



2018 Annual Groundwater Monitoring and Corrective Action Report - Waste Disposal Area NIPSCO R. M. Schahfer Generating Station

Prepared Pursuant to 40 CFR §257.90(e) and Corresponding Regulations under 329 Indiana
Administrative Code 10-9-1

Submitted to:

Northern Indiana Public Service Company

R.M. Schahfer Generating Station
Wheatfield, Indiana

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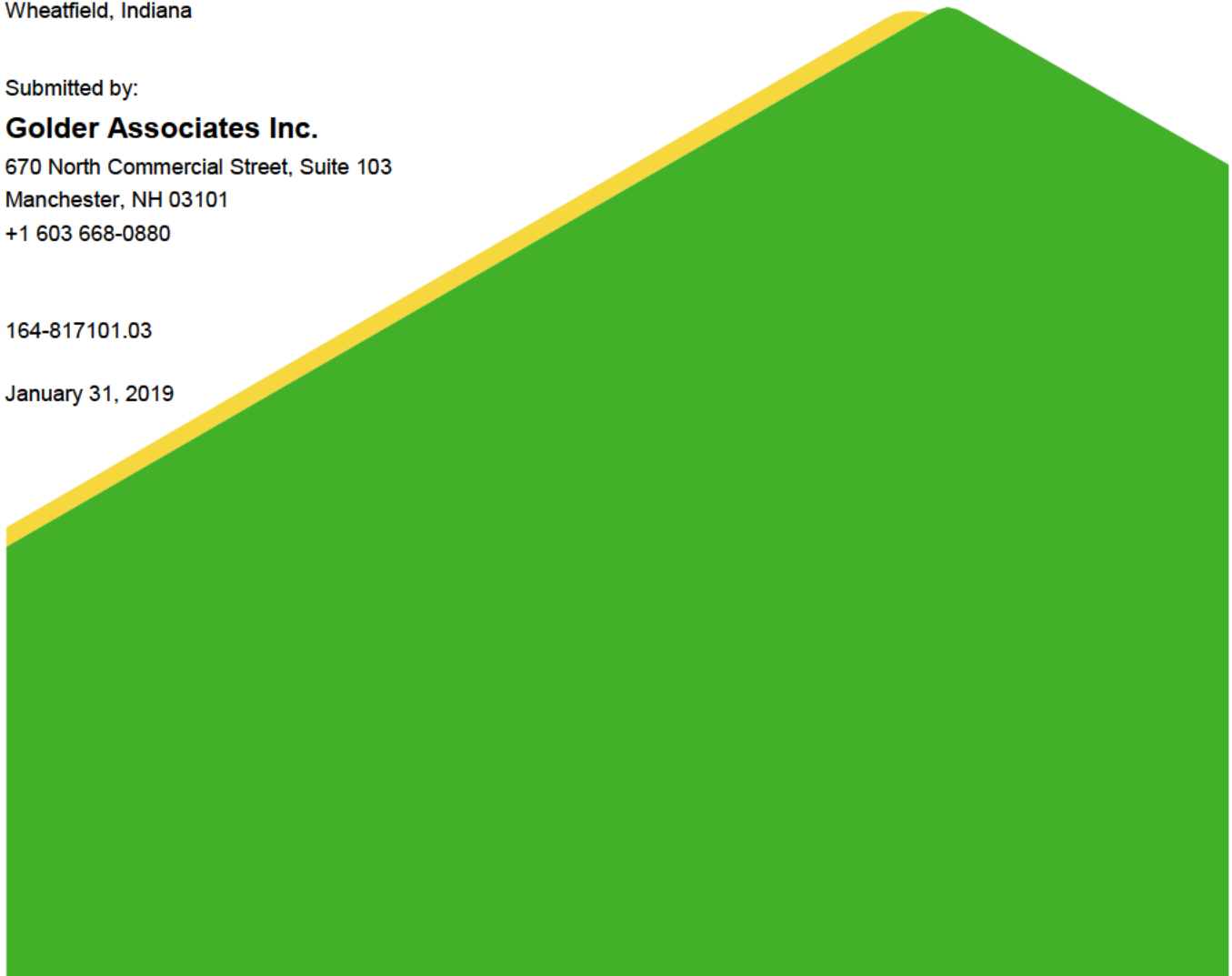


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1.0 INTRODUCTION

On behalf of Northern Indiana Public Service Company (NIPSCO), Golder Associates Inc. (Golder) prepared this 2018 CCR annual groundwater monitoring and corrective action report (2018 Annual Report) for the Rollin M. Schahfer Generating Station (RMSGGS, Schahfer) Waste Disposal Area (WDA, the CCR Unit) located in Wheatfield, Indiana. RMSGGS occupies an area of approximately four-square miles located at 2723 E 1500 N Road, Wheatfield, Jasper County, Indiana (Latitude 41° 12' 36" N and Longitude 87° 01' 48" W, see Figure 1). As shown in Figure 2, the WDA is an approximately 80-acre impoundment located in the southwest portion of the RMSGGS facility. Golder prepared the 2018 Annual Report in accordance with 40 Code of Federal Regulations (CFR) Part 257 as amended (CCR Final Rule) and corresponding regulations under 329 Indiana Administrative Code (IAC) 10-9-1.

Routine monitoring activities performed during the reporting period include inspection of wells for integrity and security, measurement of groundwater levels prior to sample collection in order to assess groundwater flow direction, and collection of samples for laboratory analysis.

In conformance with the applicable requirements of 40 CFR §257.90(e)(1) through (5) and corresponding State of Indiana requirements, the 2018 Annual Report:

- Documents the status of the groundwater monitoring and corrective action program
- Provides figures showing the CCR unit and monitoring well locations
- Summarizes key CCR groundwater activities completed during calendar year 2018
- Includes all CCR groundwater monitoring data obtained in calendar year 2018
- Describes any problems encountered during the monitoring activities
- Discusses actions taken to resolve the problems, if applicable
- Projects key activities for the upcoming year

2.0 GROUNDWATER MONITORING AND CORRECTIVE ACTION PROGRAM STATUS

Starting in 2016 following the installation of a groundwater monitoring system and throughout calendar year 2017, Golder collected background groundwater samples and performed Detection Monitoring at the Schahfer WDA pursuant to the requirements of 40 CFR §257.94 and corresponding State of Indiana requirements. In 2018, Golder performed the first and second Assessment Monitoring sampling events pursuant to the requirements of 40 CFR §257.95. Following the first Assessment Monitoring Sampling event, including verification sampling, Golder prepared an alternative source demonstration (ASD) for the WDA indicating that the detections of Appendix IV parameters downgradient of the WDA are not due to a release from the WDA. Based upon groundwater monitoring results collected pursuant to the CCR Final Rule to date, corrective action program requirements have neither been triggered nor implemented at this CCR unit.

2.1 Key Actions Completed - 2018

NIPSCO completed the following key actions relative to CCR groundwater well installation and monitoring at the WDA during calendar year 2018:

- Submittal of the of 2017 Groundwater Monitoring and Corrective Action Annual Report in January 2018 (40 CFR §257.90(e))
- Evaluation of the results of the first Detection Monitoring event in January 2018 (40 CFR §257.94)
- Performance of the first Assessment Monitoring event in March and April 2018 (40 CFR §257.95)
- Notification that an Assessment Monitoring program has been established in May 2018 (40 CFR §257.94(e))
- Establishment of groundwater protection standards (GWPS) and evaluation of the results of the first Assessment Monitoring event in August 2018 (40 CFR §257.95(d))
- Notification that constituents in Appendix IV exceeded the groundwater protection standard in September 2018 (40 CFR §257.95(g))
- Installation of additional monitoring wells to characterize the nature and extent of the plume and to monitor groundwater quality at the property boundary in May and July 2018 (40 CFR §257.95(g))
- Certification of WDA Alternative Source Demonstration in November 2018 (40 CFR §257.95(g))
- Performance of the second Assessment Monitoring event in October 2018 (40 CFR §257.95)

2.2 Monitoring System Modifications

Consistent with the requirements of 40 CFR §§257.90 and 257.91 and corresponding State of Indiana requirements, NIPSCO modified the groundwater monitoring well network to include two new deep wells (GAMW-01B, GAMW-12B) and four assessment monitoring well pairs (GAMW-42/42B, GAMW-43/43B, GAMW-44/44B, and GAMW-51/51B) in May and July 2018 at the locations shown in Figure 2. Golder installed the two new deep wells to monitor groundwater at the bedrock/overburden interface co-located with existing shallow wells (GAMW-01 and GAMW-12) near the waste boundary and four new well pairs further downgradient of the WDA to assess extent of potential groundwater impacts detected during Assessment Monitoring (see Figure 2). An overview of the modified groundwater monitoring network is provided below.

Background Monitoring Wells	Downgradient Monitoring Wells	Assessment Monitoring Wells
GAMW-03 and GAMW-03B	GAMW-01, GAMW-01B*, GAMW-12, GAMW-12B*, GAMW-13, GAMW-13B, GAMW-14, and GAMW-14B	GAMW-42*, GAMW-42B*, GAMW-43*, GAMW-43B*, GAMW-44*, GAMW-44B*, GAMW-51*, and GAMW-51B*

*Monitoring well installed in 2018

Table 1 provides a summary of the well rationale/purpose and date of installation. Golder installed, developed, and surveyed the wells in accordance with the CCR Groundwater Monitoring Program Implementation Manual prepared by Golder in October 2017.

2.3 Background Monitoring (2016 to 2017)

Per the requirements of 40 CFR §257.94, Golder collected eight independent background groundwater samples from each background and downgradient well between July 2016 and August 2017. Golder used the results of the background monitoring phase to develop appropriate, statistically valid background values for each

constituent/monitoring well. Golder submitted the samples to a contract laboratory, in accordance with chain of custody and quality assurance/quality control procedures, for analysis of 40 CFR Part 257 Appendix III and Appendix IV constituents. In addition, Golder personnel measured field water quality parameters including specific conductance, temperature, dissolved oxygen, turbidity, oxidation-reduction potential, and pH. The background data set was included in the 2017 CCR Annual Groundwater Monitoring and Corrective Action Report, dated January 31, 2018 (2017 Annual Report).

2.4 Detection Monitoring

Golder performed the first Detection Monitoring event in October 2017, followed by a statistical evaluation and data analysis in January 2018. Golder collected groundwater samples from the WDA background and downgradient monitoring wells for analysis of Appendix III constituents per 40 CFR §257.94 and included the results in the 2017 Annual Report. Following receipt and validation of laboratory results, Golder evaluated the results of the first Detection Monitoring sampling event to compare the concentration of Appendix III constituents relative to facility background concentrations. Using Sanitas™ software, Golder pooled the background data to calculate prediction limits and compared the October 2017 results to the calculated prediction limits to identify statistically significant increases (SSIs). The SSIs are summarized in the table below by downgradient monitoring well and constituent. Based on these SSIs, NIPSCO established an Assessment Monitoring program in April 2018.

	Boron	Calcium	Chloride	Fluoride	Sulfate	pH ¹	Total Dissolved Solids
GAMW-01	X						
GAMW-12							
GAMW-13							
GAMW-13B	X		X		X	X	
GAMW-14							
GAMW-14B	X		X		X	X	X

¹X represents an SSI

1 = pH value is based on field water quality meter reading

2.5 Assessment Monitoring

Golder performed the first Assessment Monitoring event (i.e. Assessment and Verification sampling) in March and April 2018, followed by a statistical evaluation and data analysis in August 2018. Golder collected groundwater samples from each background and downgradient monitoring well for analysis of Appendix IV constituents per 40 CFR §257.95 in March 2018. In April 2018, groundwater samples were collected at the downgradient monitoring well locations and analyzed for Appendix III and detected Appendix IV constituents per 40 CFR §257.95. In August 2018, Golder developed GWPS to use as a comparison against the Assessment Monitoring results. Following receipt and validation of laboratory results, Golder evaluated the Appendix IV constituent results relative to unit-specific GWPS (Table 4). At the time of the statistical evaluation the GWPS was the larger value of the Maximum Contaminant Level (MCL) or the unit-specific background concentration for each analyte based on a tolerance/prediction limit procedure under 40 CFR §257.95(h)(2). Results from the downgradient monitoring wells

were evaluated by comparing the lower confidence limit (LCL) to the CCR unit-specific GWPS for each Appendix IV analyte at each well. If the LCL exceeds the GWPS, there is statistical evidence of a statistically significant level (SSL). The SSLs are summarized in the table below by downgradient monitoring well and constituent.

	Antimony	Barium	Beryllium	Cadmium	Cobalt	Fluoride	Lead	Lithium	Mercury	Molybdenum	Radium	Selenium
GAMW-01										X		
GAMW-12												
GAMW-13												
GAMW-13B										X		
GAMW-14												
GAMW-14B										X		

"X" represents an SSL

Golder identified a potential alternative source that could explain the SSLs and prepared an ASD. An Indiana professional engineer certified the ASD in November 2018. The ASD supports the findings that the SSLs determined in August 2018 are not due to a release from the CCR Unit. The key supporting lines of evidence described in the ASD indicate that the molybdenum detected in monitoring wells downgradient of the WDA is due to a natural source and not due to the WDA. Therefore, no further action (i.e., Assessment of Corrective Measures) is warranted, and the RMSGS WDA will remain in Assessment Monitoring. The ASD is presented in Appendix A.

The sample results from Assessment Monitoring wells GAMW-42/42B, GAMW-43/43B, and GAMW-44/44B, installed on the property boundary (see Figure 2), were received and then validated in September 2018. The validated results from these wells indicate that there are no constituents detected at concentrations above health-based standards.

Golder performed the second Assessment Monitoring event in October 2018 by collecting groundwater samples from each background and downgradient monitoring well, including the new assessment monitoring wells, for analysis of Appendix III and Appendix IV constituents per 40 CFR §257.95. Golder will perform the statistical evaluation of the analytical results of the second Assessment Monitoring sampling event in February 2019.

The sampling dates, number of groundwater samples collected from each background and downgradient well, and the purpose of sampling are provided in Table 2. The analytical results are presented in Table 3.

2.6 Statistical Evaluation

Subsequent to each monitoring event, Golder assessed the analytical data for outliers, anomalies, and trends that might be an indication of a sampling or analytical error. Outliers and anomalies are generally defined as inconsistently large or small values that can occur as a result of sampling, laboratory, transportation, or

transcription errors, or even by chance alone. Significant trends may indicate natural geochemical variability, a source of systematic error, influence of an upgradient/off-site source, or an actual occurrence of CCR Unit influence. Appropriate statistical methods are used to remove outliers from the database and manage trends with detrending routines, prior to the calculation of statistical limits. To assess the data for outliers, anomalies, and trends, Golder assessed the data using time vs. concentration graphs, and statistical routines included in the Sanitas™ statistical analysis software package.

Golder identified the November 2016 fluoride results from GAMW-12, GAMW-13, GAMW-13B, and GAMW-14 as outliers and removed these data from the background data set for the following reasons:

- Statistical testing, including the Dixon outlier test, identified fluoride as an outlier;
- Trend charts indicated that the fluoride results from the November 2016 monitoring event was inconsistent with other concentrations detected in these monitoring wells; and
- This fluoride result was recorded by the validators as non-detect due to blank contamination.

Golder identified the July 2016 and January 2017 pH results from GAMW-14 as outliers and removed these data from the background data set for the following reasons:

- Statistical testing, including the Dixon outlier test, identified pH as an outlier; and
- Trend charts indicated that the pH results from the July 2016 and January 2017 monitoring event was inconsistent with other concentrations detected in this monitoring well.

Golder evaluated the background data set for trends using Sanitas™ software. Golder will continue to monitor all trends and apply detrending routines, if applicable, before using these data to calculate GWPSs. Golder identified the following Appendix IV parameter trends in background monitoring wells:

- Beryllium concentrations detected in groundwater samples collected from GAMW-03 and GAMW-03B show a decreasing trend, however, all results are below the MCL, therefore, the GWPS is equal to the MCL. No detrending routines are required.
- Lithium concentrations detected in groundwater samples collected from well GAMW-03B show a decreasing trend, however, lithium has never been detected above the laboratory reporting limit in this well. No detrending routines are required.
- Molybdenum concentrations detected in groundwater samples collected from well GAMW-03B show an increasing trend, however, molybdenum has never been detected above the laboratory reporting limit in this well. No detrending routines are required.

2.7 Problems Encountered and Follow-Up Corrective Actions

No problems were encountered in 2018.

3.0 KEY ACTIVITIES PROJECTED FOR 2019

During calendar year 2019, NIPSCO anticipates conducting the following key CCR groundwater monitoring activities for the WDA:

- Prepare and submit the appropriate notifications according to the CCR Rule;

- Continue semi-annual Assessment Monitoring groundwater sampling per CCR requirements; and,
- Inspect and maintain monitoring system including wells, pumps, and equipment.

TABLES

Table 1 Monitoring Well Network
CCR Unit Schahfer Waste Disposal Area
NIPSCO Rollin M. Schahfer Generating Station
Wheatfield, Indiana

CCR Unit	Well Purpose	Monitoring Well ID	Installation Date	Decommission Date (If Applicable)	Basis For Action	
Waste Disposal Area	Background Monitoring Well	GAMW-03	6/27/2015	-	Installed for groundwater quality monitoring ⁽¹⁾	
		GAMW-03B	5/24/2016	-		
	Downgradient Monitoring Well		GAMW-01	6/26/2015	-	Installed for groundwater quality monitoring ⁽¹⁾
			GAMW-12	5/23/2016	-	
			GAMW-13	5/24/2016	-	
			GAMW-13B	5/23/2016	-	
			GAMW-14	5/23/2016	-	
			GAMW-14B	5/23/2016	-	
			GAMW-01B	7/31/2018	-	Installed to characterize the nature and extent of a potential release ⁽²⁾
			GAMW-12B	7/31/2018	-	
			GAMW-51	7/25/2018	-	
			GAMW-51B	7/25/2018	-	
			GAMW-42	7/24/2018	-	
			GAMW-42B	7/24/2018	-	
		GAMW-43	5/16/2018	-	Installed to monitor the property boundary ⁽³⁾	
		GAMW-43B	5/16/2018	-		
GAMW-44		5/16/2018	-			
GAMW-44B		5/16/2018	-			

1) Per 40 CFR §257.93, Golder collected eight rounds of background data prior to October 17, 2017.

2) Per 40 CFR §257.95(g)(1)(i) Rule requirements, collected additional data to further characterize the groundwater downgradient of the WDA.

3) Per 40 CFR §257.95(g)(1)(iii), Golder collected data to determine if the plume is traveling off-property.

Prepared by: DFS
 Checked by: KMC
 Reviewed by: MAH

Table 2 Summary of Sampling Events
CCR Unit Schahfer Waste Disposal Area
NIPSCO Rollin M. Schahfer Generating Station
Wheatfield, Indiana

Well Purpose	Monitoring Well ID	Sample Event #10		Supplemental Sampling	Sample Event #11	Total Number of Samples
Purpose of Sample		Annual Assessment Monitoring	Semi-Annual Assessment Monitoring	Nature and Extent Characterization Sampling	Semi-Annual Assessment Monitoring	
Sample Parameters		Appendix IV	Appendix III and detected Appendix IV	Appendix III and Appendix IV	Appendix III and Appendix IV	
Background Monitoring Well	GAMW03	3/13/2018	4/20/2018	NS	10/24/2018	3
	GAMW03B	3/13/2018	4/20/2018	9/6/2018	10/24/2018	4
Downgradient Monitoring Well	GAMW01	3/12/2018	4/19/2018	NS	10/23/2018	3
	GAMW01B	NI	NI	9/6/2018	10/23/2018	2
	GAMW12	3/13/2018	4/20/2018	NS	10/23/2018	3
	GAMW12B	NI	NI	9/7/2018	10/23/2018	2
	GAMW13	3/13/2018	4/20/2018	NS	10/24/2018	3
	GAMW13B	3/13/2018	4/20/2018	9/6/2018	10/24/2018	4
	GAMW14	3/12/2018	4/19/2018	NS	10/25/2018	3
	GAMW14B	3/12/2018	4/19/2018	9/6/2018	10/25/2018	4
	GAMW51	NI	NI	9/10/2018	10/25/2018	2
	GAMW51B	NI	NI	9/10/2018	10/25/2018	2
	GAMW42	NI	NI	9/13/2018	10/31/2018	2
	GAMW42B	NI	NI	9/13/2018	NS	1
	GAMW43	NI	NI	6/13/2018	NS	1
	GAMW43B	NI	NI	6/13/2018	NS	1
	GAMW44	NI	NI	6/13/2018	NS	1
GAMW44B	NI	NI	6/13/2018	NS	1	
Total Number of Samples		8	8	13	13	42

Notes:

Sample counts do not include QC/QA samples.

NI= not installed

NS= not sampled

(1) Sample events #1-#9 were completed prior to 2018. The purpose, sample parameters, and sample dates are included in the 2017 Annual Report.

Prepared by: DFS

Checked by: KMC

Reviewed by: MAH

Table 3: Analytical Data
CCR Unit Schahfer Waste Disposal Area
NIPSCO Rollin M. Schahfer Generating Station
Wheatfield, Indiana

Analyte	Unit	GAMW01			GAMW01B		GAMW03				GAMW03B				GAMW12			
		2018-03-12	2018-04-19	2018-10-23	2018-09-06	2018-10-23	2018-03-13	2018-04-20	2018-10-24	2018-10-24	2018-03-13	2018-04-20	2018-09-06	2018-09-06	2018-10-24	2018-03-13	2018-04-20	2018-10-23
		N	N	N	N	N	N	N	FD	N	N	N	FD	N	N	N	N	N
Appendix III Parameters																		
Boron	mg/L		0.3	0.29	0.4	0.44		0.2	0.28	0.26		0.3	0.32	0.28	0.29		0.095 J	0.081 J
Calcium	mg/L		87	77	110	100		93	97	94		110	100	99	98		87	94
Chloride	mg/L		10	8.1	21	19		4.9	22	7.7		23	24	25	22		3.3	2.5
Fluoride	mg/L	0.28 J	0.32 J	0.3	0.17 J	0.14	0.16 J	0.2 J	0.21	0.15	0.2 J	0.22 J	0.23 J	0.23 J	0.21	0.19 J	0.24 J	0.19
pH	SU	7.24	7	6.78	7.01	6.74	6.61	7.13		7.37	6.83	7.12		7.1	7.77	6.62	7.17	7.79
Sulfate	mg/L		50	68	72	69		110	67	100		66	64	64	67		11	12
Total Dissolved Solids	mg/L		360	350	450	430		380	440	440		420	470	450	450		350	360
Appendix IV Parameters																		
Antimony	mg/L	0.002 U		0.002 U	0.002 U	0.002 U	0.002 U		0.002 U	0.002 U	0.002 U		0.002 U	0.002 U	0.002 U	0.00086 J		0.002 U
Arsenic	mg/L	0.02	0.03	0.035	0.00077 J	0.005 U	0.018		0.005 U	0.013	0.005 U		0.005 U	0.005 U	0.005 U	0.011	0.0085	0.018
Barium	mg/L	0.057	0.052	0.052	0.19	0.17	0.074		0.11	0.1	0.13		0.12	0.12	0.12	0.11	0.1	0.12
Beryllium	mg/L	0.001 U		0.001 U	0.00036 J	0.001 U	0.001 U		0.001 U	0.001 U	0.001 U		0.001 U	0.001 U	0.001 U	0.00032 J		0.00044 J
Cadmium	mg/L	0.001 U		0.001 U	0.001 U	0.001 U	0.001 U		0.001 U	0.001 U	0.001 U		0.001 U	0.001 U	0.001 U	0.001 U		0.00024 J
Chromium	mg/L	0.002 U		0.002 U	0.002 U	0.002 U	0.002 U		0.002 U	0.002 U	0.002 U		0.002 U	0.002 U	0.002 U	0.002 U		0.002 U
Cobalt	mg/L	0.0011	0.001	0.00075 J	0.00056 J	0.00027 J	0.0038		0.001 U	0.0037	0.00024 J		0.00034 J	0.00036 J	0.001 U	0.0023	0.0016	0.0018
Fluoride	mg/L	0.28 J	0.32 J	0.3	0.17 J	0.14	0.16 J	0.2 J	0.21	0.15	0.2 J	0.22 J	0.23 J	0.23 J	0.21	0.19 J	0.24 J	0.19
Lead	mg/L	0.001 U		0.001 U	0.001 U	0.001 U	0.001 U		0.001 U	0.001 U	0.001 U		0.001 U	0.001 U	0.001 U	0.001 U		0.001 U
Lithium	mg/L	0.0019 J		0.0028 J	0.0039 J	0.0046 J	0.006 J		0.008 U	0.0074 J	0.008 U		0.008 U	0.008 U	0.008 U	0.0023 J		0.0032 J
Mercury	mg/L	0.0002 U		0.0002 U	0.0002 U	0.0002 U	0.0002 U		0.0002 U	0.0002 U	0.0002 U		0.0002 U	0.0002 U	0.0002 U	0.0002 U		0.0002 U
Molybdenum	mg/L	0.014	0.016	0.015	0.0015 J	0.01 U	0.0063 J		0.0065 J	0.0082 J	0.0066 J		0.0067 J	0.0067 J	0.0066 J	0.0035 J		0.0033 J
Radium 226 + 228	pci/L		0.475	1.45 J+	2.16	2.62 J+			1.11 J+	1.38 J+			1.14	1.06	1.26 J+		0.67	1.3 J+
Radium-226	pci/L		0.292	0.614 J+	1.56	1.47 J+			0.567 J+	0.342 J+			0.671	0.574	0.478 J+		0.321	0.57 J+
Radium-228	pci/L		0.183	0.832 J+	0.6	1.15 J+			0.547	1.04			0.47	0.49	0.783		0.35	0.734 J+
Selenium	mg/L	0.0016 J		0.001 J	0.001 J	0.005 U	0.005 U		0.005 U	0.005 U	0.005 U		0.005 U	0.0014 J	0.005 U	0.00091 J		0.005 U
Thallium	mg/L	0.001 U		0.001 U	0.001 U	0.001 U	0.001 U		0.001 U	0.001 U	0.001 U		0.001 U	0.001 U	0.001 U	0.001 U		0.001 U
Field Parameters																		
Dissolved Oxygen	mg/L	0.28	0.14	0.22	0.62	0.23	1.3	0.9		0.99	0.4	0.19		1.12	0.5	0.33	0.25	0.93
Oxidation-Reduction Potential	millivolts	-85.1	284.1	-130.2	-96.2	-111.7	-76.4	-98.2		-283.8	-85.2	-95.1		-66.2	-294.4	-87.5	-239.8	-377.3
pH	SU	7.24	7	6.78	7.01	6.74	6.61	7.13		7.37	6.83	7.12		7.1	7.77	6.62	7.17	7.79
Specific Conductance	uS/cm	395	550	594	684	687	369	572		675	515	778		669	719	393	558	628
Temperature	deg C	9.2	9.4	16.9	13.9	13.9	8.6	7.9		16.2	11.3	4.1		13	13.69	8.2	8.7	16.99
Turbidity	NTU	4.61	4.05	4.81	4.16	2.41	4.66	4.96		3.55	4.59	4.36		3.55	3.54	3.55	4.12	2.91

Note:
 mg/L = milligrams per liter
 uS/cm = micro Siemens per centimeter
 deg C = degrees Celsius
 NTU = Nephelometric Turbidity Units
 SU = Standard Units
 pci/L = picocuries per liter

"U" = Indicates the result is not detected above the method detection limit (MDL) for the sample; the quantitation limit (RL) is provided.
 "J" = Indicates the result was estimated.
 "J+" = Indicates the result was estimated and may be biased high.
 "J-" = Indicates the result was estimated and may be biased low.
 provided.
 "O" = Indicates the result was identified as an outlier and removed from the background data set.

Table 3: Analytical Data
CCR Unit Schahfer Waste Disposal Area
NIPSCO Rollin M. Schahfer Generating Station
Wheatfield, Indiana

Analyte	Unit	GAMW12B		GAMW13			GAMW13B				GAMW14			GAMW14B				
		2018-09-07	2018-10-23	2018-03-13	2018-04-20	2018-10-24	2018-03-13	2018-04-20	2018-04-20	2018-09-06	2018-10-24	2018-03-12	2018-04-19	2018-10-25	2018-03-12	2018-04-19	2018-09-06	2018-10-25
		N	N	N	N	N	N	FD	N	N	N	N	N	N	N	N	N	N
Appendix III Parameters																		
Boron	mg/L	0.28	0.26		0.21	0.38			0.76	0.72	0.71		0.25	0.3		3	2.9	2.8
Calcium	mg/L	100	110		110	74			76	72	71		37	58		150	150	150
Chloride	mg/L	22	19		9.7	14			27	27	24		1.4	13		110	110	97
Fluoride	mg/L	0.12 J	0.096	5 U	0.27 J	0.28	0.27 J		0.31 J	0.28 J	0.25	0.25 J	0.29 J	0.2	10 U	0.43 J-	0.33 J	0.31
pH	SU	7.15	8.83	6.4	6.94	6.88	7.27		7.64	7.37	7.45	6.75	6.99	7.26	7.59	7.55	7.29	7.67
Sulfate	mg/L	63	49		52	59			150	150	150		35	51		990	1100	1100
Total Dissolved Solids	mg/L	870 J+	450		400 J	350			370 J	410	420		220	290		2000	2000	1900
Appendix IV Parameters																		
Antimony	mg/L	0.002 U	0.002 U	0.002 U		0.002 U	0.002 U			0.002 U	0.002 U	0.0016 J		0.002 U	0.002 U		0.002 U	0.002 U
Arsenic	mg/L	0.0013 J	0.00079 J	0.0039 J		0.01	0.0012 J	0.00098 J		0.005 U	0.005 U	0.0021 J		0.014	0.0012 J		0.005 U	0.005 U
Barium	mg/L	0.11	0.12	0.11	0.12	0.14	0.1	0.091	0.094	0.087	0.082	0.061	0.049	0.058	0.11	0.11	0.12	0.12
Beryllium	mg/L	0.001 U	0.001 U	0.001 U		0.001 U	0.001 U			0.001 U	0.001 U	0.001 U		0.001 U	0.001 U		0.001 U	0.001 U
Cadmium	mg/L	0.001 U	0.001 U	0.001 U		0.001 U	0.001 U			0.001 U	0.001 U	0.001 U		0.001 U	0.001 U		0.001 U	0.001 U
Chromium	mg/L	0.002 U	0.00099 J	0.0012 J		0.002 U	0.002 U			0.002 U	0.002 U	0.0011 J		0.002 U	0.002 U		0.002 U	0.002 U
Cobalt	mg/L	0.00039 J	0.00038 J	0.0029	0.00096 J	0.00032 J	0.001 U	0.001 U		0.00019 J	0.001 U	0.035	0.052	0.031	0.00019 J		0.00039 J	0.00022 J
Fluoride	mg/L	0.12 J	0.096	5 U	0.27 J	0.28	0.27 J		0.31 J	0.28 J	0.25	0.25 J	0.29 J	0.2	10 U	0.43 J-	0.33 J	0.31
Lead	mg/L	0.001 U	0.001 U	0.001 U		0.001 U	0.001 U			0.001 U	0.001 U	0.001 U		0.001 U	0.001 U		0.001 U	0.001 U
Lithium	mg/L	0.0042 J	0.0042 J	0.008 U		0.008 U	0.008 U	0.008 U		0.008 U	0.0018 J	0.008 U		0.008 U	0.0043 J		0.0056 J	0.0057 J
Mercury	mg/L	0.0002 U	0.0002 U	0.0002 U		0.0002 U	0.0002 U			0.0002 U	0.0002 U	0.0002 U		0.0002 U	0.0002 U		0.0002 U	0.0002 U
Molybdenum	mg/L	0.01 U	0.01 U	0.0053 J		0.0054 J	0.021	0.022	0.021	0.018	0.018	0.011	0.0096 J	0.011	0.022	0.026	0.033	0.035
Radium 226 + 228	pci/L	1.66 J+	1.61 J+		0.401	1.84 J+		0.571	0.863	0.885	1.76 J+		0.399	0.671		1.68	2.55	2.73
Radium-226	pci/L	0.886 J+	0.916 J+		0.224	0.671 J+		0.293	0.311	0.567	0.646 J+		0.0656	0.239		0.823	1.24	1.66
Radium-228	pci/L	0.774	0.695 J+		0.177	1.17		0.278	0.552	0.386 U	1.11		0.333	0.432		0.861	1.31	1.07
Selenium	mg/L	0.0024 J	0.005 U	0.0011 J		0.005 U	0.005 U	0.005 U		0.001 J	0.005 U	0.005 U		0.005 U	0.005 U		0.0021 J	0.001 J
Thallium	mg/L	0.001 U	0.001 U	0.001 U		0.001 U	0.001 U			0.001 U	0.001 U	0.001 U		0.001 U	0.001 U		0.001 U	0.001 U
Field Parameters																		
Dissolved Oxygen	mg/L	0.6	0.52	0.81	0.32	1.12	0.53		0.14	0.38	1.24	1.33	1.02	1.8	0.37	0.17	0.44	1.3
Oxidation-Reduction Potential	millivolts	-98.9	-378.3	-101.1	-112.4	-268.7	-98.1		-230.2	-118.7	-235.5	-117	-243.1	-240.9	102.6	-286.8	-114.1	-211.9
pH	SU	7.15	8.83	6.4	6.94	6.88	7.27		7.64	7.37	7.45	6.75	6.99	7.26	7.59	7.55	7.29	7.67
Specific Conductance	uS/cm	712	760	446	723	614	464		607	631	639	241	283	464	1844	2171	2642	2542
Temperature	deg C	14	14.11	8.2	8.7	17.02	12		12.3	14.14	14.1	8.99	9.4	16.3	12.4	12.5	13.91	13.4
Turbidity	NTU	3.33	1.39	4.77	2.88	1.12	4.22		4.19	2.25	1.08	4.41	4.89	1.81	3.79	2.59	1.42	1.41

Note:

mg/L = milligrams per liter

uS/cm = micro Siemens per centimeter

deg C = degrees Celsius

NTU = Nephelometric Turbidity Units

SU = Standard Units

pci/L = picocuries per liter

"U" = Indicates the result is not detected above the method detection limit (MDL) for the sample; the quantitation limit (RL) is provided.

"J" = Indicates the result was estimated.

"J+" = Indicates the result was estimated and may be biased high.

"J-" = Indicates the result was estimated and may be biased low.

"O" = Indicates the result was identified as an outlier and removed from the background data set.

Table 3: Analytical Data
CCR Unit Schahfer Waste Disposal Area
NIPSCO Rollin M. Schahfer Generating Station
Wheatfield, Indiana

Analyte	Unit	GAMW42		GAMW42B	GAMW43	GAMW43B	GAMW44	GAMW44B		GAMW51		GAMW51B	
		2018-09-13	2018-10-31	2018-09-13	2018-06-13	2018-06-13	2018-06-13	2018-06-13	2018-06-13	2018-06-13	2018-09-10	2018-10-25	2018-09-10
		N	N	N	N	N	N	FD	N	N	N	N	N
Appendix III Parameters													
Boron	mg/L	0.04 J	0.041 J	0.061 J	0.025 J	0.037 J	0.05 J	0.036 J	0.034 J	0.68	0.58	6.9	7.4
Calcium	mg/L	44	38	46	26	38	25	39	40	130	130	250	240
Chloride	mg/L	3.1	2.8	4	6	1.5	10	7.8	7.9	6.3	3.6	62	54
Fluoride	mg/L	0.25 J	0.2	0.25 J	0.15 J	0.16 J	0.096 J	0.1 J	0.11 J	0.44 J	0.41	0.79 J	0.8
pH	SU	7.54	7.15	8.08	6.63	7.11	6.77		7.29	8.08	7.69	8.72	8.86
Sulfate	mg/L	21	23	21	25	26	50	24	25	130	110	1300	1600
Total Dissolved Solids	mg/L	190	170	190	160	180	200	180	170	550	530	2200	2200
Appendix IV Parameters													
Antimony	mg/L	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.0008 J	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Arsenic	mg/L	0.01	0.0037 J	0.005 U	0.0073	0.0018 J	0.0054	0.005 U	0.005 U	0.0032 J	0.0031 J	0.0017 J	0.0013 J
Barium	mg/L	0.034	0.046	0.016	0.028	0.015	0.024	0.013	0.013	0.16	0.17	0.07	0.063
Beryllium	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Cadmium	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Chromium	mg/L	0.002 U	0.0014 J	0.002 U	0.002 U	0.0011 J	0.0023	0.0011 J	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Cobalt	mg/L	0.00027 J	0.00053 J	0.001 U	0.0023	0.00033 J	0.0025	0.001 U	0.001 U	0.001	0.0011	0.00028 J	0.00022 J
Fluoride	mg/L	0.25 J	0.2	0.25 J	0.15 J	0.16 J	0.096 J	0.1 J	0.11 J	0.44 J	0.41	0.79 J	0.8
Lead	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.00092 J	0.001 U	0.00048 J	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Lithium	mg/L	0.008 U	0.008 U	0.0018 J	0.008 U	0.008 U	0.008 U	0.008 U	0.008 U	0.0073 J	0.0052 J	0.05	0.048
Mercury	mg/L	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Molybdenum	mg/L	0.0035 J	0.0022 J	0.0048 J	0.004 J	0.0022 J	0.013	0.0021 J	0.0021 J	0.028	0.022	0.13	0.13
Radium 226 + 228	pci/L	0.476		0.661	0.323 U	0.408	0.649	0.306 U	0.368 U	1.43	0.961	2.01	2.75
Radium-226	pci/L	0.26		0.419	0.285 U	0.252 U	0.268	0.221 U	0.256 U	0.681 J+	0.635	1.27 J+	1.46
Radium-228	pci/L	0.335 U		0.356 U	0.323 U	0.303 U	0.381	0.306 U	0.368 U	0.745	0.354 U	0.741	1.29
Selenium	mg/L	0.005 U	0.005 U	0.005 U	0.001 J	0.00089 J	0.0014 J	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.0011 J
Thallium	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Field Parameters													
Dissolved Oxygen	mg/L	0.8	0.13	0.53	0.19	0.18	0.68		0.48	0.31	1.9	0.26	1.08
Oxidation-Reduction Potential	millivolts	-112.2	-147.1	-248.6	-12	-81.5	51.6		-55.9	-124.4	-247.2	-169.2	-258.6
pH	SU	7.54	7.15	8.08	6.63	7.11	6.77		7.29	8.08	7.69	8.72	8.86
Specific Conductance	uS/cm	288	274	297	269	245	272		248	1076	806	3438	2720
Temperature	deg C	14.8	13.9	12.8	13.1	12.1	12.8		11.6	15.79	15.08	14.43	13.63
Turbidity	NTU	3.92	4.11	4.9	4.35	2.01	4.38		3.22	0.94	1	2.98	1.49

Note:

mg/L = milligrams per liter
 uS/cm = micro Siemens per centimeter
 deg C = degrees Celsius
 NTU = Nephelometric Turbidity Units
 SU = Standard Units
 pci/L = picocuries per liter

"U" = Indicates the result is not detected above the method detection limit (MDL) for the sample; the quantitation limit (RL) is provided.

"J" = Indicates the result was estimated.

"J+" = Indicates the result was estimated and may be biased high.

"J-" = Indicates the result was estimated and may be biased low.
 provided.

"O" = Indicates the result was identified as an outlier and removed from the background data set.

Prepared by: DFS
 Checked by: KMC
 Reviewed by: MAH

**Table 4 Groundwater Protection Standards
CCR Unit Schahfer Waste Disposal Area
NIPSCO Rollin M. Schahfer Generating Station
Wheatfield, Indiana**

Analyte	MCL (mg/L)	GWPS (mg/L)
Antimony	0.006	0.006
Arsenic	0.01	0.015
Barium	2	2
Beryllium	0.004	0.004
Cadmium	0.005	0.005
Chromium	0.1	0.1
Cobalt ⁽¹⁾	0.006 ⁽²⁾	0.015
Fluoride	4	4
Lead ⁽¹⁾	0.015 ⁽²⁾	0.0005
Lithium ⁽¹⁾	0.04 ⁽²⁾	0.0088
Mercury	0.002	0.002
Molybdenum ⁽¹⁾	0.1 ⁽²⁾	0.009
Radium 226+228	5	5
Selenium	0.05	0.05
Thallium	0.002	0.002

Notes:

MCL= Environmental Protection Agency Maximum Contaminant Concentration

GWPS= Groundwater Protection Standard calculated August 23, 2018.

mg/L= milligrams per liter

1) These four constituents do not have an established MCL. Prior to the Phase 1 Part 1 ammendment becoming effective on August 29, 2018, the GWPS was calculated based on background concentrations according to the CCR Final Rule.

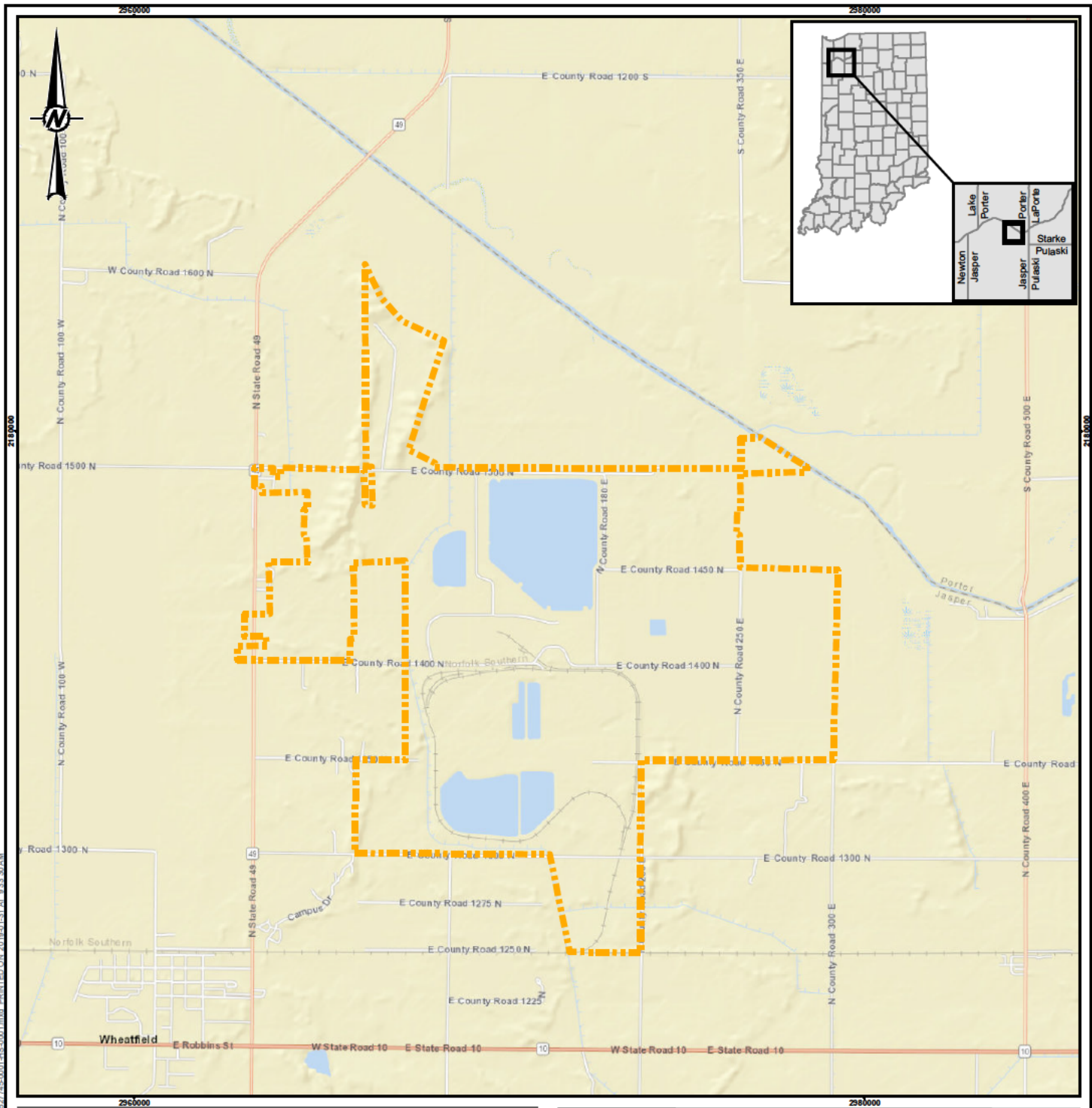
2) The Phase 1 Part 1 amended health-based standard, effective August 29, 2018.

Prepared by: DFS

Checked by: KMC

Reviewed by: MAH

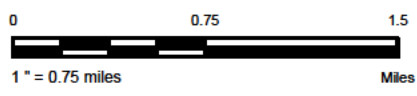
FIGURES



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LEGEND

Approximate Property Line



REFERENCE(S)

SERVICE LAYER CREDITS: SOURCES: ESRI, HERE, GARMIN, USGS, NTERMAP, INCREMENT P, NRCAN, ESRI JAPAN, METI, ESRI CH NA (HONG KONG), ESRI KOREA, ESRI (THAILAND), NGCC, © OPENSTREETMAP CONTR BUTORS, AND THE GIS USER COMMUNITY

CLIENT

NORTHERN INDIANA PUBLIC SERVICE COMPANY

PROJECT

NORTHERN INDIANA PUBLIC SERVICE COMPANY
R.M. SCHAHFER GENERATING STATION
WHEATFIELD, INDIANA

TITLE

SITE LOCATION MAP

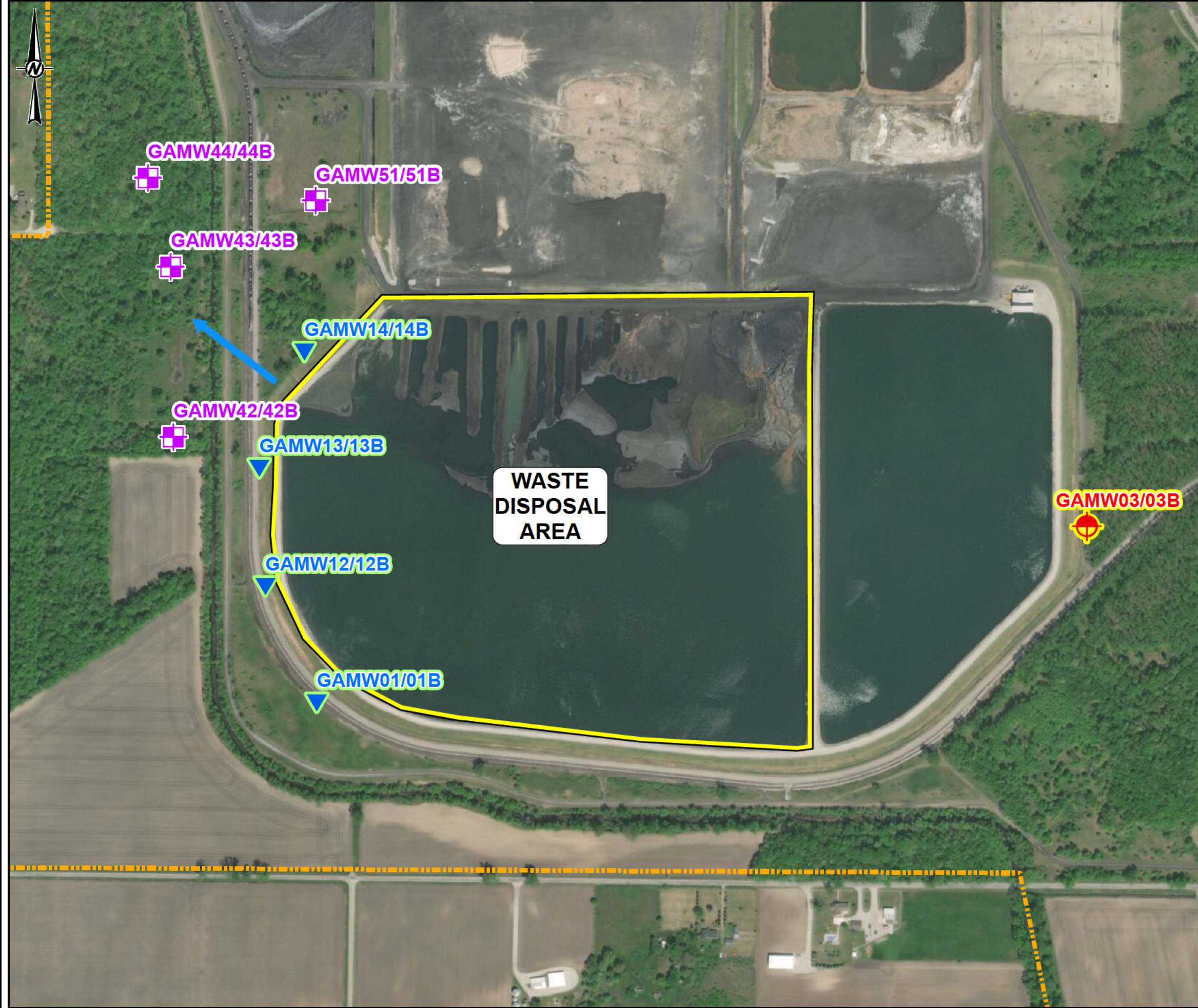
CONSULTANT



YYYY-MM-DD	1/31/2019
DESIGNED	DFS
PREPARED	SHL
REV EWED	JSP
APPROVED	MAH

PROJECT NO.	CONTROL	REV.	FIGURE
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1 in IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ANS/A



LEGEND

- Assessment Monitoring Well
- Background Monitoring Well
- Downgradient Monitoring Well
- Generalized Groundwater Flow Direction
- CCR Unit
- Approximate Property Line



NOTE(S)
 1. THIS FIGURE DEPICTS THE GENERALIZED GROUNDWATER FLOW D RECTION WITH N THE UPPER PORTION OF THE SURFICIAL AQUIFER.

REFERENCE(S)
 1. SERVICE LAYER CREDITS: SOURCE: ESRI, DIGITALGLOBE, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEROGRO D, IGN, AND THE GIS USER COMMUNITY

CLIENT
 NORTHERN INDIANA PUBLIC SERVICE COMPANY

PROJECT
 NORTHERN INDIANA PUBLIC SERVICE COMPANY
 R.M. SCHAFER GENERATING STATION
 WHEATFIELD, INDIANA

TITLE
**MONITORING WELL LOCATIONS
 WASTE DISPOSAL AREA**

CONSULTANT	YYYY-MM-DD	1/31/2019
	DESIGNED	DFS
	PREPARED	SHL
	REV EWED	MAH
	APPROVED	MAH

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APPENDIX A
WASTE DISPOSAL AREA
ALTERNATIVE SOURCE DEMONSTRATION
NOVEMBER 2018

**Northern Indiana Public Service Company
R. M. Schahfer Generating Station
Wheatfield, Indiana
Waste Disposal Area**

Certification of Alternative Source Demonstration

40 CFR §257.95(g)(3) & Corresponding Regulations under 329 Indiana Administrative Code 10-9-1

I have personally reviewed this alternative source demonstration (ASD), the subject of which is the Waste Disposal Area at the NIPSCO R. M. Schahfer Generating Station, prepared by Golder Associates Inc. and dated November 2018. Based on an inquiry of those individuals immediately responsible, and on supporting data which I understand to be true, accurate and complete, I verify the information in this ASD is accurate and meets the applicable requirements of the CCR Final Rule. In consideration of the above, I certify to the best of my knowledge, information, and belief, that the ASD for the regulated CCR management unit referred to as the Waste Disposal Area has been prepared and meets the applicable requirements of 40 CFR §257.95(g)(3) and corresponding State of Indiana requirements.



11-19-2018



Richard A. Wesenberg, P.E.
Program Leader and Principal
Licensed Professional Engineer
State of Indiana License Number: PE11500584



NORTHERN INDIANA PUBLIC SERVICE COMPANY R.M. SCHAHFER GENERATING STATION WHEATFIELD, INDIANA

WASTE DISPOSAL AREA

ALTERNATIVE SOURCE DEMONSTRATION

*Prepared Pursuant to 40 CFR 40 CFR §257.94(e)(2) and Corresponding
Regulations under 329 Indiana Administrative Code 10-9-1*

November 2018


A large decorative graphic at the bottom of the page, consisting of a solid green trapezoidal shape with a yellow border along its top edge, sloping upwards from left to right.

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APPENDICES

Appendix A Analytical Results

1.0 INTRODUCTION

On behalf of Northern Indiana Public Service Company (NIPSCO), Golder Associates Inc. (Golder) performed a statistical evaluation of groundwater analytical results from the first (April/May 2018) groundwater Assessment Monitoring event at the Rollin M. Schahfer Generating Station (RMSGs or Site) Waste Disposal Area (WDA, the CCR Unit), located at 2723 E 1500 N Road, Wheatfield, Jasper County, Indiana (see Figure 1). The statistical evaluation was performed in accordance with applicable provisions of 40 Code of Federal Regulations (CFR) Parts 257 and 261, "Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals (CCR) from Electric Utilities; Final Rule" (CCR Final Rule), as amended, and corresponding regulations under 329 Indiana Administrative Code (IAC) 10-9-1.

Statistical analyses of the Appendix IV Assessment Monitoring data for molybdenum indicated the lower confidence interval (LCI) exceeded the background concentration for that parameter in three downgradient monitoring wells (GAMW-01, GAMW-13B, and GAMW-14B), which NIPSCO interpreted as apparent evidence of a statistically-significant level (SSL). Although an SSL generally indicates that the groundwater monitoring program should transition from Assessment Monitoring to Assessment of Corrective Measures, 40 CFR §257.95(g)(3) allows the owner or operator (i.e., NIPSCO) 90 days from the date of determination (August 23, 2018) to demonstrate a source other than the CCR unit or another condition caused the molybdenum SSLs.

Golder's initial review of the Site history and geologic conditions indicated the potential for SSLs to have resulted from a source other than the CCR unit. To further assess potential sources and natural variability of groundwater concentrations, Golder collected and analyzed overburden, bedrock, porewater, CCR source materials, and groundwater samples. Based upon this assessment and in accordance with provisions of the 40 CFR §257.95(g)(3), Golder prepared this Alternative Source Demonstration (ASD) for the WDA. This ASD includes an evaluation of geological, hydrogeological, and chemical information obtained from borings and monitoring wells installed within and adjacent to the WDA.

The ASD provides the basis for concluding that the apparent SSLs are not a result of a release from the WDA. The following sections provide a summary of the RMSGs WDA Conceptual Site Model, sampling procedures and analytical methods, analytical and geochemical modeling results, and lines of evidence demonstrating an alternative source is responsible for the molybdenum SSLs.

2.0 CONCEPTUAL SITE MODEL

Golder developed this conceptual site model (CSM) to help frame and support the ASD assessment approach. The CSM presents WDA construction and operational history, a summary of geologic and hydrogeologic information, and a discussion of groundwater monitoring data, which together lays the groundwork for consideration in the development of the ASD. Additionally, related to the CSM, this section of the report introduces findings of literature research that suggest certain naturally-occurring groundwater conditions observed at Schahfer may be the cause of the apparent SSL.

2.1 Description of Waste Disposal Area

NIPSCO constructed the WDA in 1982, which is an approximately 80-acre impoundment located in the southwestern corner of RMSGs as shown in Figure 2. According to NIPSCO construction drawings, the WDA is unlined and is surrounded by berms which were constructed with an approximate two-foot wide slurry wall that extends from just below the top of the berms to the underlying shale located approximately 30 to 35 feet below

ground surface (ft bgs). NIPSCO's engineer, Sargent & Lundy, designed and constructed the slurry walls to provide a hydraulic barrier to reduce potential migration of the contents of the WDA.

The WDA receives primarily bottom ash/boiler slag that is sluiced from all four active boilers. Most of the ash/slag is deposited in the northern half of the WDA where the slurry lines discharge. Due to size of the unit and settling/depositional properties of the CCR materials, very little, if any, ash/slag is present in the southern half of the WDA.

2.2 Site Geology and Hydrogeology

The Site is directly underlain by unconsolidated, upper-Pleistocene (post-Wisconsin) fine-grained sand and silt and outwash deposits of the Atherton Formation, occasionally overlain by alluvial and lacustrine deposits of the Martinsville Formation (Schneider and Keller 1970). According to Fraser and Bleur (1991), during the late Pleistocene, the Site was occupied by a post-glacial lake followed by a broad, low-gradient outwash stream that deposited sand uniformly across the basin to form the Kankakee-Valparaiso Formation. Golder's interpretation of the Site geology is based on bedrock geology maps, prior reports and CCR-related well installation activities, and includes:

- Brown fine- to medium-grained sand from the ground surface to approximately 14 ft bgs
- Grayish-brown fine to medium sand from approximately 14 ft bgs to 30 -35 ft bgs (coarsens with depth)
- Bedrock: Black to dark gray shale with planar cleavage. Top of bedrock is approximately 30 to 35 ft bgs near the impoundments

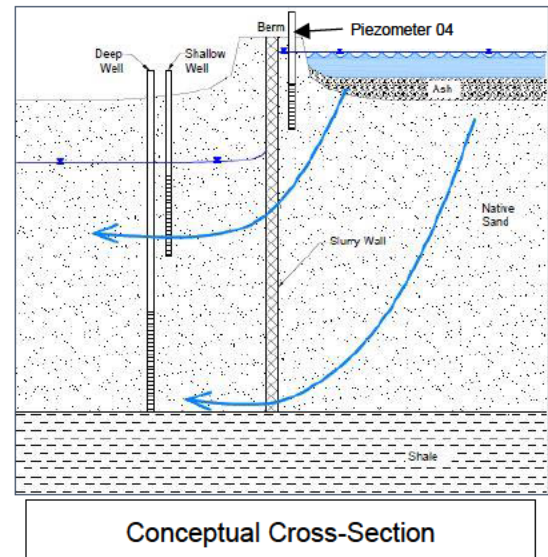
Regional bedrock consists of more than 4,000 feet of sedimentary rocks overly Precambrian granitic bedrock (Fenelon, Bobay, and others 1994). This assemblage is part of the north side of the Kankakee Arch, the major structural feature in the Kankakee River Basin. The first 3,500 feet of sedimentary rocks overlying the granitic bedrock are Cambrian and Ordovician in age. The uppermost 300 feet of Ordovician rocks are composed of shale and minor limestones and are referred to as the Maquoketa Group. The Maquoketa Group underlies Silurian, Devonian and Mississippian rocks and consist of a wide variety of sedimentary layers ranging from shaley to coarse-grained carbonate rocks. This carbonate sequence is overlain by a series of shales including the Antrim Shale, a brownish-black, non-calcareous shale (Fenelon, Bobay, and others 1994).

Available groundwater elevation data indicate that groundwater in the uppermost aquifer near the WDA flows to the north and northwest (and possibly northeast). Localized groundwater flow direction is influenced by the slurry walls that surround the WDA and adjacent Recycle Settling Basin and inactive Retired Waste Disposal Area (RWDA - both of these are non-CCR regulated). Hydraulic heads measured inside the slurry walls that surround the WDA are significantly higher (i.e., up to 15 feet or more) than those measured beyond the slurry wall. This contrast in potentiometric levels indicates that the slurry walls significantly impede the flow of water from the CCR unit to the uppermost aquifer.

2.3 Groundwater Monitoring Network

Design of the CCR Final Rule-compliant WDA monitoring program considered the size, disposal/operational history, hydraulic influence of the slurry walls, anticipated groundwater flow direction, and saturated thickness of

the uppermost aquifer. Based on the available hydrogeologic information for the WDA, groundwater mounding is occurring within the slurry walls. NIPSCO’s monitoring approach for the CCR surface impoundments featured the installation of well pairs including shallow (approximately 15 ft bgs) and deep (approximately 35 ft bgs – to the top of shale [signified with a “B” in Figure 2]) couplets at each background and downgradient monitoring well location outside of the perimeter slurry walls as shown in Figure 2. As-built drawings of the slurry walls are not available; therefore, it is unknown if the slurry walls were keyed into the underlying shale. Depending upon the degree of contact between the slurry walls and shale, the higher hydraulic head observed within the slurry walls may result in the discharge of water beneath the slurry walls. Consequently, as illustrated in this graphic, Golder installed deep monitoring wells to supplement shallow wells and monitor potential flow paths beneath the slurry walls into the aquifer. Piezometer 04, constructed as a two-inch diameter, polyvinyl chloride (PVC) piezometer, screened approximately 21 to 26 ft bgs, is located within the slurry wall of the WDA (GAPIEZ04, see Figure 2) and is used to monitor the porewater within the WDA.



The WDA monitoring network includes two background and ten downgradient monitoring wells. The groundwater monitoring network is summarized in the following table:

Table 2-3: Waste Disposal Area Monitoring Well Network

Background Monitoring Wells	Downgradient Monitoring Wells	Downgradient Property Boundary Wells
GAMW-03 and GAMW-03B	GAMW-01, GAMW-01B*, GAMW-12, GAMW-12B*, GAMW-13, GAMW-13B, GAMW-14, and GAMW-14B	GAMW-42* and GAMW-42B*

*Monitoring well installed in 2018

2.4 Groundwater Conditions

Between July 2016 and August 2017, Golder collected eight independent background groundwater samples from each background and downgradient well, as required by 40 CFR §257.94. The results of the background monitoring phase were used to develop appropriate, statistically valid background values for each constituent/monitoring well. Following completion of the eight background monitoring events, Golder collected the first Detection Monitoring groundwater samples in October 2017 and compared the results to the calculated prediction limits to determine statistically significant increases (SSIs). Based on these results, NIPSCO established an Assessment Monitoring program in January 2018.

Golder performed the first Assessment Monitoring event in March 2018. Groundwater samples were collected at all background and downgradient monitoring well locations and analyzed for 40 CFR Part 257 Appendix IV constituents. Verification sampling was completed in April 2018 and groundwater samples were analyzed for Appendix III constituents and detected Appendix IV constituents per 40 CFR §257.95. Following receipt and validation of laboratory results, Golder evaluated the results of the first Assessment Monitoring sampling event to

determine the concentration of Appendix IV constituents relative to CCR Unit-specific calculated groundwater protection standards (GWPSs). The GWPS is the maximum contaminant level (MCL) (if an MCL exists) or the unit-specific background concentration for each analyte using a tolerance/prediction limit procedure.

Based on this statistical analysis, Golder concluded that the only constituent demonstrating an apparent SSL was molybdenum. The calculated GWPS (unit-specific background concentration) for molybdenum is 0.009 milligrams per liter (mg/L). Molybdenum concentrations in groundwater samples collected from downgradient monitoring wells GAMW-01, GAMW-13B, and GAMW-14B exceed this GWPS. However, the detected groundwater molybdenum concentrations do not exceed the new U. S. Environmental Protection Agency (USEPA) risk-based level for molybdenum of 0.1 mg/L, which USEPA published in the Federal Register on July 30, 2018 and became effective August 29, 2018 (CCR Final Rule Part 1 Phase 1 Addendum). While the new risk-based level was promulgated after the determination of the molybdenum SSLs, for purposes of this initial evaluation the GWPS is characterized as the standard in effect at the time of the analysis. The new risk-based molybdenum standard will apply to all subsequent samples.

A literature review of other locations underlain by similar shales revealed the documented occurrence of molybdenum at concentrations >0.1 milligram per liter (mg/L) in groundwater. Molybdenum is a naturally-occurring metal that can be found in similar black shales of up to 1,240 milligrams per kilogram (mg/kg) (Smedley and Kinniburgh, 2017). Additional literature suggests localized increases in groundwater sodium and sulfate concentrations were co-occurring with molybdenum. Using various geochemical techniques, including groundwater dating and isotopic methods, the authors determined that the release of molybdenum, sodium, and sulfate was due to the oxidative weathering of pyritic shale-rich bedrock (Harkness et al. 2017). The type of shale identified in the literature review is similar to the shale that is present at RMSGS.

3.0 SAMPLING PROCEDURES AND ANALYTICAL METHODS

To further assess potential groundwater impacts downgradient of the WDA and collect data (i.e., overburden, bedrock, porewater, and groundwater) and support an ASD for molybdenum, Golder performed supplemental assessment activities between July 24 and September 25, 2018. Golder performed the supplemental assessment activities in accordance with the RMSGS Groundwater Monitoring Program Implementation Manual (Golder 2017). The following sections summarize the supplemental assessment activities.

3.1 Overburden, Bedrock, and Source Material Assessment

3.1.1 Sample Collection

Golder subcontracted a licensed well driller to advance overburden borings and install monitoring wells using sonic drilling methods. The drillers collected continuous cores from all deep wells (i.e., "B" flagged wells). Golder collected a composite overburden sample (i.e., two-foot interval) from within the well screened intervals (i.e., 10-foot screened interval) of monitoring wells GAMW-01B, GAMW-12B, GAMW-42B, and from three overburden borings north of the WDA (i.e., not associated with the WDA well network but similar geology) identified as SB-52B, SB-54B, and SB-56B. The unique overburden sample description included the overburden boring name and approximate depth of the sample (e.g., SB-01B-25'-27').

Golder collected two shale samples from borings GAMW-01B and GAMW-42B, including one shale sample located just below the contact between the overburden/shale (i.e., considered as "weathered" shale) and one shale sample located approximately two feet into the shale (i.e., considered as "non-weathered" shale) for laboratory analysis.

Golder collected three WDA source material samples from the north side of the WDA using an excavator (see Figure 2 for sample locations). Golder's field engineer composited three sub-samples from each excavation into one sample per excavation area for submittal to the laboratory including:

- WDA-West Sample: Collected from approximately 1.5 ft bgs in a pile of recently dredged source material, which originated from the northwestern corner of the WDA.
- WDA-MID Sample: Collected from approximately 1.0 ft bgs from a recently dredged source material pile, which originated near the effluent discharge pipes in the north-central portion of the WDA
- WDA-East Sample: Collected from approximately 1.5 ft bgs from a recently dredged source material pile, which originated from the northeastern portion of the WDA

The sample type and analytical testing requirements for each overburden, shale, and WDA source material samples are provided in the table below.

Table 3-1: Summary of Overburden, Shale, and WDA Source Material Samples

Sample Location	Sample Type	Number of Samples	Analysis	Notes
Downgradient boring (GAMW01B)	Shale	2	Total metals, 7-step sequential extraction, X-ray diffraction (XRD)	One weathered and one non-weathered sample
Side-gradient boring (GAMW42B)	Shale	2	Total metals, 7-step sequential extraction, XRD	One weathered and one non-weathered sample
Side-gradient boring (GAMW42B)	Overburden	1	Total metals, 7-step sequential extraction	Overburden from screened interval
Downgradient boring (GAMW01B)	Overburden	1	Total metals, 7-step sequential extraction	Overburden from screened interval
Downgradient boring (GAMW12B)	Overburden	1	Total metals, 7-step sequential extraction	Overburden from screened interval
Downgradient boring (SB-52B)	Overburden	1	Total metals, 7-step sequential extraction, XRD	Overburden from screened interval
Downgradient boring (SB-54B)	Overburden	1	Total metals, 7-step sequential extraction, XRD	Overburden from screened interval
Downgradient boring (SB-56B)	Overburden	1	Total metals, 7-step sequential extraction, XRD	Overburden from screened interval
WDA	CCR	3	Total metals, SPLP extraction	Composite samples

3.1.2 Geochemical Characterization

Golder used multiple geochemical analytical methods to assess the overburden, bedrock, and WDA source material samples including mineralogical testing, chemical composition (total metals) testing, leachability testing, and sequential extraction. The selected geochemical test methods are summarized in the following paragraphs.

Mineralogical Composition: The purpose of the mineralogical test was to identify and quantify the crystalline mineral phases in each sample. This information is needed for geochemical modeling as constituents of concern (COC) release or uptake is potentially influenced by the mineral phases present (Hem 1989). The laboratory (SGS Minerals Services) performed the mineralogical analysis using quantitative (Rietveld) X-ray diffraction (XRD) (ME-LR-MIN-MET-MN-DO5) and a Bruker AXS D8 Advance Diffractometer.

Total Metals: The purpose of this test was to assess the chemical composition of potential source and aquifer materials. The total mass of metals in combination with the results from leachability testing and sequential extraction can be used to determine the provenance of the COC metals and their relative leachability. The laboratory analyzed a target analyte list of metals following the USEPA SW846 6010C Inductively Coupled Plasma- Atomic Emission Spectrometry Revision 3 (November 2000) and USEPA SW846 7471B Mercury in Solid or Semisolid Wastes (Manual Cold-Vapor Technique) Revision 2 (January 1998).

Leachability: The purpose of this test was to obtain an understanding of the fraction of total metals that is leachable, which is important to evaluating the long-term stability of potential source materials. The analysis simulates the interaction between a solid and meteoric water, and thus provides the leachability potential of a material. This analysis was only conducted on WDA source materials (i.e., samples collected from within the WDA). The laboratory used porewater collected by Golder from the WDA Piezometer 04 as the leaching medium to simulate natural conditions. The laboratory tested the leachability of the WDA source materials using USEPA SW846 1312 Modified Synthetic Precipitation Leaching Procedure (SPLP) (September 1994).

Sequential Extraction: This test consists of a seven-step metals extraction from solids to provide the provenance of the COCs (i.e., the operationally-defined fraction that contains the COC)¹. This sequence of steps, provides valuable information on metal mobility. For instance, metals bound in the carbonate fraction or that are exchangeable are much more likely to become mobile with changes to pH and groundwater geochemistry, while metals bound within a sulfide or silicate fraction are not as likely to be released to groundwater under natural conditions. A metal present in the exchangeable fraction is more likely to be surface adsorbed and, therefore, more labile than a metal residing in the silicate fraction. The laboratory analyzed the samples using USEPA SW846 6020B Inductively Coupled Plasma- MS Revision 2 (July 2014) and USEPA SW846 7470A Mercury in Liquid Wastes (Manual Cold- Vapor Technique) Revision 1 (September 1994).

¹ Sequential extraction of metals from overburden and bedrock samples consisted of seven discrete steps for this investigation:

Step 1 - Exchangeable Phase: This extraction includes trace elements that are reversibly adsorbed to overburden minerals, amorphous solids, and/or organic material by electrostatic forces.

Step 2 - Carbonate Phase: This extraction targets trace elements that are adsorbed or otherwise bound to carbonate minerals.

Step 3 – Non-Crystalline Materials Phase: This extraction targets trace elements that are complexed by amorphous minerals (e.g., iron).

Step 4 - Metal Hydroxide Phase: Trace elements bound to hydroxides of iron, manganese, and/or aluminum.

Step 5 - Organic Phase: This extraction targets trace elements strongly bound via chemisorption to organic material.

Step 6 - Acid/Sulfide Fraction: The extraction is used to identify trace elements precipitated as sulfide minerals.

Step 7 - Residual Fraction: Trace elements remaining in the overburden after the previous extractions will be distributed between silicates, phosphates, and refractory oxides.

3.2 Groundwater and Porewater

3.2.1 Sample Collection

Golder field personnel collected porewater (i.e., water in direct contact with CCR materials) and groundwater samples in accordance with the RMSGS Groundwater Monitoring Program Implementation Manual (Golder 2017). Golder collected groundwater and porewater samples for analysis of Appendix III and IV metals and other groundwater quality parameters, as described below, from a subset of WDA monitoring wells including: GAMW-03B, GAMW-01B, GAMW-12B, GAMW-13B, GAMW-14B, GAMW-42, and GAMW-42B.

3.2.2 Geochemical Analysis

The geochemical analysis of the porewater and groundwater samples included total metals and major cations and anions. These selected analytical methods are summarized below.

Metals: Metals analyses (i.e., Appendix III and IV) are important to understand the geochemical properties of porewater and groundwater. In porewater, metal results can be used for geochemical modeling and provide an indication of the leachable fraction of the solids (ITRC, 2012). In groundwater, metals analysis allows for the delineation of a potential plume, and background contributions from natural sources or off-site locations.

Major Cations and Anions/Field Parameters: Geochemical modeling of mineral solubility, metal attenuation and background contributions requires analysis of major cations and anions because they affect and participate in sorption and mineral dissolution/precipitation reactions. Required field parameters include pH, dissolved oxygen, oxidation reduction potential (ORP), conductivity, and temperature, which are needed to support geochemical modeling and serve an important quality assurance/quality control (QA/QC) function.

The laboratory analyzed porewater and groundwater samples using the following methods:

- Total Hardness following Standard Method (SM) 2340B (1997)
- Chloride, Fluoride, and Sulfide following USEPA SW846 9056A Determination of Inorganic Anions by Ion Chromatography Revision 1 (February 2007)
- pH following USEPA SW846 9040C pH Electrometric Measurement (November 2004)
- Total Target Analyte List (TAL) Metals following USEPA SW846 6010C Inductively Coupled Plasma-Atomic Emission Spectrometry Revision 3 (November 2000), SW846 6020B Inductively Coupled Plasma-MS Revision 2 (July 2014), and SW846 6020A Inductively Coupled Plasma- MS Revision 1 (January 1998)
- Mercury following USEPA SW846 7470A Mercury in Liquid Wastes (Manual Cold- Vapor Technique) Revision 1 (September 1994)
- Total Dissolved Solids following SM 2540C Total Dissolved Solids Dried at 180°C (1993)
- Nitrate and nitrite following EPA 353.2 Determination of Nitrate-Nitrite Nitrogen by Automated Colorimetry, Revision 2.0 (August 1993)
- Alkalinity following SM 2320B Alkalinity by Titration (2005)
- Phosphorous following SM 4500-P E Phosphorous by Ascorbic Acid Method (2005)

4.0 DATA EVALUATION AND FINDINGS

4.1 Bedrock Mineralogical Composition

Quantitative X-ray diffraction (XRD) with Rietveld refinement was used to identify minerals in four bedrock and three overburden samples collected during the drilling activities (Table 4-1). Golder collected two bedrock samples per borehole: one bedrock sample just below the overburden/bedrock interface and the second bedrock sample from a deeper, more competent bedrock to identify the weathering potential at the overburden/bedrock interface. The overburden samples were collected to assess the relationship between overburden and bedrock parent materials. Understanding the mineralogy of the aquifer and bedrock system is important for identifying potential natural sources of molybdenum.

The mineralogical analysis identified sulfide minerals (pyrite and marcasite, which are iron sulfide minerals) in all four bedrock samples, at concentrations up to 6.8 % by weight (% wt.). These minerals can oxidize in the presence of even trace amounts of dissolved oxygen, which would lead to the mobilization of trace metals or metalloids known to associate with sulfide minerals (e.g., arsenic and molybdenum) into groundwater. As expected, the overburden samples are mineralogically different from the bedrock shale samples and have much lower sulfide mineral content (0.1 wt. % pyrite and marcasite). Potential shale weathering and/or shale pieces appear to have been present in overburden sample SB-52B-35'-37', which showed a closer relationship mineralogically to the bedrock samples, with the highest sulfide mineral abundance (0.6 wt. %) of the three overburden samples submitted for mineralogical testing.

The range of sulfide mineral contents in bedrock (4.9 to 6.8 % wt.) may be indicative of localized weathering of the shale-rich bedrock parent material and oxidation of sulfide minerals. Bedrock weathering also explains the localized differences in groundwater quality, such as at well GAMW-14B, where sodium and sulfate concentrations were approximately 15 and four times higher, respectively, than in WDA porewater. The higher sulfate and sodium groundwater concentrations are consistent with oxidation of sulfide minerals and weathering of shale-rich bedrock. The coincidental release of sulfate, sodium, and molybdenum from shales during weathering has been well documented in previous studies (Harkness et al. 2017; Lourigan and Phelps 2013).

Table 4-1: Mineralogical Composition of Bedrock and Overburden Samples Collected Downgradient of the Waste Disposal Area

Mineral	Bedrock Samples				Overburden Samples		
	SB-01B		SB-42B		SB-52B	SB-54B	SB-56B
	36-37' bgs	40-41' bgs	34-36' bgs	36-38' bgs	35-37' bgs	30-32' bgs	30-33' bgs
Quartz	35.8	28.9	45.0	42.9	53.4	61.4	72.1
Pyrite	3.9	3.5	3.0	3.3	0.4	0.1	0.1
Marcasite	1.2	1.4	3.2	3.5	0.2	-	-
Muscovite	24.2	23.1	23.8	25.7	7.8	1.7	1.3
Biotite	1.8	2.1	1.6	1.8	1.1	0.6	0.2
Chlorite	6.5	5.2	5.5	6.2	2.6	1.0	1.1

Mineral	Bedrock Samples				Overburden Samples		
	SB-01B		SB-42B		SB-52B	SB-54B	SB-56B
	36-37' bgs	40-41' bgs	34-36' bgs	36-38' bgs	35-37' bgs	30-32' bgs	30-33' bgs
Microcline	17.8	19.1	12.0	11.4	9.2	7.5	6.6
Orthoclase	2.8	2.3	2.1	2.4	2.2	0.7	0.6
Hematite	0.3	0.3	0.4	0.5	0.3	0.4	0.6
Dolomite	1.3	8.8	0.1	0.2	7.9	9.6	5.3
Calcite	0.7	0.6	0.7	0.6	4.7	5.8	3.9
Albite	2.2	1.1	1.8	1.0	7.3	9.1	6.4
Epidote	1.7	2.9	0.8	0.6	2.8	2.1	1.9
Anatase	-	0.7	-	-	-	-	-
TOTAL	100	100	100	100	100	100	100

4.2 Potential Molybdenum Sources

Golder utilized several lines of evidence to assess potential molybdenum sources that can contribute molybdenum to groundwater, including:

- **Total Molybdenum Concentrations:** This test is used to determine the total amount of molybdenum present in bedrock, overburden, and WDA source materials.
- **Sequential Metal Extraction:** This test is more comprehensive than the leachability test and provides information on the provenance of the molybdenum in overburden and bedrock, i.e., the specific mineral phase(s) in which the molybdenum resides. This information helps identify under what geochemical conditions molybdenum may be released into groundwater.
- **Leachability Test:** This test is used to determine the amount of leachable molybdenum from WDA source materials to groundwater. The USEPA Modified SPLP Method was applied, which mimics natural conditions in groundwater.

The laboratory reported total molybdenum concentrations for three WDA source material samples, four bedrock (shale) samples, and four overburden samples collected within the screened intervals of the monitoring wells installed in 2018. Bedrock samples had the highest total molybdenum concentrations, ranging from 18 to 94 mg/kg, while overburden and WDA source material samples contained much lower levels, ranging from 0.91 to 2.9 mg/kg and 1.4 to 6.8 mg/kg, respectively, as shown in Appendix A. The range of molybdenum contents in bedrock may be a result of natural geological processes that occurred during deposition or, given the presence of sulfide minerals (Table 4-1), the result of bedrock weathering.

Bedrock sequential extraction test results confirmed an association between molybdenum and sulfide minerals in all bedrock samples, as shown in Appendix A. Molybdenum associated with sulfide minerals accounted for 57 to 72% of the total molybdenum present. Sulfide association with molybdenum would occur during geogenic deposition of chalcophile elements (i.e., elements that have an affinity for sulfur) during sedimentary rock (shale) formation. Weathering of shale and oxidation of sulfides would result in release of molybdenum to groundwater. In the absence of weathering, molybdenum is effectively retained in the sulfide mineral.

In the overburden samples, total molybdenum concentrations ranged from 0.91 to 2.9 mg/kg while molybdenum showed a stronger association with amorphous minerals (e.g., iron, manganese, or aluminum oxy(hydr)oxides) than with sulfide minerals. Molybdenum sorbed to such phases is much more sensitive to changes in groundwater geochemistry and can, thus, be more easily re-mobilized into groundwater. As a consequence, seasonal or other natural fluctuations in groundwater conditions can lead to fluctuating molybdenum concentrations.

The laboratory determined the leachability of three WDA source material samples using the USEPA Modified SPLP Method. Using interstitial porewater from the WDA (i.e., GAPIEZ-04), the molybdenum concentrations in the SPLP leachates ranged from 0.004 to 0.006 mg/L (lower than the WDA-specific GWPS of 0.009 mg/L). These data indicate that the WDA source material has a very low leaching potential for molybdenum. The leachability results are also in good agreement with the total molybdenum concentrations observed in WDA porewater of <0.003 mg/L (see Section 4.3).

4.3 Groundwater and Porewater Geochemistry

Molybdenum groundwater and porewater concentrations are provided in Appendix A. Molybdenum concentrations in groundwater samples collected from three monitoring wells (i.e., one shallow and two deep wells) downgradient of the WDA exceeded the WDA-specific GWPS (0.009 mg/L) and range from 0.01 to 0.045 mg/L (GAMW-01, GAMW-13B, GAMW-14B). However, these concentrations did not exceed the new USEPA risk-based background level for molybdenum of 0.1 mg/L, which USEPA published in the Federal Register on July 30, 2018 and which became effective August 29, 2018 (CCR Final Rule Part 1 Phase 1 Addendum). Molybdenum concentrations in groundwater samples collected from background wells GAMW-03 and GAMW-03B (0.0043 to 0.009 mg/L) were not detected above the laboratory reporting limit.

Molybdenum concentrations in porewater samples collected from piezometer GAPIEZ04, installed in the northwest corner of the WDA and in direct contact with CCR materials, were less than 0.003 mg/L during both monitoring events. These concentrations are lower than those in the downgradient samples, suggesting that the molybdenum present in the downgradient groundwater samples is not due to a release from the CCR.

The analytical data also suggest that groundwater in some wells (GAMW-01 and GAMW-14B) displays significant seasonal variability in molybdenum concentrations (Figure 4-3(1)). The molybdenum concentrations in these two wells do not appear to follow any trend (i.e., upward, downward, or constant). This indicates that the molybdenum patterns in groundwater in these wells likely result from natural fluctuations in groundwater conditions and are not representative of a release from a constant and consistent source such as the CCR.

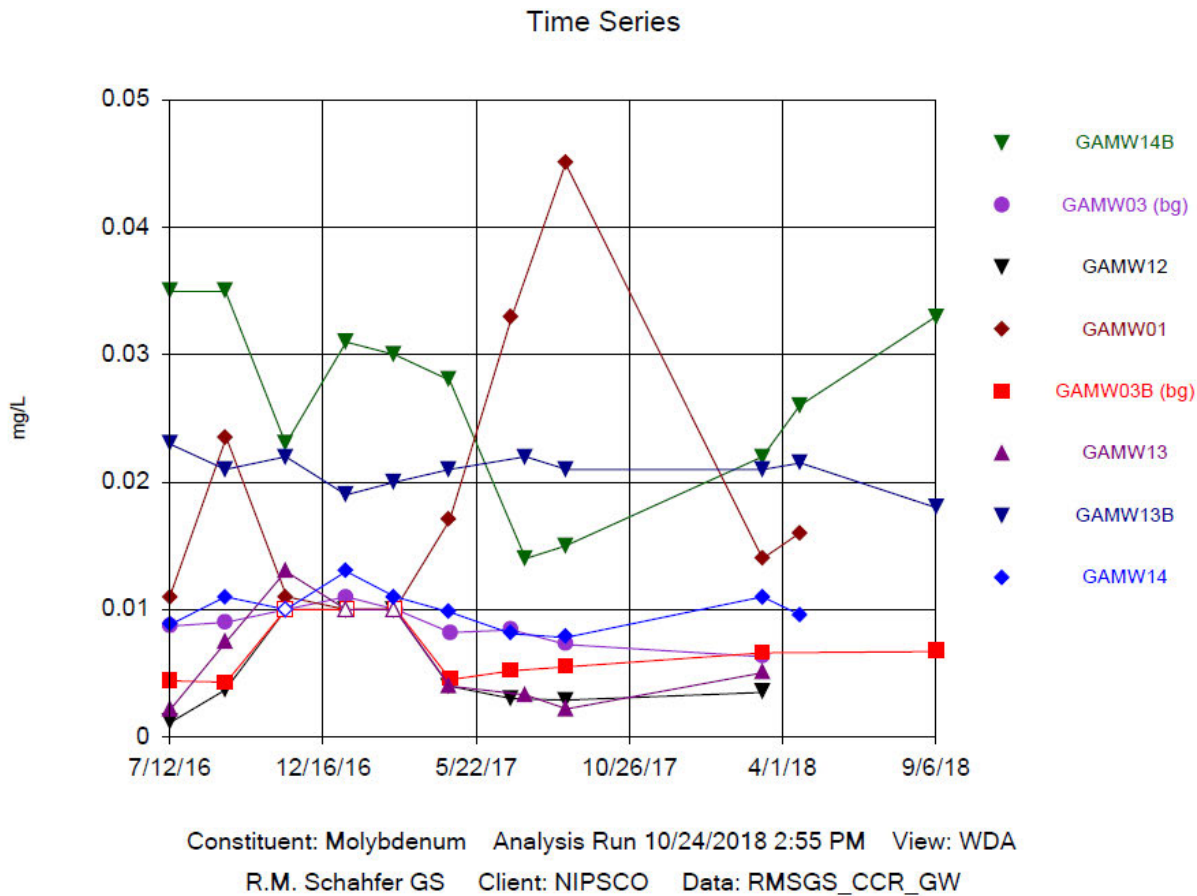


Figure 4-3(1): WDA Molybdenum Trend Chart (July 2016-September 2018)

Figure 4-3(1) also shows molybdenum concentrations are higher in groundwater samples collected from GAMW-01 than in GAMW-12, GAMW-13, and GAMW-14. If the WDA were the source of molybdenum, signs of a release would most likely be observed in those wells located closest to the source materials in the northern half of the WDA (i.e., GAMW-12, GAMW-13, and GAMW-14).

Groundwater and porewater geochemistry were also evaluated using the relative abundance of major cations and anions. Piper and other ternary plots, developed using Geochemist’s Workbench, were generated to visually depict major ion chemistry abundance and elucidate relationships between background groundwater, downgradient groundwater and porewater. Additionally, they were used to evaluate the nature and cause(s) of groundwater quality impacts, if any.

The Spece8 package in Geochemist’s Workbench was then used to evaluate mineral saturation in groundwater samples and to determine if mineral precipitation would impact relative ion abundance. Only those monitoring wells for which comprehensive analytical results (i.e., including all major ions) were available, were included in this evaluation, as this is a prerequisite for reliable geochemical modeling.

The evaluation of major ion composition indicates the samples fall into the following three discrete groups:

- Background and downgradient groundwater

- Bedrock influenced groundwater
- WDA porewater

All deep downgradient groundwater samples, except from monitoring wells GAMW-13B and GAMW-14B, showed a closer relationship to groundwater quality in background monitoring well GAMW-03B than the WDA porewater samples (see Figure 4-3(2) left). This similarity in major ion composition suggests that downgradient groundwater has the same source as background groundwater. In cases where groundwater is impacted by a potential large discrete source, such as the WDA, the groundwater would plot between the background and source groundwater, indicating mixing of the two waters.

Downgradient well GAMW-13B is an exception to the general trend and plots between the WDA and background well GAMW-03B. However, upon further evaluation using a ternary diagram for sulfate, chloride, and sodium (tracers commonly used to identify CCR-influenced waters), groundwater in well GAMW-13B is found to be more related to the other downgradient wells than the WDA due to its higher relative sodium content (Figure 4-3(2) right). This is further supported by the total dissolved solids (TDS) content measured in GAMW-13B (430 mg/L), which was lower than in both the WDA (670 mg/L) and groundwater from background well GAMW-03/03B (490 mg/L; Figure 4-3(2) right *only*). In the absence of attenuation reactions such as mineral precipitation (which would lower the TDS of a groundwater sample), the TDS of a mixture of two samples should range between the TDS values of both inputs. Based on geochemical modeling, mineral saturation is not achieved in GAMW-13B, so this groundwater does not represent a mixture of WDA porewater and groundwater from GAMW-03B. The analytical data used to develop the Piper Plots is provided in Appendix A.

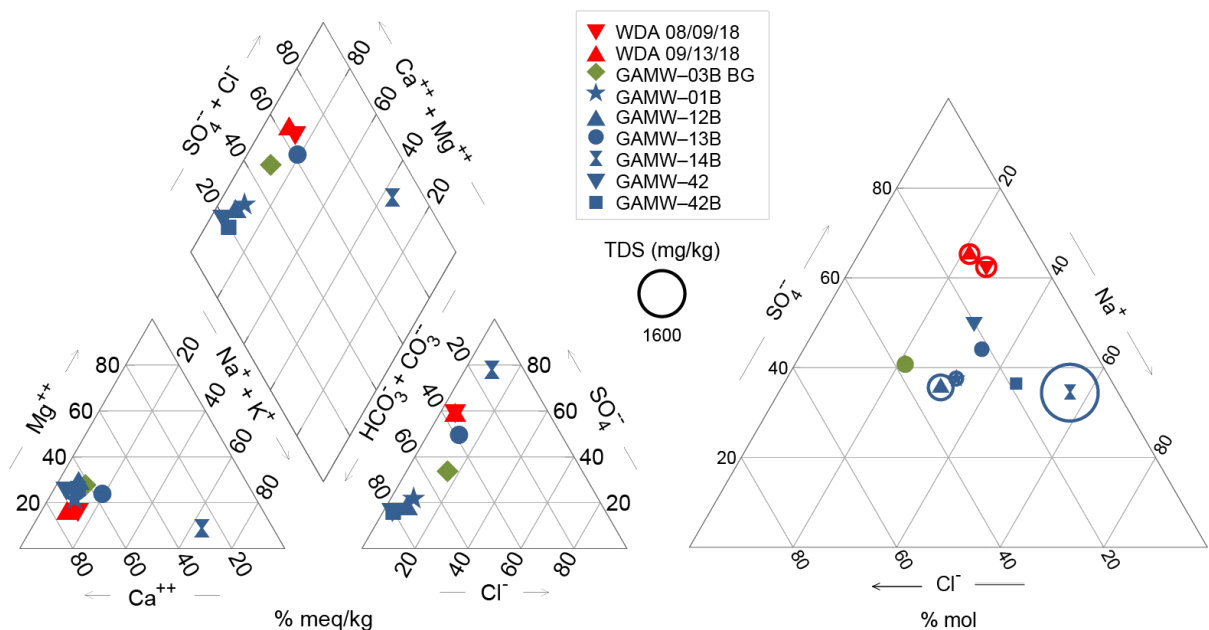


Figure 4-3(2): WDA Piper Plot (left) and ternary plot (right) of certain ions (sulfate, sodium, and chloride) and TDS

Groundwater in monitoring well GAMW-14B is also geochemically different from groundwater from the other monitoring wells and WDA porewater samples. Its' much higher TDS content (2,000 mg/L) is due to a greater

abundance of sodium and sulfate as compared to WDA porewater (660 to 670 mg/L) and the other groundwater samples (190 to 870 mg/L). Sodium concentrations were 15 times higher in the groundwater sample from GAMW-14B than in the WDA porewater, while the sulfate concentration was nearly four times higher than in the WDA porewater. Compared to average concentrations in background groundwater, sodium and sulfate concentrations in groundwater from GAMW-14B were 21 and 7 times higher, respectively.

Geochemical modeling has demonstrated that both sodium and sulfate can be considered conservative tracers (i.e., they are not attenuated through adsorption or mineral precipitation) in site groundwater. The sodium to sulfate ratio should, therefore, remain generally constant and indications of mixing or dilution would change this ratio in a predictable manner. The ratio of sodium to sulfate in GAMW-14B (3.9 to 10) is much higher than in the WDA porewater (0.8 to 1:10) and ambient groundwater (1.25 to 10). No possible combination of WDA porewater and ambient groundwater could achieve this ratio. Thus, groundwater in monitoring well GAMW-14B is considered not affected by WDA porewater but only influenced by direct interaction with bedrock, including release of molybdenum.

4.4 Data Usability

Golder validates 100% of the groundwater data generated as part of the CCR monitoring program in accordance with the National Functional Guidelines for Inorganic Superfund Data Review (EPA 540-R-013-001, August 2014). All data included in this report have been accepted or qualified on the basis of specific QC criteria as described in the Groundwater Monitoring Program Implementation Manual (Golder 2017).

5.0 EVIDENCE OF AN ALTERNATIVE SOURCE

Based on a literature review and the testing results presented above, it is Golder's opinion that the molybdenum SSL detected in groundwater near the WDA is linked to an alternative source rather than a release from the WDA. Golder concludes the source of molybdenum is naturally-occurring molybdenum present in overburden and bedrock.

Primary lines of evidence and conclusions drawn from the evidence used to support this ASD are provided in Table 5.1.

Table 5.1: Primary Lines of Evidence and Supporting ASD Analysis

Key Line of Evidence	Supporting Evidence	Description
Groundwater Geochemistry	Relative ion abundance differs from the WDA	As presented in the Piper and other ternary diagrams, major ion concentrations show distinct differences between the WDA porewater and downgradient groundwater samples. The geochemical properties of the downgradient groundwater samples cannot have been generated by a release from the WDA.
	Temporal trends and associations	In certain downgradient wells, significant seasonal variability is observed in molybdenum groundwater concentrations. In addition, molybdenum concentrations do not appear to follow any trend. This suggests the molybdenum is naturally occurring and not representative of a constant and consistent release from the WDA. Given the WDA disposal history, types of CCR materials placed in the WDA, and decades since CCR was first placed in the WDA, Golder anticipates that a mature plume (i.e., steady-state or consistent concentration levels), if any, would be detected in groundwater near the WDA. However, this is not the case, indicating the molybdenum does not originate from the WDA.

Key Line of Evidence	Supporting Evidence	Description
	Sodium and sulfate ion ratios	Groundwater in monitoring well GAMW-14B shows increased sulfate, sodium, and molybdenum concentrations, consistent with oxidation of sulfide minerals present in shale-rich bedrock. Sodium and sulfate concentrations and sodium to sulfate ratios in groundwater samples from well GAMW-14B are much higher than in the WDA porewater and downgradient groundwater, supporting the hypothesis that molybdenum in GAMW-14B is not derived from the WDA but from bedrock.
	Total dissolved solids	The TDS content in downgradient well GAMW-13B is lower than in both ambient groundwater and WDA porewater. GAMW-14B has a higher TDS content than even WDA porewater. Neither GAMW-13B nor GAMW-14B, therefore, contain a mixture of WDA porewater and ambient groundwater.
	Non-detect molybdenum concentrations in WDA porewater	WDA porewater samples had the lowest measured molybdenum concentrations (<0.003 mg/L) of all groundwater samples analyzed as part of this ASD, including background groundwater samples. Leach test results further indicate WDA source materials have a similarly low potential to leach molybdenum. Therefore, another molybdenum source must be present to account for the higher molybdenum concentrations observed in downgradient groundwater.
Source of Molybdenum	Molybdenum content of overburdens, bedrock, and WDA source materials	Bedrock had the highest molybdenum concentrations. Molybdenum is present at lower concentrations in the overburden and WDA source materials. An adequate amount of naturally-occurring molybdenum, therefore, is present in overburden and bedrock to cause the observed molybdenum concentrations in groundwater.
	Molybdenum association in bedrock	Molybdenum in bedrock was found to be primarily associated with sulfide minerals. During bedrock weathering and associated sulfide oxidation, this molybdenum is released.
	Mineralogy	Results from the mineralogical analysis indicate sulfide minerals are present in bedrock, representing a potential source for the molybdenum and sulfate observed in groundwater. The presence of molybdenum, sodium, and sulfate is consistent with a literature review of similar shales in the region.
	Hydrogeology	GAMW-01, a shallow well located farthest from the WDA source material and the other shallow monitoring wells (GAMW-12, GAMW-13, and GAMW-14), contains molybdenum in concentrations above the GWPS. Molybdenum has generally not been detected in samples from monitoring wells GAMW-12, GAMW-13, and GAMW-14, which are closer to and downgradient of the source material. This concentration pattern is inconsistent with the CCR being the source of molybdenum.

6.0 CONCLUSION

The preceding information serves as the ASD prepared for the WDA in accordance with 40 CFR 257.95(g)(3)(ii) and supports the finding that the SSLs determined on August 23, 2018 are not due to a release from the CCR Unit. The key supporting lines of evidence described above indicate that the molybdenum detected in monitoring wells downgradient of the WDA is due to a natural source and not due to the WDA. Therefore, no further action (i.e., Assessment of Corrective Measures) is warranted, and the RMSGS WDA will remain in Assessment Monitoring.

7.0 REFERENCES

- Fenelon, J.M., K.E. Bobay, T.K. Greeman, M.E. Hoover, D.A. Cohen, K.K. Fowler, M.C. Woodfield, and J. M. Durbin., 1994. Hydrogeologic Atlas of Aquifers in Indiana. U.S. Geological Survey, Water Resources Investigations, Report 92-4142.
- Fraser, G.S., and Bleuer, N.K., 1991. Geologic framework of the aquifers in the Kankakee River lowland: Indiana Geological Survey Occasional Paper 60.
- Golder Associates Inc., 2017. Rollin M. Schahfer Generating Station Groundwater Monitoring Program Implementation Manual
- Harkness, J. S., Darrah, T. H., Moore, M. T., Whyte, C. J., Mathewson, P. D., Cook, T., and Vengosh, A., 2017. Naturally occurring versus anthropogenic sources of elevated molybdenum in groundwater: Evidence for Geogenic contamination from Southeast Wisconsin, United States. *Environmental Science & Technology*, 51(21), 12190-12199.
- Hem, J. D., U.S Geological Survey Water Supply Paper 2254 1989. Study and interpretation of the chemical characteristics of natural water.
- Lourigan, J., and Phelps, W., 2013. Caledonia Groundwater Molybdenum Investigation Southeast Wisconsin. Wisconsin Department of Natural Resources.
- Schneider, A.F. and Keller, S.J., 1970. Geologic Map of the Chicago Quadrangle, Indiana, Illinois, and Michigan; Indiana Geological Survey, Bloomington.
- Smedley, P. L. and Kinniburgh, D. G., 2017. Molybdenum in natural waters: A review of occurrence, distributions and controls. *Applied Geochemistry*, 84, 387-432.
- USEPA, 1996. Test methods for evaluating solid waste, physical/chemical methods (SW-846): 3rd edition, Environmental Protection Agency, National Center for Environmental Publications, Cincinnati, Ohio, accessed at URL <https://www.epa.gov/hw-sw846>.
- USEPA, 2014. National Functional Guidelines for Inorganic Superfund Data Review (EPA 540-R-013-001).

Sincerely,

GOLDER ASSOCIATES INC.

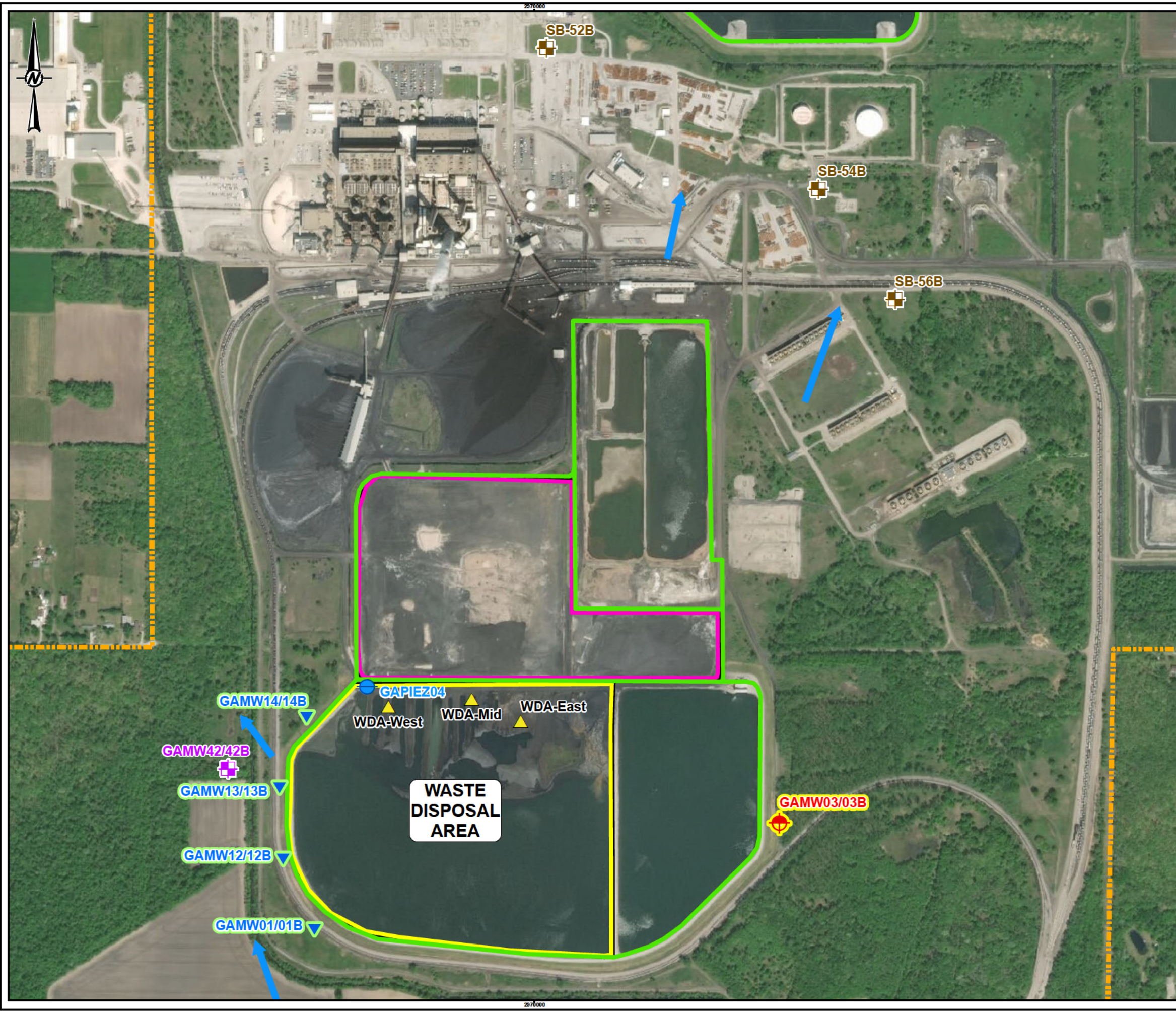


Mark A. Haney
Program Leader and Principal



Rens Verburg
Principal Geochemist

FIGURES



- LEGEND**
- Background Monitoring Well
 - Downgradient Monitoring Well
 - Assessment Monitoring Well
 - Porewater Sample Location
 - Soil Boring Location
 - CCR Source Material Sample Location
 - Slurry Wall
 - CCR Unit
 - Approximate Extent of Inactive Retired Waste Disposal Area
 - Generalized Groundwater Flow Directions
 - Approximate Property Line



NOTE(S)

REFERENCE(S)
 1. SERVICE LAYER CREDITS: SOURCE: ESRI, DIGITALGLOBE, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEROGRO D, IGN, AND THE GIS USER COMMUNITY

CLIENT

NORTHERN INDIANA PUBLIC SERVICE COMPANY

PROJECT
 NORTHERN INDIANA PUBLIC SERVICE COMPANY
 R.M. SCHAHFER GENERATING STATION
 WHEATFIELD, INDIANA

TITLE

SAMPLE LOCATION MAP

CONSULTANT	YYYY-MM-DD	11/14/2018
	DESIGNED	JSP
	PREPARED	SHL
	REV EWED	JSP
	APPROVED	MAH

PROJECT NO.	CONTROL	REV.	FIGURE
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1 in IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ANSI B

APPENDIX A
Analytical Results

Table A.1: Soil and CCR Material Molybdenum Results
Waste Disposal Area
R. M. Schahfer Generating Station
Wheatfield, Indiana

Sample Location	SB-01B	SB-01B	SB-01B	SB-12B	SB-42B	SB-42B	SB-42B	SB-52B	SB-54B	SB-56B	WDA-EAST	WDA-MID	WDA-WEST
Start Depth	25	36	40	32	30	34	36	35	30	30	0	0	0
End Depth	27	37	41	34	34	36	38	37	32	32	1.5	1	1.5
Source Material	Overburden	Bedrock	Bedrock	Overburden	Overburden	Bedrock	Bedrock	Overburden	Overburden	Overburden	CCR	CCR	CCR
SEP Step 1	9.3 U (0%)	1.4 J (3%)	1.3 J (6%)	9.6 U (0%)	9.7 U (0%)	4.2 J (4%)	2.2 J (2%)	8.9 U (0%)	9.8 U (0%)	2.2 J (2%)			
SEP Step 2	6.9 U (0%)	0.4 J (1%)	7.3 U (0%)	7.2 U (0%)	7.3 U (0%)	1.5 J (1%)	0.58 J (0%)	6.7 U (0%)	7.3 U (0%)	0.58 J (0%)			
SEP Step 3	0.67 J (73%)	4 (8%)	3.4 (15%)	0.15 J (19%)	0.18 J (100%)	14 (12%)	11 (9%)	0.51 J (46%)	0.59 J (45%)	11 (9%)			
SEP Step 4	0.25 J (27%)	1.9 J (4%)	2.2 J (10%)	0.14 J (18%)	2.4 U (0%)	5.8 (5%)	4.3 (4%)	0.39 J (35%)	0.53 J (41%)	4.3 (4%)			
SEP Step 5	35 U (0%)	1.5 J (3%)	36 U (0%)	36 U (0%)	36 U (0%)	2.4 J (2%)	5.1 J (4%)	33 U (0%)	37 U (0%)	5.1 J (4%)			
SEP Step 6	2.3 U (0%)	38 (72%)	13 (59%)	0.49 J (63%)	2.4 U (0%)	71 (59%)	68 (57%)	0.21 J (19%)	0.18 J (14%)	68 (57%)			
SEP Step 7	2.3 U (0%)	5.1 (10%)	1.8 J (8%)	2.4 U (0%)	2.4 U (0%)	23 (19%)	26 (22%)	2.2 U (0%)	2.4 U (0%)	26 (22%)			
SEP SUM	0.92 J (100%)	53 (100%)	22 (100%)	0.78 J (100%)	0.18 J (100%)	120 (100%)	120 (100%)	1.1 J (100%)	1.3 J (100%)	120 (100%)			
Total Result	2.9 J	41	18	0.91 J	4.6 U	94	83	3.8 J	0.88 J	83	1.4 J	6.4	6.8
SPLP Result											0.005 J	0.0043 J	0.0061 J

Notes:

All results displayed are molybdenum results in milligram per kilogram (mg/kg), except SPLP results which are in milligram per liter (mg/L).

Percent (%) displayed is the amount of molybdenum detected in the given step compared to the calculated total molybdenum "SEP SUM".

SEP: Sequential Extraction Procedure

Step 1 - Exchangeable Phase: This extraction includes trace elements that are reversibly adsorbed to soil minerals, amorphous solids, and/or organic material by electrostatic forces.

Step 2 - Carbonate Phase: This extraction targets trace elements that are adsorbed or otherwise bound to carbonate minerals.

Step 3 - Non-Crystalline Materials Phase: This extraction targets trace elements that are complexed by amorphous minerals (e.g. iron).

Step 4 - Metal Hydroxide Phase: This extraction targets trace elements bound to hydroxides of iron, manganese, and/or aluminum.

Step 5 - Organic Phase: This extraction targets trace elements strongly bound via chemisorption to organic material.

Step 6 - Acid/Sulfide Fraction: The extraction is used to identify trace elements precipitated as sulfide minerals.

Step 7 - Residual Fraction: Trace elements remaining in the soil after the previous extractions will be distributed between silicates, phosphates, and refractory oxides.

SPLP: Synthetic Precipitation Leaching Procedure

J: Indicates result was detected above the laboratory method detection limit, but below the laboratory reporting limit, the estimated result is provided.

U: Indicates result was not detected above the laboratory method detection limit, the laboratory reporting limit is provided.

Prepared by: DFS

Checked by: KMC

Reviewed by: JSP

Table A.2: Groundwater and Porewater Molybdenum Results
Waste Disposal Area
R. M. Schahfer Generating Station
Wheatfield, Indiana

Location		GAMW01		GAMW01B	GAMW03		GAMW03B		GAMW12		GAMW12B	GAMW13		GAMW13B		GAMW14		GAMW14B	GAMW42	GAMW42B	GAPIEZ04
Sample Type		FD	N	N	FD	N	FD	N	FD	N	N	FD	N	FD	N	N	N	N	N	N	N
Date	Fraction																				
2016-07	Total		0.011			0.0087 J		0.0044 J	0.01 U	0.002 J			0.0021 J		0.023		0.0088 J	0.035			
2016-09	Total	0.025	0.022			0.009 J		0.0043 J		0.0037 J			0.0074 J		0.021		0.011	0.035			
2016-11	Total		0.011			0.01 U		0.01 U		0.01 U			0.013		0.022		0.01 U	0.023			
2017-01	Total		0.01 U		0.012 J+	0.01 U		0.01 U		0.01 U			0.01 U		0.019 J+		0.013 J+	0.031 J+			
2017-02	Total		0.01 U			0.01 U		0.01 U		0.01 U			0.01 U	0.02	0.02		0.011	0.03			
2017-04	Total		0.017			0.0082 J		0.0045 J		0.004 J			0.004 J	0.021	0.021		0.0098 J	0.028			
2017-06	Total		0.033			0.0084 J		0.0052 J		0.003 J			0.0033 J		0.022	0.008 J	0.0082 J	0.014			
2017-08	Total		0.045		0.0069 J	0.0076 J		0.0055 J		0.0029 J			0.0022 J		0.021		0.0078 J	0.015			
2018-03	Total		0.014			0.0063 J		0.0066 J		0.0035 J			0.0053 J		0.021		0.011	0.022			
2018-04	Total		0.016										0.022	0.021			0.0096 J	0.026			
2018-08	Dissolved																				0.0028 J
2018-09	Dissolved			0.0014 J				0.0066 J				0.0012 J			0.019			0.034			
2018-09	Total			0.0015 J			0.0067 J	0.0067 J				0.01 U			0.018			0.033	0.0035 J	0.0048 J	0.0028 J

Notes:

Table shows all Molybdenum results in milligram per liter (mg/L)

J: Indicates result was detected above the laboratory method detection limit, but below the laboratory reporting limit, the estimated result is provided.

J+: Indicates result was qualified as estimated, biased high during data validation.

U: Indicates result was not detected above the laboratory method detection limit, the laboratory reporting limit is provided.

FD: Field duplicate

N: Normal sample

Prepared by: DFS
 Checked by: KMC
 Reviewed by: JSP

Table A.3: Groundwater and Porewater Chemistry Data
Waste Disposal Area
R. M. Schahfer Generating Station
Wheatfield, Indiana

Parameter	Unit	GAPIEZ04 (8/9/2018)	GAPIEZ04 (9/13/2018)	GAMW-03B	GAMW-01B	GAMW-12B	GAMW-13B	GAMW-14B	GAMW-42	GAMW-42B
Calcium	mg/L	140	160	100	110	100	77	160	44	46
Magnesium	mg/L	20	20	27	21	27	19	31	9.9	11
Sodium	mg/L	28	22	20	15	13	28	430	3 J	6.2
Potassium	mg/L	4.8 J	5	1.4 J	5.1	2.8	2.9 J	13	0.76 J	1.9 J
Alkalinity	mg/L	210 J	220	310	290	340	150	220	130	140
Sulfate	mg/L	280	280	160	72	63	150	1100	21	21
Chloride	mg/L	19	21	55	21	22	27	110	3.1	4
Total Dissolved Solids	mg/L	670	660	490	450	870	430	2000	190	200
pH		7.35	7.27	7.1	7.01	7.15	7.37	7.29	7.54	8.08

Notes:

Table shows maximum result collected in September 2018 unless otherwise indicated, results are in milligram per liter (mg/L)

J: Indicates the result is estimated.

U: Indicates result was not detected above the laboratory method detection limit, the laboratory reporting limit is provided.

Prepared by: PJN
 Checked by: DFS
 Reviewed by: JSP



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