REPORT

Active Coal Combustion Residuals Landfill Annual Groundwater Monitoring Report - 2018

Escalante Generating Station, Prewitt, New Mexico

Submitted to:

Tri-State Generation and Transmission Association, Inc.
P.O. Box 33695
Denver, Colorado 80233

Submitted by:

Golder Associates Inc.
44 Union Boulevard, Suite 300 Lakewood, Colorado 80228

+1 303 980-0540

18104293

January 29, 2019

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1.0 INTRODUCTION

Golder Associates Inc. (Golder) has prepared this report to describe the 2018 groundwater monitoring activities and comparative statistical analysis for the active coal combustion residuals (CCR) landfill (the Facility) at Escalante Generating Station (the site), which is owned and operated by Tri-State Generation and Transmission Association, Inc. (Tri-State). This report was written to meet the requirements of 40 CFR 257.90(e).

1.1 Facility Information

Escalante Generating Station is a 270-megawatt coal-fired electric generation facility located near Prewitt, New Mexico. The active CCR landfill at the site contains fly ash, bottom ash, and flue gas desulfurization solids (scrubber solids).

1.2 Purpose

The CCR rule established specific requirements for reporting of groundwater monitoring and corrective action in 40 CFR 257.90. Per part (e) of 40 CFR 257.90, no later than January 31, 2018, and annually thereafter, owners or operators of CCR units must prepare an annual groundwater monitoring and corrective action report.

2.0 GROUNDWATER MONITORING NETWORK PROGRAM STATUS

The groundwater monitoring system for the active CCR landfill at Escalante Generating Station consists of six monitoring wells, as shown on Figure 1. The two upgradient monitoring wells are TRcpc-1 and TRcpc-2. The four downgradient monitoring wells are TRcpc-15, TRcpc-16, TRcpc-17, and TRcpc-18 (Golder 2017a).

2.1 Completed Key Actions in 2018

The following key actions were completed in 2018:

- The 2017 Annual Groundwater Monitoring Report was finalized and placed within the operating record and on Tri-State’s publicly accessible CCR website.
- The second and third detection monitoring sampling events were performed.
- An alternative source demonstration (ASD) was performed as a result of a verified statistically significant increase (SSI) for total recoverable calcium at TRcpc-18 (Appendix A), and it was recommended that the Facility remain in detection monitoring.

2.2 Installation and Decommissioning of Monitoring Wells

No monitoring wells were installed or decommissioned for the active CCR landfill at Escalante Generating Station in 2018.

2.3 Problems and Resolutions

No problems were identified for 2018.

2.4 Proposed Key Activities for 2019

The following key actions are expected to be completed in 2019:

- Confirmatory resampling is planned to be conducted in the first quarter of 2019.
- Detection monitoring sampling events are planned to occur in the second and fourth quarters of 2019.

3.0 GROUNDWATER MONITORING PROGRAM STATUS

Activities associated with the groundwater monitoring program are described below.

3.1 Groundwater Flow

Groundwater elevations were measured in each well prior to purging during each sampling event. Elevations are presented in Table 1 through Table 6. Groundwater elevations from the April 2018 and October 2018 sampling events are shown on Figure 1 and Figure 2, respectively.

Based on the April 2018 and October 2018 groundwater elevations, the groundwater in the Correo Sandstone generally flows east with a localized northerly flow component under the active CCR landfill.

The groundwater flow rate was estimated with the equation $V_s = k \times i / n_e$, where:

- V_s is the groundwater flow rate, in feet per day (ft/day);
- k is the hydraulic conductivity estimated from site pumping test data, in ft/day;
- i is the hydraulic gradient calculated based on groundwater elevations between TRcpc-1 and TRcpc-16, in feet per feet (ft/ft);
- n_e is the effective porosity, estimated to be 0.33 based on historical testing results for samples of Correo Sandstone obtained on site.

Groundwater flow velocity estimates range from 0.00004 ft/day to 0.19 ft/day for the April 2018 and October 2018 sampling events.

3.2 Monitoring Data (Analytical Results)

Analytical results for detection monitoring in 2018 are shown in Table 1 through Table 6.

3.3 Samples Collected

The second and third detection monitoring sampling events were conducted in April and October of 2018. Additionally, samples were collected from wells TRcpc-2, TRcpc-17, and TRcpc-18 in January 2018 and from wells TRcpc-1, TRcpc-15, TRcpc-17, and TRcpc-18 in July 2018 for confirmatory resampling associated with the detection monitoring program.

3.4 Comparative Statistical Analysis

The comparative statistical analysis is summarized below, and the results are presented in Table 7 through Table 12. A full description of the steps taken for the comparative statistical analysis can be found in the Groundwater Monitoring Statistical Methods Certification (Golder 2017b).

3.4.1 Definitions

The following definitions are used in discussion of the comparative statistical analysis:

- SSI – is a statistically significant increase (SSI) and is defined as an analytical result that exceeds the parametric or non-parametric statistical limit established by the baseline statistical analysis.

- False-positive SSI – is defined as an analytical result that exceeds the statistical limit but can clearly be attributed to laboratory error or changes in analytical precision or is invalidated through confirmatory resampling.
- Confirmatory resampling – is designated as the resampling event that occurs within 90 days of detecting an SSI over the statistical limit for determination of a verified SSI.
- Verified SSI – is interpreted as two consecutive SSIs (the original sample and the confirmatory resample for analytical results) for the same constituent at the same well.

3.4.2 Unverified Statistically Significant Increases

Six unverified SSIs were identified for the October 2018 sampling event. These include field pH at TRcpc-1, TRcpc-2, and TRcpc-17; total dissolved solids (TDS) at TRcpc-1; chloride at TRcpc-16; and sulfate at TRcpc-18.

Per the Groundwater Monitoring Statistical Methods Certification (Golder 2017b), a confirmatory resampling event for these unverified SSI is scheduled to occur within 90 days of the SSI determination, during the first quarter of 2019.

3.4.3 False-positive Statistically Significant Increases

Confirmatory resampling for unverified SSIs associated with the August 2017 sampling event occurred in January 2018. The resampling event identified two false positives associated with the August 2017 sampling event. These include field pH at TRcpc-2 and TRcpc-17. No further action is needed.

Confirmatory resampling for unverified SSIs associated with the April 2018 sampling event occurred in July 2018. The resampling event identified four false positives associated with the April 2018 sampling event. These include field pH at TRcpc-1, TRcpc-15, TRcpc-17, and TRcpc-18. No further action is needed.

3.4.4 Verified Statistically Significant Increases

Total recoverable calcium for samples collected from TRcpc-18 during both 2018 detection monitoring events are verified SSIs. The initial exceedance for TRcpc-18 total recoverable calcium occurred during the August 2017 sampling event and was verified with confirmatory resampling conducted in January 2018. In April 2018, an alternative source demonstration was conducted for total recoverable calcium in TRcpc-18, and it was recommended that the Facility remain in detection monitoring (Appendix A). During the April 2018 and October 2018 detection motioning sampling events, the total recoverable calcium results also exceeded the statistical limits. The April 2018 ASD indicating that the calcium results reflect natural variability is applicable to the April 2018 and October 2018 results, and it is recommended that the Facility remain in detection monitoring.

4.0 PROGRAM TRANSITIONS

Beginning in third quarter of 2017, the groundwater monitoring program for the active CCR landfill at Escalante Generating Station transitioned from the baseline period to detection monitoring. The Facility is currently in detection monitoring, and no program transitions occurred in 2018.

4.1 Detection Monitoring

Samples for the detection monitoring program are collected on a semi-annual basis, beginning with the sample collected in August 2017. Tri-State plans to collect semi-annual samples for the detection monitoring program in the second and fourth quarters of 2019. In 2018, an alternative source demonstration was performed for total recoverable calcium in TRcpc-18 (Appendix A), and no further actions are required.

4.2 Assessment Monitoring

The groundwater monitoring program for the active CCR landfill at Escalante Generating Station is not in assessment monitoring. Assessment monitoring has not been triggered as described in 40 CFR 257.95. As such, no alternative source demonstrations have been made under an assessment monitoring program and no actions are required.

4.3 Corrective Measures and Assessment

The groundwater monitoring program for the active CCR landfill at Escalante Generating Station does not indicate the need for corrective measures. An assessment of corrective measures, as described in 40 CFR 257.96, is not required.

5.0 RECOMMENDATIONS AND CLOSING

This report presents the groundwater monitoring activities and results for the 2018 detection monitoring program for the active CCR landfill at Escalante Generating Station, along with the comparative statistical analysis. The significant findings from the 2018 monitoring activities and comparative statistical analysis are as follows:

- Six unverified SSIs were identified based on the results of the October 2018 detection monitoring sampling event, and confirmatory resampling is scheduled for the first quarter of 2019.
- Confirmatory resampling in January 2018 identified two false-positives associated with the August 2017 sampling event.
- Confirmatory resampling in July 2018 identified four false-positive SSIs associated with the April 2018 sampling event.
- Total recoverable calcium in TRcpc-18 was identified as a verified SSI for both detection monitoring samples collected in 2018. An alternative source demonstration was performed in 2018 indicating that the calcium results reflect natural variability. It is recommended that the Facility remain in detection monitoring, and no further actions are required.

As described in the Groundwater Monitoring System Certification (Golder 2017a) and the Groundwater Monitoring Statistical Methods Certification (Golder 2017b), the groundwater monitoring and analytical procedures meet the requirements of the CCR rule, and modifications to the monitoring network and sampling program are not recommended at this time.

Signature Page

Golder Associates Inc.

Sara Harkins	Jason Obermeyer, PE
Senior Project Geochemist	*Associate and Senior Consultant*

SH/JO/ds

https://golderassociates.sharepoint.com/sites/33023g/deliverables/reports/18104293_1_r_0_2018annrpt/18104293-0003--1-r-a-escalante_2018_annual_report.docx

Tables

Table 1. Sample Results Summary Table – TRcpc-1

Analytes	Units	Compliance Point (4/12/2018)	Confirmatory Resample (7/11/2018)	Compliance Point (10/29/2018)
Static Water Elevation	ft amsl	6862.3	6862.6	6862.6
Appendix III				
Boron, Total Recoverable	mg/L	1.5	--	1.4
Calcium, Total Recoverable	mg/L	12	--	12
Chloride	mg/L	620 F1	--	650
Fluoride	mg/L	1.6	--	1.6
pH, Field-Measured	pH units	7.7	8.9	7.7
Sulfate	mg/L	800	--	860 B
Total Dissolved Solids	mg/L	2500	--	3200

NOTES:

ft amsl: feet above mean sea level

mg/L: milligrams per liter

B: Analyte detected in the laboratory quality control blank and the sample

F1: Laboratory quality control matrix spike and/or matrix spike duplicate sample recovered outside acceptable limits

Table 2. Sample Results Summary Table – TRcpc-2

Analytes	Units	Confirmatory Resample (1/16/2018)	Compliance Point (4/12/2018)	Compliance Point (10/30/2018)
Static Water Elevation	ft amsl	6853.4	6852.5	6852.5
Appendix III				
Boron, Total Recoverable	mg/L	--	1.5	1.4
Calcium, Total Recoverable	mg/L	--	14	14
Chloride	mg/L	--	1100	1200
Fluoride	mg/L	--	1.9	1.8
pH, Field-Measured	pH units	8.7	8.1	7.8
Sulfate	mg/L	--	490	570 B
Total Dissolved Solids	mg/L	--	2700	2900

NOTES:

ft amsl: feet above mean sea level

mg/L: milligrams per liter

B: Analyte detected in the laboratory quality control blank and the sample

Table 3. Sample Results Summary Table – TRcpc-15

Analytes	Units	Compliance Point (4/12/2018)	Confirmatory Resample (7/11/2018)	Compliance Point (10/22/2018)
Static Water Elevation	ft amsl	6830.6	6830.7	6829.7
Appendix III				
Boron, Total Recoverable	mg/L	1.3	--	1.2
Calcium, Total Recoverable	mg/L	7.2	--	6.8
Chloride	mg/L	570	--	580
Fluoride	mg/L	2.8	--	2.8
pH, Field-Measured	pH units	7.8	8.6	8.6
Sulfate	mg/L	240	--	260 B
Total Dissolved Solids	mg/L	1600	--	1700 H

NOTES:

ft amsl: feet above mean sea level

mg/L: milligrams per liter

B: Analyte detected in the laboratory quality control blank and the sample

H: Analyte analyzed outside of holding time

Table 4. Sample Results Summary Table – TRcpc-16

Analytes	Units	Compliance Point (4/12/2018)	Compliance Point (10/23/2018)
Static Water Elevation	ft amsl	6829.5	6829.6
Appendix III			
Boron, Total Recoverable	mg/L	1.5	1.3
Calcium, Total Recoverable	mg/L	5.3	4.8
Chloride	mg/L	460	490
Fluoride	mg/L	3.4	3.6
pH, Field-Measured	pH units	8.5	8.4
Sulfate	mg/L	250	260 B
Total Dissolved Solids	mg/L	1500	1500 H

NOTES:

ft amsl: feet above mean sea level

mg/L: milligrams per liter

B: Analyte detected in the laboratory quality control blank and the sample

H: Analyte analyzed outside of holding time

Table 5. Sample Results Summary Table – TRcpc-17

Analytes	Units	Confirmatory Resample (1/16/2018)	Compliance Point (4/12/2018)	Confirmatory Resample (7/11/2018)	Compliance Point (10/25/2018)
Static Water Elevation	ft amsl	6833.1	6833.1	6833.0	6833.1
Appendix III					
Boron, Total Recoverable	mg/L	--	1.4	--	1.2
Calcium, Total Recoverable	mg/L	--	19	--	18
Chloride	mg/L	--	1500	--	1600
Fluoride	mg/L	--	2.5	--	2.6
pH, Field-Measured	pH units	8.6	8.8	8.5	8.7
Sulfate	mg/L	--	330	--	330 B
Total Dissolved Solids	mg/L	--	3000	--	3200 H

NOTES:

ft amsl: feet above mean sea level

mg/L: milligrams per liter

B: Analyte detected in the laboratory quality control blank and the sample

H: Analyte analyzed outside of holding time

Table 6. Sample Results Summary Table – TRcpc-18

Analytes	Units	Confirmatory Resample (1/16/2018)	Compliance Point (4/12/2018)	Confirmatory Resample (7/11/2018)	Compliance Point (10/30/2018)
Static Water Elevation	ft amsl	6842.7	6842.7	6842.5	6842.5
Appendix III					
Boron, Total Recoverable	mg/L	0.70	0.82	--	0.81
Calcium, Total Recoverable	mg/L	4.6	5.0	--	4.6
Chloride	mg/L	--	360	--	360
Fluoride	mg/L	--	1.7	--	1.7
pH, Field-Measured	pH units	9.6	8.4	9.7	10.0
Sulfate	mg/L	--	210	--	250 B
Total Dissolved Solids	mg/L	--	1200	--	1200

NOTES:

ft amsl: feet above mean sea level

mg/L: milligrams per liter

B: Analyte detected in the laboratory quality control blank and the sample

Table 7. Statistics Summary Table – TRcpc-1

Analytes	Units	Selected Statistical Method	Statistical Limit	April 2018				October 2018	
				Compliance Point (4/12/2018)		Confirmatory Resample (7/11/2018)	SSI Determination	Compliance Point (10/29/2018)		SSI Determination
Appendix III										
Boron, Total Recoverable	mg/L	NP-PL	1.6	1.5		--	No	1.4		No
Calcium, Total Recoverable	mg/L	NP-PL	13	12		--	No	12		No
Chloride	mg/L	NP-PL	660	620	F1	--	No	650		No
Fluoride	mg/L	NP-PL	1.8	1.6		--	No	1.6		No
pH, Field-Measured	pH units	NP-PL	8.3, 9.1	7.7		8.9	False Positive	7.7		Unverified SSI
Sulfate	mg/L	NP-PL	910	800		--	No	860	B	No
Total Dissolved Solids	mg/L	NP-PL	2600	2500		--	No	3200		Unverified SSI

NOTES:

NP-PL: Non-parametric Prediction Limit

mg/L: milligrams per liter

B: Analyte detected in the laboratory quality control blank and the sample

F1: Laboratory quality control matrix spike and/or matrix spike duplicate sample recovered outside acceptable limits

Table 8. Statistics Summary Table – TRcpc-2

Analytes	Units	Selected Statistical Method	Statistical Limit	August 2017				April 2018		October 2018		
				Compliance Point (8/31/2017)		Confirmatory Resample (1/16/2018)	SSI Determination	Compliance Point (4/12/2018)	SSI Determination	Compliance Point (10/30/2018)		SSI Determination
Appendix III												
Boron, Total Recoverable	mg/L	P-PL	1.7	1.5		--	No	1.5	No	1.4		No
Calcium, Total Recoverable	mg/L	NP-PL	15	15		--	No	14	No	14		No
Chloride	mg/L	NP-PL	1200	990	B	--	No	1100	No	1200		No
Fluoride	mg/L	NP-PL	2.2	2.1		--	No	1.9	No	1.8		No
pH, Field-Measured	pH units	P-PL	8.1, 8.7	9.4		8.7	False Positive	8.1	No	7.8		Unverified SSI
Sulfate	mg/L	NP-PL	590	480		--	No	490	No	570	B	No
Total Dissolved Solids	mg/L	P-PL	3025	2700		--	No	2700	No	2900		No

NOTES:
P-PL: Parametric Prediction Limit
NP-PL: Non-parametric Prediction Limit
mg/L: milligrams per liter
B: Analyte detected in the laboratory quality control blank and the sample

Table 9. Statistics Summary Table – TRcpc-15

Analytes	Units	Selected Statistical Method	Statistical Limit	April 2018			October 2018		
				Compliance Point (4/12/2018)	Confirmatory Resample (7/11/2018)	SSI Determination	Compliance Point (10/22/2018)		SSI Determination
Appendix III									
Boron, Total Recoverable	mg/L	P-PL	1.63	1.3	--	No	1.2		No
Calcium, Total Recoverable	mg/L	P-PL	8.5	7.2	--	No	6.8		No
Chloride	mg/L	P-PL	618	570	--	No	580		No
Fluoride	mg/L	NP-PL	3.0	2.8	--	No	2.8		No
pH, Field-Measured	pH units	P-PL	8.4, 8.8	7.8	8.6	False Positive	8.6		No
Sulfate	mg/L	NP-PL	270	240	--	No	260	B	No
Total Dissolved Solids	mg/L	NP-PL	2200	1600	--	No	1700	H	No

NOTES:
P-PL: Parametric Prediction Limit
NP-PL: Non-parametric Prediction Limit
mg/L: milligrams per liter
B: Analyte detected in the laboratory quality control blank and the sample
H: Analyte analyzed outside of holding time

Table 10. Statistics Summary Table – TRcpc-16

Analytes	Units	Selected Statistical Method	Statistical Limit	April 2018			October 2018		
				Compliance Point (4/12/2018)		SSI Determination	Compliance Point (10/23/2018)		SSI Determination
Appendix III									
Boron, Total Recoverable	mg/L	P-PL	1.77	1.50		No	1.3		No
Calcium, Total Recoverable	mg/L	P-PL	7.3	5.3		No	4.8		No
Chloride	mg/L	NP-PL	480	460		No	490		Unverified SSI
Fluoride	mg/L	NP-PL	3.6	3.4		No	3.6		No
pH, Field-Measured	pH units	P-PL	8.3, 8.9	8.5		No	8.4		No
Sulfate	mg/L	NP-PL	290	250		No	260	B	No
Total Dissolved Solids	mg/L	NP-PL	2200	1500		No	1500	H	No

NOTES:

P-PL: Parametric Prediction Limit

NP-PL: Non-parametric Prediction Limit

mg/L: milligrams per liter

B: Analyte detected in the laboratory quality control blank and the sample

H: Analyte analyzed outside of holding time

Table 11. Statistics Summary Table – TRcpc-17

Analytes	Units	Selected Statistical Method	Statistical Limit	August 2017			April 2018			October 2018	
				Compliance Point (8/31/2017)	Confirmatory Resample (1/16/2018)	SSI Determination	Compliance Point (4/12/2018)	Confirmatory Resample (7/11/2018)	SSI Determination	Compliance Point (10/25/2018)	SSI Determination
Appendix III											
Boron, Total Recoverable	mg/L	NP-PL	1.4	1.4	--	No	1.4	--	No	1.2	No
Calcium, Total Recoverable	mg/L	Trend[1]	-	18	--	No	19	--	No	18	No
Chloride	mg/L	NP-PL	1700	1500 B	--	No	1500	--	No	1600	No
Fluoride	mg/L	NP-PL	2.7	2.7	--	No	2.5	--	No	2.6	No
pH, Field-Measured[2]	pH units	P-PL	8.1, 8.2	8.8 (8.6)	8.6 (8.2)	False Positive	8.8 (8.3)	8.5 (8.0)[3]	False Positive	8.7 (8.0)	Unverified SSI
Sulfate	mg/L	P-PL	395	340	--	No	330	--	No	330 B	No
Total Dissolved Solids	mg/L	P-PL	3855	3100	--	No	3000	--	No	3200 H	No

NOTES:

P-PL: Parametric Prediction Limit

NP-PL: Non-parametric Prediction Limit

mg/L: milligrams per liter

B: Analyte detected in the laboratory quality control blank and the sample

H: Analyte analyzed outside of holding time

1. Trend analysis used for the determination of SSIs.
2. A statistical limit was established using detrended data. Compliance data is detrended for comparison to statistical limit. Detrended value is shown in parentheses.
3. Value does not verify exceedance of upper statistical limit

Table 12. Statistics Summary Table – TRcpc-18

Analytes	Units	Selected Statistical Method	Statistical Limit	August 2017			April 2018			October 2018	
				Compliance Point (8/31/2017)	Confirmatory Resample (1/16/2018)	SSI Determination	Compliance Point (4/12/2018)	Confirmatory Resample (7/11/2018)	SSI Determination	Compliance Point (10/30/2018)	SSI Determination
Appendix III											
Boron, Total Recoverable	mg/L	P-PL	0.97	0.79	--	No	0.82	--	No	0.81	No
Calcium, Total Recoverable[1]	mg/L	NP-PL	4.2	4.9	4.6	Verified SSI[1]	5.0	--	Verified SSI[1]	4.6	Verified SSI[1]
Chloride	mg/L	NP-PL	380	320 B	--	No	360	--	No	360	No
Fluoride	mg/L	P-PL	2.5	1.6	--	No	1.7	--	No	1.7	No
pH, Field-Measured	pH units	P-PL	9.4, 11.8	9.6	--	No	8.4	9.7	False Positive	10.0	No
Sulfate	mg/L	NP-PL	210	180	--	No	210	--	No	250 B	Unverified SSI
Total Dissolved Solids	mg/L	NP-PL	1400	1200	--	No	1200	--	No	1200	No

NOTES:
P-PL: Parametric Prediction Limit
NP-PL: Non-parametric Prediction Limit
mg/L: milligrams per liter
B: Analyte detected in the laboratory quality control blank and the sample
1. Successful alternative source demonstration (ASD) conducted in April 2018, indicating the Facility remains in detection monitoring. This ASD is also applicable to the April and October 2018 sampling results.

Figures

LEGEND

TRcpc-1	UPGRADIENT MONITORING WELL
TRcpc-18	DOWNGRADIENT MONITORING WELL
6860	GROUNDWATER ELEVATION (APRIL 2018)

0 300 600
SCALE FEET

CLIENT
TRI-STATE Generation and Transmission Association, Inc.
A Touchstone Energy® Cooperative

CONSULTANT
GOLDER

YYYY-MM-DD	2019-01-14
DESIGNED	DVS
PREPARED	KAC
REVIEWED	JEO
APPROVED	JEO

PROJECT
ESCALANTE GENERATING STATION
ACTIVE COAL COMBUSTION RESIDUALS LANDFILL
ANNUAL GROUNDWATER MONITORING REPORT

TITLE
MONITORING WELL LOCATIONS AND GROUNDWATER ELEVATIONS (APRIL 2018)

PROJECT NO.	REV.	FIGURE
18104293	A	1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

LEGEND

TRcpc-1	UPGRADIENT MONITORING WELL
TRcpc-18	DOWNGRADIENT MONITORING WELL
6860	GROUNDWATER ELEVATION (OCTOBER 2018)

0 300 600
SCALE FEET

N

CLIENT
TRI-STATE Generation and Transmission Association, Inc.
A Touchstone Energy® Cooperative

CONSULTANT
GOLDER

YYYY-MM-DD	2019-01-14
DESIGNED	DVS
PREPARED	KAC
REVIEWED	JEO
APPROVED	JEO

PROJECT
ESCALANTE GENERATING STATION
ACTIVE COAL COMBUSTION RESIDUALS LANDFILL
ANNUAL GROUNDWATER MONITORING REPORT

TITLE
MONITORING WELL LOCATIONS AND GROUNDWATER ELEVATIONS (OCTOBER 2018)

PROJECT NO.	REV.	FIGURE
18104293	A	2

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

APPENDIX A

Demonstration of Natural Variability for Calcium at TRcpc-18, Escalante Station

CERTIFICATION

Professional Engineer Certification Statement [40 CFR 257.94(e)(2)]

I hereby certify that, having reviewed the attached documentation and being familiar with the provisions of Title 40 of the Code of Federal Regulations Section 257.94 (40 CFR 257.94), this written demonstration is accurate to the best of my knowledge and has been prepared in accordance with recognized and generally accepted good engineering practices, including the consideration of applicable industry standards, and the requirements of 40 CFR 257.94(e)(2).

Golder Associates Inc.

Signature

April 25, 2018

Date of Certification

Jason Obermeyer, PE

Name

24619

New Mexico Professional Engineer Number

TECHNICAL MEMORANDUM

DATE April 25, 2018 **Project No.** 1783558

TO Chantell Johnson
Tri-State Generation and Transmission Association, Inc.

FROM Sara Harkins and Matt Cahalan

CC Ron Jorgenson and Jason Obermeyer **EMAIL: Jason_Obermeyer@Golder.com**

DEMONSTRATION OF NATURAL VARIABILITY FOR CALCIUM AT TRCPC-18, ESCALANTE STATION

Golder Associates Inc. (Golder) is providing this technical memorandum to support a demonstration of natural variability resulting in a statistically significant increase (SSI) for total recoverable calcium at groundwater monitoring well TRCPC-18 located at the active coal combustion residuals (CCR) landfill at Escalante Generating Station (the site), which is owned and operated by Tri-State Generation and Transmission Association, Inc. (Tri-State). Groundwater is being monitored at Escalante Station to meet the requirements of the Environmental Protection Agency's (EPA) Coal Combustion Residual (CCR) Rule (40 CFR Part 257).

1.0 ESCALANTE STATION CCR GROUNDWATER MONITORING PROGRAM

The monitoring network in the Escalante Station CCR Groundwater Program consists of groundwater wells TRCPC-1, TRCPC-2, TRCPC-15, TRCPC-16, TRCPC-17, and TRCPC-18 to monitor groundwater conditions around the active CCR landfill, which contains fly ash, bottom ash, and flue gas desulfurization solids (scrubber solids). The locations of the monitoring wells and the active CCR landfill are shown on Figure 1. Each of the six monitoring wells are screened in the Correo Sandstone, which represents the uppermost continuous water-bearing unit (i.e., aquifer) below the active CCR landfill. TRCPC-1 and TRCPC-2 are upgradient of the active CCR landfill, and TRCPC-15 through TRCPC-18 are downgradient.

Eight groundwater samples were collected on a monthly frequency from September 2016 through May 2017 at each monitoring well (with an additional sample for TRCPC-1 in August 2017). The resulting data were used to establish intrawell baseline statistical limits for each Appendix III constituent at each groundwater well. Intrawell baseline statistical limits represent groundwater conditions in each individual groundwater well (USEPA 2009). Samples collected after baseline statistical limits were established are part of the detection monitoring program. Data from the detection monitoring sampling are compared to the statistical limits to assess possible changes in groundwater chemistry at each well. When the concentration of a given constituent exceeds the statistical limit in two consecutive sampling events, it is considered a verified statistically significant increase (SSI) over the baseline concentration.

Calcium concentrations at TRCPC-18 exceeded the non-parametric statistical limit of 4.2 milligrams per liter (mg/L) during the first semi-annual compliance event in August 2017 (4.9 mg/L) and during the confirmatory sampling event in January 2018 (4.6 mg/L), indicating an SSI over baseline. The non-parametric limit is the highest concentration observed during the baseline period for the well. A non-parametric methodology was selected for calcium at TRCPC-18 because the baseline data were not normally or lognormally distributed, which is a requirement to implement a parametric methodology.

The following sections describe the site geology, provide comparisons to other CCR groundwater monitoring wells at the site, and explain the statistical methodology relevant to the observed calcium concentrations at TRCPC-18. This demonstration is performed in accordance with the statistical method certification for the site (Golder 2017) to meet the requirements of 40 CFR 257.94(e)(2), which states that the site may remain in detection monitoring if a demonstration can be made that a source other than the regulated CCR unit caused the SSI or that the SSI was a result of an error in sampling, analysis, or statistical evaluation or natural variability in groundwater quality that was not fully captured during baseline data collection. More specifically, this technical memorandum supports the demonstration that the SSI for calcium at TRCPC-18 (August 2017 and January 2018 samples) was a result of natural variability in groundwater quality that was not fully captured during baseline data collection.

2.0 GEOLOGY AND HYDROGEOLOGY

The active CCR landfill is immediately underlain by Quaternary alluvium of variable thickness. The alluvial material is primarily composed of unconsolidated silty sand and clayey sand. The Triassic-aged Chinle Claystone underlies the alluvium and thickens towards the northeast within the boundary of the site, with thicknesses ranging from approximately 45 feet at TRCPC-18 to 205 feet at TRCPC-15. The Chinle Claystone behaves as a confining unit based on the thickness of the low-permeability claystone.

The Triassic-aged Correo Sandstone underlies the Chinle Claystone confining unit. As mentioned above, the six groundwater monitoring wells are each screened in the Correo Sandstone. The groundwater levels in the CCR wells, which are much higher than the screened interval (i.e., closer to the ground surface), indicate that the groundwater is under confining pressure from the overlying Chinle Claystone confining unit. The groundwater flow direction in the Correo Sandstone bed in the vicinity of the active CCR landfill is generally from west to east, with possible minor northerly or southerly components, as indicated by static groundwater levels in the monitoring wells installed at the site.

The Correo Sandstone is relatively uniform in thickness across the site and dips towards the northeast. According to Moench and Schlee (1967), the Correo Sandstone in the nearby Laguna mining district southeast of the site is composed primarily of quartz and feldspar and firmly cemented with quartz and calcite ($CaCO_3$). Calcite cement is more prominent in conglomeritic lenses of the Correo Sandstone. The regional interpretations of the Correo Sandstone by Moench and Schlee (1967) generally agree with the borehole logs from Golder (2016), which describe the Correo Sandstone as weakly cemented and having calcareous fragments.

Monitoring well TRCPC-18 is located on the south side of the active CCR landfill and was installed in January 2016. The Chinle Claystone is approximately 45 feet thick at this location, with a silty sand interval from 56 to 67.5 feet below ground surface (ft bgs) (Golder 2016). The Correo Sandstone was observed from 117 to 155 ft bgs, and the monitoring well is screened from 120 to 150 ft bgs. Due to the presence of calcareous fragments and calcite cement in the Correo Sandstone, natural variation of total recoverable calcium concentrations in groundwater samples is expected, and the extent of the natural variation was likely not observed during baseline sampling, as discussed further in Section 3.0.

3.0 CALCIUM BASELINE AND HISTORICAL DATA COMPARISONS

Summary statistics for the total recoverable calcium data collected during the baseline period for the CCR monitoring wells, as well as dissolved calcium data for TRCPC-1 and TRCPC-2, are presented in Table 1. Summary statistics and time series graphs, presented in Table 1 and Figure 2, respectively, are useful for evaluating variability within TRCPC-18 and amongst the other CCR monitoring wells. The baseline data indicate that calcium concentration varies at each monitoring well, as indicated by the standard deviation and coefficient of variation. When compared to other monitoring wells, TRCPC-18 shows the smallest range, lowest standard deviation, and third lowest coefficient of variation. Additionally, total recoverable calcium concentrations for the May and August 2018 sampling events are plotted on Figure 1. This demonstrates that the calcium concentrations at TRCPC-18 are lower than those in the other wells in the CCR program.

Due to the time constraints associated with the implementation of the CCR Rule (40 CFR Part 257), the baseline data for the CCR program were collected on a compressed schedule, which consisted of monthly sampling between September 2016 and May 2017. We consider it likely that this compressed schedule (of less than one year) did not allow for natural variations in groundwater concentrations, such as those attributable to seasonal fluctuations or other sources of natural variability (Section 2.0), to be fully observed during the baseline data collection period.

The expected variation in calcium concentration in the Correo Sandstone beneath the site can approximated by the dissolved calcium data collected from 1985 to 2017 at upgradient TRCPC-1 and TRCPC-2 (Figure 2 and Table 1). Although data collection began in 1983, the dissolved calcium data prior to 1985 have not been included in these calculations because the concentrations were much higher than in the remaining data set. The historical calcium data (98 data points) at TRCPC-1 and TRCPC-2 have calculated coefficients of variation of 0.10 and 0.11, respectively, which are more than twice the coefficients of variation calculated for the eight baseline data points for total recoverable calcium for these wells (0.03 and 0.05, respectively). The greater variation observed with historical data can be mainly attributed to the larger sample size and longer monitoring period, which more suitably encompass expected natural variation. Thus, the relatively small variation observed with TRCPC-18 calcium baseline data, with a coefficient of variation of 0.05, is in part a function of the limited sample size and monitoring period. The two compliance monitoring concentrations are likely part of the expected natural variation, especially considering the coefficient of variation for the entire total recoverable calcium dataset for TRCPC-18 (10 data points) is 0.08.

4.0 NON-PARAMETRIC PREDICTION LIMITS AND FALSE POSITIVE RATE

The primary goal in a groundwater detection monitoring program is to identify real changes to groundwater quality if they occur, with a specific focus on increasing concentrations in detection monitoring data when compared to baseline data. Statistical tests are used to identify the possible presence of elevated concentrations, and they must have adequate statistical power to do so. Statistical power is the likelihood of detecting a change in concentrations when a change is present in reality. A second critical goal is to avoid false positive errors (Type I errors), which occur when groundwater concentrations are incorrectly identified as being significantly greater than baseline when contamination does not exist.

A site-wide false positive rate (SWFPR) is used to measure the susceptibility to false positive errors. The Unified Guidance (USEPA 2009) recommends an annual SWFPR of 10%. This SWFPR equates to a *target* per well-constituent false positive rate of 0.38% using equation 19.17 in the Unified Guidance:

$$\alpha_{w\,.\,c} = 1 - (1 - \alpha)^{1/(w\,.\,c)}$$

where α is the SWFPR, *w* equals the actual number of downgradient compliance wells (four in this case), and *c* is the number of monitoring constituents (seven in this case). However, based on Table 19-19 in Appendix D of the Unified Guidance the *achievable* false positive rate for a non-parametric prediction limit with a background dataset of eight measurements where two statistical evaluations are performed per year is 4.2% (much greater than the target of 0.38% noted above). The only way to reduce this false positive rate would be to increase the number of background samples, which was not feasible under the time constraints of the CCR Rule. Thus, there is a relatively high probability of falsely identifying groundwater contamination for parameters that are being tested with a non-parametric methodology at the site, which may have occurred during the comparative statistical analysis for calcium in TRCPC-18. Unfortunately, due to the nature of the non-parametric prediction limits, the false positive rate will remain elevated for the site until more sampling events are conducted. The data from future sampling events can be incorporated into an updated baseline period in accordance with the statistical methodology for the site (Golder 2017), which will result in either one of the following: 1) the underlying data distribution can be defined and a parametric methodology can be implemented, or 2) a non-parametric prediction limit can be constructed on a greater number of samples.

5.0 TREND ANALYSIS

Due to the false positive potential associated with the selected non-parametric prediction limit methodology, an alternate method was also used to interpret the data. The TRCPC-18 calcium data were examined for the presence of a statistically significant increasing trend using the non-parametric Mann-Kendall test.

A statistically significant trend in calcium at TRCPC-18 is not observed for the 10 samples (baseline plus compliance) or the eight most recent samples. Therefore, the results of the trend analysis do not indicate that a significant change in calcium concentration has occurred at TRCPC-18 during the period of record. Trend analysis graphs are included in Figures 3 and 4.

6.0 SUMMARY AND CONCLUSIONS

This demonstration details the reasons behind Golder’s conclusion that the statistically significant increase in total recoverable calcium at TRCPC-18 is not an indication of groundwater impacts from Escalante Station’s active CCR landfill, but rather a reflection of natural variability in calcium concentrations. The lines of evidence can be summarized as follows:

- Downgradient well TRCPC-18 has lower reported total recoverable calcium concentrations than the other active CCR landfill monitoring wells, including the upgradient wells (Figure 1).
- Variability in calcium concentrations are anticipated because the host formation of the active CCR landfill monitoring wells, the Correo Sandstone, is calcite ($CaCO_3$) cemented, which represents a source of calcium that is subject to natural variations.
- Due to time constraints associated with the implementation of the CCR Rule (40 CFR Part 257), the baseline data for the CCR program were collected on a compressed schedule, which did not allow for natural variations in groundwater concentrations to be fully observed during the baseline data collection period.
- Because of the low variability and limited number of baseline samples currently available, the selected statistical methodology to assess total recoverable calcium data at TRCPC-18, a non-parametric prediction limit, has a high false positive rate.
- Analysis of the total recoverable calcium data by an alternate methodology, the Mann-Kendall test for trends, does not indicate a statistically significant increasing trend in the total recoverable calcium data.

Based on the findings of this demonstration, Golder recommends that Tri-State continue with the detection monitoring program for the active CCR landfill at Escalante Station.

7.0 REFERENCES

Golder Associates Inc. (Golder), 2016. Drilling and Monitoring Well Installation Summary at the Escalante Generating Station in Prewitt, New Mexico. August 19.

Golder Associates Inc. (Golder), 2017. Active Coal Combustion Residuals Landfill Groundwater Statistical Method Certification. October 13.

Moench, R.H., and Schlee, J.S., 1967. Geology and Uranium Deposits of the Laguna District, New Mexico. United States Geological Survey Professional Paper 519.

U.S. Environmental Protection Agency (USEPA), Office of Solid Waste, 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance. March.

ATTACHMENTS

Table 1 – Calcium Summary Statistics
Figure 1 – Groundwater Elevations and Calcium Concentrations
Figure 2 – Calcium Time Series
Figure 3 – Trend Test: 10 Data Points
Figure 4 – Trend Test: 8 Data Points

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Table

Table 1: Calcium Summary Statistics

Monitoring Well	Constituent[(2)]	Date Range[(1)]	Calcium Concentration				
			Minimum	Mean	Maximum	Coefficient of Variation	Standard Deviation
TRCPC-1	Calcium, dissolved	1985-2017[(3)]	11.0	13.1	17.0	0.10	1.31
TRCPC-1	Calcium, total recoverable	2016-2017	12.0	12.1	13.0	0.03	0.38
TRCPC-2	Calcium, dissolved	1985-2017[(3)]	11.0	13.7	23.0	0.11	1.46
TRCPC-2	Calcium, total recoverable	2016-2017	13.0	13.9	15.0	0.05	0.64
TRCPC-15	Calcium, total recoverable	2016-2017	7.1	7.5	7.9	0.04	0.28
TRCPC-16	Calcium, total recoverable	2016-2017	5.0	5.7	6.5	0.08	0.45
TRCPC-17	Calcium, total recoverable	2016-2017	17.0	19.0	21.0	0.08	1.51
TRCPC-18	Calcium, total recoverable	2016-2017	3.6	4.1	4.2	0.05	0.21

Notes:

(1): 2016-2017 date range indicates baseline sampling period for CCR Groundwater Program.

(2): CCR Rule requires analysis of total recoverable metals. Dissolved calcium analyses at TRCPC-1 and TRCPC-2 were conducted under a separate testing program.

(3): TRCPC-1 and TRCPC-2 dissolved calcium data prior to 1985 were not included in calculations due to higher reported concentrations.

Figures

LEGEND

TRcpc-1	UPGRADIENT MONITORING WELL
TRcpc-18	DOWNGRADIENT MONITORING WELL
6860	GROUNDWATER ELEVATION (MARCH 2017)
5.4 mg/L	CALCIUM CONCENTRATION FROM 5/15/2018 SAMPLING EVENT
5.2 mg/L	CALCIUM CONCENTRATION FROM 8/31/2018 SAMPLING EVENT

0 300 600
SCALE FEET

N

CLIENT

TRI-STATE Generation and Transmission Association, Inc.
A Touchstone Energy® Cooperative

CONSULTANT

GOLDER

YYYY-MM-DD	2018-04-05
DESIGNED	DVS
PREPARED	DVS
REVIEWED	JEO
APPROVED	RRJ

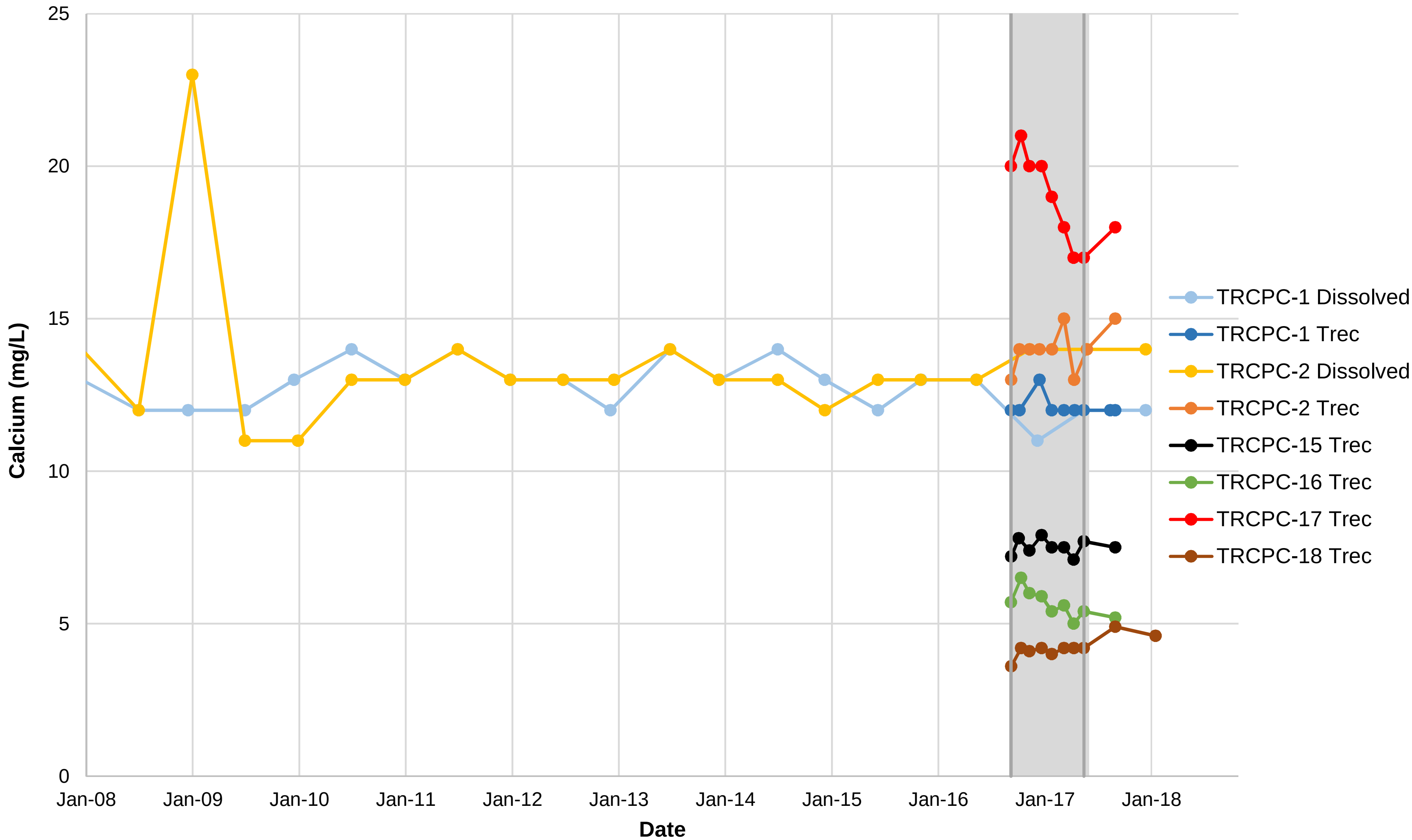
PROJECT

ESCALANTE GENERATING STATION
ACTIVE COAL COMBUSTION RESIDUALS LANDFILL

TITLE

GROUNDWATER ELEVATIONS AND CALCIUM CONCENTRATIONS

PROJECT NO.	REV.	FIGURE
1783558	0	1



Notes:

Data from 1983 to 2007 not displayed in order to provide better visualization of more recent data

Trec = Total recoverable

Gray shading indicates baseline period (September 2016 to May 2017)

Figure 2

Calcium Time Series

Escalante Station CCR Groundwater Program

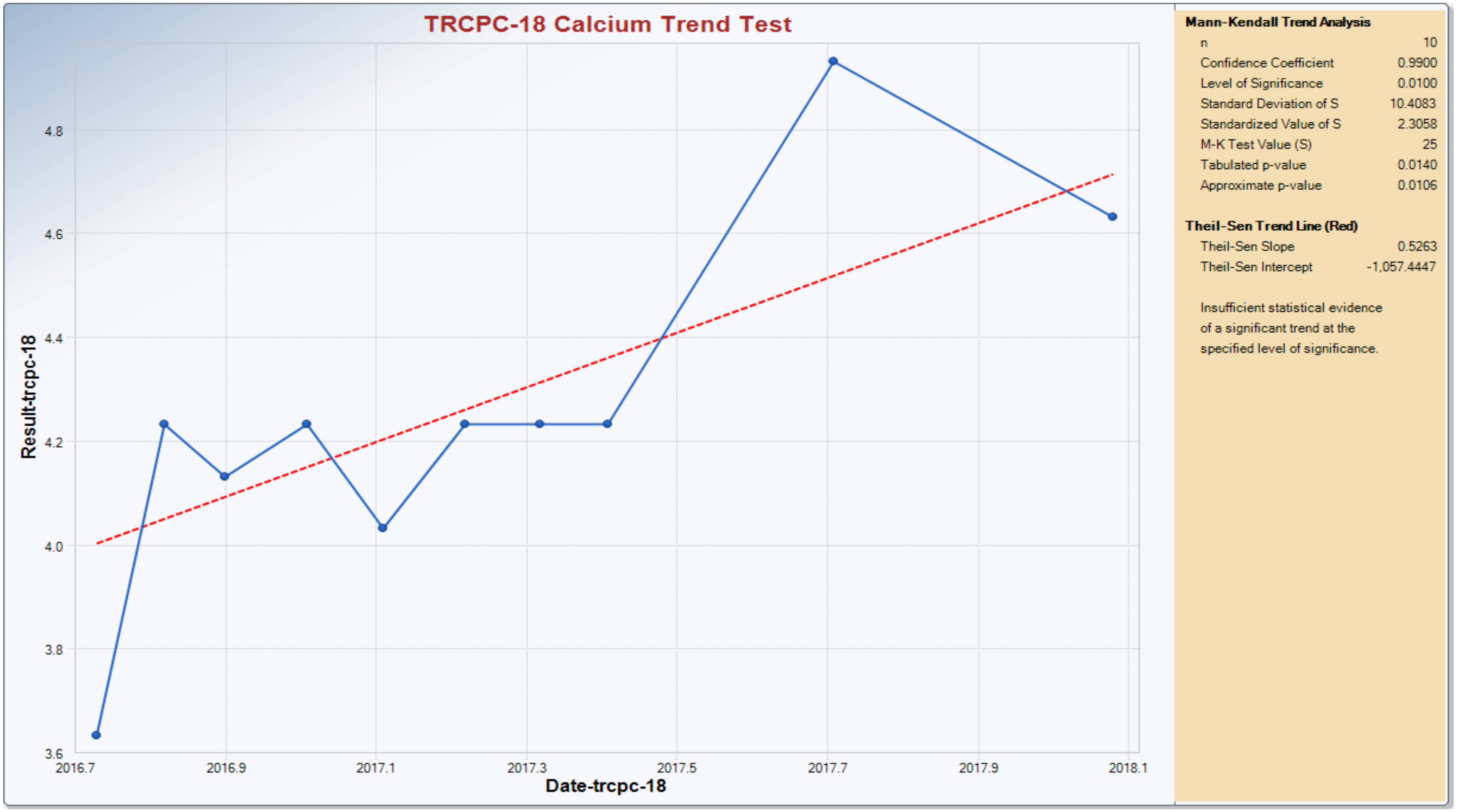


Figure 3

Trend Test: 10 Data Points

Escalante Station CCR Groundwater Program

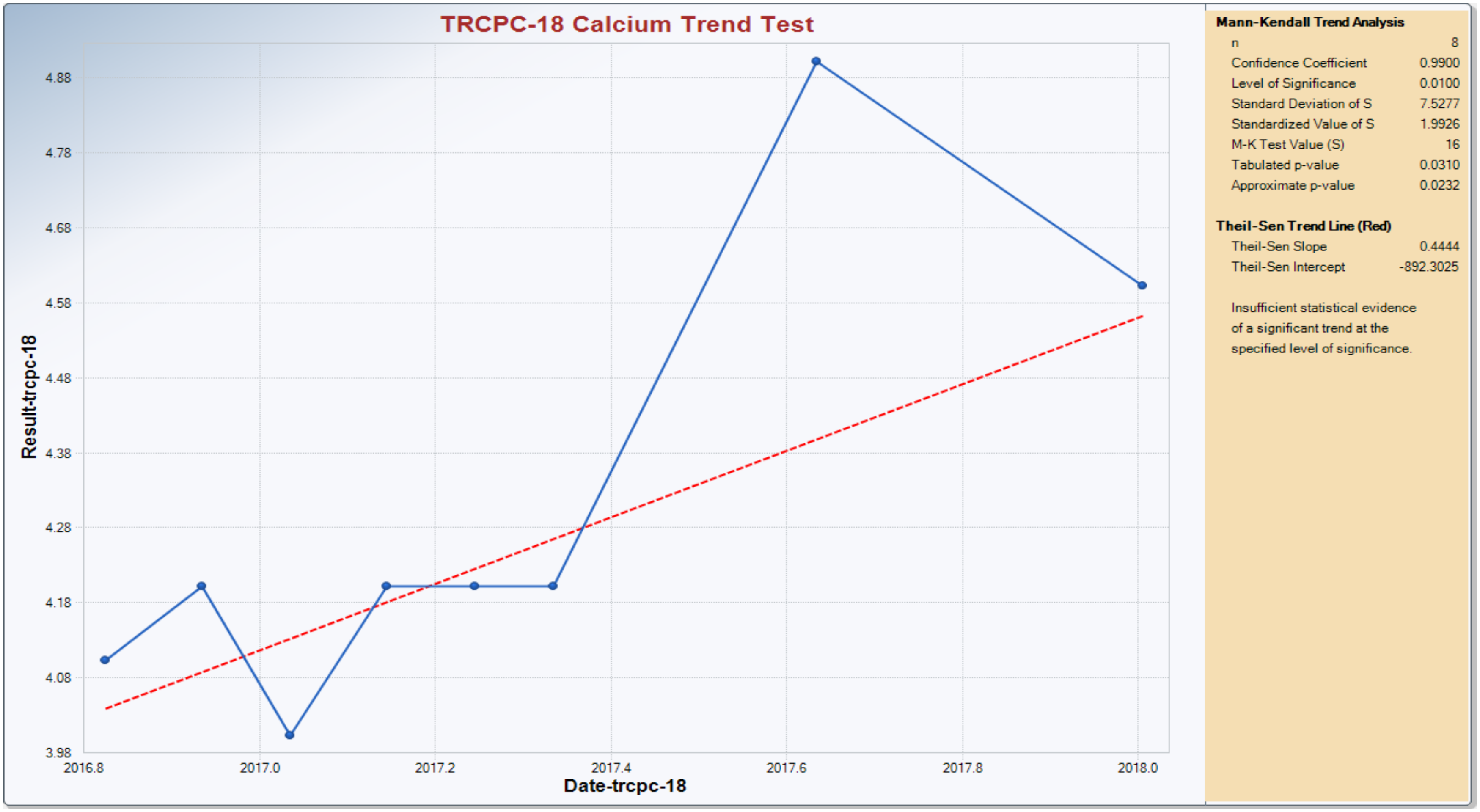


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Figure 4

Trend Test: 8 Data Points

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