	1419	wsh	24.20	6.65	1,743	-174.1	0.240	<.100
6/6/17	1452	wsh	24.10	6.64	198	-159.2	<.10	<.100
6/6/17	1435	wsh	21.70	6.73	1,498	-158.1	0.100	<.100
6/6/17	1516	wsh	32.40	9.90	869	69.4		

Well Number	Chloride mg/L	Nitrate-Nitrogen mg/L	Sulfate mg/L	Dissolved Arsenic mg/L	Dissolved Barium mg/L	Dissolved Calcium mg/L	Dissolved Copper mg/L	Dissolved Iron mg/L	Dissolved Potassium mg/L	Dissolved Selenium mg/L	Dissolved Sodium mg/L	Alkalinity mg/L	COD mg/L	Hardness mg/L	Total Phosphorus mg/L	TDS mg/L	TOC mg/L	Total Residue mg/L
MW93-1	16.1	<.25	265	<.005	0.013	206.00	<.010	<.075	0.45	<.005	58.4	398	<15.0	568	<.025	810	3.31	820
MW93-2	1580	<.25	3630	0.038	0.033	45.20	0.014	<.075	241	0.015	2310	246	82.2	114	0.588	7350	12.1	7380
MW93-3	113	1.53	18.2	<.005	0.199	56.00	<.010	<.075	4.37	0.005	301	304	<15.0	192	0.048	780	2.54	830
MW03-1	0.887		8.92	<.005							6.56	56						
MW03-2	117		332	<.005							96.8	192						

GRDA GROUNDWATER SAMPLING

DATE: 09/22/17

Logbook Entry By: wsh

Reviewed By: MB

Final Review By: _____

Well Number	Total Depth	TOC Elev.	Depth to Water Level	Stabilized Water Level
MW93-1	15.6'	619.83	11.3	608.53
MW93-2	22.2'	607.62	7.1	600.52
MW93-3	27.3'	608.10	12.1	596.00
MW03-1	12.3'	602.87	10.7	592.17
MW03-2	26.9'	607.82	15.1	592.71
F0-8				

Date Sampled	Time Sampled	Sampler
9/22/17	1006	wsh
9/22/17	1021	wsh
9/22/17	1026	wsh
9/22/17	1055	wsh/ev
9/22/17	1044	wsh/ev

Date Sample Analyzed	Time Sample Analyzed	Analyst	Temp. ° C	pH	Specific Conductivity	ORP mv	Fluoride mg/L	Boron mg/L
9/22/17	1006	wsh	24.4	6.70	1203	21.4	0.110	0.499
9/22/17	1021	wsh	25.0	9.01	11.32	-35.1	0.510	2.480
9/22/17	1026	wsh	21.8	6.82	2,242	-34.0	0.200	0.118
9/22/17	1055	wsh	22.9	7.30	463	-14.4	0.100	0.025
9/22/17	1044	wsh	22.0	6.83	1,694	-16.0	< .10	< .025

Well Number	Chloride mg/L	Nitrate-Nitrogen mg/L	Sulfate mg/L	Dissolved Arsenic mg/L	Dissolved Barium mg/L	Dissolved Calcium mg/L	Dissolved Copper mg/L	Dissolved Iron mg/L	Dissolved Potassium mg/L	Dissolved Selenium mg/L	Dissolved Sodium mg/L	Alkalinity mg/L	COD mg/L	Hardness mg/L	Total Phosphorus mg/L	TDS mg/L	TOC mg/L	Total Residue mg/L
MW93-1																		
MW93-2																		
MW93-3											369							
MW03-1																		
MW03-2	188																	

GRDA GROUNDWATER SAMPLING

DATE: 11/07/17

Logbook Entry By: wsh

Reviewed By: _____

Final Review By: _____

Well Number	Total Depth	TOC Elev.	Depth to Water Level	Stabilized Water Level
MW93-1	15.6'	619.83	11.1	608.73
MW93-2	22.2'	607.62	8.0	599.62
MW93-3	27.3'	608.10	12.3	595.80
MW03-1	12.3'	602.87	10.3	592.57
MW03-2	26.9'	607.82	15.4	592.42
F0-8				

Date Sampled	Time Sampled	Sampler
11/7/17	1023	bs/cb
11/7/17	1038	bs/cb
11/7/17	1048	bs/cb
11/7/17	1118	bs/cb
11/7/17	1058	bs/cb

Date Sample Analyzed	Time Sample Analyzed	Analyst	Temp. ° C	pH	Specific Conductivity	ORP mv	Fluoride mg/L	Boron mg/L
11/7/17	1023	bs/cb	18.5	6.21	1458	-51.0	0.120	0.460
11/7/17	1038	bs/cb	18.7	8.86	10.52	-44.5	<.10	2.180
11/7/17	1048	bs/cb	17.3	6.46	2,121	-39.8	0.200	<.100
11/7/17	1118	bs/cb	16.5	6.44	444	-42.2	0.120	<.100
11/7/17	1058	bs/cb	15.9	6.22	2,042	-38.2	0.100	<.100

Well Number	Chloride mg/L	Nitrate-Nitrogen mg/L	Sulfate mg/L	Dissolved Arsenic mg/L	Dissolved Barium mg/L	Dissolved Calcium mg/L	Dissolved Copper mg/L	Dissolved Iron mg/L	Dissolved Potassium mg/L	Dissolved Selenium mg/L	Dissolved Sodium mg/L	Alkalinity mg/L	COD mg/L	Hardness mg/L	Total Phosphorus mg/L	TDS mg/L	TOC mg/L	Total Residue mg/L
MW93-1	16.2	<.25	281	<.005	0.015	212.00	<.010	<.075	<.25	<.005	45.2	394	<15	598	<.025	878	3.46	896
MW93-2	1160	<.25	4340	0.028	0.061	68.50	<.010	<.075	246	0.015	2750	430	148	183	0.484	7820	12.3	9360
MW93-3	402	0.96	80.3	<.005	0.227	80.20	<.010	<.075	3.73	<.005	368	409	<15	275	0.056	1250	3.15	1220
MW03-1	1.13		14.4	<.005							17.6	217						
MW03-2	288		516	<.005							120	192						