

2018 Annual Groundwater Monitoring and Corrective Action Report

Duck Creek Landfill – CCR Unit ID 204
Duck Creek Power Station
17751 North Cilco Road
Canton, Illinois 61520

Illinois Power Resources Generating, LLC

January 31, 2019



JANUARY 31, 2019 | PROJECT #70089

2018 Annual Groundwater Monitoring and Corrective Action Report

Duck Creek Landfill – CCR Unit ID 204
Duck Creek Power Station
Canton, Illinois

Prepared for:
Illinois Power Resources Generating, LLC



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ACRONYMS AND ABBREVIATIONS

ASD	Alternate Source Demonstration
CCR	Coal Combustion Residuals
CFR	Code of Federal Regulations
mg/L	milligrams per liter
NRT/OBG	Natural Resource Technology, an OBG Company
OBG	O'Brien & Gere Engineers, part of Ramboll
SSI	Statistically Significant Increase
S.U.	Standard Units
TDS	Total Dissolved Solids

Duck Creek

SECTION 1: INTRODUCTION

This report has been prepared on behalf of Illinois Power Resources Generating, LLC by O'Brien & Gere Engineers, part of Ramboll (OBG), to provide the information required by the Code of Federal Regulations (CFR) found in 40 CFR 257.90(e) for the Duck Creek Landfill located at Duck Creek Power Station near Canton, Illinois.

In accordance with 40 CFR § 257.90(e), the owner or operator of an existing Coal Combustion Residuals (CCR) unit must prepare an annual groundwater monitoring and corrective action report, for the preceding calendar year, that documents the status of the groundwater monitoring and corrective action program for the CCR unit, summarizes key actions completed, describes any problems encountered, discusses actions to resolve the problems, and projects key activities for the upcoming year. At a minimum, the annual report must contain the following information, to the extent available:

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.
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.
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.
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).
5. Other information required to be included in the annual report as specified in §§ 257.90 through 257.98¹.

This report provides the required information for the Duck Creek Landfill for calendar year 2018.

¹ For calendar year 2018, corrective action and other information required to be included in the annual report as specified in §§ 257.96 through 257.98 is not applicable.

SECTION 2: MONITORING AND CORRECTIVE ACTION PROGRAM STATUS

Detection Monitoring Program sampling event dates and parameters collected are provided in the detection monitoring program summary table below. One sample was collected from each background and downgradient well in the monitoring system during the sampling events in November 2017, June 2018, and October 2018. Resampling was conducted in January 2018 and July 2018 on a subset of the Appendix III parameters. Analytical data was evaluated after each event in accordance with the Statistical Analysis Plan, Duck Creek Power Station, Illinois Power Resources Generating, LLC (NRT/OBG, 2017a) to identify any statistically significant increases (SSIs) of Appendix III parameters over background concentrations. The dates the SSIs were evaluated are provided in the detection monitoring program summary table below.

Detection Monitoring Program Summary			
Sampling Dates	Parameters Collected	SSIs	ASD Completion
November 10 and 11, 2017	Appendix III	Yes	April 9, 2018
January 17, 2018	SSI parameters only	Not Applicable	Not Applicable
June 6 and 7, 2018	Appendix III	Yes	To Be Determined
July 6, 2018	SSI parameters only	Not Applicable	Not Applicable
October 4 and 5, 2018	Appendix III	To Be Determined	To Be Determined

Potential alternate sources were evaluated as outlined in the 40 CFR § 257.94(e)(2). An alternate source demonstration (ASD) was completed and certified by a qualified professional engineer. The date the ASD was completed is provided in the detection monitoring program summary table. The ASD is included in Appendix A.

Statistical background values are provided in Table 1. Analytical results from the events summarized in the detection monitoring program summary table above are included in Table 2.

The Duck Creek Landfill remains in the Detection Monitoring Program in accordance with 40 CFR § 257.94.

SECTION 3: KEY ACTIONS COMPLETED IN 2018

Four groundwater monitoring events were completed in 2018 under the Detection Monitoring Program. These events occurred in January, June, July, and October, and are detailed in Section 2. One groundwater sample was collected from each background and downgradient well in the monitoring system during the sampling events in June 2018 and October 2018. Resampling was conducted in January 2018 and July 2018 on a subset of the Appendix III parameters. All samples were collected and analyzed in accordance with the Sampling and Analysis Plan (NRT/OBG, 2017b). All monitoring data obtained under 40 CFR §§ 257.90 through 257.98 (as applicable) in 2018 are presented in Table 2.

The groundwater monitoring system, including the CCR unit and all background and downgradient monitoring wells, is presented in Figure 1.

Duck Creek

SECTION 4: PROBLEMS ENCOUNTERED AND ACTIONS TO RESOLVE THE PROBLEMS

No problems were encountered with the groundwater monitoring program during 2018. Groundwater samples were collected and analyzed in accordance with the Sampling and Analysis Plan (NRT/OBG, 2017b), and all data was accepted.

Duck Creek

SECTION 5: KEY ACTIVITIES PLANNED FOR 2019

The following key activities are planned for 2019:

- Continuation of the Detection Monitoring Program with semi-annual sampling scheduled for the first and third quarters of 2019.
- Complete evaluation of analytical data from the downgradient wells, using background data to determine whether an SSI of Appendix III parameters over background concentrations has occurred.
- If an SSI is identified, potential alternate sources (i.e., a source other than the CCR unit caused the SSI or that SSI resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality) will be evaluated. If an alternate source is demonstrated to be the cause of the SSI, a written demonstration will be completed within 90 days of SSI determination and included in the annual groundwater monitoring and corrective action report for 2019.
 - » If an alternate source(s) is not identified to be the cause of the SSI, the applicable requirements of 40 CFR §§ 257.94 through 257.98 (e.g., assessment monitoring) as may apply in 2019 will be met, including associated recordkeeping/notifications required by 40 CFR §§ 257.105 through 257.108.

Duck Creek

REFERENCES

Natural Resource Technology, an OBG Company, 2017a, Statistical Analysis Plan, Duck Creek Power Station, Edwards Power Station, Illinois Power Resources Generating, LLC, October 17, 2017.

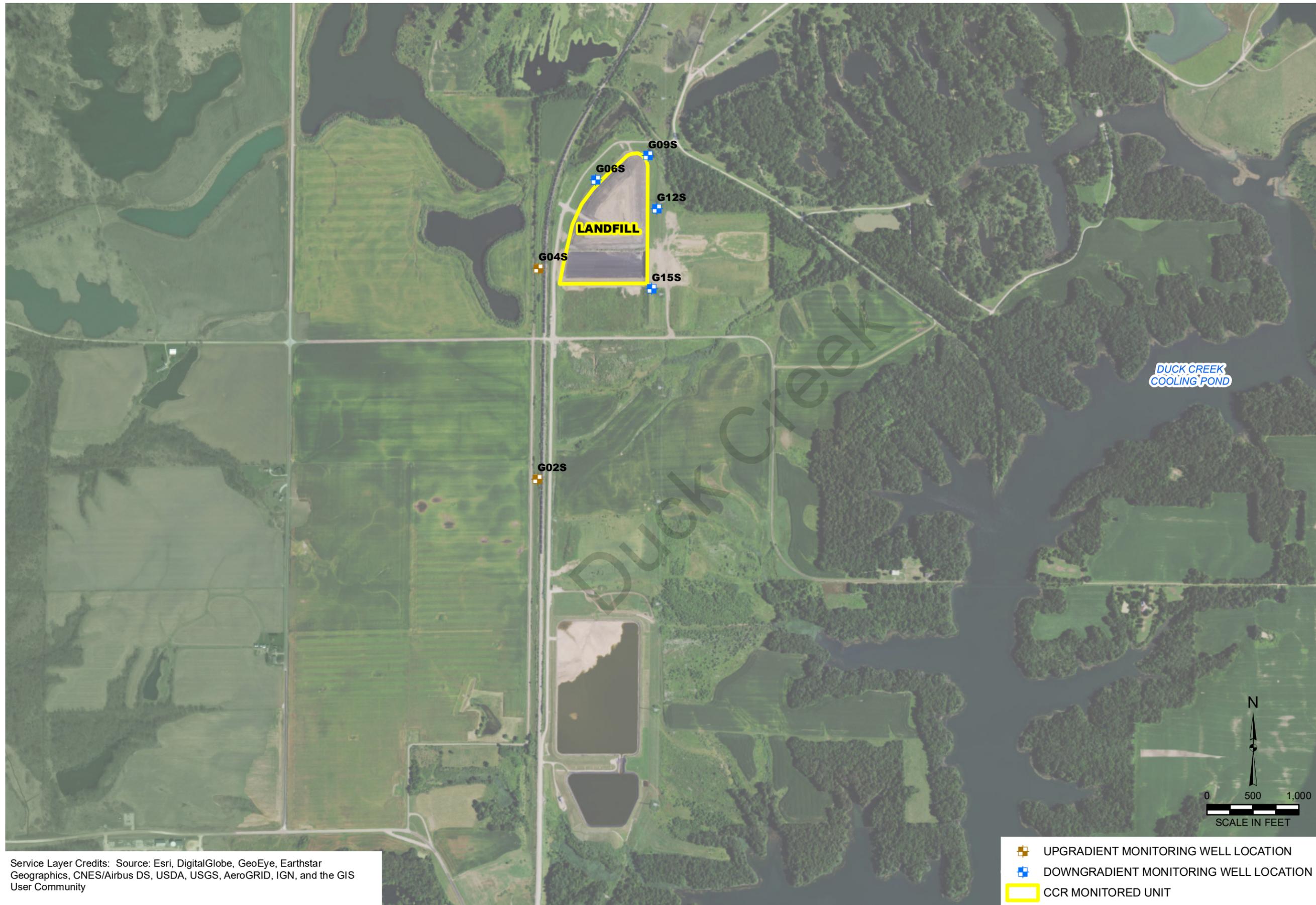
Natural Resource Technology, an OBG Company, 2017b, Sampling and Analysis Plan, Duck Creek Landfill, Duck Creek Power Station, Canton, Illinois, Project No. 2285, Revision 0, October 17, 2017.

Duck Creek

Figures

Duck Creek

Y:\Mapping\Projects\222285\MXD\2018_AnnualGWM_CAR\Figure_1_GWS_WellLoc_DuckCreek_LF.mxd Author: stolzsd Date: 1/28/2019 1:27:04 PM



Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

-  UPGRADIENT MONITORING WELL LOCATION
-  DOWNGRADIENT MONITORING WELL LOCATION
-  CCR MONITORED UNIT

DRAWN BY/DATE:
SDS 11/28/18
REVIEWED BY/DATE:
AJB 1/24/19
APPROVED BY/DATE:
NMP 1/28/19

GROUNDWATER SAMPLING WELL LOCATION MAP
 DUCK CREEK LANDFILL
 UNIT ID: 204
 2018 ANNUAL GROUNDWATER MONITORING AND CORRECTIVE ACTION REPORT
 VISTRA CCR RULE GROUNDWATER MONITORING
 DUCK CREEK POWER STATION
 CANTON, ILLINOIS

PROJECT NO: 70089
 FIGURE NO: 1



Tables

Duck Creek

Table 1. Statistical Background Values

2018 Annual Groundwater Monitoring and Corrective Action Report

Duck Creek Power Station

Unit ID 204 - Duck Creek Landfill

Parameter	Statistical Background Value
Appendix III	
Boron (mg/L)	0.129
Calcium (mg/L)	165.05
Chloride (mg/L)	20
Fluoride (mg/L)	0.527
pH (S.U.)	6.5 / 7.3
Sulfate (mg/L)	330
TDS (mg/L)	835

[O: KLS 8/30/18, C: RAB 8/31/18]

Notes:

mg/L = milligrams per liter

S.U. = Standard Units

TDS = Total Dissolved Solids

Duck Creek

Table 2. Appendix III Analytical Results

2018 Annual Groundwater Monitoring and Corrective Action Report

Duck Creek Power Station

Unit ID 204 - Duck Creek Landfill

Sample Location	Date Sampled	B, total (mg/L)	Ca, total (mg/L)	Cl, total (mg/L)	F, total (mg/L)	pH (field) (S.U.)	SO4, total (mg/L)	TDS (mg/L)
Background / Upgradient Monitoring Wells								
G02S	11/10/2017	0.036	95	3.1	0.410	6.9	2.9	390
	1/17/2018	NA	NA	2.7	NA	6.9	NA	NA
	6/6/2018	0.042	95	2.4	0.369	6.9	<1	340
	7/6/2018	NA	NA	2.9	NA	7.0	NA	NA
	10/4/2018	0.046	97	2.7	0.285	7.1	<1	340
G04S	11/10/2017	0.013	140	19	0.334	7.2	250	580
	1/17/2018	NA	NA	17	NA	7.0	NA	NA
	6/6/2018	0.014	150	17	0.364	6.9	250	640
	7/6/2018	NA	NA	20	NA	6.9	NA	NA
	10/4/2018	0.15	120	18	<0.25	6.8	240	620
Downgradient Monitoring Wells								
G06S	11/11/2017	0.018	120	14	0.359	7.2	44	290
	6/6/2018	0.047	350	11	0.366	6.9	44	370
	7/6/2018	NA	NA	11	NA	6.4	NA	NA
	10/4/2018	0.022	110	9.5	<0.25	6.8	40	380
G09S	11/11/2017	0.016	92	23	0.380	7.1	50	360
	1/17/2018	NA	NA	24	NA	7.2	NA	NA
	6/7/2018	0.027	120	19	<0.25	7.1	53	400
	7/6/2018	NA	NA	23	NA	7.1	NA	NA
	10/4/2018	0.037	110	19	<0.25	7.2	54	390
G12S	11/11/2017	0.011	80	17	0.408	6.9	98	360
	6/7/2018	<0.01	82	16	0.276	7.2	95	350
	7/6/2018	NA	NA	20	NA	7.2	NA	NA
	10/4/2018	0.018	85	16	0.274	7.1	95	340
G15S	11/11/2017	<0.01	86	16	0.297	7.3	45	380
	6/7/2018	<0.01	91	16	0.250	7.1	50	340
	7/6/2018	NA	NA	17	NA	7.1	NA	NA
	10/5/2018	0.011	92	17	0.418	7.0	46	340

[O: RAB 12/26/18, C: JQW 12/27/18][U: RAB 1/26/19]

Notes:

mg/L = milligrams per liter

S.U. = Standard Units

TDS = Total Dissolved Solids

< = concentration is less than the reporting limit

Appendix A

**Alternate Source
Demonstration**

Duck Creek

April 9, 2018

This alternate source demonstration has been prepared on behalf of Illinois Power Resources Generating, LLC by O'Brien & Gere Engineers, Inc. (OBG) to provide pertinent information pursuant to 40 CFR § 257.94(e)(2) for the Duck Creek Landfill located at Duck Creek Power Station near Canton, Illinois.

Initial background groundwater monitoring consisting of a minimum of eight samples as required under 40 CFR § 257.94(b) was initiated in December 2015 and completed prior to October 17, 2017. The first semi-annual detection monitoring samples were collected on November 10 and 11, 2017. Evaluation of analytical data from the first detection monitoring sample for statistically significant increases (SSIs) of 40 CFR Part 257 Appendix III parameters over background concentrations was completed within 90 days of collection and analysis of the sample (January 9, 2018). That evaluation identified the following SSIs at downgradient monitoring wells:

- Chloride at well G09S

In accordance with the Statistical Analysis Plan¹, to verify this SSI, well G09S was resampled on January 17, 2018 and analyzed only for the SSI parameter. Following evaluation of analytical data from the resample, the SSI for chloride at well G09S remained.

40 CFR § 257.94(e)(2) allows the owner or operator 90 days from the date of an SSI determination to complete a written demonstration that a source other than the CCR unit caused the SSI, or that the SSI resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality ("alternate source demonstration"). Pursuant to 40 CFR § 257.94(e)(2), the following demonstrates that sources other than the Duck Creek Landfill were the cause of the SSI listed above. This alternate source demonstration (ASD) was completed within 90 days of determination of the SSIs (April 9, 2018) as required by 40 CFR § 257.94(e)(2).

ALTERNATE SOURCE DEMONSTRATION: LINES OF EVIDENCE

As allowed by 40 CFR § 257.94(e)(2), this ASD demonstrates that sources other than Duck Creek Landfill (the CCR unit) caused the SSI. Lines of evidence (LOE) supporting this ASD include the following:

1. Proximity to historic coal mining activity
2. Elevated concentrations of chloride observed upgradient of the Duck Creek Landfill
3. Concentrations of boron and sulfate, common indicators for CCR impacts to groundwater, in the downgradient wells are stable and at or below concentrations in the background wells

These lines of evidence are described and supported in greater detail below. Monitoring wells are shown on Figure 1.

¹ Natural Resource Technology, an OBG Company, 2017, Statistical Analysis Plan, Duck Creek Power Station, Illinois Power Resources Generating, LLC, October 17, 2017.

LOE #1: PROXIMITY TO HISTORIC COAL MINING ACTIVITY

The area surrounding the Duck Creek Landfill is reclaimed mine land. Figure 2 shows the extents of nearby mines. The coal in this area has a sulfur content greater than 2.5 lbs of sulfur per million BTUs, the highest sulfur classification used by Illinois State Geological Survey².

The coal varies in depth from 0 to 50 feet (ft) below ground surface (bgs). The wells associated with the monitoring system established for the Duck Creek Landfill pursuant to 40CFR § 257.91 are screened between 30 and 44 ft bgs. Potentiometric data indicates that groundwater flows to the east-northeast as shown on Figure 3. Background well G02S is located approximately 5,500 ft downgradient from the nearby mine (Figure 2). The other wells in the monitoring system (G04S, G06S, G09S, G12S, and G15S) are located between 50 ft to 1,500 ft downgradient from the mine boundary.

State of Illinois groundwater quality regulations (Illinois Administrative Code [IAC] Title 35 Part 620 Groundwater Quality) acknowledge that water quality is adversely affected in areas where coal mining activity has occurred. The groundwater standards for chloride, iron, manganese, sulfates, TDS and pH within previously mined areas are the existing concentrations.

A study of groundwater quality near surface coal mines, performed by the U.S. Geological Survey (USGS)³, provides data on the effects of mines on groundwater quality. Downgradient wells in the study were generally within 2,000 ft from reclaimed surface mines. Regional differences in major ion composition of groundwater in unmined and mined areas were evaluated using Piper diagrams. Groundwater samples collected from wells downgradient of the reclaimed mine areas have high concentrations of carbonate-bicarbonate anions with no dominant cation. Groundwater samples collected from the Duck Creek Landfill monitoring system also have high concentrations of carbonate-bicarbonate anions as well as high concentrations of calcium cations. Piper diagrams in Figures 4 and 5 present this graphically and Table 1 summarizes the ionic composition.

² "Illinois Coal Reserves Assessment and Database Development: Final Report", Open File Series 1997-4, Illinois State Geological Survey, Coal Section, 1997.

³ "Ground-Water Quality in Unmined Areas and Near Reclaimed Surface Coal Mines in the Northern and Central Appalachian Coal Regions, Pennsylvania and West Virginia", Scientific Investigations Report 2006-5059, US Geological Survey, 2006.

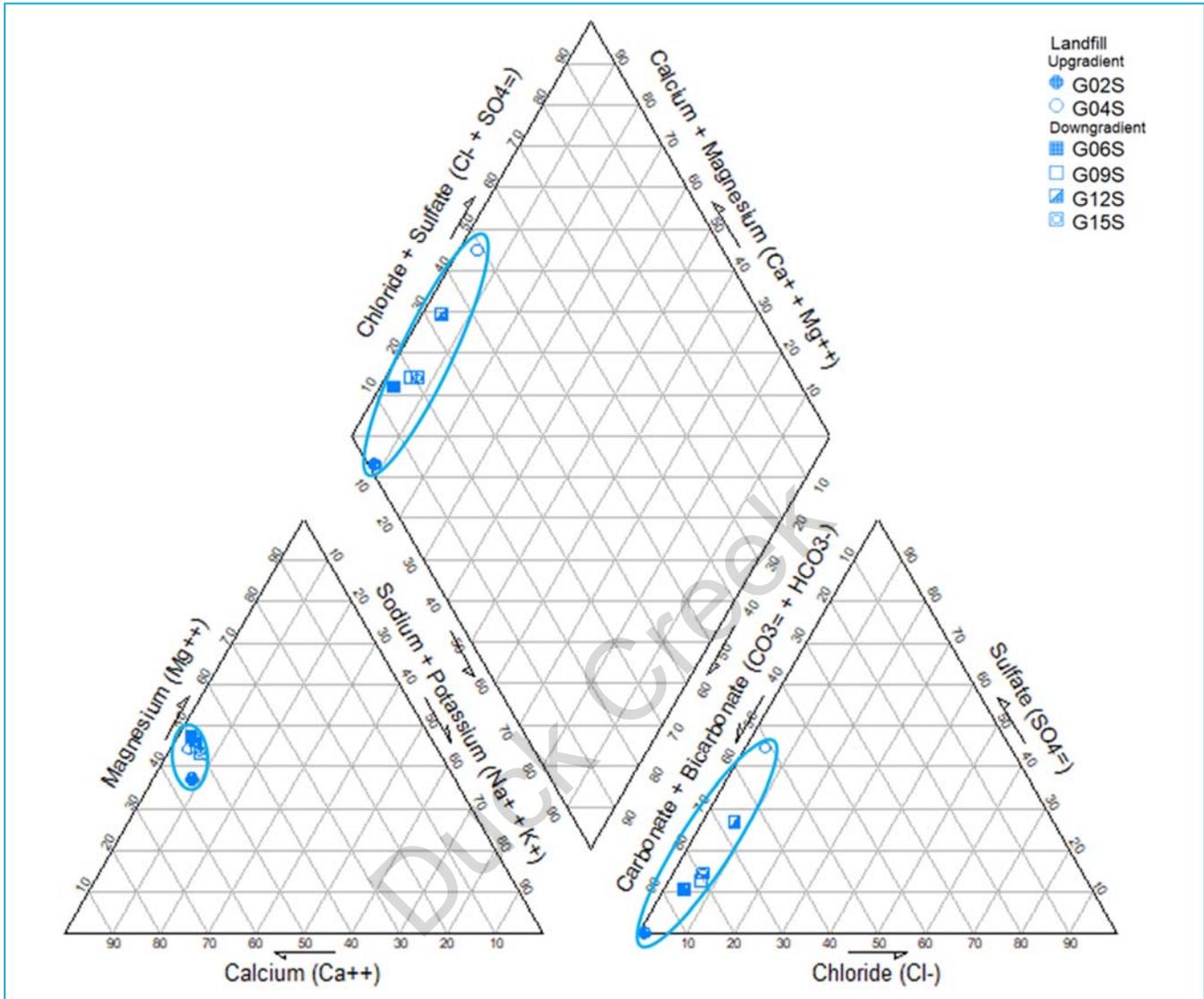


Figure 4. Piper diagram showing ionic composition of samples of background and downgradient groundwater associated with the Duck Creek Landfill

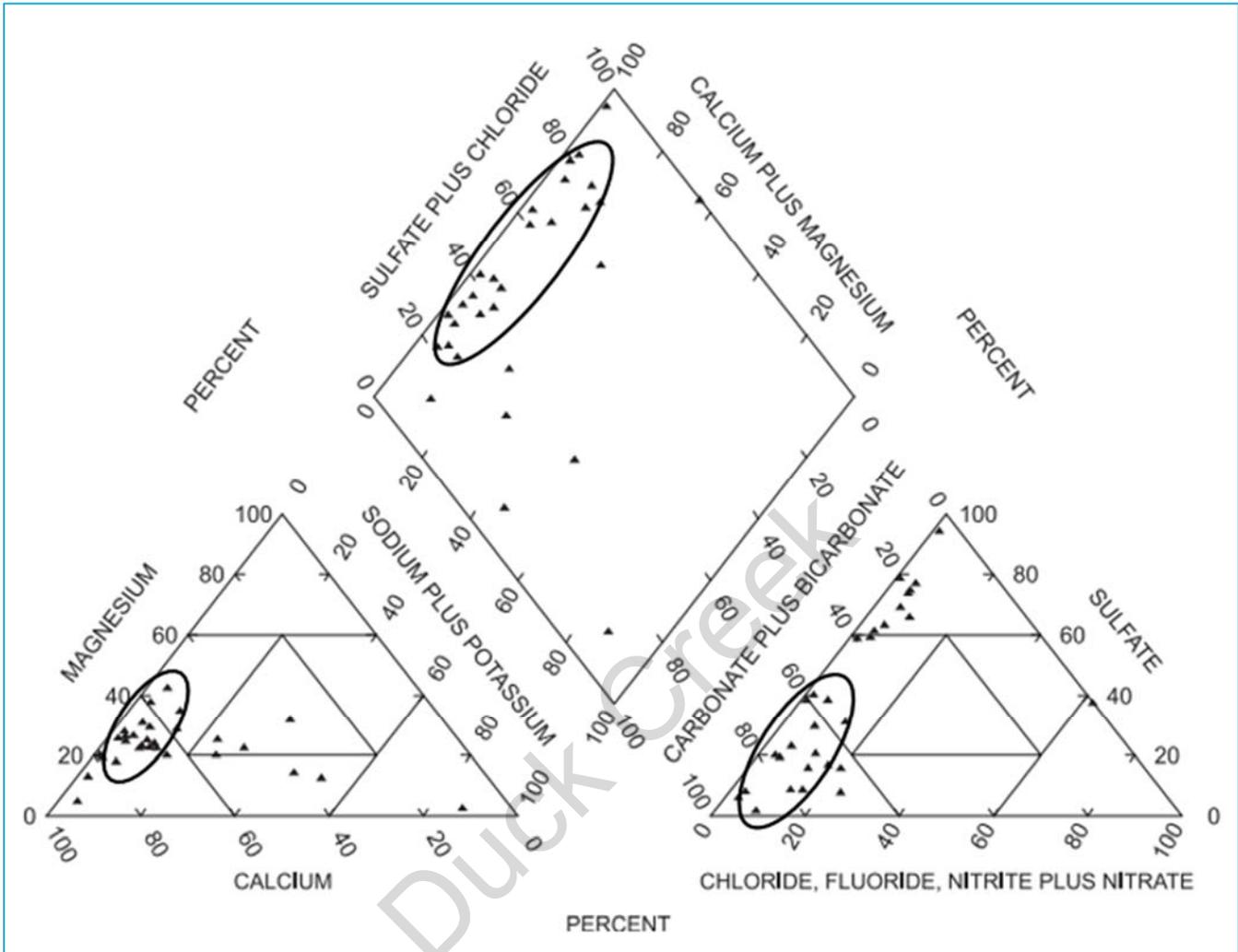


Figure 5. Piper diagram showing ionic composition of groundwater downgradient of reclaimed surface coal mines in high-sulfur coal regions (modified from USGS)

Grouping	Blue (Figure 4)	Black (Figure 5)
Locations	Duck Creek Landfill	Groundwater (Reclaimed Surface Coal Mines Study)
Dominant Cation	No dominant cation	Calcium
Dominant Anion	Carbonate-Bicarbonate	Carbonate-Bicarbonate

Table 1. Comparison of ionic classification of groundwater associated with the Duck Creek Landfill and groundwater downgradient of reclaimed surface coal mines in high-sulfur coal regions

The nearly identical ionic classifications presented in Table 1, and the close proximity of the mines, demonstrates that mining activity has affected groundwater quality at the Duck Creek Landfill.

LOE #2: ELEVATED CONCENTRATIONS OF CHLORIDE OBSERVED UPGRADIENT OF THE DUCK CREEK LANDFILL

Figure 6 presents a time series of chloride concentrations in groundwater samples from the monitoring system and well G03L. G03L is screened in the loess present in the subsurface above, and hydraulically connected to, the Uppermost Aquifer, and is monitored as a requirement of the landfill operating permit issued by the Illinois Environmental Protection Agency. It is located hydraulically upgradient of the Duck Creek Landfill based upon potentiometric map (Figure 3). Chloride concentrations in upgradient well G03L are at a similar magnitude as the concentrations in the downgradient well G09S. Groundwater samples from upgradient well G03L have exceeded the background upper prediction limit (UPL) for the past 2 years, demonstrating that the source of chloride is upgradient of the landfill.

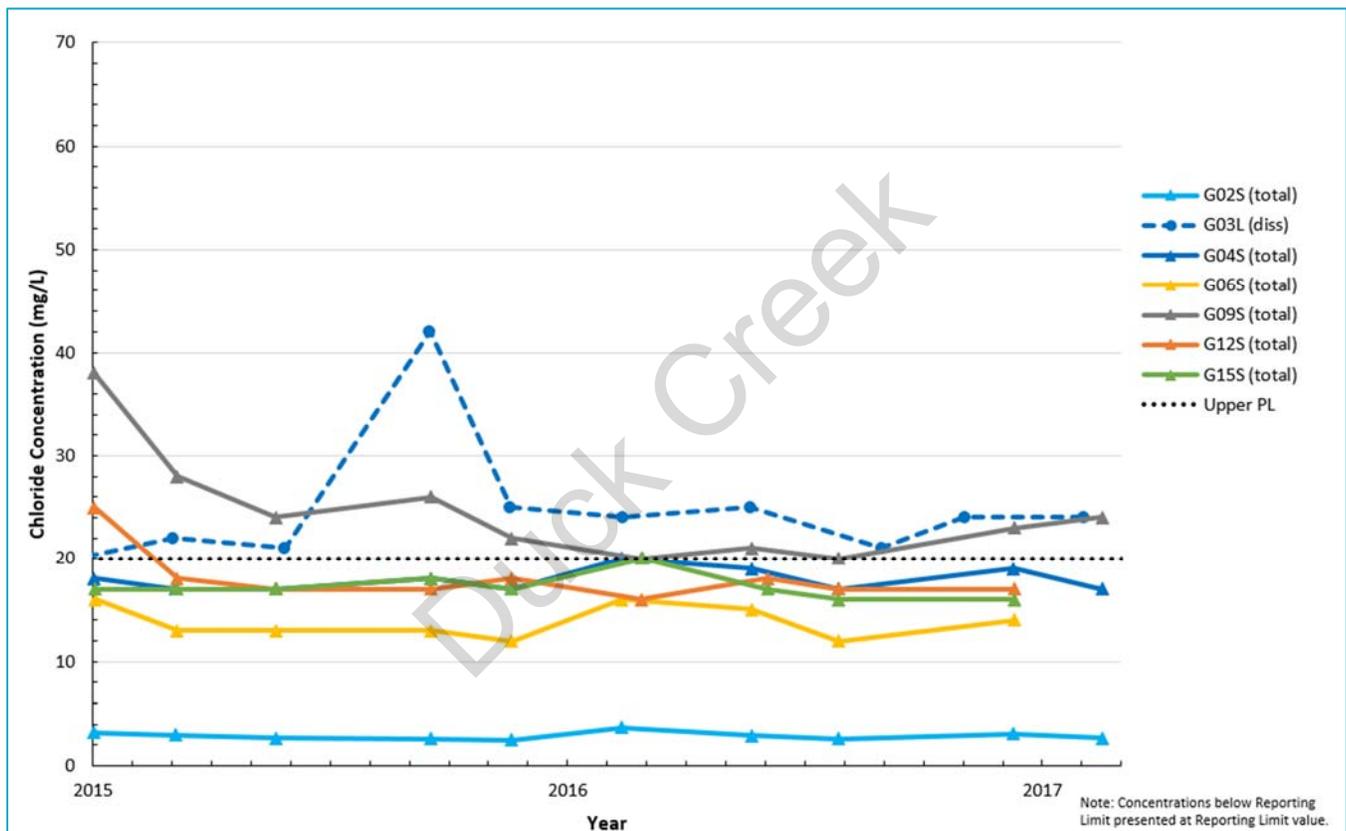


Figure 6. Chloride time series

LOE #3: CONCENTRATIONS OF BORON AND SULFATE, COMMON INDICATORS FOR CCR IMPACTS TO GROUNDWATER, IN THE DOWNGRAIDENT WELLS ARE STABLE AND AT OR BELOW CONCENTRATIONS IN THE BACKGROUND WELLS

Boron and sulfate are common indicators of CCR impacts to groundwater due to their leachability from CCR and mobility in groundwater; however, downgradient concentrations of both are substantially below background UPLs as shown in Figures 7 and Figure 8.

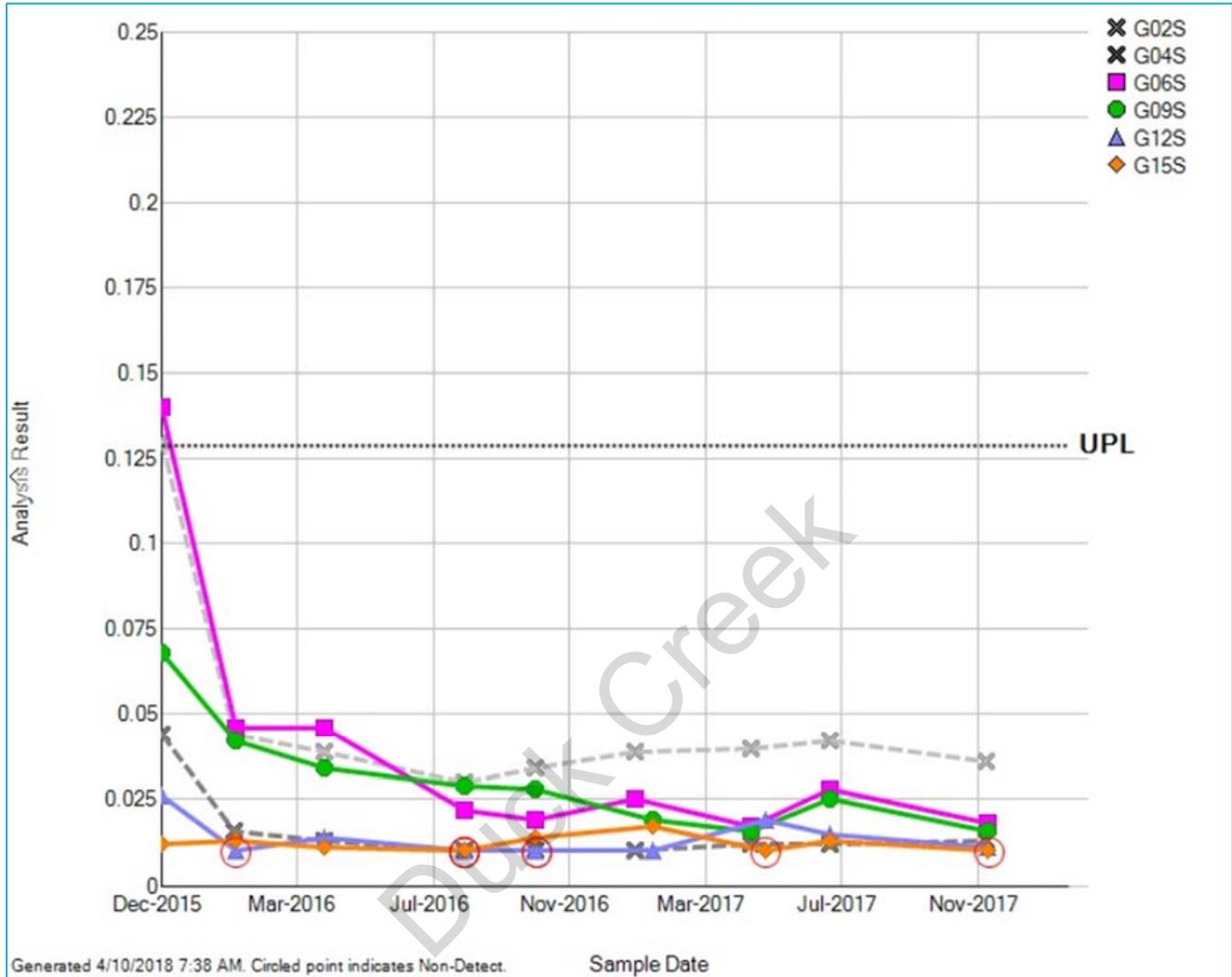


Figure 7. – Boron time series

Figure 7, and the statistical summary provided in Attachment A, demonstrate the following observations about the downgradient wells:

- Boron concentrations are very near or below detection limits. As listed in the statistical summary (rightmost column), boron was detected in most of the samples.
- Median boron concentration varied from 0.012 mg/L to 0.029 mg/L, or approximately four times lower than the UPL for boron determined from background monitoring wells G02S and G04S.

Mann-Kendall trend analysis tests were performed (Attachment A) to determine if concentrations at each well were increasing, decreasing or stable. Boron concentrations are stable in G02S, G04S, G12S, and G15S; and decreasing in G06S and G09S.

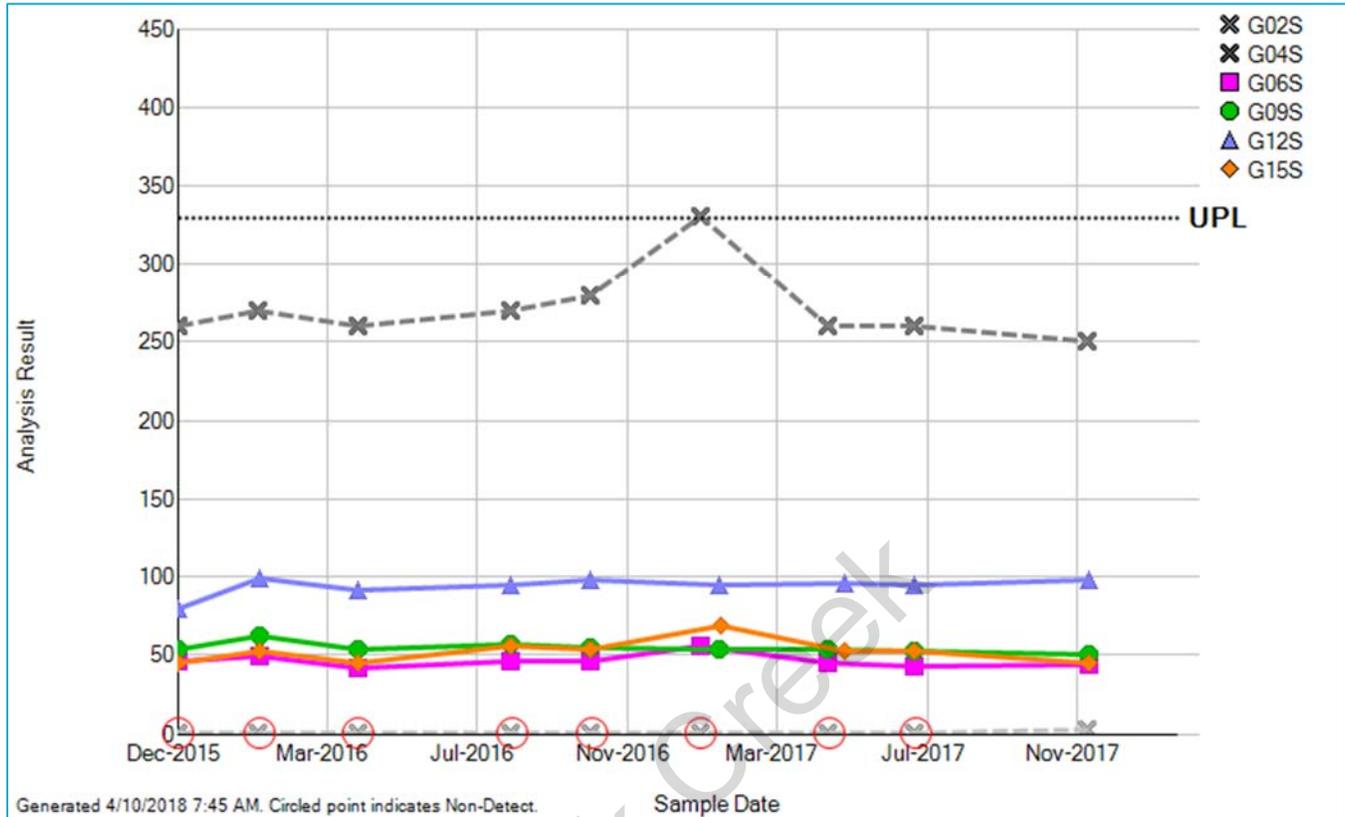


Figure 8 – Sulfate time series

Figure 8, and the statistical summary provided in Attachment B, demonstrate the following observations about the downgradient wells:

- All sulfate concentrations in downgradient wells are substantially below the UPL of 330 mg/L, determined from background monitoring wells G02S and G04S.
- Upgradient well G04S has the greatest sulfate content, which is to be expected since it is the closest well downgradient of the coal mining activity.
- Maximum sulfate concentrations measured in groundwater at downgradient wells in 2015-2017 ranged from 56 to 99 mg/L, or three to six times lower than the UPL.

Mann-Kendall trend analysis tests were performed (Attachment B) to determine if concentrations at each well were increasing, decreasing or stable. Sulfate concentrations are stable in wells G02S, G04S, G06S, G12S, and G15S; and decreasing in G09S.

Based on these three lines of evidence, it has been demonstrated that the chloride SSI in G09S is not due to the Duck Creek Landfill but is from an alternate anthropogenic source.

This information serves as the written alternate source demonstration prepared in accordance with 40 CFR § 257.94(e)(2) that the SSI observed during the detection monitoring program was not due to the CCR unit but was from anthropogenic impacts from historic coal mining activity. Therefore, an assessment monitoring program is not required and the Duck Creek Landfill will remain in detection monitoring.

Attachment A Boron - Statistical Summary and Trend Analysis

Attachment B Sulfate - Statistical Summary and Trend Analysis

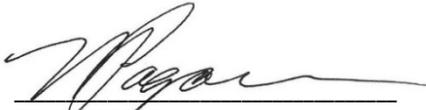
I, Eric J. Tlachac, a qualified professional engineer in good standing in the State of Illinois, certify that the information in this report is accurate as of the date of my signature below. The content of this report is not to be used for other than its intended purpose and meaning, or for extrapolations beyond the interpretations contained herein.



Eric J. Tlachac
Qualified Professional Engineer
062-063091
Illinois
O'Brien & Gere Engineers, Inc.
Date: April 9, 2018



I, Nicole M. Pagano, a professional geologist in good standing in the State of Illinois, certify that the information in this report is accurate as of the date of my signature below. The content of this report is not to be used for other than its intended purpose and meaning, or for extrapolations beyond the interpretations contained herein.



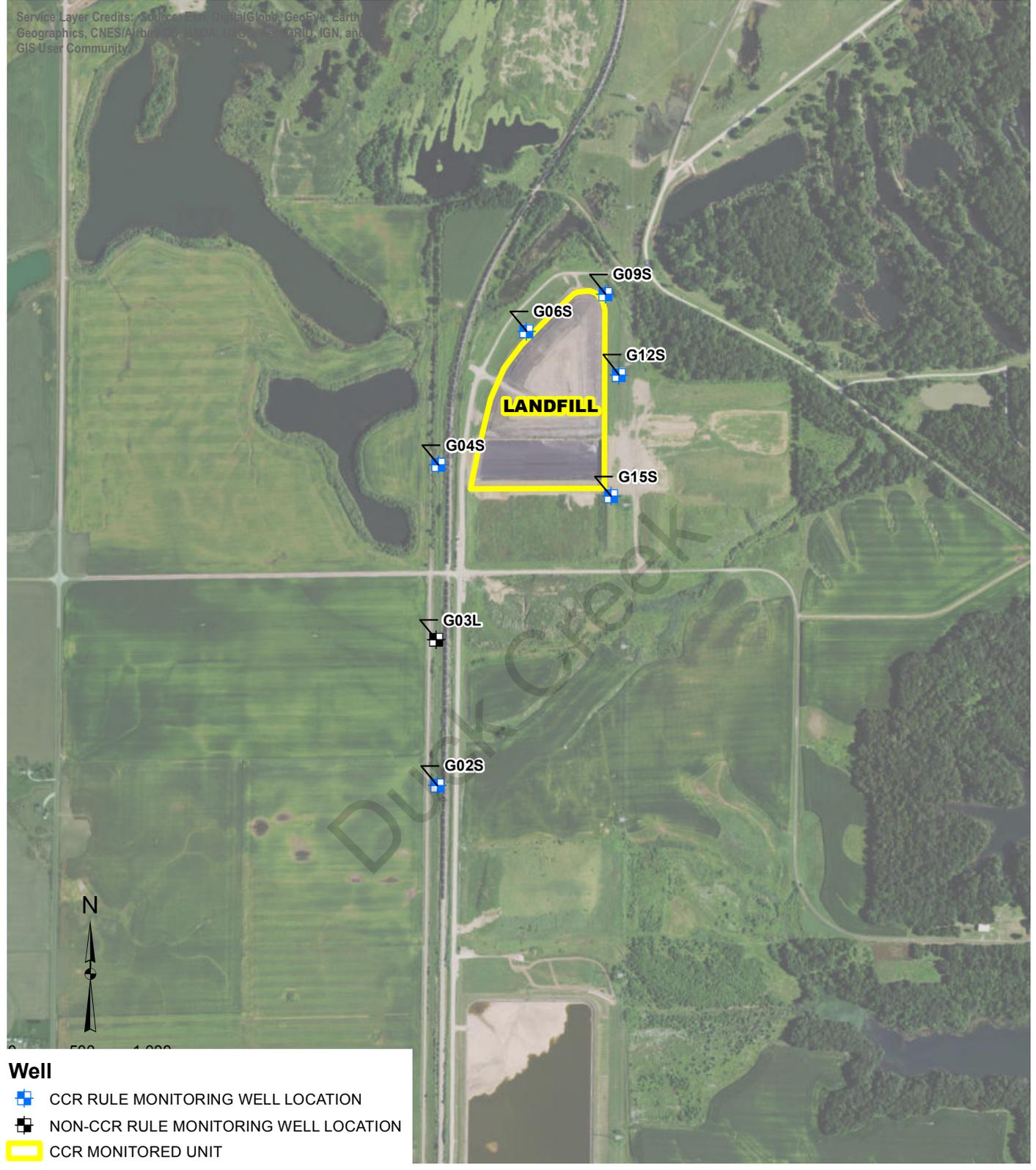
Nicole M. Pagano
Professional Geologist
196-000750
O'Brien & Gere Engineers, Inc.
Date: April 9, 2018



Figures

Duck Creek

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, AeroGRID, IGN, and the GIS User Community



- Well**
-  CCR RULE MONITORING WELL LOCATION
 -  NON-CCR RULE MONITORING WELL LOCATION
 -  CCR MONITORED UNIT

DRAWN BY/DATE:
SDS 4/9/18
REVIEWED BY/DATE:
NMP 4/9/18
APPROVED BY/DATE:
NMP 4/9/18

FACILITY MAP WITH MONITORING WELLS

ALTERNATIVE SOURCE DEMONSTRATION
DUCK CREEK POWER STATION
CANTON, ILLINOIS

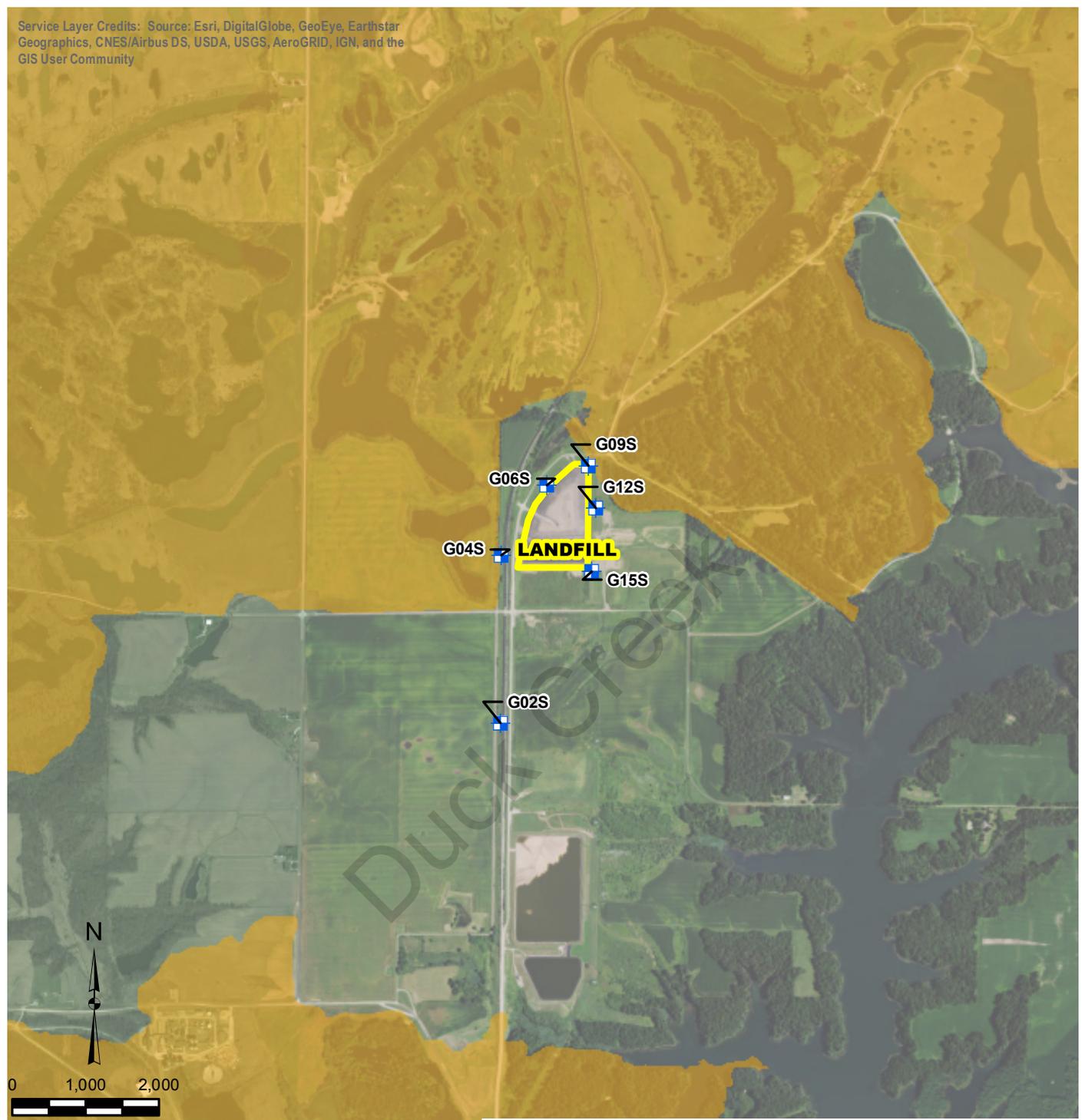
PROJECT NO: 67719

FIGURE NO: 1



Y:\Mapping\Projects\22\2285\MXD\Alt_Sources_DemDCL\Figure 1_Facility Map with Wells.mxd Author: BartelAB; Date/Time: 4/13/2018, 10:44:11 AM

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



-  CCR RULE MONITORING WELL LOCATION
-  CCR MONITORED UNIT
-  MINE COVERAGE AREA

MINING COVERAGE AREA SOURCE:
 LOUCHIOS, A., ELRICK, S., KOROSE, C, AND MORSE, D.,
 OCTOBER 28, 2009. SPRINGFIELD COAL THICKNESS FULTON COUNTY,
 UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN.

Y:\Mapping\Projects\222285M\XD\Alt_Sources_DermDCL\Figure 2_Mining Extents.mxd Author: stobzsd; Date/Time: 4/13/2018, 12:12:40 PM

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 SDS 4/9/18
 REVIEWED BY/DATE:
 NMP 4/9/18
 APPROVED BY/DATE:
 NMP 4/9/18

MINING EXTENTS

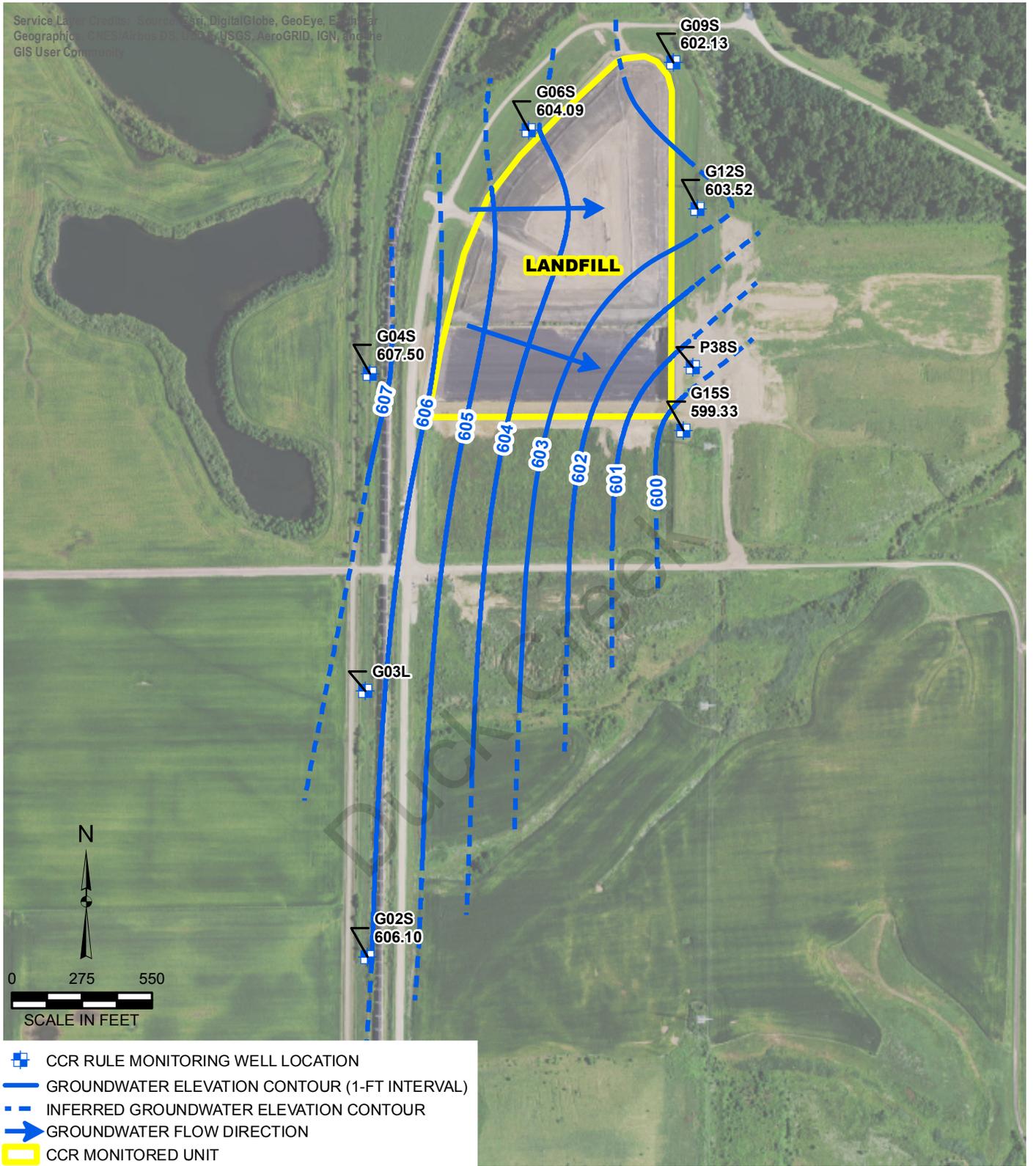
ALTERNATIVE SOURCE DEMONSTRATION
 DUCK CREEK POWER STATION
 CANTON, ILLINOIS

PROJECT NO: 67719

FIGURE NO: 2



Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar
 Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the
 GIS User Community



- CCR RULE MONITORING WELL LOCATION
- GROUNDWATER ELEVATION CONTOUR (1-FT INTERVAL)
- - - INFERRED GROUNDWATER ELEVATION CONTOUR
- ➔ GROUNDWATER FLOW DIRECTION
- CCR MONITORED UNIT

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 SDS 3/30/18
 REVIEWED BY/DATE:
 JJW 3/30/18
 APPROVED BY/DATE:
 NMP 4/9/18

**DUCK CREEK LANDFILL (UNIT ID: 204)
 UPPERMOST AQUIFER UNIT
 GROUNDWATER ELEVATION CONTOUR MAP
 NOVEMBER 10-11, 2017**

ALTERNATE SOURCE DEMONSTRATION
 DUCK CREEK POWER STATION
 CANTON, ILLINOIS

PROJECT NO: 67719

FIGURE NO: 3



Attachment A
**Boron – Statistical
Summary and Trend
Analysis**

Duck Creek

**Duck Creek
Statistical Summary for Pooled Locations**

User Supplied Information

Date Range: 12/02/2015 to 10/01/2017

Option for LT Pts:

x 1.00

Pooled Locations: G02S,G04S

Parameter	Units	Count	Mean	Median	Maximum	Minimum	Std Dev	Sen Slope Units/yr	Normal / Log Normal	% of Non-Detects
B, tot	mg/L	16	0.033	0.032	0.130	0.010	0.029	-0.023	No / No	12.50

Duck Creek

Shapiro-Wilk Normality test performed at 0.05 significance level.

**Duck Creek
Statistical Summary for Multiple Parameters (100)**

User Supplied Information

Date Range: 12/02/2015 to 10/30/2017

Option for LT Pts:

x 1.00

Locations: G06S,G09S,G12S,G15S

Parameter **Units**
B, tot **mg/L**

Location	Class	Count	Mean	Median	Maximum	Minimum	Std Dev	Sen Slope Units/yr	Normal / Log Normal	% of Non-Detects
G15S	Compliance	8	0.013	0.013	0.017	0.010	0.002	0.00	Yes / Yes	25.00
G12S	Compliance	8	0.014	0.012	0.026	0.010	0.006	0.00	No / Yes	37.50
G09S	Compliance	8	0.033	0.029	0.068	0.016	0.016	-0.02	Yes / Yes	0.00
G06S	Compliance	8	0.043	0.027	0.140	0.017	0.041	-0.03	No / Yes	0.00

Duck Creek

Shapiro-Wilk Normality test performed at 0.05 significance level.

**Duck Creek
Statistical Summary for Multiple Parameters (100)**

User Supplied Information

Date Range: 12/02/2015 to 10/30/2017

Option for LT Pts:

x 1.00

Locations: G06S,G09S,G12S,G15S

Duck Creek

Duck Creek Mann-Kendall Trend Analysis

User Supplied Information

Location ID:	G02S	Parameter Code:	01022
Location Class:		Parameter:	B, tot
Location Type:		Units:	mg/L
Confidence Level:	95.00%	Period Length:	1 month(s)
Date Range:	12/02/2015 to 10/17/2018	Limit Name:	
		Averaged:	No

Trend Analysis

Trend of the least squares straight line

Slope (fitted to data):	-0.000067	mg/L per day
R-Squared error of fit:	0.272138	

Sen's Non-parametric estimate of the slope (One-Sided Test)

Median Slope:	-0.000009	mg/L per day
Lower Confidence Limit of Slope, M1:	-0.000070	mg/L per day
Upper Confidence Limit of Slope, M2+1:	0.000013	mg/L per day

Non-parametric Mann-Kendall Test for Trend

S Statistic:	-0.629	
Z test:	1.645	
At the 95.0 % Confidence Level (One-Sided Test):	None	

Duck Creek Mann-Kendall Trend Analysis

User Supplied Information

Location ID:	G04S	Parameter Code:	01022
Location Class:		Parameter:	B, tot
Location Type:		Units:	mg/L
Confidence Level:	95.00%	Period Length:	1 month(s)
Date Range:	12/02/2015 to 10/17/2018	Limit Name:	
		Averaged:	No

Trend Analysis

Trend of the least squares straight line		
Slope (fitted to data):	-0.000025	mg/L per day
R-Squared error of fit:	0.303595	
Sen's Non-parametric estimate of the slope (One-Sided Test)		
Median Slope:	-0.000004	mg/L per day
Lower Confidence Limit of Slope, M1:	-0.000029	mg/L per day
Upper Confidence Limit of Slope, M2+1:	0.000006	mg/L per day
Non-parametric Mann-Kendall Test for Trend		
S Statistic:	-0.861	
Z test:	1.645	
At the 95.0 % Confidence Level (One-Sided Test):	None	

Duck Creek Mann-Kendall Trend Analysis

User Supplied Information

Location ID:	G06S	Parameter Code:	01022
Location Class:		Parameter:	B, tot
Location Type:		Units:	mg/L
Confidence Level:	95.00%	Period Length:	1 month(s)
Date Range:	12/02/2015 to 10/17/2018	Limit Name:	
		Averaged:	No

Trend Analysis

Trend of the least squares straight line		
Slope (fitted to data):	-0.000110	mg/L per day
R-Squared error of fit:	0.456533	
Sen's Non-parametric estimate of the slope (One-Sided Test)		
Median Slope:	-0.000055	mg/L per day
Lower Confidence Limit of Slope, M1:	-0.000144	mg/L per day
Upper Confidence Limit of Slope, M2+1:	-0.000009	mg/L per day
Non-parametric Mann-Kendall Test for Trend		
S Statistic:	-2.097	
Z test:	1.645	
At the 95.0 % Confidence Level (One-Sided Test):	Downward	

Duck Creek Mann-Kendall Trend Analysis

User Supplied Information

Location ID:	G09S	Parameter Code:	01022
Location Class:		Parameter:	B, tot
Location Type:		Units:	mg/L
Confidence Level:	95.00%	Period Length:	1 month(s)
Date Range:	12/02/2015 to 10/17/2018	Limit Name:	
		Averaged:	No

Trend Analysis

Trend of the least squares straight line		
Slope (fitted to data):	-0.000057	mg/L per day
R-Squared error of fit:	0.703967	
Sen's Non-parametric estimate of the slope (One-Sided Test)		
Median Slope:	-0.000053	mg/L per day
Lower Confidence Limit of Slope, M1:	-0.000072	mg/L per day
Upper Confidence Limit of Slope, M2+1:	-0.000031	mg/L per day
Non-parametric Mann-Kendall Test for Trend		
S Statistic:	-3.145	
Z test:	1.645	
At the 95.0 % Confidence Level (One-Sided Test):	Downward	

Duck Creek Mann-Kendall Trend Analysis

User Supplied Information

Location ID:	G12S	Parameter Code:	01022
Location Class:		Parameter:	B, tot
Location Type:		Units:	mg/L
Confidence Level:	95.00%	Period Length:	1 month(s)
Date Range:	12/02/2015 to 10/17/2018	Limit Name:	
		Averaged:	No

Trend Analysis

Trend of the least squares straight line		
Slope (fitted to data):	-0.000006	mg/L per day
R-Squared error of fit:	0.073802	
Sen's Non-parametric estimate of the slope (One-Sided Test)		
Median Slope:	0.000000	mg/L per day
Lower Confidence Limit of Slope, M1:	-0.000022	mg/L per day
Upper Confidence Limit of Slope, M2+1:	0.000007	mg/L per day
Non-parametric Mann-Kendall Test for Trend		
S Statistic:	0.000	
Z test:	1.645	
At the 95.0 % Confidence Level (One-Sided Test):	None	

Duck Creek Mann-Kendall Trend Analysis

User Supplied Information

Location ID:	G15S	Parameter Code:	01022
Location Class:		Parameter:	B, tot
Location Type:		Units:	mg/L
Confidence Level:	95.00%	Period Length:	1 month(s)
Date Range:	12/02/2015 to 10/17/2018	Limit Name:	
		Averaged:	No

Trend Analysis

Trend of the least squares straight line		
Slope (fitted to data):	-0.000001	mg/L per day
R-Squared error of fit:	0.007480	
Sen's Non-parametric estimate of the slope (One-Sided Test)		
Median Slope:	-0.000001	mg/L per day
Lower Confidence Limit of Slope, M1:	-0.000008	mg/L per day
Upper Confidence Limit of Slope, M2+1:	0.000009	mg/L per day
Non-parametric Mann-Kendall Test for Trend		
S Statistic:	-0.321	
Z test:	1.645	
At the 95.0 % Confidence Level (One-Sided Test):	None	

Attachment B

**Sulfate – Statistical
Summary and Trend
Analysis**

Duck Creek

**Duck Creek
Statistical Summary for Pooled Locations**

User Supplied Information

Date Range: 12/02/2015 to 10/01/2017

Option for LT Pts:

x 1.00

Pooled Locations: G02S,G04S

Parameter	Units	Count	Mean	Median	Maximum	Minimum	Std Dev	Sen Slope Units/yr	Normal / Log Normal	% of Non-Detects
SO4, tot	mg/L	16	137.375	130.500	330.000	1.000	141.788	0.000	No / No	50.00

Duck Creek

**Duck Creek
Statistical Summary for Multiple Parameters (100)**

User Supplied Information

Date Range: 12/02/2015 to 10/30/2017

Option for LT Pts:

x 1.00

Locations: G06S,G09S,G12S,G15S

**Parameter Units
SO4, tot mg/L**

Location	Class	Count	Mean	Median	Maximum	Minimum	Std Dev	Sen Slope Units/yr	Normal / Log Normal	% of Non-Detects
G15S	Compliance	8	53.375	53.000	69.000	45.000	7.501	5.03	Yes / Yes	0.00
G12S	Compliance	8	93.500	95.000	99.000	79.000	6.325	2.39	No / No	0.00
G09S	Compliance	8	55.250	54.000	62.000	52.000	3.059	-2.81	No / No	0.00
G06S	Compliance	8	46.625	46.000	56.000	42.000	4.340	-1.10	Yes / Yes	0.00

Shapiro-Wilk Normality test performed at 0.05 significance level.

**Duck Creek
Statistical Summary for Multiple Parameters (100)**

User Supplied Information

Date Range: 12/02/2015 to 10/30/2017

Option for LT Pts:

x 1.00

Locations: G06S,G09S,G12S,G15S

Duck Creek

Duck Creek Mann-Kendall Trend Analysis

User Supplied Information

Location ID:	G02S	Parameter Code:	00945
Location Class:		Parameter:	SO4, tot
Location Type:		Units:	mg/L
Confidence Level:	95.00%	Period Length:	1 month(s)
Date Range:	12/02/2015 to 10/17/2018	Limit Name:	
		Averaged:	No

Trend Analysis

Trend of the least squares straight line		
Slope (fitted to data):	0.001554	mg/L per day
R-Squared error of fit:	0.347565	
Sen's Non-parametric estimate of the slope (One-Sided Test)		
Median Slope:	0.000000	mg/L per day
Lower Confidence Limit of Slope, M1:	0.000000	mg/L per day
Upper Confidence Limit of Slope, M2+1:	0.000000	mg/L per day
Non-parametric Mann-Kendall Test for Trend		
S Statistic:	1.356	
Z test:	1.645	
At the 95.0 % Confidence Level (One-Sided Test):	None	

Duck Creek Mann-Kendall Trend Analysis

User Supplied Information

Location ID:	G04S	Parameter Code:	00945
Location Class:		Parameter:	SO4, tot
Location Type:		Units:	mg/L
Confidence Level:	95.00%	Period Length:	1 month(s)
Date Range:	12/02/2015 to 10/17/2018	Limit Name:	
		Averaged:	No

Trend Analysis

Trend of the least squares straight line		
Slope (fitted to data):	-0.004469	mg/L per day
R-Squared error of fit:	0.002054	
Sen's Non-parametric estimate of the slope (One-Sided Test)		
Median Slope:	0.000000	mg/L per day
Lower Confidence Limit of Slope, M1:	-0.042363	mg/L per day
Upper Confidence Limit of Slope, M2+1:	0.049480	mg/L per day
Non-parametric Mann-Kendall Test for Trend		
S Statistic:	-0.441	
Z test:	1.645	
At the 95.0 % Confidence Level (One-Sided Test):	None	

Duck Creek Mann-Kendall Trend Analysis

User Supplied Information

Location ID:	G06S	Parameter Code:	00945
Location Class:		Parameter:	SO4, tot
Location Type:		Units:	mg/L
Confidence Level:	95.00%	Period Length:	1 month(s)
Date Range:	12/02/2015 to 10/17/2018	Limit Name:	
		Averaged:	No

Trend Analysis

Trend of the least squares straight line		
Slope (fitted to data):	-0.002042	mg/L per day
R-Squared error of fit:	0.013941	
Sen's Non-parametric estimate of the slope (One-Sided Test)		
Median Slope:	-0.004247	mg/L per day
Lower Confidence Limit of Slope, M1:	-0.011067	mg/L per day
Upper Confidence Limit of Slope, M2+1:	0.006314	mg/L per day
Non-parametric Mann-Kendall Test for Trend		
S Statistic:	-0.851	
Z test:	1.645	
At the 95.0 % Confidence Level (One-Sided Test):	None	

Duck Creek Mann-Kendall Trend Analysis

User Supplied Information

Location ID:	G09S	Parameter Code:	00945
Location Class:		Parameter:	SO4, tot
Location Type:		Units:	mg/L
Confidence Level:	95.00%	Period Length:	1 month(s)
Date Range:	12/02/2015 to 10/17/2018	Limit Name:	
		Averaged:	No

Trend Analysis

Trend of the least squares straight line		
Slope (fitted to data):	-0.009418	mg/L per day
R-Squared error of fit:	0.457648	
Sen's Non-parametric estimate of the slope (One-Sided Test)		
Median Slope:	-0.012025	mg/L per day
Lower Confidence Limit of Slope, M1:	-0.018292	mg/L per day
Upper Confidence Limit of Slope, M2+1:	0.000000	mg/L per day
Non-parametric Mann-Kendall Test for Trend		
S Statistic:	-2.081	
Z test:	1.645	
At the 95.0 % Confidence Level (One-Sided Test):	Downward	

Duck Creek Mann-Kendall Trend Analysis

User Supplied Information

Location ID:	G12S	Parameter Code:	00945
Location Class:		Parameter:	SO4, tot
Location Type:		Units:	mg/L
Confidence Level:	95.00%	Period Length:	1 month(s)
Date Range:	12/02/2015 to 10/17/2018	Limit Name:	
		Averaged:	No

Trend Analysis

Trend of the least squares straight line		
Slope (fitted to data):	0.013490	mg/L per day
R-Squared error of fit:	0.286181	
Sen's Non-parametric estimate of the slope (One-Sided Test)		
Median Slope:	0.009763	mg/L per day
Lower Confidence Limit of Slope, M1:	-0.003144	mg/L per day
Upper Confidence Limit of Slope, M2+1:	0.027525	mg/L per day
Non-parametric Mann-Kendall Test for Trend		
S Statistic:	0.963	
Z test:	1.645	
At the 95.0 % Confidence Level (One-Sided Test):	None	

Duck Creek Mann-Kendall Trend Analysis

User Supplied Information

Location ID:	G15S	Parameter Code:	00945
Location Class:		Parameter:	SO4, tot
Location Type:		Units:	mg/L
Confidence Level:	95.00%	Period Length:	1 month(s)
Date Range:	12/02/2015 to 10/17/2018	Limit Name:	
		Averaged:	No

Trend Analysis

Trend of the least squares straight line		
Slope (fitted to data):	0.004618	mg/L per day
R-Squared error of fit:	0.021882	
Sen's Non-parametric estimate of the slope (One-Sided Test)		
Median Slope:	0.000000	mg/L per day
Lower Confidence Limit of Slope, M1:	-0.016471	mg/L per day
Upper Confidence Limit of Slope, M2+1:	0.025860	mg/L per day
Non-parametric Mann-Kendall Test for Trend		
S Statistic:	0.000	
Z test:	1.645	
At the 95.0 % Confidence Level (One-Sided Test):	None	

Duck Creek

