2018 ANNUAL GROUNDWATER MONITORING AND CORRECTIVE ACTION REPORT CLASS 2 LANDFILL CROSS GENERATING STATION

by Santee Cooper
Moncks Corner, South Carolina

January 2019

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1. 40 CFR § 257.90 Applicability

1.1 40 CFR § 257.90(a)

All CCR landfills, CCR surface impoundments, and lateral expansions of CCR units are subject to the groundwater monitoring and corrective action requirements under § 257.90 through § 257.98.

The Class 2 Landfill at Cross Generating Station (CGS) is subject to the groundwater monitoring and corrective action requirements described under Code of Federal Regulations Title 40 (40 CFR) § 257.90 through § 257.98. This document addresses the requirement for the Owner/Operator to prepare an Annual Report per § 257.90(e). The Class 2 Landfill ceased operations by December 31, 2015, and closure was completed by June 30, 2016 per a plan approved by South Carolina Department of Health and Environmental Control. The Class 2 Landfill was certified closed on February 28, 2017.

1.2 40 CFR § 257.90(e) - SUMMARY

Annual groundwater monitoring and corrective action report. For existing CCR landfills and existing CCR surface impoundments, no later than January 31, 2018, and annually thereafter, the owner or operator must prepare an annual groundwater monitoring and corrective action report. For new CCR landfills, new CCR surface impoundments, and all lateral expansions of CCR units, the owner or operator must prepare the initial annual groundwater monitoring and corrective action report no later than January 31 of the year following the calendar year a groundwater monitoring system has been established for such CCR unit as required by this subpart, and annually thereafter. For the preceding calendar year, the annual report must document the status of the groundwater monitoring and corrective action program for the CCR unit, summarize key actions completed, describe any problems encountered, discuss actions to resolve the problems, and project key activities for the upcoming year. For purposes of this section, the owner or operator has prepared the annual report when the report is placed in the facility's operating record as required by § 257.105(h)(1).

This Annual Report documents the activities completed in 2018 for the Class 2 Landfill at CGS as required by the Rule. Groundwater sampling and analysis was conducted per the requirements described in § 257.93, and the status of the groundwater monitoring program described in § 257.95 is provided in this report.

1.2.1 Status of the Groundwater Monitoring and Corrective Action Program

As provided in the notification on January 15th, 2018 statistically significant increases (SSI) of Appendix III constituents were identified downgradient of the Class 2 Landfill. An alternate source demonstration (ASD) was not conducted. As a result, an Assessment Monitoring program was initiated as required by § 257.94(e)(2). The notification was placed in the facility's operating record as required by 257.106(h)(4).

1.2.2 Key Actions Completed

The following key actions were completed in 2018:

- Conducted a statistical analysis of detection monitoring results to evaluate potential SSIs of Appendix III constituents above background downgradient of the Class 2 Landfill.

- Prepared 2017 Annual Report including:
    - The Annual Report was placed in the facility's operating record pursuant to § 257.105(h)(1);
    - Pursuant to § 257.106(h)(1), the notification was sent to the relevant State Director and/or Tribal authority within 30 days of the Annual Report being placed in the facility's operating record [§ 257.106(d)];
    - Pursuant to § 257.107(h)(1), the Annual Report was posted to the CCR Website within 30 days of the Annual Report being placed in the facility's operating record [§ 257.107(d)];
- Established assessment monitoring program in accordance with § 257.94 (e)(1)
- Placed the notification in the operating record that an assessment monitoring program was established per 257.105 (h)(5)
- Notified the relevant State Director with 30 days of placing the notification in the facility's operating record that an assessment monitoring program was established in accordance with § 257.106(h)(4) and § 257.106 (d);
- Posted the notification to the CCR Website within 30 days of the notice that an assessment monitoring program was established per § 257.107(h)(4) and § 257.107 (d);
- Collected and analyzed two rounds of groundwater monitoring (February and June) (Table 1) in accordance with § 257.95(b) and § 257.95(d)(1) and recorded the concentrations in the facility's operating record as required by § 257.95(d)(1); and
- Established groundwater protection standards for those detected Appendix IV constituents in accordance with § 257.95(d)(2) (Table 1);
- Completed statistical evaluation to determine statistically significant exceedance of GWPS for Appendix IV in accordance with § 257.93(h)(2);
- Placed in the operating record that the GW protection standard was exceeded per §257.105(h)(8)
- Notification was sent to the relevant State Director with 30 days of determining that the GW protection standard was exceeded per § 257.106(d) and §257.106(h)(6);
- Posted the notification to the CCR Website within 30 days of notifying the relevant State Director that the GW protection standard was exceeded per §257.107(h)(6) and § 257.107(d); and
- Initiated a characterization of the nature and extent of Appendix IV constituents identified at statistically significant levels above the GWPS in accordance with § 257.95(g)(1).

1.2.3 Problems Encountered

Problems such as damaged wells or issues with sample collection or lack of sampling, were not encountered at the Class 2 Landfill in 2018. However, when compiling the annual report an error was discovered regarding the laboratory reported unit of measure for Calcium. Calcium was analyzed per EPA 6020B and the results were incorrectly reported as parts per billion (ug/L) instead of parts per million (mg/L). This error has been corrected in the Santee Cooper database and this annual report so that Calcium is correctly reported in mg/L. Additionally, the 10/1/18 samples for groundwater wells PM-1 and CBW-1 were not analyzed within the required holding time for Mercury. As these were the background wells, and the oversight was caught in a timely manner, PM-1 and CBW-1 were resampled for Mercury on 11/29/18, with the same result (<0.20 ug/L).

1.2.4 Actions to Resolve Problems

The Calcium reporting values were corrected in the Santee Cooper database. As noted above, the wells were resampled for Mercury to ensure a sample was analyzed within the required holding time.

1.2.5 Project Key Activities for Upcoming Year

Key activities to be completed in 2019 include the following:

- Prepare the 2019 annual report; place it in the record as required by § 257.105(h)(1), notify the state [§ 257.106(d)]; and post to website [§ 257.107(d)].
- Based on the findings of the statistical analysis, conduct semi-annual groundwater monitoring to characterize the nature and extent of Appendix IV constituents identified at statistically significant levels above the GWPS in accordance with §257.95(g)(1)(iv); and
- Based on the findings of the statistical analysis, an evaluation of alternate sources of Appendix IV parameters, determination of nature and extent, and an assessment of corrective measures will be considered as provided in § 257.95(g)(1) and § 257.95(g)(3).

1.3 40 CFR § 257.90(e) - INFORMATION

At a minimum, the annual groundwater monitoring and corrective action report must contain the following information, to the extent available:

1.3.1 40 CFR § 257.90(e)(1)

A map, aerial image, or diagram showing the CCR unit and all background (or upgradient) and downgradient monitoring wells, to include the well identification numbers, that are part of the groundwater monitoring program for the CCR unit;

As required by § 257.90(e)(1), a map showing the locations of the CCR unit and associated upgradient and downgradient monitoring wells for the Class 2 Landfill is presented as Figure 1. In addition, this information is presented in the CCR Groundwater Monitoring Plan, which was placed in the facility's operating record by 17 October 2017 as required by § 257.105(h)(2).

1.3.2 40 CFR § 257.90(e)(2)

Identification of any monitoring wells that were installed or decommissioned during the preceding year, along with a narrative description of why those actions were taken;

Groundwater monitoring wells were not installed or decommissioned in 2018.

1.3.3 40 CFR § 257.90(e)(3)

In addition to all the monitoring data obtained under § 257.90 through § 257.98, a summary including the number of groundwater samples that were collected for analysis for each background and downgradient well, the dates the samples were collected, and whether the sample was required by the detection monitoring or assessment monitoring programs;

In accordance with § 257.95(b) and § 257.95(d)(1), two independent samples from each background and downgradient monitoring well were collected and analyzed. A summary table including the sample names, dates of sample collection, reason for sample collection (detection or assessment), and

monitoring data obtained for the groundwater monitoring program for the Class 2 Landfill is presented in Table I of this report. In addition, as required by § 257.95(d)(3), Table 1 includes the groundwater protection standards established under § 257.95(d)(2).

1.3.4 40 CFR § 257.90(e)(4)

A narrative discussion of any transition between monitoring programs (e.g., the date and circumstances for transitioning from detection monitoring to assessment monitoring in addition to identifying the constituent(s) detected at a statistically significant increase over background levels); and

As required by § 257.93(h) a statistical analysis of the Appendix III constituents was completed by January 15, 2018. Baseline analytical data collected from background monitoring wells PM-1 and CBW-1 were combined to develop Upper Tolerance Limits (UTLs). The UTLs for each Appendix III constituent were compared to the analytical results for the downgradient monitoring wells POZ-4, POZ-6, and POZ-7. Constituents with analytical results exceeding the UTLs were identified as SSIs over background for the respective Appendix III constituent. This statistical analysis determined that statistically significant increases of boron, calcium, chloride, pH, sulfate and total dissolved solids were present downgradient of the Class 2 Landfill. A source causing the SSI over background levels other than the CCR unit was not identified at that time and an Assessment Monitoring program was initiated. The Assessment Monitoring program has been established to meet the requirements of 40 CFR § 257.95.

As required by § 257.93(h)(2), a statistical analysis of Appendix IV constituents was completed by October 15, 2018. This statistical analysis determined that statistically significant increase of cobalt was present (Appendix A). There is no maximum contaminant level (MCL) for cobalt. Therefore, the groundwater protection standard is the regional screening level (RSL).

1.3.5 40 CFR § 257.90(e)(5)

Other information required to be included in the annual report as specified in § 257.90 through § 257.98.

Other information including development of groundwater protection standards, recording groundwater monitoring results in the operating record, and an evaluation of alternate sources is discussed in preceding sections.

TABLES

TABLE 1 - Summary of Analytical Results

Cross Generating Station Class 2 Landfill

Well ID	Purpose	Date of Sample Event		Appendix III Constituents								Appendix IV Constituents										
				Boron	Calcium	Calcium	Chloride	Fluoride	Sulfate	Total Dissolved Solids	pH	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Fluoride	Lead	Lithium	Lithium
			Unit	ug/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	SU	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	mg/L	ug/L	ug/L	ug/L
			Method	EPA 6020B	EPA 6010D	EPA 6020B	EPA 300.0	EPA 300.0	EPA 300.0	SM 2540C		EPA 6020B	EPA 6020B	EPA 6020B	EPA 6020B	EPA 6020B	EPA 6020B	EPA 6020B	EPA 300.0	EPA 6020B	EPA 6010D	EPA 6020B
			GWPS/US EPA MCL/RSL	-	-	-	-	4	-	-	-	6	10	2000	4	5	100	6	4	15	40	40
Site Background Wells																						
PM-1	Background	2/7/2018		<15		14.7	12.4	<0.10	13.5	112	5.29	<5.0	<5.0	75.6	<0.5	<0.50	<5.0	0.89	<0.10	<1.0		<10
PM-1	Background	6/20/2018		16	37		13.4	<0.10	8.58	200	5.58	<25	<5.0	103	<0.5	<0.5	<5.0	1	<0.10	<1.0	<10	
PM-1	Background	10/1/2018		15		16.6	12.9	<0.10	11.9	130	5.08		<5.0	76.9	<0.50			0.84	<0.10	<1.0		<10
PM-1	Resample Hg	11/29/2018																				
PM-1	**total samples**			3	1	2	3	3	3	3	3	2	3	3	3	2	2	3	3	3	1	2
CBW-1	Background	2/7/2018		18		24	2.88	0.19	69.1	92	4.42	<5.0	<5.0	43.6	<0.50	<0.50	<5.0	0.88	0.19	2.7		<10
CBW-1	Background	6/20/2018		20	24		3	0.2	67.9	138.8	4.32	<25	<5.0	43	<0.5	<0.5	<5.0	1	0.2	3	<10	
CBW-1	Background	10/1/2018		25		22.7	2.71	0.19	65.5	107.5	4.09		<5.0	42.8	<0.50			0.76	0.19	3.1		<10
CBW-1	Resample Hg	11/29/2018																				
CBW-1	**total samples**			3	1	2	3	3	3	3	3	2	3	3	3	2	2	3	3	3	1	2
Class 2 Landfill Wells																						
POZ-4	Assessment	2/7/2018		16		391	640	<0.10	185	1770	6.22	<5.0	<5.0	70.2	<0.50	<0.50	<5.0	53.3	<0.10	<1.0		11
POZ-4	Assessment	6/28/2018		20	450		730	0.16	227	2505	5.78	<25	<5.0	90	1	<0.5	<5.0	177	0.16	<1.0	20	
POZ-4	**total samples**			2	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1
POZ-6	Assessment	2/6/2018		56		467	277	<0.10	478	1606	6.63	<5.0	<5.0	43.6	<0.5	<0.50	<5.0	0.99	<0.10	<1.0		<10
POZ-6	Assessment	6/28/2018		55	420		272	0.15	432	1932	6.7	<25	<5.0	45	<0.5	<0.5	<5.0	5	0.15	<1.0	<10	
POZ-6	**total samples**			2	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1
POZ-7	Assessment	2/7/2018		<15		32.5	52	<0.10	<2.00	226	5.68	<5.0	<5.0	235	0.83	<0.50	<5.0	0.9	<0.10	<1.0		<10
POZ-7	Duplicate	2/7/2018		<15		35.6	59.9	<0.10	<2.00	218		<5.0	<5.0	272	0.77	<0.50	<5.0	0.74	<0.10	<1.0		<10
POZ-7	Assessment	6/27/2018		23	130		217	0.13	14.4	891.2	6.11	<25	<5.0	389	<0.5	<0.5	<5.0	<0.5	0.13	<1.0	20	
POZ-7	Duplicate	6/27/2018		25	140		226	0.13	15.7	907.5		<25	<5.0	402	<0.5	<0.5	17	<0.5	0.13	<1.0	22	
POZ-7	**total samples**			4	2	2	4	4	4	4	2	4	4	4	4	4	4	4	4	4	2	2

Notes:

J: Estimated value

TABLE 1 - Summary of Analytical Results

Cross Generating Station Class 2 Landfill

Well ID	Purpose	Date of Sample Event		Mercury	Molybdenum	Molybdenum	Radium 226	Radium 228	Radium 226 & 228 Combined	Selenium	Selenium	Thallium	Field Parameters							
													Depth to Groundwater	Groundwater Elevation	pH	Specific Conductivity	Temperature	Oxidation Reduction Potential	Turbidity	Dissolved Oxygen
			Unit	ug/L	ug/L	ug/L	pCi/L	pCi/L	pCi/L	ug/L	ug/L	ug/L	Feet (btoc)	Feet (msl)	SU	uS	C	mv	NTU	ppm
			Method	EPA 7470	EPA 6010D	EPA 6020B	EPA 900.1 Mod	EPA 904.0		EPA 6010D	EPA 6020B	EPA 6020B						SM2580		
			GWPS/US EPA MCL/RSL	2	100	100	-	-	5	50	50	2	-	-	-	-	-	-	-	-
Site Background Wells																				
PM-1	Background	2/7/2018		<0.2	<10		<1.00	<3.00	<4.00		<10	<1.0	7.91	75.33	5.29	188	17.02	85	1	1.09
PM-1	Background	6/20/2018		<0.2		<10	4.09	<3.00	7.09 J		<10	<1.0	8.88	74.36	5.58	279	23.54	123	1.6	0.81
PM-1	Background	10/1/2018		<0.2			13.3	<3.00	16.3 J	<10.0			8.01	75.23	5.08	201	25.31	104	0	0.99
PM-1	Resample Hg	11/29/2018		<0.20																
PM-1	**total samples**			4	1	1	3	3	3	1	2	2	3	3	3	3	3	3	3	3
CBW-1	Background	2/7/2018		<0.2	<10		<1.00	<3.00	<4.00		<10	<1.0	9.8	76	4.42	199	19.15	138	0.9	0.93
CBW-1	Background	6/20/2018		<0.2		<10	<1.00	<3.00	<4.00		<10	<1.0	10.35	75.45	4.32	196	22.69	105	1.9	0.85
CBW-1	Background	10/1/2018		<0.2			2.11	<3.00	5.11 J	<10.0			10.51	75.29	4.09	196	23.78	127	0	0.92
CBW-1	Resample Hg	11/29/2018		<0.20																
CBW-1	**total samples**			4	1	1	3	3	3	1	2	2	3	3	3	3	3	3	3	3
Class 2 Landfill Wells																				
POZ-4	Assessment	2/7/2018		<0.2	<10		<1.00	<3.00	<4.00		<10	<1.0	4.65	78.08	6.22	2170	20.22	135	0	1.45
POZ-4	Assessment	6/28/2018		<0.2		<10	3.29	<3.00	6.29 J		<10	<1.0	7.71	75.02	5.78	2880	22.88	68	0	0.52
POZ-4	**total samples**			2	1	1	2	2	2	0	2	2	2	2	2	2	2	2	2	2
POZ-6	Assessment	2/8/2018		<0.2	<10		<1.00	<3.00	<4.00		<10	<1.0	5.85	77.99	6.63	2190	16.36	106	2.5	2.53
POZ-6	Assessment	6/28/2018		<0.2		<10	<1.00	<3.00	<4.00		<10	<1.0	9.91	73.93	6.7	2070	27.41	3	0	3.99
POZ-6	**total samples**			2	1	1	2	2	2	0	2	2	2	2	2	2	2	2	2	2
POZ-7	Assessment	2/7/2018		<0.2	<10		1.14	<3.00	4.14 J		<10	<1.0	5.04	76.98	5.68	226	19.05	196	0	3.18
POZ-7	Duplicate	2/7/2018		<0.2	<10		<1.00	<3.00	<4.00		<10	<1.0								
POZ-7	Assessment	6/27/2018		0.25		<10	2.39	<3.00	5.39 J		<10	<1.0	7.48	74.54	6.11	817	23.85	153	0	1.61
POZ-7	Duplicate	6/27/2018		0.3		<10	1.83	<3.00	4.83 J		<10	<1.0								
POZ-7	**total samples**			4	2	2	4	4	4	0	4	4	2	2	2	2	2	2	2	2

Notes:

J: Estimated value

FIGURES

LEGEND

- CLASS II LANDFILL WELL
- ASH POND WELL
- CLASS 3 LANDFILL AREA B WELL
- BACKGROUND WELL
- CCR BOUNDARY

NOTE:

AERIAL IMAGERY SOURCE: ESRI

N

0 1,000 2,000

SCALE IN FEET

HALEY ALDRICH

SANTEE COOPER
CROSS GENERATING STATION
CROSS, SOUTH CAROLINA

LOCATION OF GROUNDWATER MONITORING WELLS FOR CCR COMPLIANCE – 2018

JANUARY 2019

FIGURE 1

GIS FILE PATH: \\haleyaldrich.com\share\boj_common\Projects\42122_Santee_Cooper\Global\GIS\Map_Projects\2019_01\132892_004_0001_CROSS_CCR_COMPLIANCE_WELLS.mxd — USER: ajospa — LAST SAVED: 1/30/2019 1:09:15 PM

Appendix A – Statistical Analysis

Summary of Appendix III Groundwater Monitoring Results Pursuant to 40 CFR § 257393 and 40 CFR § 257.94, Cross Generating Station, Class 2 Landfill

The South Carolina Public Service Authority (Santee Cooper) is implementing the 17 April 2015 U.S. Environmental Protection Agency (U.S. EPA) Federal Coal Combustion Residuals (CCR) Rule (40 CFR § 257 and 261) for the Cross Generating Station, located in Berkeley County, South Carolina. Santee Cooper provided Haley & Aldrich with groundwater monitoring data collected from a groundwater monitoring system that meets the requirements of 40 CFR §257.91. This memorandum documents the results of statistical tests conducted to determine if Appendix III groundwater monitoring constituents detected in downgradient wells are at levels that exhibit a statistically significant increase above background or upgradient wells consistent with the requirements in 40 CFR § 257.94.

Collection dates of groundwater samples from the CCR Unit span from 22 October 2015 through 11 October 2017. The data satisfy the CCR Rule requirement of collecting a minimum of 8 rounds of hydrological and groundwater quality data from upgradient wells. The Upper Tolerance Limit (UTL) statistical analysis was used as specified in the certification statement of October 15, 2017. The UTL is an accepted method under the CCR Rule and is the upper endpoint of a tolerance interval that is designed to contain a pre-specified proportion (e.g. 95 percent) of the background dataset.

Data from the most recent sample event from the downgradient monitoring wells for the Class 2 Landfill unit were compared to the UTL calculated from the background data (Table 1) from upgradient wells for the Appendix III constituents (boron, calcium, chloride, fluoride, pH, sulfate, and total dissolved solids). Based on these comparisons, the following results are indicated:

Class 2 Landfill: Boron, calcium, chloride, pH, sulfate, and total dissolved solids from one or more downgradient sample(s) indicated a statistically significant increase above background.

Statistical Evaluation of Appendix III Constituents

The Rule, 40 CFR §257.93(f) (1-4), provides four specific options to statistically evaluate whether water quality downgradient of the CCR Unit represents an SSI of Appendix III parameters compared to background water quality of the CCR Unit. The Upper Tolerance Limit (UTL) was used to evaluate potential SSIs. A 95% Upper Tolerance Limit for 99% coverage was calculated to compare to downgradient groundwater analytical results for this evaluation.

UTL STATISTICAL ANALYSIS

The UTL is an accepted statistical method identified in the CCR Rule to evaluate the groundwater analytical data at CCR Units. A tolerance interval is a concentration range, with some confidence level, designed to contain a pre-specified proportion (e.g., 99 percent) of the underlying population from which the statistical sample is drawn (background). The upper endpoint of a tolerance interval is called the upper tolerance limit or UTL. Depending on the assumed distribution of background, parametric or non-parametric procedures were used to develop the UTL. Parametric tolerance limits utilize assumed distributions of the sample background data to develop the UTL, and non-parametric limits utilize order statistics or bootstrap methods to develop the UTL. The UTL was calculated using the U.S. EPA's ProUCL 5.1 software from the background well data after testing for outlier sample results that would warrant removal from the data set based on likely error in sampling or measurement. Both visual and statistical outlier tests for the background data were performed using ProUCL, and a visual inspection of the data

was performed for the downgradient sample data. No sample data were deemed as outliers that warranted removal from the data set.

RESULTS OF APPENDIX III DOWNGRADIENT STATISTICAL COMPARISONS

The sample concentrations at the downgradient wells for each of the Appendix III constituents from the October 2017 detection monitoring sampling event were compared to their respective UTLs. A sample concentration greater than the UTL is considered to represent a statistically significant increase. Based on these comparisons, the statistically significant increase(s) over background are:

- Boron at POZ-6;
- Calcium at POZ-4, POZ-6, and POZ-7;
- Chloride at POZ-4, POZ-6, and POZ-7;
- pH at POZ-4, POZ-6, and POZ-7;
- Sulfate at POZ-4 and POZ-6;
- Total Dissolved Solids at POZ-4, POZ-6, and POZ-7.

Table 1
Summary of background sample results and comparison of downgradient sample results
Cross Generating Station
Berkeley County, South Carolina

Background Samples								
CBW-1	**Sample Date**	**Boron (ug/L)**	**Calcium (ug/L)**	**Chloride (mg/L)**	**Fluoride (ug/L)**	**pH**	**Sulfate (mg/L)**	**Total Dissolved Solids (mg/L)**
AD33587	10/19/2015	32	27	3.21	0.25	4.46	81.5	150
AD40794	1/26/2016	21.8	27	2.95	0.3	4.13	88.2	120
AD47597	4/19/2016	18.3	29.4	2.33	0.29	4.33	86	120
AD56662	7/18/2016	21.7	28.7	2.95	0.27	4.39	90.1	132
AD65015	10/11/2016	30.2	22.7	3	0.28	4.15	73.7	151.7
AD72819	1/23/2017	24.9	26.2	2.45	0.25	4.32	77.7	148
AD79015	4/17/2017	18	25.6	2.96	0.22	4.26	71.2	62
AD86327	7/25/2017	22	-	2.61	-	4.22	73.3	92
AD93494	9/25/2017	24	21.9	2.51	0.23	4.34	74.5	ND (<40.0)
AD94541	10/9/2017	23	23	2.73	0.22	4.25	76.8	115
PM-1								
AD33581	10/19/2015	17.8	26	12.7	ND (<0.10)	5.46	26.5	206
AD40780	1/26/2016	ND (<15.0)	27	11.3	ND (<0.10)	5.2	25.5	165
AD47596	4/19/2016	ND (<15.0)	23.3	12.1	ND (<0.10)	5.32	20.2	130
AD56653	7/18/2016	16.3	18.8	13.2	ND (<0.10)	5.21	16	124
AD65014	10/11/2016	16.5	16.4	12.8	ND (<0.10)	5.04	19.3	200
AD72805	1/23/2017	ND (<15.0)	10.4	13.5	ND (<0.10)	5	8.82	138
AD79006	4/17/2017	19	12.5	12.7	ND (<0.10)	5.2	9.71	56
AD86311	7/12/2017	-	18.5	12.1	-	5.07	11.1	108
AD93483	9/25/2017	18	15.4	13.3	ND (<0.10)	5.26	8.03	ND (<40.0)
AD94530	10/9/2017	21	17	12.6	ND (<0.10)	5.21	8.77	80
Assumed Data Distribution for Calculation of UTL		Normal	Normal	Non-parametric	Non-parametric	Non-parametric	Non-parametric	Normal
95% Upper Tolerance Limit with 99% coverage*		36.18	40.71	13.5	0.3	5.46	90.1	269.7
Minimum Detection		16.3	10.4	2.33	0.22	4.13	8.03	56
Maximum Detection		32	29.4	13.3	0.3	5.46	90.1	206
Mean Detection		20.5	21.94	7.7	0.178	4.741	47.35	118.9
Frequency of Detection		84%	100%	100%	50%	100%	100%	90%
Downgradient Well	**Sample Date**	**Boron**	**Calcium**	**Chloride**	**Fluoride**	**pH**	**Sulfate**	**Total Dissolved Solids**
Class II Landfill								
POZ-4	10/11/2017	25	520	826	ND (<0.10)	5.79	278	2415
POZ-6	10/11/2017	62	450	329	ND (<0.10)	6.47	517	1808
POZ-7	10/10/2017	18	74	118	0.12	6.06	4.42	513.3

Notes and Abbreviations:
1. ND: Not Detected at concentrations greater than specified reporting limit.
2. Shaded downgradient result is a statistically significant increase based on comparison to calculated UTL.
3. Non-parametric methods of UTL calculation confidence coefficient is 0.165 to 0.182 based on pooled background n=18 to 20. Approximately 299 samples required to achieve 0.95.

Statistical Analysis for October 2018
Appendix IV GWPS Exceeded

Summary of Appendix IV Groundwater Monitoring Results Pursuant to 40 CFR § 257.93 and 40 CFR § 257.95, Cross Generating Station, Class 2 Landfill

The South Carolina Public Service Authority (Santee Cooper) is implementing the 17 April 2015 U.S. Environmental Protection Agency (U.S. EPA) Federal Coal Combustion Residuals (CCR) Rule (40 CFR § 257 and 261) for the Cross Generating Station, located in Berkeley County, South Carolina. Santee Cooper provided Haley & Aldrich with groundwater monitoring data collected from a groundwater monitoring system that meets the requirements of 40 CFR §257.91. This memorandum documents the results of statistical tests conducted to determine if Appendix IV groundwater monitoring constituents detected in downgradient wells are at levels that exhibit statistically significant levels above the groundwater protection standards consistent with the requirements in 40 CFR § 257.95.

Collection dates of groundwater samples from the CCR Unit span from 22 October 2015 through 27 June 2018. The data satisfy the CCR Rule requirement of collecting a minimum of 8 rounds of hydrological and groundwater quality data from upgradient and downgradient wells to establish baseline groundwater quality conditions and to determine if statistically significant increases of the Appendix III constituents were present downgradient of the CCR unit. The Upper Tolerance Level (UTL) statistical analysis was used as specified in the certification statement of October 15, 2017. The Confidence Interval is an accepted method under the CCR. This evaluation identified SSIs above background downgradient of the Class 2 Landfill triggering assessment monitoring.

As prescribed in § 257.95(b) and § 257.95(d)(1), two rounds of assessment monitoring were completed as required. Following completion of the second round of assessment monitoring a statistical analysis of the assessment monitoring results was conducted as required by § 257.95(g). The statistical analysis was completed by October 15, 2018 as required. Consistent with § 257.93 the analysis was performed in two steps. Each step involved multiple statistical procedures. First step involved an exploratory data analysis for background and downgradient wells; and the second step involved downgradient well data comparison to Groundwater Protection Standards (GWPS) for statistically significant levels (SSLs) determination.

Step-1- Exploratory data analysis: The datasets for background and downgradient wells was examined using various graphical and statistical testing procedures. The descriptive statistics for each well dataset were evaluated for number of observations, number of detects, percentage of non-detects (ND), range of ND concentration, mean, median (50th percentile), 95th percentile, variance, standard deviation, and coefficient of variation. This was followed by an outlier evaluation, data censorship (% of non-detects), determination of adequate number of data, equality of variance, normality or other distribution and temporal trends. Because constituents listed in Appendix IV tend to have more left-censored data than Appendix-III constituents censored data will be handled as recommended in the Unified Guidance based on the percent of censored data. Methods such as simple imputations, Kaplan-Meier estimation and double quantification rule were used.

Step-2- Downgradient data comparison: The Unified Guidance recommends a different statistical approach for assessment monitoring than for detection monitoring. In assessment monitoring, the mean or median confidence limits of the observations in downgradient wells are compared to a fixed numerical limit established as the GWPS. The Confidence Level was calculated using the U.S. EPA's ProUCL 5.1 software from the well data after testing for outlier sample results that would warrant removal from the data set based on potential error in sampling or measurement. Both visual and statistical outlier tests for

the data were performed using ProUCL, and a visual inspection of the data was performed for the sample data. No sample data were deemed as outliers that warranted removal from the data set. For constituents with an established Maximum Contaminant Level (MCL), the MCL was used as the GWPS, For those constituents where the USEPA has not established an MCL (cobalt, lithium, and molybdenum) the risk-based Regional Screening Level was used as the GWPS, as per the EPA's Phase 1 Part 1 update.

The determination of an SSL at each downgradient well was based on mean or median or single point comparison to the GWPS. For downgradient wells with minimum eight data points, parametric or non-parametric confidence levels of mean or median were calculated. A statistically significant level (SSL) is indicated if the 95% lower confidence interval (LCI) in the downgradient wells exceed the GWPS.

RESULTS OF APPENDIX IV STATISTICAL ANALYSIS

The sample concentrations at the downgradient wells for each of the detected Appendix IV constituents from the June 2018 detection monitoring sampling event were compared to their respective Groundwater Protection Standards. A lower confidence limit greater than the applicable groundwater protection standard, the greater of US EPA MCL/RSL or the background level, is considered to represent a statistically significant level above the GWPS. Based on these comparisons, cobalt in downgradient monitoring well POZ-4 was the only Appendix IV constituent identified at a statistically significant level above the GWPS.

Table 1
Summary of background sample results and comparison of downgradient sample results
Cross Generating Station
Berkeley County, South Carolina

Background Well	Sample Date	Antimony ug/L	Arsenic ug/L	Barium ug/L	Beryllium ug/L	Cadmium ug/L	Chromium ug/L	Cobalt ug/L	Fluoride mg/L	Lead ug/L	Lithium ug/L	Mercury ug/L
CBW-1	10/19/2015	ND(<5.0)	16	61	0.63	ND(<0.50)	14	3.4	0.25	11	ND(<10.0)	ND(<0.20)
CBW-1	1/26/2016	ND(<5.0)	6.7	44	ND(<0.50)	ND(<0.50)	ND(<5.0)	1.3	0.3	3.6	ND(<10.0)	ND(<1.0)
CBW-1	4/19/2016	ND(<5.0)	ND(<5.0)	43.8	ND(<0.5)	ND(<0.5)	ND(<5.0)	1.16	0.29	2.8	ND(<10.0)	ND(<0.200)
CBW-1	7/18/2016	ND(<5.0)	ND(<5.0)	37.8	ND(<0.5)	ND(<0.5)	ND(<5.0)	1.15	0.27	3.18	ND(<10.0)	ND(<0.200)
CBW-1	10/11/2016	ND(<5)	5.37	47.3	ND(<0.5)	ND(<0.50)	ND(<5)	1.09	0.28	3.75	ND(<10.0)	ND(<0.200)
CBW-1	1/23/2017	ND(<5.0)	ND(<5.0)	42.1	ND(<0.50)	ND(<0.50)	ND(<5.0)	1	0.25	3.1	ND(<10.0)	ND(<0.200)
CBW-1	4/17/2017	ND(<5.0)	ND(<5.0)	41.8	ND(<0.50)	ND(<0.50)	ND(<5.0)	1.1	0.22	2.8	ND(<10)	ND(<0.200)
CBW-1	7/25/2017		ND(<5.0)	42.1		ND(<0.50)	ND(<5.0)			3.2		
CBW-1	9/25/2017	ND(<5.0)	ND(<5.0)	44	ND(<0.50)	ND(<0.50)	ND(<5.0)	0.86	0.23	3.2	ND(<10)	ND(<0.20)
CBW-1	10/9/2017								0.22			
CBW-1	2/7/2018	ND(<5.0)	ND(<5.0)	43.6	ND(<0.50)	ND(<0.50)	ND(<5.0)	0.88	0.19	2.7	ND(<10)	ND(<0.2)
CBW-1	6/20/2018	ND(<25)	ND(<5.0)	43	ND(<0.5)	ND(<0.5)	ND(<5.0)	1	0.2	3	ND(<10)	ND(<0.2)
PM-1	10/19/2015	ND(<5.0)	4.2	100	ND(<0.50)	ND(<0.50)	ND(<5.0)	1	ND(<0.10)	ND(<2.5)	ND(<10.0)	ND(<0.20)
PM-1	1/26/2016	ND(<5.0)	3.5	87	ND(<0.50)	ND(<0.50)	ND(<5.0)	0.9	ND(<0.10)	ND(<2.5)	ND(<10.0)	ND(<1.0)
PM-1	4/19/2016	ND(<5.0)	ND(<5.0)	87.5	ND(<0.5)	ND(<0.5)	ND(<5.0)	0.79	ND(<0.10)	ND(<1.0)	ND(<10.0)	ND(<0.200)
PM-1	7/18/2016	ND(<5.0)	ND(<5.0)	86.8	ND(<0.5)	ND(<0.5)	ND(<5.0)	0.85	ND(<0.10)	ND(<1.0)	ND(<10.0)	ND(<0.200)
PM-1	10/11/2016	ND(<5)	ND(<5)	77	ND(<0.5)	ND(<0.50)	ND(<5)	0.851	ND(<0.10)	ND(<1)	ND(<10.0)	ND(<0.200)
PM-1	1/23/2017	ND(<5.0)	ND(<5.0)	70.3	ND(<0.50)	ND(<0.50)	ND(<5.0)	0.93	ND(<0.10)	ND(<1.0)	ND(<10.0)	ND(<0.200)
PM-1	4/17/2017	ND(<5.0)	ND(<5.0)	80.2	ND(<0.50)	ND(<0.50)	ND(<5.0)	0.98	ND(<0.10)	ND(<1.0)	ND(<10)	ND(<0.200)
PM-1	7/12/2017		ND(<5.0)	80.3		ND(<0.50)	ND(<5.0)					
PM-1	8/31/2017									ND(<1.0)		
PM-1	9/25/2017	ND(<5.0)	ND(<5.0)	75.3	ND(<0.50)	ND(<0.50)	ND(<5.0)	0.91	ND(<0.10)	ND(<1.0)	ND(<10)	ND(<0.20)
PM-1	10/9/2017								ND(<0.10)			
PM-1	2/7/2018	ND(<5.0)	ND(<5.0)	75.6	ND(<0.5)	ND(<0.50)	ND(<5.0)	0.89	ND(<0.10)	ND(<1.0)	ND(<10)	ND(<0.2)
PM-1	6/20/2018	ND(<25)	ND(<5.0)	103	ND(<0.5)	ND(<0.5)	ND(<5.0)	1	ND(<0.10)	ND(<1.0)	ND(<10)	ND(<0.2)
Assumed Data Distribution for Calculation of UTL		Non-parametric	Normal	Non-parametric	Non-parametric	Non-parametric	Non-parametric	Lognormal	Gamma	Gamma	Non-parametric	Non-parametric
95% Upper Tolerance Limit with 99% coverage*		5	6.509	103	0.5	0.5	5	1.495	0.455	4.93	10	0.2
Maximum Contaminant Level		6	10	2000	4	5	100	6	4	15	40	2
Minimum Detection		N/A	3.5	37.8	N/A	N/A	N/A	0.79	0.19	2.7	N/A	N/A
Maximum Detection		N/A	6.7	103	N/A	N/A	N/A	1.3	0.3	3.75	N/A	N/A
Mean Detection		N/A	4.943	64.4	N/A	N/A	N/A	0.981	0.245	3.133	N/A	N/A
Frequency of Detection		0%	19%	100%	0%	0%	0%	100%	48%	48%	0%	0%
Class II Landfill Downgradient Well												
POZ-4	6/28/2018	ND(<25)	ND(<5.0)	90	1	ND(<0.5)	ND(<5.0)	177	0.16	ND(<1.0)	20	ND(<0.2)
POZ-6	6/28/2018	ND(<25)	ND(<5.0)	45	ND(<0.5)	ND(<0.5)	ND(<5.0)	5	0.15	ND(<1.0)	ND(<10)	ND(<0.2)
POZ-7	6/27/2018	ND(<25)	ND(<5.0)	389	ND(<0.5)	ND(<0.5)	ND(<5.0)	ND(<0.5)	0.13	ND(<1.0)	20	0.25

Notes and Abbreviations:

1. ND: Not Detected at concentrations greater than specified reporting limit.
2. Shaded downgradient result is a statistically significant increase based on comparison to calculated UTL or the relavent MCL, whichever value is greatest.
3. Results from samples collected on 10/19/2015 from CBW-1 were excluded from UTL calculation due to multiple predicted outliers in combination with high turbidity. It is likely that this sample is not representative of groundwater conditions.
3. Quality control sample AE13409 collected on 6/27/2018 from POZ-7 was not used in this analysis.
4. Non-parametric methods of UTL calculation confidence coefficient is 0.165 to 0.182 based on pooled background n=18 to 20. Approximately 299 samples required to achieve 0.95.

Table 1
Summary of background sample results and compa
Cross Generating Station
Berkeley County, South Carolina

Background Well	Sample Date	Molybdenum ug/L	Radium 226 pCi/L	Radium 228 pCi/L	Selenium ug/L	Thallium ug/L
CBW-1	10/19/2015	ND(<10)	ND(<1.00)	ND(<3.00)	ND(<20)	ND(<1.0)
CBW-1	1/26/2016	ND(<10)	ND(<1.00)	ND(<3.00)	ND(<20)	ND(<1.0)
CBW-1	4/19/2016	ND(<10.0)	ND(<1.00)	4.31	ND(<10.0)	ND(<1.0)
CBW-1	7/18/2016	ND(<10.0)	ND(<1.00)	ND(<3.00)	ND(<10.0)	ND(<1.0)
CBW-1	10/11/2016	ND(<10.0)	1.43	ND(<3.00)	ND(<10)	ND(<1)
CBW-1	1/23/2017	ND(<10.0)	3.34	ND(<3.00)	ND(<10)	ND(<1.0)
CBW-1	4/17/2017	ND(<10.0)	ND(<1.00)	ND(<3.00)	ND(<10)	ND(<1.0)
CBW-1	7/25/2017				ND(<10)	
CBW-1	9/25/2017	ND(<10.0)	ND(<1.00)	ND(<3.00)	ND(<10)	ND(<1.0)
CBW-1	10/9/2017					
CBW-1	2/7/2018	ND(<10)	ND(<1.00)	ND(<3.00)	ND(<10)	ND(<1.0)
CBW-1	6/20/2018	ND(<10)	ND(<1.00)	ND(<3.00)	ND(<10)	ND(<1.0)
PM-1	10/19/2015	ND(<10)	1.59	ND(<3.00)	ND(<20)	ND(<1.0)
PM-1	1/26/2016	ND(<10)	1.31	ND(<3.00)	ND(<20)	ND(<1.0)
PM-1	4/19/2016	ND(<10.0)	ND(<1.00)	ND(<3.00)	ND(<10.0)	ND(<1.0)
PM-1	7/18/2016	ND(<10.0)	ND(<1.00)	ND(<3.00)	ND(<10.0)	ND(<1.0)
PM-1	10/11/2016	ND(<10.0)	1.49	ND(<3.00)	ND(<10)	ND(<1)
PM-1	1/23/2017	ND(<10.0)	ND(<1.00)	ND(<3.00)	ND(<10)	ND(<1.0)
PM-1	4/17/2017	ND(<10.0)	ND(<1.00)	ND(<3.00)	ND(<10)	ND(<1.0)
PM-1	7/12/2017					
PM-1	8/31/2017				ND(<10)	
PM-1	9/25/2017	ND(<10.0)	ND(<1.00)	ND(<3.00)	ND(<10)	ND(<1.0)
PM-1	10/9/2017					
PM-1	2/7/2018	ND(<10)	ND(<1.00)	ND(<3.00)	ND(<10)	ND(<1.0)
PM-1	6/20/2018	ND(<10)	4.09	ND(<3.00)	ND(<10)	ND(<1.0)
Assumed Data Distribution for Calculation of UTL		Non-parametric	Approx. Lognormal	Non-parametric	Non-parametric	Non-parametric
95% Upper Tolerance Limit with 99% coverage*		10	4.56	4.31	10	1
Maximum Contaminant Level		100	5	5	50	2
Minimum Detection		N/A	1.31	4.31	N/A	N/A
Maximum Detection		N/A	3.09	4.31	N/A	N/A
Mean Detection		N/A	2.208	4.31	N/A	N/A
Frequency of Detection		0%	32%	5%	0%	0%
Class II Landfill Downgradient Well						
POZ-4	6/28/2018	ND(<10)	3.29	ND(<3.00)	ND(<10)	ND(<1.0)
POZ-6	6/28/2018	ND(<10)	ND(<1.00)	ND(<3.00)	ND(<10)	ND(<1.0)
POZ-7	6/27/2018	ND(<10)	2.39	ND(<3.00)	ND(<10)	ND(<1.0)

Notes and Abbreviations:
1. ND: Not Detected at concentrations greater than s
2. Shaded downgradient result is a statistically signific
3. Results from samples collected on 10/19/2015 from
3. Quality control sample AE13409 collected on 6/27/2
4. Non-parametric methods of UTL calculation confide