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January 24, 2020

Hillary Young
Land Protection Division
Department of Environmental Quality
P.O. Box 1677
Oklahoma City, OK 73101-1677

RE: Muskogee Generating Station
Inactive Coal Combustion Residuals Ash Pond
Annual Groundwater Monitoring Report

Ms. Young:

As per the most recent meeting between Oklahoma Gas and Electric Services (OG&E) and the Oklahoma Department of Environmental Quality, OG&E is submitting a revision to the required Annual Groundwater Monitoring Report for the Inactive CCR Impoundment located at OG&E Muskogee Generating Station. After the meeting and further consideration on our part, OG&E chose to go with analysis of the three constituents Molybdenum, Cobalt, and Lithium as originally suggested. The results of the confidence interval summary are attached to the following report.

If you have any questions concerning this report, please contact me by either my office (405-553-3349) or cell phone (405-708-9964).

Sincerely,

Tad Dow
Sr. Envirochemist

Enclosures

Annual Groundwater Monitoring Report
For the Inactive CCR Impoundment at Muskogee Power Plant

FACILITY LOCATION:
5501 Three Forks Road
Ft. Gibson, OK 74434

Revision 2
Date: January 23, 2020

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1.0 INTRODUCTION

Oklahoma Gas and Electric Company (OG&E) has prepared this initial annual groundwater and corrective action monitoring report for the Muskogee Power Plant (MK) in accordance with the Oklahoma Department of Environmental Quality (ODEQ) OAC 252:517-15-5(b)(5), Groundwater Monitoring and Corrective Action for Inactive Coal Combustion Residuals (CCR) Surface Impoundments, and OAC 252:517-9-1(e) Annual Groundwater Monitoring and Corrective Action Report requirements. This annual groundwater and corrective action monitoring report provides the information to support the establishment of baseline background groundwater conditions in accordance with OAC 252:517-9-4 Groundwater Sampling and Analysis requirements for Calendar Year (CY) 2018. The OG&E MK inactive CCR impoundment is located in Fort Gibson, Oklahoma (see Figure 1-1).

2.0 MK CCR IMPOUNDMENT STATUS

The inactive CCR impoundment at the OG&E MK power plant ceased receiving bottom ash on October 14, 2015. OG&E subsequently filed a Notice of Intent to initiate closure of the inactive impoundment on December 10, 2015. The clean closure of the MK inactive CCR surface impoundment was initiated in October 2018 and has been complete as of August 22, 2019. Clean closure activities for the inactive CCR impoundment in CY2018 and CY2019 included: removal and off-site disposal of all CCR within an ODEQ permitted solid waste disposal facility; removal of impoundment berms and regrading of all soils to match the surrounding topography; and, hydro-seeding of the surface soils in July 2019. The surface soils have been successfully revegetated and OG&E is completing certification for the closure of the inactive CCR impoundment.

Figure 1-1 Location Map

3.0 GROUNDWATER MONITORING ACTIVITIES

Owners and operators of electric utility CCR units are required to implement a groundwater monitoring system and program that together are capable of detecting CCR impacts on groundwater quality, if any, underlying each utility CCR landfill and/or CCR surface impoundment.

The groundwater monitoring system at the MK inactive CCR impoundment consists of five appropriately located monitoring wells (two upgradient and three downgradient wells) capable of monitoring the quality of background groundwater and the quality of groundwater passing the CCR waste boundary. Monitoring wells were installed in order to yield representative groundwater samples from the uppermost aquifer. The ODEQ CCR Rule requires groundwater sampling at utility CCR-waste landfills/impoundments for specific chemical constituents of potential concern (COPCs). If the groundwater monitoring system demonstrates a verified exceedance of a groundwater protection standard for any of the identified COPC through statistical evaluation, the owner or operator must initiate corrective action.

OG&E initiated baseline groundwater monitoring in accordance with the CCR rule in March 2018. The initial eight rounds of baseline monitoring sampling and analysis were completed prior to April 17, 2019. Data for the baseline monitoring events are available at the time of this report.

The groundwater monitoring network consists of 5 monitoring wells currently in place around the MK inactive CCR impoundment. To more thoroughly assess background groundwater concentrations, monitoring well (MW-5) was included for background groundwater monitoring during this reporting period. As described in OAC 252:517-9-4(e), a determination of background quality may include sampling of wells that are not hydraulically upgradient of the CCR management area where sampling will provide an indication of background groundwater quality that is as representative as that provided by the upgradient wells.

Groundwater samples and elevation data are collected from the 5 monitoring wells. The 5 monitoring wells are screened at the water table (approximately 7 to 14 feet below ground surface. Horizontal spacing between the downgradient shallow alluvial aquifer monitoring wells ranges from approximately 350 to 1500 feet. The Monitoring Well locations are identified in Figure 2-1. Groundwater elevation data are used to identify upgradient and downgradient monitoring points and to determine the potential influence of the Arkansas River on groundwater conditions. The monitoring wells consist of 2-inch nominal inner-diameter polyvinyl chloride (PVC) casing and screen. Monitoring well construction included placement of clean silica sand in the screened interval and an annular seal of bentonite to the near surface. Monitoring well surface completions consist of a lockable stick-up surface casing set in a concrete pad and placement of protective bollards. Review of monitoring records and well inspections indicate the monitoring wells have been operated and maintained adequately to meet the design specifications of the monitoring program.

The uppermost aquifer in the vicinity is the Arkansas River alluvial aquifer. In general, the sediment grain size increases with depth; clays, silts, and fine sands are typically present from 0 to 30 feet below ground surface (bgs) where the water table occurs; coarser sands and gravels are typically present below 30 feet. In general, the subsurface geology in the vicinity of the CCR impoundments includes a layer of fine-grained materials (silts and clays) overlying predominately fine sand with some sand and gravel at depth.

Figure 2-1 Monitoring Well Location Map

3.1 Monitoring Well Inspection and Groundwater Sample Collection

Monitoring Well inspections included observations for the condition of the protective casing/vault and surrounding ground surface prior to each groundwater sampling event. Any sediment deposited on the monitoring well pads was removed as part of the inspections. During each sampling event, the monitoring wells were inspected and documented as appropriate (Attachment 2). It should be noted that the berm surrounding the inactive CCR impoundment has been removed, regraded to match the surrounding land contours, and initiated revegetation as of July 29, 2019.

Prior to each groundwater sampling event, the total well depth of each well in the monitoring network is measured to evaluate the well condition and potential sediment accumulation in the well. Total well depth measured during the inspections are presented in Attachment 2. No significant screen occlusion was determined to be present during the sampling events. In accordance with the Field Procedures, following the eight rounds of baseline sampling, the frequency of measuring total well depths may be adjusted based on review of the collected data.

Sampling was conducted using dedicated submersible pump that was flushed with Deionized water between purging and sampling. Prior to sample collection, the temperature and pH of the purge water were measured. The readings were recorded on well sampling records or in a field notebook (Attachment 2). Upon stabilization, unfiltered samples were collected in laboratory-supplied containers. The groundwater sampling records for the baseline monitoring events are included in Attachment 2. During each of the baseline sampling events, a field duplicate sample was collected for quality assurance/quality control (QA/QC) purposes.

3.2 Analytical Parameters

Groundwater samples were analyzed for the parameters specified in OAC 252:517 Appendix A and B (Tables 2.4 and 2.5, respectively) for each of the baseline monitoring events. The laboratory analyses were conducted by Accurate Environmental Laboratories located in Stillwater, Oklahoma. Analyses were conducted by the laboratory in accordance with the procedures and methods described in the United States Environmental Protection Agency (USEPA) Manual SW-846, "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (September 1986)," as updated and/or in accordance with other approved testing procedures.

Accurate Environmental Laboratories provided prepared sample containers for each monitoring event. Analytical data for each sampling event is reported as total recoverable (i.e., unfiltered) sample results and are included in Attachment 2. Following receipt of the final laboratory analytical reports of sampling, Groundwater Stats Consulting completed an analytical data quality assessment and validation for the groundwater samples collected during the baseline and initial detection monitoring events.

4.0 GROUNDWATER FLOW CONDITIONS

Groundwater levels were measured at each of the monitoring wells included in the monitoring network during each sampling and monitoring event. The groundwater elevations measured in wells during the monitoring are listed in Attachment 2. A groundwater flow map (Figure 3-1) was prepared using water level measurements from the monitoring events for the shallow portion of the alluvial aquifer. The groundwater flow direction in the alluvial aquifer is to the west-southwest and south southeast toward the Arkansas River, based on the monitoring events conducted between March 2018 and April 2019. Groundwater flow direction at the inactive CCR impoundment has been observed to be consistent with only minor temporal variations. The groundwater contour map shows the groundwater elevations in the shallow portion of the alluvial aquifer has generally ranged from 496 feet to 499 feet, with groundwater flow directions predominantly toward the Arkansas River.

The average horizontal linear groundwater velocity for the shallow portion of the alluvial aquifer was estimated based on hydraulic conductivity, horizontal gradient, and the estimated porosity of the formation. Groundwater flow velocities for each of the monitoring events are summarized in Attachment 2.

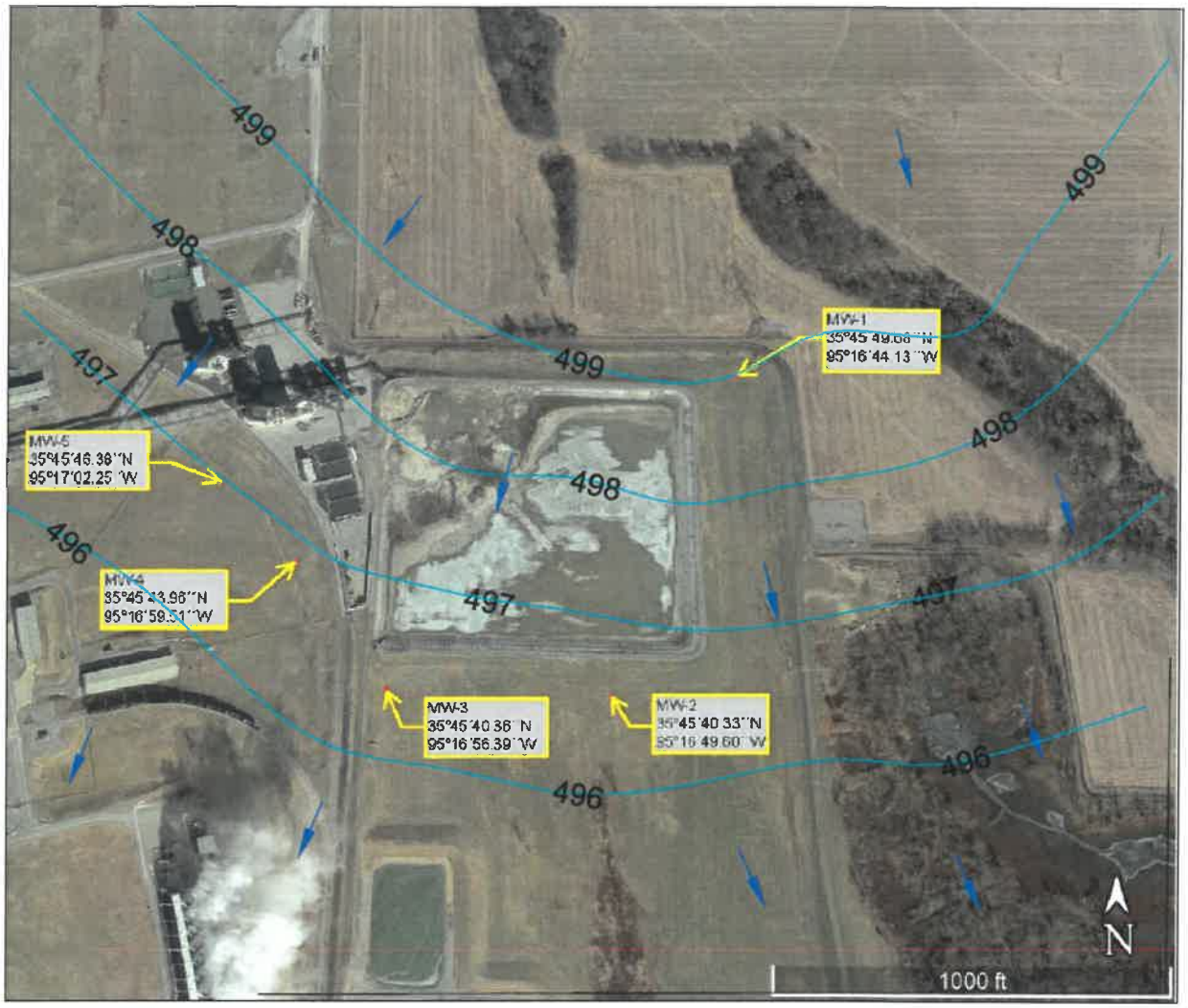


Figure 3-1 Groundwater Flow Map

5.0 GROUNDWATER MONITORING AND ANALYSIS

Groundwater sample collection records for the eight baseline monitoring events are provided in Attachment 2 along with the associated laboratory analytical reports. Analytical results for groundwater samples collected during the baseline monitoring events are also summarized in Attachment 2. The Well Completion and Plugging Report are included in Attachment 3. As part of assessment and reporting requirements under the ODEQ CCR rule, the groundwater monitoring data are subjected to statistical evaluation to demonstrate compliance with monitoring goals. Evaluation components include:

- Statistical summaries for the data sets obtained (on a per-well, per-parameter basis)
- Preparation of trend plots (concentration vs. time)
- Inter-well comparisons (downgradient vs. upgradient)
- Intra-well comparisons (vs. baseline conditions at a given well)

The statistical methods used in these evaluation steps for the MK inactive CCR impoundment are presented in the Groundwater Statistical Analysis provided in Attachment 1. The procedures in the Groundwater Statistical Analysis were selected in accordance with the ODEQ CCR rule, utilizing methodology presented in the USEPA's *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance* (Unified Guidance) (USEPA, 2009). The present evaluation utilizes the statistical methods presented therein to evaluate monitoring data from groundwater samples collected during the baseline monitoring events.

Baseline monitoring under the ODEQ CCR rule occurred at MK inactive CCR impoundment during eight monitoring events conducted between March 2018 and April 2019. These events represent the selected baseline period required for both inter-well and intra-well comparisons.

The initial ten rounds of baseline groundwater monitoring data were collected and analyzed for the OAC 252:517 Appendix A and B constituents (Tables 2.4 and 2.5, respectively).The baseline monitoring data and analysis for the MK inactive CCR impoundment are presented in Attachment 1. Statistical summary information for each data set is included along with trend analysis results in Attachment 1.

Groundwater monitoring at the MK inactive CCR impoundment was currently conducted under Detection Monitoring status per the ODEQ CCR rule. As such, the seven Appendix A constituents were analyzed in the monitoring event samples. The statistical methods selected for use are dependent upon the data and distributions and should consider the specific constituents and the nature of local hydrogeologic conditions. Depending on characteristics of the site and the groundwater monitoring data, a mix of inter-well (comparison vs. upgradient conditions) and intra-well (comparison vs. baseline) tests may be warranted. The statistical methods used for the inter-well and intra-well approaches are selected based on these factors as well as consideration of natural temporal or spatial variability of the concentrations of the groundwater constituents. Substantial natural spatial variability may necessitate intra-well methods. This statistical analysis was completed using both inter-well and intra-well approaches for the purpose of determining if a statistically significant increase (SSI) has occurred at MK inactive CCR impoundment.

A preliminary statistical analysis was conducted using the ten rounds of baseline data to initially assess the constituent data and determine the most appropriate statistical approach(es) for the data. The data were examined for outliers, the percentage of non-detect values, and to determine the statistical distribution. Time series plots and maps were used to evaluate the potential presence of temporal or spatial variations in constituent concentrations. All of the Appendix A and B constituents occur naturally in the environment. Naturally occurring constituents may vary substantially in concentration across the monitoring network due to natural hydrogeologic or geochemical factors (i.e., exhibiting spatial variability). Where this occurs, an inter-well analysis is not appropriate where this occurs. Constituent concentrations greater than upgradient conditions might be incorrectly attributed to impact from MK inactive CCR impoundment, when the differences are natural and unrelated to MK inactive CCR impoundment and due to locally varying distributions of groundwater constituents. In such cases, an intra-well approach is appropriate.

6.0 CONCLUSIONS AND RECOMMENDATIONS

Groundwater flow in the shallow portion of the alluvial aquifer in the vicinity of MK inactive impoundment is predominantly to the west-southwest and south southeast, toward the Arkansas River. The groundwater contour map (Figure 3-1) indicates the monitoring network is sufficient and has appropriately located upgradient and downgradient well locations.

A statistical evaluation of groundwater monitoring data collected during the baseline period (March 2018 to April 2019) has been conducted in accordance with the ODEQ CCR rule and Unified Guidance for assessing groundwater data (USEPA, 2009). This evaluation was successful in characterizing the baseline data sets, assessing the baseline data for trends, and generating inter-well upgradient background reference values and intra-well baseline values against which future monitoring data may be evaluated.

Key results of the evaluation include:

o Constituent concentrations appear to vary between the two background wells. Evaluation of the baseline period data indicates spatial variability in groundwater collected at different monitoring wells at the site, requiring intra-well comparisons.

o Concentration trends over time were observed in some baseline data sets at downgradient wells, but not in the upgradient well.

o The constituent concentration for the samples and their corresponding Clean Water Act Maximum Contaminant Levels (MCLs) are listed in Attachment 2, Well data sample summary. The concentration limits for the constituents are either below MCLs or Below Practical Quantitation Limit (BPQL).

o Inter-well baseline values have been calculated from the baseline data for two background well (MW-1 and MW-5).

o Intra-well baseline values have been calculated on a per-constituent, per-well basis for Appendix B constituents.

o Inter-well comparisons – monitoring results at downgradient wells are consistent with upgradient background conditions during the baseline period. However, observations were above upgradient background conditions.

o Intra-well comparisons – The September 2018 monitoring data exceed their corresponding intra-well baseline values (calcium – MW-3 & MW-4, chloride – MW-3, MW-3 & MW-4 and sulfate - MW-3 & MW-4). These data sets all exhibited increasing trends over time during the baseline period, and the September 2018, January and April 2019 data appear consistent with the apparent trends.

o As a result of the background screening, intrawell prediction limits were recommended for boron, fluoride and pH. While interwell prediction limits were recommended for calcium, chloride, sulfate and TDS.

o The prediction limit exceedance was further evaluated using Sen's Slope/Mann Kendall trend test. Upgradient wells are included in the trend tests to identify whether similar patterns exist upgradient of the facility for the same parameters which would indicate that groundwater is naturally changing. No statistically significant increasing or decreasing trends were noted in any of the down gradient wells which indicates that data are stable over time.

o In the event of an initial exceedance by compliance well data, the 1-of 2 resample plan allows for collection of an additional sample to determine whether the initial exceedance is confirmed. When the resample confirms the initial exceedance, a statistically significant increase (SSI) is identified, and further research would be required to identify the cause of the exceedance (i.e. impact from the site, natural variation, or an off-site source). If the resample falls within the statistical limit, the initial exceedance is considered false positive result and, therefore, no further action is necessary.

o In summary, the intrawell prediction limits identified an exceedance of fluoride in well MW-4. The interwell prediction limits identified exceedances for calcium in well MW-4; chloride in wells MW-2, MW-3 and MW-4; sulfate in well MW-4 and TDS in wells MW-3 and MW-4. The trend tests identified no statistically significant increasing trends for any of the prediction limit exceedances.

o USEPA has established Maximum Contaminant Level (MCL) for constituents of potential concern. Confidence intervals were used to compare all data from a given well to a groundwater protection standard (either the established standards from the CCR rule or from background limits established from pooled upgradient well data - whichever is higher). The monitoring results at downgradient wells are consistent with upgradient background conditions. Non-parametric confidence intervals were developed for Cobalt, Lithium and Molybdenum to compare against the established MCLs and GWPS. Background comparison identified an initial exceedance for Molybdenum in MW03 and MW04. The Non-parametric confidence intervals developed for Cobalt, Lithium and Molybdenum (Attachment 1) confirmed that the compliance limits are not exceeded and there are no confirmed SSIs.

o The clean closure activities for the MK inactive CCR surface impoundment are complete. The groundwater analyses demonstrates no statistically significant exceedance and groundwater monitoring can be discontinued.

7.0 REFERENCES

- United States Department of Agriculture (USDA), 2015, Web Soil Survey, Natural Resource Conservation Service
- United States Environmental Protection Agency (USEPA), 2009, Unified Guidance for Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance, EPA 530/R-09-007, March 2009.
- USEPA, 2015, Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities; Final Rule, 40 CFR Parts 257 and 261, Federal Register, Vol. 80, No. 74, April 17, 2015.

8.0 STATEMENT OF CERTIFICATION

I hereby certify, as a Professional Engineer in the State of Oklahoma, that the information in this document was assembled under my direct supervisory control. I certify that to the best of my knowledge and belief, the information presented in this document are correct.

I certify as a Professional Engineer in the State of Oklahoma, that the clean closure activities for the MK inactive CCR surface impoundment is complete. Clean closure activities for the inactive CCR impoundment included: removal and off-site disposal of all CCR within an ODEQ permitted solid waste disposal facility; removal of impoundment berms and regrading of all soils to match the surrounding topography; and, hydro-seeding of the surface soils. The surface soil has successfully revegetated.

Construction activities were completed on August 22, 2019 in accordance with the CCR Rule, 40 Code of Federal Regulations 40 CFR 257.102 (f) (3) and MK CCR Inactive Impoundment Closure Plan, March 12, 2018.

Suraj A. Balan, P.E.

01/23/2020
Date

Oklahoma Certificate of Authorization Number: 159

Attachment 1

Groundwater Statistical Analysis

Attachment 2

Field Forms and Analytical Reports

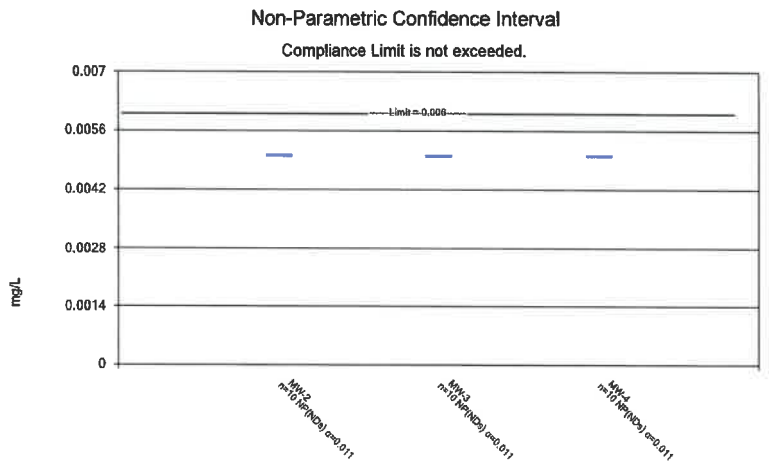
Attachment 3

Multi-Purpose Well Completion and Plugging Report

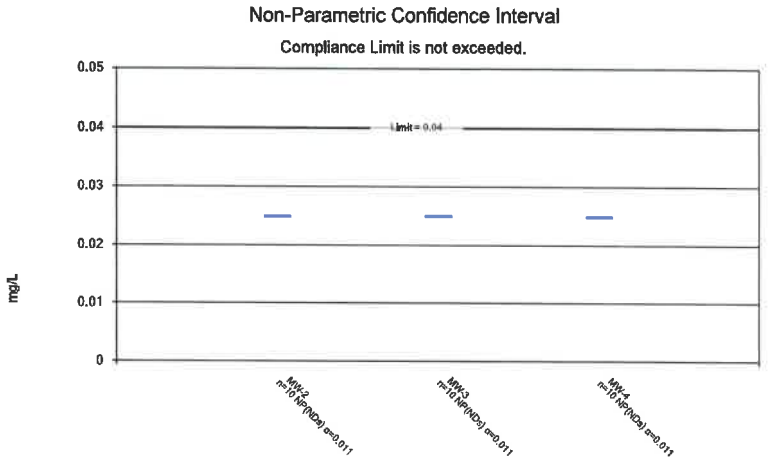
Confidence Interval Summary Table - All Results (No Significant)

Muskogee Power Plant Client: OGE Energy Corp. Data: Muskogee Power Plant Printed 1/17/2020, 12:35 PM

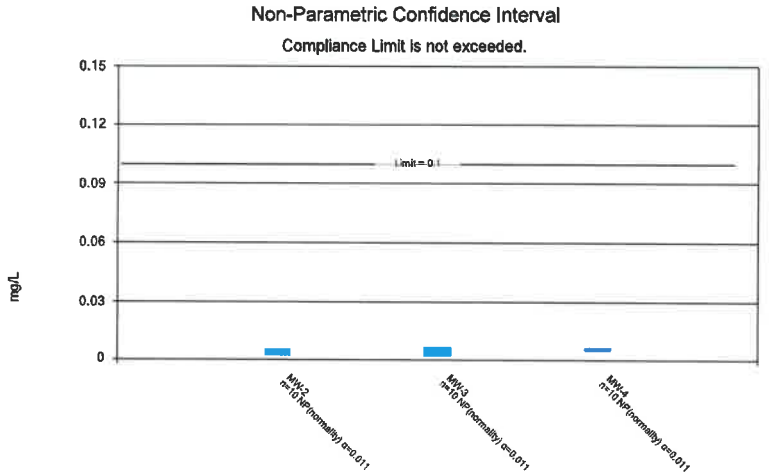
Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Sig.	N	Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Cobalt (mg/L)	MW-2	0.005	0.005	0.006	No	10	0.005	0	100	None	No	0.011	NP (NDs)
Cobalt (mg/L)	MW-3	0.005	0.005	0.006	No	10	0.005	0	100	None	No	0.011	NP (NDs)
Cobalt (mg/L)	MW-4	0.005	0.005	0.006	No	10	0.005	0	100	None	No	0.011	NP (NDs)
Lithium (mg/L)	MW-2	0.025	0.025	0.04	No	10	0.025	0	100	None	No	0.011	NP (NDs)
Lithium (mg/L)	MW-3	0.025	0.025	0.04	No	10	0.025	0	100	None	No	0.011	NP (NDs)
Lithium (mg/L)	MW-4	0.025	0.025	0.04	No	10	0.025	0	100	None	No	0.011	NP (NDs)
Molybdenum (mg/L)	MW-2	0.005	0.0025	0.1	No	10	0.0035	0.001291	60	None	No	0.011	NP (normality)
Molybdenum (mg/L)	MW-3	0.006	0.0025	0.1	No	10	0.0045	0.001748	40	None	No	0.011	NP (normality)
Molybdenum (mg/L)	MW-4	0.006	0.005	0.1	No	10	0.00565	0.001203	10	None	No	0.011	NP (normality)



Constituent: Cobalt Analysis Run 1/17/2020 12:34 PM View: Co, Li, Mo
Muskogee Power Plant Client: OGE Energy Corp. Data: Muskogee Power Plant



Constituent: Lithium Analysis Run 1/17/2020 12:34 PM View: Co, Li, Mo
Muskogee Power Plant Client: OGE Energy Corp. Data: Muskogee Power Plant



Constituent: Molybdenum Analysis Run 1/17/2020 12:34 PM View: Co, Li, Mo
Muskogee Power Plant Client: OGE Energy Corp. Data: Muskogee Power Plant