2018 Annual Groundwater Monitoring and Corrective Action Report

Edgewater Generating Station
Sheboygan, Wisconsin

Prepared for:

Alliant Energy

SCS ENGINEERS

25216068.18 | January 31, 2019

2830 Dairy Drive
Madison, WI 53718-6751
608-224-2830

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1.0 INTRODUCTION

This 2018 Annual Groundwater Monitoring and Corrective Action Report was prepared to support compliance with the groundwater monitoring requirements of the Coal Combustion Residuals (CCR) Rule [40 CFR 257.50-107]. Specifically, this report was prepared to fulfill the requirements of 40 CFR 257.90(e). The applicable sections of the Rule are provided below in italics, followed by applicable information relative to the 2018 Annual Groundwater Monitoring and Corrective Action Report for the CCR Units.

This report covers the period of groundwater monitoring from January 1, 2018 through December 31, 2018.

The groundwater monitoring system at the Edgewater Generating Station is a multi-unit system. The Edgewater Generation Station has four existing CCR units which are contiguous:

- EDG Slag Pond (existing CCR surface impoundment)
- EDG North A-Pond (existing CCR surface impoundment)
- EDG South A-Pond (existing CCR surface impoundment)
- EDG B-Pond (existing surface CCR impoundment)

The system is designed to detect monitored constituents at the waste boundary of the CCR unit as required by 40 CFR 257.91(d). The groundwater monitoring system consists of one upgradient and three downgradient monitoring wells.

2.0 §257.90(E) ANNUAL REPORT REQUIREMENTS

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

2.1 §257.90(E)(1) SITE MAP

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;

A map with an aerial image showing the CCR units and all background (or upgradient) and downgradient monitoring wells with identification numbers for the groundwater monitoring program is provided as **Figure 1**.

2.2 §257.90(E)(2) MONITORING SYSTEM CHANGES

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;

No new monitoring wells were installed and no wells were decommissioned as part of the groundwater monitoring program for the CCR unit in 2018.

2.3 §257.90(E)(3) SUMMARY OF SAMPLING EVENTS

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;

Two groundwater samples were collected from each CCR monitoring well in 2018, as part of the semiannual groundwater sampling for the detection monitoring program at Edgewater Generating Station (**Table 1**). The date of sample collection, field measurements, and the analytical results of the analytical laboratory analyses are provided in **Appendix A**.

Assessment Monitoring has not been initiated for the CCR units at the Edgewater Generating Station.

2.4 §257.90(E)(4) MONITORING TRANSITION NARRATIVE

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);

There were no transitions between monitoring programs in 2018. The Edgewater Generating station CCR units remained in the detection monitoring program.

In 2018, the monitoring results for the October 2017 and April 2018 monitoring events were evaluated for statistically significant increases (SSIs) in detection monitoring parameters relative to background. For both events, SSIs for boron, fluoride, field pH, and sulfate were identified; however, alternative source demonstrations (ASDs) were completed, demonstrating that a source other than the CCR units was the likely cause of the observed concentrations. The ASD reports are provided in **Appendix B**.

2.5 §257.90(E)(5) OTHER REQUIREMENTS

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

Additional potentially applicable requirements for the annual report, and the location of the requirement within the Rule, are provided in the following sections. For each cited section of the Rule, the portion referencing the annual report requirement is provided below in italics, followed by applicable information relative to the 2018 Annual Groundwater Monitoring and Corrective Action Report for the CCR Units.

2.5.1 §257.90(e) General Requirements

For the preceding calendar year, the annual report must document the status of the groundwater monitoring and corrective action program for the CCR unit, summarize key actions completed, *describe any problems encountered, discuss actions to resolve the problems, and project key activities for the upcoming year.*

Status of Groundwater Monitoring and Corrective Action Program. The groundwater monitoring and corrective action program is currently in detection monitoring.

Summary of Key Actions Completed (2018):

- Statistical evaluation and determination of SSIs for the October 2017 and April 2018 monitoring events.
- ASD reports for the SSIs identified from the October 2017 and April 2018 monitoring events.
- Two semiannual groundwater sampling and analysis events (April and October 2018).

Description of Any Problems Encountered. No problems were encountered in 2018.

Discussion of Actions to Resolve the Problems. Not applicable.

Projection of Key Activities for the Upcoming Year (2019):

- Statistical evaluation and determination of any SSIs for the October 2018 and April 2019 monitoring events;
- If an SSI is determined, then within 90 days either:
  - Complete alternative source demonstration (if applicable), or
  - Establish an assessment monitoring program; and
- Two semiannual groundwater sampling and analysis events (April and October 2019).

2.5.2 §257.94(d) Alternative Detection Monitoring Frequency

The owner or operator must include the demonstration providing the basis for the alternative monitoring frequency and the certification by a qualified professional engineer in the annual groundwater monitoring and corrective action report required by §257.90(e).

Not applicable. No alternative detection monitoring frequency has been proposed.

2.5.3 §257.94(e)(2) Alternative Source Demonstration for Detection Monitoring

The owner or operator must also include the demonstration in the annual groundwater monitoring and corrective action report required by §257.90(e), in addition to the certification by a qualified professional engineer.

The ASD reports prepared to address the SSIs observed for the October 2017 and April 2018 sampling events are provided in **Appendix B.** The ASD reports are certified by a qualified professional engineer.

2.5.4 §257.95(c) Alternative Assessment Monitoring Frequency

The owner or operator must include the demonstration providing the basis for the alternative monitoring frequency and the certification by a qualified professional engineer in the annual groundwater monitoring and corrective action report required by §257.90(e).

Not applicable. Assessment monitoring has not been initiated.

2.5.5 §257.95(d)(3) Assessment Monitoring Results and Standards

Include the recorded concentrations required by paragraph (d)(1) of this section, identify the background concentrations established under §257.94(b), and identify the groundwater protection standards established under paragraph (d)(2) of this section in the annual groundwater monitoring and corrective action report required by §257.90(e).

Not applicable. Assessment monitoring has not been initiated.

2.5.6 §257.95(g)(3)(ii) Alternative Source Demonstration for Assessment Monitoring

The owner or operator must also include the demonstration in the annual groundwater monitoring and corrective action report required by §257.90(e), in addition to the certification by a qualified professional engineer.

Not applicable. Assessment monitoring has not been initiated.

2.5.7 §257.96(a) Extension of Time for Corrective Measures Assessment

The assessment of corrective measures must be completed within 90 days, unless the owner or operator demonstrates the need for additional time to complete the assessment of corrective measure due to site-specific conditions or circumstances. The owner or operator must obtain a certification from a qualified professional engineer attesting that the demonstration is accurate. The 90-day deadline to complete the assessment of corrective measures may be extended for longer than 60 days. The owner or operator must also include the demonstration in the annual groundwater monitoring and corrective action report required by §257.90(e), in addition to the certification by a qualified professional engineer.

Not applicable. Corrective measures assessment has not been initiated.

Table 1

CCR Rule Groundwater Samples Summary

Table 1. CCR Rule Groundwater Samples Summary

Edgewater Generating Station / SCS Engineers Project #25216068

Sample Dates	Downgradient Wells			Background Well
	MW-301	MW-302	MW-303	2R-OW
4/2/2018	D	D	D	D
10/1/2018	D	D	D	D
Total Samples	2	2	2	2

Abbreviations:
D = Required by Detection Monitoring Program

Created by: NDK Date: 1/4/2018
Last revision by: NDK Date: 12/12/2018
Checked by: MDB Date: 12/12/2018

I:\25216068.00\Deliverables\2018 Annual Report -CCR\Table\[Table 1. GW Sampling Summary Table -EDG 2018.xlsx]GW Summary

Figure 1

Site Plan and Monitoring Well Locations

LEGEND

⊕	ABANDONED MONITORING WELL
●	MONITORING WELL
◉	PIEZOMETER
🔴	CCR RULE MONITORING WELL
▬	CCR RULE LIMITS
— — —	CLOSED LANDFILL LIMITS

NOTES:

1. AERIAL PHOTOGRAPH FROM THE NATIONAL AGRICULTURE IMAGERY PROGRAM AND PUBLISHED BY THE USDA FSA AERIAL PHOTOGRAPHY FIELD OFFICE. DATE OF IMAGE IS OCTOBER 1, 2013.
2. EXISTING WELL LOCATIONS ARE APPROXIMATE AND ARE BASED ON OCTOBER 2011 WATER TABLE MAP PREPARED BY TRC.
3. CCR RULE LIMITS AND CLOSED LANDFILL LOCATION ARE APPROXIMATE.
4. NEW MONITORING WELL LOCATIONS WERE SURVEYED BY CQM, INC. ON FEBRUARY 12, 2016.

500 0 500

SCALE: 1" = 500'

PROJECT NO.	25216068.18	DRAWN BY:	KP/BJM/RJG
DRAWN:	02/28/14	CHECKED BY:	KAK
REVISED:	10/09/18	APPROVED BY:	

ENGINEER

SCS ENGINEERS
2830 DAIRY DRIVE MADISON, WI 53718-6751
PHONE: (608) 224-2830

CLIENT

WISCONSIN POWER AND LIGHT
EDGEWATER GENERATING STATION
3739 LAKESHORE DRIVE
SHEBOYGAN, WI 53081

SITE

EDGEWATER 1-4 (CLOSED)
ASH DISPOSAL FACILITY
SHEBOYGAN, WISCONSIN

MONITORING WELL LOCATION MAP

FIGURE
1

I:\25216068.00\Drawings\2 Monitoring Well Location Map.dwg, 1/9/2019 2:29:49 PM

Appendix A

Laboratory Reports

A1 April 2018 Detection Monitoring

Pace Analytical®
www.pacelabs.com

Pace Analytical Services, LLC
1241 Bellevue Street - Suite 9
Green Bay, WI 54302
(920)469-2436

April 18, 2018

Meghan Blodgett
SCS ENGINEERS
2830 Dairy Drive
Madison, WI 53718

RE: Project: 25216068.18 EDGEWTR CLOSED CCR
Pace Project No.: 40166962

Dear Meghan Blodgett:

Enclosed are the analytical results for sample(s) received by the laboratory on April 04, 2018. The results relate only to the samples included in this report. Results reported herein conform to the most current, applicable TNI/NELAC standards and the laboratory's Quality Assurance Manual, where applicable, unless otherwise noted in the body of the report.

If you have any questions concerning this report, please feel free to contact me.

Sincerely,

Dan Milewsky
dan.milewsky@pacelabs.com
(920)469-2436
Project Manager

Enclosures

cc: Tom Karwoski, SCS ENGINEERS
Kyle Kramer, SCS ENGINEERS
Nicole Kron, SCS ENGINEERS
Jeff Maxted, ALLIANT ENERGY
Marc Morandi, ALLIANT ENERGY

CERTIFICATIONS

Project:	25216068.18 EDGEWTR CLOSED CCR
Pace Project No.:	40166962

Green Bay Certification IDs

1241 Bellevue Street, Green Bay, WI 54302
Florida/NELAP Certification #: E87948
Illinois Certification #: 200050
Kentucky UST Certification #: 82
Louisiana Certification #: 04168
Minnesota Certification #: 055-999-334
New York Certification #: 12064
North Dakota Certification #: R-150
Virginia VELAP ID: 460263
South Carolina Certification #: 83006001
Texas Certification #: T104704529-14-1
Wisconsin Certification #: 405132750
Wisconsin DATCP Certification #: 105-444
USDA Soil Permit #: P330-16-00157
Federal Fish & Wildlife Permit #: LE51774A-0

SAMPLE SUMMARY

Project: 25216068.18 EDGEWTR CLOSED CCR
Pace Project No.: 40166962

Lab ID	Sample ID	Matrix	Date Collected	Date Received
40166944015	**MW-301**	Water	04/02/18 10:26	04/04/18 11:30
40166944016	**MW-302**	Water	04/02/18 11:56	04/04/18 11:30
40166944017	**MW-303**	Water	04/02/18 11:06	04/04/18 11:30
40166944018	**2R-0W**	Water	04/02/18 12:51	04/04/18 11:30
40166944019	**FIELD BLANK**	Water	04/02/18 13:00	04/04/18 11:30

SAMPLE ANALYTE COUNT

Project:	25216068.18 EDGEWTR CLOSED CCR
Pace Project No.:	40166962

Lab ID	Sample ID	Method	Analysts	Analytes Reported
40166944015	**MW-301**	EPA 6020	DS1	2
			RMW	7
		SM 2540C	TMK	1
		EPA 9040	ALY	1
		EPA 300.0	HMB	3
40166944016	**MW-302**	EPA 6020	DS1	2
			RMW	7
		SM 2540C	TMK	1
		EPA 9040	ALY	1
		EPA 300.0	HMB	3
40166944017	**MW-303**	EPA 6020	DS1	2
			RMW	7
		SM 2540C	TMK	1
		EPA 9040	ALY	1
		EPA 300.0	HMB	3
40166944018	**2R-0W**	EPA 6020	DS1	2
			RMW	7
		SM 2540C	DEY	1
		EPA 9040	ALY	1
		EPA 300.0	HMB	3
40166944019	**FIELD BLANK**	EPA 6020	DS1	2
		SM 2540C	DEY	1
		EPA 9040	ALY	1
		EPA 300.0	HMB	3

ANALYTICAL RESULTS

Project: 25216068.18 EDGEWTR CLOSED CCR
Pace Project No.: 40166962

Sample: MW-301 **Lab ID: 40166944015** Collected: 04/02/18 10:26 Received: 04/04/18 11:30 Matrix: Water

Parameters	Results	Units	LOQ	LOD	DF	Prepared	Analyzed	CAS No.	Qual
6020 MET ICPMS	Analytical Method: EPA 6020 Preparation Method: EPA 3010								
Boron	**7950**	ug/L	110	33.0	10	04/05/18 07:17	04/06/18 21:10	7440-42-8	
Calcium	**78900**	ug/L	250	69.8	1	04/05/18 07:17	04/06/18 23:43	7440-70-2	
Field Data	Analytical Method:								
Field pH	**8.02**	Std. Units			1		04/02/18 10:26		
Field Specific Conductance	**1071**	umhos/cm			1		04/02/18 10:26		
Oxygen, Dissolved	**6.50**	mg/L			1		04/02/18 10:26	7782-44-7	
REDOX	**44**	mV			1		04/02/18 10:26		
Turbidity	**12.19**	NTU			1		04/02/18 10:26		
Static Water Level	**598.54**	feet			1		04/02/18 10:26		
Temperature, Water (C)	**7.8**	deg C			1		04/02/18 10:26		
2540C Total Dissolved Solids	Analytical Method: SM 2540C								
Total Dissolved Solids	**752**	mg/L	20.0	8.7	1		04/05/18 15:04		
9040 pH	Analytical Method: EPA 9040								
pH at 25 Degrees C	**7.8**	Std. Units	0.10	0.010	1		04/09/18 09:48		H6
300.0 IC Anions 28 Days	Analytical Method: EPA 300.0								
Chloride	**11.2**	mg/L	2.0	0.50	1		04/11/18 19:09	16887-00-6	
Fluoride	**0.25J**	mg/L	0.30	0.10	1		04/11/18 19:09	16984-48-8	
Sulfate	**332**	mg/L	30.0	10.0	10		04/12/18 18:44	14808-79-8	

Sample: MW-302 **Lab ID: 40166944016** Collected: 04/02/18 11:56 Received: 04/04/18 11:30 Matrix: Water

Parameters	Results	Units	LOQ	LOD	DF	Prepared	Analyzed	CAS No.	Qual
6020 MET ICPMS	Analytical Method: EPA 6020 Preparation Method: EPA 3010								
Boron	**1800**	ug/L	110	33.0	10	04/05/18 07:17	04/06/18 21:18	7440-42-8	
Calcium	**68000**	ug/L	250	69.8	1	04/05/18 07:17	04/06/18 23:50	7440-70-2	
Field Data	Analytical Method:								
Field pH	**7.78**	Std. Units			1		04/02/18 11:56		
Field Specific Conductance	**517**	umhos/cm			1		04/02/18 11:56		
Oxygen, Dissolved	**0.60**	mg/L			1		04/02/18 11:56	7782-44-7	
REDOX	**-123**	mV			1		04/02/18 11:56		
Turbidity	**24.89**	NTU			1		04/02/18 11:56		
Static Water Level	**595.71**	feet			1		04/02/18 11:56		
Temperature, Water (C)	**10.3**	deg C			1		04/02/18 11:56		
2540C Total Dissolved Solids	Analytical Method: SM 2540C								
Total Dissolved Solids	**314**	mg/L	20.0	8.7	1		04/05/18 15:04		

ANALYTICAL RESULTS

Project: 25216068.18 EDGEWTR CLOSED CCR
Pace Project No.: 40166962

Sample: MW-302 **Lab ID: 40166944016** Collected: 04/02/18 11:56 Received: 04/04/18 11:30 Matrix: Water

Parameters	Results	Units	LOQ	LOD	DF	Prepared	Analyzed	CAS No.	Qual
9040 pH	Analytical Method: EPA 9040								
pH at 25 Degrees C	**7.8**	Std. Units	0.10	0.010	1		04/09/18 09:40		H6
300.0 IC Anions 28 Days	Analytical Method: EPA 300.0								
Chloride	**18.5**	mg/L	2.0	0.50	1		04/11/18 19:52	16887-00-6	
Fluoride	**0.78**	mg/L	0.30	0.10	1		04/11/18 19:52	16984-48-8	
Sulfate	**72.7**	mg/L	15.0	5.0	5		04/12/18 18:55	14808-79-8	

Sample: MW-303 **Lab ID: 40166944017** Collected: 04/02/18 11:06 Received: 04/04/18 11:30 Matrix: Water

Parameters	Results	Units	LOQ	LOD	DF	Prepared	Analyzed	CAS No.	Qual
6020 MET ICPMS	Analytical Method: EPA 6020 Preparation Method: EPA 3010								
Boron	**3040**	ug/L	110	33.0	10	04/05/18 07:17	04/06/18 21:25	7440-42-8	
Calcium	**146000**	ug/L	250	69.8	1	04/05/18 07:17	04/06/18 23:58	7440-70-2	
Field Data	Analytical Method:								
Field pH	**6.86**	Std. Units			1		04/02/18 11:06		
Field Specific Conductance	**1131**	umhos/cm			1		04/02/18 11:06		
Oxygen, Dissolved	**0.30**	mg/L			1		04/02/18 11:06	7782-44-7	
REDOX	**-97**	mV			1		04/02/18 11:06		
Turbidity	**233.5**	NTU			1		04/02/18 11:06		
Static Water Level	**588.77**	feet			1		04/02/18 11:06		
Temperature, Water (C)	**9.8**	deg C			1		04/02/18 11:06		
2540C Total Dissolved Solids	Analytical Method: SM 2540C								
Total Dissolved Solids	**630**	mg/L	20.0	8.7	1		04/05/18 15:04		
9040 pH	Analytical Method: EPA 9040								
pH at 25 Degrees C	**7.0**	Std. Units	0.10	0.010	1		04/09/18 09:50		H6
300.0 IC Anions 28 Days	Analytical Method: EPA 300.0								
Chloride	**19.7**	mg/L	10.0	2.5	5		04/11/18 20:02	16887-00-6	B
Fluoride	**<0.50**	mg/L	1.5	0.50	5		04/11/18 20:02	16984-48-8	D3
Sulfate	**<5.0**	mg/L	15.0	5.0	5		04/11/18 20:02	14808-79-8	D3

Sample: 2R-0W **Lab ID: 40166944018** Collected: 04/02/18 12:51 Received: 04/04/18 11:30 Matrix: Water

Parameters	Results	Units	LOQ	LOD	DF	Prepared	Analyzed	CAS No.	Qual
6020 MET ICPMS	Analytical Method: EPA 6020 Preparation Method: EPA 3010								
Boron	**19.7**	ug/L	11.0	3.3	1	04/05/18 07:17	04/09/18 15:41	7440-42-8	
Calcium	**121000**	ug/L	250	69.8	1	04/05/18 07:17	04/07/18 00:06	7440-70-2	

ANALYTICAL RESULTS

Project: 25216068.18 EDGEWTR CLOSED CCR
Pace Project No.: 40166962

Sample: 2R-0W **Lab ID: 40166944018** Collected: 04/02/18 12:51 Received: 04/04/18 11:30 Matrix: Water

Parameters	Results	Units	LOQ	LOD	DF	Prepared	Analyzed	CAS No.	Qual
Field Data	Analytical Method:								
Field pH	**7.29**	Std. Units			1		04/02/18 12:51		
Field Specific Conductance	**1177**	umhos/cm			1		04/02/18 12:51		
Oxygen, Dissolved	**6.7**	mg/L			1		04/02/18 12:51	7782-44-7	
REDOX	**85**	mV			1		04/02/18 12:51		
Turbidity	**6.38**	NTU			1		04/02/18 12:51		
Static Water Level	**607.87**	feet			1		04/02/18 12:51		
Temperature, Water (C)	**5.2**	deg C			1		04/02/18 12:51		
2540C Total Dissolved Solids	Analytical Method: SM 2540C								
Total Dissolved Solids	**680**	mg/L	20.0	8.7	1		04/09/18 15:14		
9040 pH	Analytical Method: EPA 9040								
pH at 25 Degrees C	**7.4**	Std. Units	0.10	0.010	1		04/09/18 09:52		H6
300.0 IC Anions 28 Days	Analytical Method: EPA 300.0								
Chloride	**108**	mg/L	10.0	2.5	5		04/12/18 19:05	16887-00-6	
Fluoride	**0.12J**	mg/L	0.30	0.10	1		04/11/18 20:13	16984-48-8	
Sulfate	**17.2**	mg/L	3.0	1.0	1		04/11/18 20:13	14808-79-8	

Sample: FIELD BLANK **Lab ID: 40166944019** Collected: 04/02/18 13:00 Received: 04/04/18 11:30 Matrix: Water

Parameters	Results	Units	LOQ	LOD	DF	Prepared	Analyzed	CAS No.	Qual
6020 MET ICPMS	Analytical Method: EPA 6020 Preparation Method: EPA 3010								
Boron	**<3.3**	ug/L	11.0	3.3	1	04/05/18 07:17	04/06/18 17:52	7440-42-8	
Calcium	**114J**	ug/L	250	69.8	1	04/05/18 07:17	04/06/18 17:52	7440-70-2	
2540C Total Dissolved Solids	Analytical Method: SM 2540C								
Total Dissolved Solids	**<8.7**	mg/L	20.0	8.7	1		04/09/18 15:14		
9040 pH	Analytical Method: EPA 9040								
pH at 25 Degrees C	**6.2**	Std. Units	0.10	0.010	1		04/09/18 09:55		H6
300.0 IC Anions 28 Days	Analytical Method: EPA 300.0								
Chloride	**<0.50**	mg/L	2.0	0.50	1		04/11/18 20:23	16887-00-6	
Fluoride	**<0.10**	mg/L	0.30	0.10	1		04/11/18 20:23	16984-48-8	
Sulfate	**<1.0**	mg/L	3.0	1.0	1		04/11/18 20:23	14808-79-8	

QUALITY CONTROL DATA

Project: 25216068.18 EDGEWTR CLOSED CCR
Pace Project No.: 40166962

QC Batch: 285207
Analysis Method: EPA 6020
QC Batch Method: EPA 3010
Analysis Description: 6020 MET
Associated Lab Samples: 40166944015, 40166944016, 40166944017, 40166944018, 40166944019

METHOD BLANK: 1669183
Matrix: Water
Associated Lab Samples: 40166944015, 40166944016, 40166944017, 40166944018, 40166944019

Parameter	Units	Blank Result	Reporting Limit	Analyzed	Qualifiers
Boron	ug/L	<3.3	11.0	04/06/18 17:37	
Calcium	ug/L	<69.8	250	04/06/18 17:37	

LABORATORY CONTROL SAMPLE: 1669184

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Boron	ug/L	500	473	95	80-120	
Calcium	ug/L	5000	4900	98	80-120	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 1669185 1669186

Parameter	Units	40166877001 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Boron	ug/L	1420	500	500	1810	1810	76	78	75-125	0	20	
Calcium	ug/L	82400	5000	5000	85400	88600	60	123	75-125	4	20	P6

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: 25216068.18 EDGEWTR CLOSED CCR
Pace Project No.: 40166962

QC Batch: 285316
QC Batch Method: SM 2540C
Analysis Method: SM 2540C
Analysis Description: 2540C Total Dissolved Solids
Associated Lab Samples: 40166944015, 40166944016, 40166944017

METHOD BLANK: 1669676
Matrix: Water
Associated Lab Samples: 40166944015, 40166944016, 40166944017

Parameter	Units	Blank Result	Reporting Limit	Analyzed	Qualifiers
Total Dissolved Solids	mg/L	<8.7	20.0	04/05/18 14:59	

LABORATORY CONTROL SAMPLE: 1669677

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Total Dissolved Solids	mg/L	610	598	98	80-120	

SAMPLE DUPLICATE: 1669678

Parameter	Units	40166856003 Result	Dup Result	RPD	Max RPD	Qualifiers
Total Dissolved Solids	mg/L	182	180	1	5	

SAMPLE DUPLICATE: 1669679

Parameter	Units	40166868001 Result	Dup Result	RPD	Max RPD	Qualifiers
Total Dissolved Solids	mg/L	450	454	1	5	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: 25216068.18 EDGEWTR CLOSED CCR
Pace Project No.: 40166962

QC Batch: 285548
Analysis Method: SM 2540C
QC Batch Method: SM 2540C
Analysis Description: 2540C Total Dissolved Solids
Associated Lab Samples: 40166944018, 40166944019

METHOD BLANK: 1670975
Matrix: Water
Associated Lab Samples: 40166944018, 40166944019

Parameter	Units	Blank Result	Reporting Limit	Analyzed	Qualifiers
Total Dissolved Solids	mg/L	<8.7	20.0	04/09/18 15:12	

LABORATORY CONTROL SAMPLE: 1670976

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Total Dissolved Solids	mg/L	610	592	97	80-120	

SAMPLE DUPLICATE: 1670977

Parameter	Units	40166944018 Result	Dup Result	RPD	Max RPD	Qualifiers
Total Dissolved Solids	mg/L	680	674	1	5	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: 25216068.18 EDGEWTR CLOSED CCR
Pace Project No.: 40166962

QC Batch: 285482
Analysis Method: EPA 9040
QC Batch Method: EPA 9040
Analysis Description: 9040 pH
Associated Lab Samples: 40166944015, 40166944016, 40166944017, 40166944018, 40166944019

SAMPLE DUPLICATE: 1670757

Parameter	Units	40166819001 Result	Dup Result	RPD	Max RPD	Qualifiers
pH at 25 Degrees C	Std. Units	7.4	7.8	5	20	H6,PI

SAMPLE DUPLICATE: 1670758

Parameter	Units	40166944015 Result	Dup Result	RPD	Max RPD	Qualifiers
pH at 25 Degrees C	Std. Units	7.8	7.8	1	20	H6

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: 25216068.18 EDGEWTR CLOSED CCR
Pace Project No.: 40166962

QC Batch: 285544
Analysis Method: EPA 300.0
QC Batch Method: EPA 300.0
Analysis Description: 300.0 IC Anions
Associated Lab Samples: 40166944015, 40166944016, 40166944017, 40166944018, 40166944019

METHOD BLANK: 1670941
Matrix: Water
Associated Lab Samples: 40166944015, 40166944016, 40166944017, 40166944018, 40166944019

Parameter	Units	Blank Result	Reporting Limit	Analyzed	Qualifiers
Chloride	mg/L	0.54J	2.0	04/11/18 16:10	
Fluoride	mg/L	<0.10	0.30	04/11/18 16:10	
Sulfate	mg/L	<1.0	3.0	04/11/18 16:10	

LABORATORY CONTROL SAMPLE: 1670942

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Chloride	mg/L	20	19.8	99	90-110	
Fluoride	mg/L	2	2.0	101	90-110	
Sulfate	mg/L	20	19.8	99	90-110	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 1670943 1670944

Parameter	Units	40167160001 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Chloride	mg/L	16.9	100	100	121	121	104	104	90-110	0	15	
Fluoride	mg/L	<0.50	10	10	10.7	10.8	102	104	90-110	1	15	
Sulfate	mg/L	70.6	100	100	176	174	105	104	90-110	1	15	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 1670945 1670946

Parameter	Units	40167111002 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Chloride	mg/L	1060	2000	2000	3200	3210	107	108	90-110	0	15	
Fluoride	mg/L	<10.0	200	200	210	211	105	105	90-110	0	15	
Sulfate	mg/L	<100	2000	2000	2140	2140	104	104	90-110	0	15	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALIFIERS

Project:	25216068.18 EDGEWTR CLOSED CCR
Pace Project No.:	40166962

DEFINITIONS

DF - Dilution Factor, if reported, represents the factor applied to the reported data due to dilution of the sample aliquot.

ND - Not Detected at or above LOD.

J - Estimated concentration at or above the LOD and below the LOQ.

LOD - Limit of Detection adjusted for dilution factor and percent moisture.

LOQ - Limit of Quantitation adjusted for dilution factor and percent moisture.

S - Surrogate

1,2-Diphenylhydrazine decomposes to and cannot be separated from Azobenzene using Method 8270. The result for each analyte is a combined concentration.

Consistent with EPA guidelines, unrounded data are displayed and have been used to calculate % recovery and RPD values.

LCS(D) - Laboratory Control Sample (Duplicate)

MS(D) - Matrix Spike (Duplicate)

DUP - Sample Duplicate

RPD - Relative Percent Difference

NC - Not Calculable.

SG - Silica Gel - Clean-Up

U - Indicates the compound was analyzed for, but not detected at or above the adjusted LOD.

N-Nitrosodiphenylamine decomposes and cannot be separated from Diphenylamine using Method 8270. The result reported for each analyte is a combined concentration.

Pace Analytical is TNI accredited. Contact your Pace PM for the current list of accredited analytes.

TNI - The NELAC Institute.

ANALYTE QUALIFIERS

B	Analyte was detected in the associated method blank.
D3	Sample was diluted due to the presence of high levels of non-target analytes or other matrix interference.
H6	Analysis initiated outside of the 15 minute EPA required holding time.
P6	Matrix spike recovery was outside laboratory control limits due to a parent sample concentration notably higher than the spike level.
PI	The precision between the sample and the duplicate sample exceeded laboratory control limits.

QUALITY CONTROL DATA CROSS REFERENCE TABLE

Project: 25216068.18 EDGEWTR CLOSED CCR
Pace Project No.: 40166962

Lab ID	Sample ID	QC Batch Method	QC Batch	Analytical Method	Analytical Batch
40166944015	**MW-301**	EPA 3010	285207	EPA 6020	285302
40166944016	**MW-302**	EPA 3010	285207	EPA 6020	285302
40166944017	**MW-303**	EPA 3010	285207	EPA 6020	285302
40166944018	**2R-0W**	EPA 3010	285207	EPA 6020	285302
40166944019	**FIELD BLANK**	EPA 3010	285207	EPA 6020	285302
40166944015	**MW-301**				
40166944016	**MW-302**				
40166944017	**MW-303**				
40166944018	**2R-0W**				
40166944015	**MW-301**	SM 2540C	285316		
40166944016	**MW-302**	SM 2540C	285316		
40166944017	**MW-303**	SM 2540C	285316		
40166944018	**2R-0W**	SM 2540C	285548		
40166944019	**FIELD BLANK**	SM 2540C	285548		
40166944015	**MW-301**	EPA 9040	285482		
40166944016	**MW-302**	EPA 9040	285482		
40166944017	**MW-303**	EPA 9040	285482		
40166944018	**2R-0W**	EPA 9040	285482		
40166944019	**FIELD BLANK**	EPA 9040	285482		
40166944015	**MW-301**	EPA 300.0	285544		
40166944016	**MW-302**	EPA 300.0	285544		
40166944017	**MW-303**	EPA 300.0	285544		
40166944018	**2R-0W**	EPA 300.0	285544		
40166944019	**FIELD BLANK**	EPA 300.0	285544		

(Please Print Clearly)

Company Name:	SCS Engineers
Branch/Location:	Madison Wi
Project Contact:	Tom Karwoski
Phone:	
Project Number:	25216068.18
Project Name:	Edgewater Closed Ash Fill
Project State:	WI
Sampled By (Print):	Gary Sterkel
Sampled By (Sign):	Gary Sterkel
PO #:	
Regulatory Program:	

Pace Analytical®
www.pacelabs.com

CHAIN OF CUSTODY

UPPER MIDWEST REGION
MN: 612-607-1700 **WI:** 920-469-2436

Page 1 of

40166944

*Preservation Codes
A=None B=HCL C=H2SO4 D=HNO3 E=DI Water F=Methanol G=NaOH
H=Sodium Bisulfate Solution I=Sodium Thiosulfate J=Other

Quote #:	
Mail To Contact:	
Mail To Company:	
Mail To Address:	
Invoice To Contact:	
Invoice To Company:	SCS Engineers
Invoice To Address:	2830 Dairy Dr Madison Wi 53718
Invoice To Phone:	

Data Package Options (billable)
☐ EPA Level III
☐ EPA Level IV

MS/MSD
☐ On your sample (billable)
☐ NOT needed on your sample

Matrix Codes
A = Air W = Water
B = Biota DW = Drinking Water
C = Charcoal GW = Ground Water
O = Oil SW = Surface Water
S = Soil WW = Waste Water
Sl = Sludge WP = Wipe

					FILTERED? (YES/NO) Y/N	N	N	N	N	N	N	N			
					PRESERVATION (CODE)* Pick Letter	D	D	A	A	A	A	N			
		COLLECTION			Analyses Requested	Boron	Calcium	Chloride	Fluoride	pH	Sulfate	TDS			
PACE LAB #	CLIENT FIELD ID	DATE	TIME	MATRIX										CLIENT COMMENTS	LAB COMMENTS (Lab Use Only) / Profile #
015	MW-301	4/2/18	1026	GW		X	X	X	X	X	X	X			
016	MW-302	4/2/18	1156	GW		X	X	X	X	X	X	X			
017	WW-303	4/2/18	1106	GW		X	X	X	X	X	X	X			
018	2B-OW	4/2/18	1251	GW		X	X	X	X	X	X	X			
019	Field Blank	4/2/18	1300	GW		X	X	X	X	X	X	X			

Rush Turnaround Time Requested - Prelims
(Rush TAT subject to approval/surcharge)
Date Needed:

Transmit Prelim Rush Results by (complete what you want):
Email #1:
Email #2:
Telephone:
Fax:

Samples on HOLD are subject to special pricing and release of liability

Relinquished By:	Date/Time:	Received By:	Date/Time:
Gary Sterkel	4/3/18 0800	Mary Fannin	4/3/18 9:45
Mary Fannin	4/3/18 1510		
CS Logistics	4/4/18 1130		4/4/18 1130

PACE Project No. 40166944

Receipt Temp = ROI °C

Sample Receipt pH
[✓ OK] / Adjusted

Cooler Custody Seal
[✓ Present] / Not Present
Intact / Not Intact

Version 6.0 06/14/06

C019a(27Jun2006)

ORIGINAL

Pace Analytical Services, LLC
1241 Bellevue Street, Suite 9
Green Bay, WI 54302

Sample Preservation Receipt Form

Client Name: SCS Engineers

Project # 40166944

All containers needing preservation have been checked and noted below: ☒ Yes ☐ No ☐ N/A

Lab Lot# of pH paper: 10US4771

Lab Std #ID of preservation (if pH adjusted):

Initial when completed: SSM

Date/ Time:

Pace Lab #	Glass							Plastic							Vials						Jars			General			VOA Vials (>6mm) *	H2SO4 pH ≤2	NaOH+Zn Act pH ≥9	NaOH pH ≥12	HNO3 pH ≤2	pH after adjusted	Volume (mL)
	AG1U	AG1H	AG4S	AG4U	AG5U	AG2S	BG3U	BP1U	BP2N	BP2Z	BP3U	BP3C	BP3N	BP3S	DG9A	DG9T	VG9U	VG9H	VG9M	VG9D	JGFU	WGFU	WPFU	SP5T	ZPLC	GN							
001											1		1																		X		2.5 / 5 / 10
002											1		1																		X		2.5 / 5 / 10
003											1		1																		X		2.5 / 5 / 10
004											1		1																		X		2.5 / 5 / 10
005											1		1																		X		2.5 / 5 / 10
006											1		1																		X		2.5 / 5 / 10
007											1		1																		X		2.5 / 5 / 10
008											1		1																		X		2.5 / 5 / 10
009											1		1																		X		2.5 / 5 / 10
010											1		1																		X		2.5 / 5 / 10
011											1		1																		X		2.5 / 5 / 10
012											1		1																		X		2.5 / 5 / 10
013											1		1																		X		2.5 / 5 / 10
014											1		1																		X		2.5 / 5 / 10
015											2		1																		X		2.5 / 5 / 10
016											2		1																		X		2.5 / 5 / 10
017											2		1																		X		2.5 / 5 / 10
018											2		1																		X		2.5 / 5 / 10
019											2		1																		X		2.5 / 5 / 10
020																																	2.5 / 5 / 10

Exceptions to preservation check: VOA, Coliform, TOC, TOX, TOH, O&G, WI DRO, Phenolics, Other: ________ Headspace in VOA Vials (>6mm) : ☐Yes ☐No ☒N/A ***If yes look in headspace column**

AG1U	1 liter amber glass	**BP1U**	1 liter plastic unpres	**DG9A**	40 mL amber ascorbic	**JGFU**	4 oz amber jar unpres
AG1H	1 liter amber glass HCL	**BP2N**	500 mL plastic HNO3	**DG9T**	40 mL amber Na Thio	**WGFU**	4 oz clear jar unpres
AG4S	125 mL amber glass H2SO4	**BP2Z**	500 mL plastic NaOH, Znact	**VG9U**	40 mL clear vial unpres	**WPFU**	4 oz plastic jar unpres
AG4U	120 mL amber glass unpres	**BP3U**	250 mL plastic unpres	**VG9H**	40 mL clear vial HCL		
AG5U	100 mL amber glass unpres	**BP3C**	250 mL plastic NaOH	**VG9M**	40 mL clear vial MeOH	**SP5T**	120 mL plastic Na Thiosulfate
AG2S	500 mL amber glass H2SO4	**BP3N**	250 mL plastic HNO3	**VG9D**	40 mL clear vial DI	**ZPLC**	ziploc bag
BG3U	250 mL clear glass unpres	**BP3S**	250 mL plastic H2SO4			**GN:**	

Page 1 of 2

Pace Analytical™ 1241 Bellevue Street, Green Bay, WI 54302	Document Name: **Sample Condition Upon Receipt (SCUR)** Document No.: **F-GB-C-031-rev.06**	Document Revised: 31Jan2018 Issuing Authority: Pace Green Bay Quality Office

Sample Condition Upon Receipt Form (SCUR)

Project #:

WO# : 40166944

40166944

Client Name: SCS Engineers

Courier: ☒ CS Logistics ☐ Fed Ex ☐ Speedee ☐ UPS ☐ Waltco ☐ Client ☐ Pace Other:

Tracking #:

Custody Seal on Cooler/Box Present: ☒ yes ☐ no Seals intact: ☒ yes ☐ no

Custody Seal on Samples Present: ☐ yes ☒ no Seals intact: ☐ yes ☐ no

Packing Material: ☒ Bubble Wrap ☐ Bubble Bags ☐ None ☐ Other

Thermometer Used SR - N/A **Type of Ice:** [✓ Wet] Blue Dry None ☒ Samples on ice, cooling process has begun

Cooler Temperature Uncorr: ROT /Corr:

Temp Blank Present: ☐ yes ☒ no **Biological Tissue is Frozen:** ☐ yes ☐ no

Temp should be above freezing to 6°C.
Biota Samples may be received at ≤ 0°C.

Person examining contents:
Date: 4/4/18
Initials: SSM

Chain of Custody Present:	☒Yes ☐No ☐N/A	1.
Chain of Custody Filled Out:	☒Yes ☐No ☐N/A	2.
Chain of Custody Relinquished:	☒Yes ☐No ☐N/A	3.
Sampler Name & Signature on COC:	☒Yes ☐No ☐N/A	4.
Samples Arrived within Hold Time:	☒Yes ☐No ☐N/A	5.
- VOA Samples frozen upon receipt	☐Yes ☐No	Date/Time:
Short Hold Time Analysis (<72hr):	☐Yes ☒No ☐N/A	6.
Rush Turn Around Time Requested:	☐Yes ☒No ☐N/A	7.
Sufficient Volume: ☐Yes ☒No ☐N/A MS/MSD	☐Yes ☒No ☐N/A	8.
Correct Containers Used:	☒Yes ☐No ☐N/A	9.
-Pace Containers Used:	☒Yes ☐No ☐N/A	
-Pace IR Containers Used:	☐Yes ☐No ☒N/A	
Containers Intact:	☒Yes ☐No ☐N/A	10.
Filtered volume received for Dissolved tests	☒Yes ☐No ☐N/A	11.
Sample Labels match COC:	☐Yes ☒No ☐N/A	12. 001 - collect time "1255" 017- ID "MW-303" SSM 4/4/18
-Includes date/time/ID/Analysis Matrix: W		
Trip Blank Present:	☐Yes ☐No ☒N/A	13.
Trip Blank Custody Seals Present	☐Yes ☐No ☒N/A	
Pace Trip Blank Lot # (if purchased):		

Client Notification/ Resolution:

If checked, see attached form for additional comments ☐

Person Contacted: Date/Time:

Comments/ Resolution: 1-250mL poly unpreserved + 1-250mL poly nitric bottle returned unused w/ shipment
SSM 4/4/18

Project Manager Review: RMR for DM **Date:** 4/4/18

A2 October 2018 Detection Monitoring

Pace Analytical Services, LLC
1241 Bellevue Street - Suite 9
Green Bay, WI 54302
(920)469-2436

October 18, 2018

Meghan Blodgett
SCS ENGINEERS
2830 Dairy Drive
Madison, WI 53718

RE: Project: 25216068.18 WPL EDGE CLOSE CCR
Pace Project No.: 40176947

Dear Meghan Blodgett:

Enclosed are the analytical results for sample(s) received by the laboratory on October 03, 2018. The results relate only to the samples included in this report. Results reported herein conform to the most current, applicable TNI/NELAC standards and the laboratory's Quality Assurance Manual, where applicable, unless otherwise noted in the body of the report.

If you have any questions concerning this report, please feel free to contact me.

Sincerely,

Dan Milewsky
dan.milewsky@pacelabs.com
(920)469-2436
Project Manager

Enclosures

cc: Tom Karwoski, SCS ENGINEERS
Nicole Kron, SCS ENGINEERS
Jeff Maxted, ALLIANT ENERGY
Marc Morandi, ALLIANT ENERGY

CERTIFICATIONS

Project:	25216068.18 WPL EDGE CLOSE CCR
Pace Project No.:	40176947

Green Bay Certification IDs

1241 Bellevue Street, Green Bay, WI 54302
Florida/NELAP Certification #: E87948
Illinois Certification #: 200050
Kentucky UST Certification #: 82
Louisiana Certification #: 04168
Minnesota Certification #: 055-999-334
New York Certification #: 12064
North Dakota Certification #: R-150
Virginia VELAP ID: 460263
South Carolina Certification #: 83006001
Texas Certification #: T104704529-14-1
Wisconsin Certification #: 405132750
Wisconsin DATCP Certification #: 105-444
USDA Soil Permit #: P330-16-00157
Federal Fish & Wildlife Permit #: LE51774A-0

SAMPLE SUMMARY

Project: 25216068.18 WPL EDGE CLOSE CCR
Pace Project No.: 40176947

Lab ID	Sample ID	Matrix	Date Collected	Date Received
40176947001	**MW-301**	Water	10/01/18 12:08	10/03/18 10:05
40176947002	**MW-302**	Water	10/01/18 14:56	10/03/18 10:05
40176947003	**MW-303**	Water	10/01/18 12:51	10/03/18 10:05
40176947004	**2R-OW**	Water	10/01/18 10:31	10/03/18 10:05
40176947005	**FIELD BLANK**	Water	10/01/18 15:00	10/03/18 10:05

SAMPLE ANALYTE COUNT

Project: 25216068.18 WPL EDGE CLOSE CCR
Pace Project No.: 40176947

Lab ID	Sample ID	Method	Analysts	Analytes Reported
40176947001	**MW-301**	EPA 6020	KXS	2
			AXL	7
		SM 2540C	TMK	1
		EPA 9040	ALY	1
		EPA 300.0	HMB	3
40176947002	**MW-302**	EPA 6020	KXS	2
			AXL	7
		SM 2540C	TMK	1
		EPA 9040	ALY	1
		EPA 300.0	HMB	3
40176947003	**MW-303**	EPA 6020	KXS	2
			AXL	7
		SM 2540C	TMK	1
		EPA 9040	ALY	1
		EPA 300.0	HMB	3
40176947004	**2R-OW**	EPA 6020	KXS	2
			AXL	7
		SM 2540C	TMK	1
		EPA 9040	ALY	1
		EPA 300.0	HMB	3
40176947005	**FIELD BLANK**	EPA 6020	KXS	2
		SM 2540C	TMK	1
		EPA 9040	ALY	1
		EPA 300.0	HMB	3

ANALYTICAL RESULTS

Project: 25216068.18 WPL EDGE CLOSE CCR
Pace Project No.: 40176947

Sample: MW-301 **Lab ID: 40176947001** Collected: 10/01/18 12:08 Received: 10/03/18 10:05 Matrix: Water

Parameters	Results	Units	LOQ	LOD	DF	Prepared	Analyzed	CAS No.	Qual
6020 MET ICPMS	Analytical Method: EPA 6020 Preparation Method: EPA 3010								
Boron	**8230**	ug/L	220	66.0	20	10/12/18 06:51	10/16/18 02:05	7440-42-8	
Calcium	**88800**	ug/L	250	69.8	1	10/12/18 06:51	10/12/18 21:13	7440-70-2	
Field Data	Analytical Method:								
Field pH	**7.71**	Std. Units			1		10/01/18 12:08		
Field Specific Conductance	**1086**	umhos/cm			1		10/01/18 12:08		
Oxygen, Dissolved	**4.5**	mg/L			1		10/01/18 12:08	7782-44-7	
REDOX	**53**	mV			1		10/01/18 12:08		
Turbidity	**13.32**	NTU			1		10/01/18 12:08		
Static Water Level	**597.60**	feet			1		10/01/18 12:08		
Temperature, Water (C)	**11**	deg C			1		10/01/18 12:08		
2540C Total Dissolved Solids	Analytical Method: SM 2540C								
Total Dissolved Solids	**722**	mg/L	20.0	8.7	1		10/05/18 16:56		
9040 pH	Analytical Method: EPA 9040								
pH at 25 Degrees C	**7.7**	Std. Units	0.10	0.010	1		10/09/18 09:03		H6
300.0 IC Anions 28 Days	Analytical Method: EPA 300.0								
Chloride	**11.5**	mg/L	2.0	0.50	1		10/11/18 01:03	16887-00-6	
Fluoride	**0.20J**	mg/L	0.30	0.10	1		10/11/18 01:03	16984-48-8	
Sulfate	**318**	mg/L	60.0	20.0	20		10/11/18 11:16	14808-79-8	

Sample: MW-302 **Lab ID: 40176947002** Collected: 10/01/18 14:56 Received: 10/03/18 10:05 Matrix: Water

Parameters	Results	Units	LOQ	LOD	DF	Prepared	Analyzed	CAS No.	Qual
6020 MET ICPMS	Analytical Method: EPA 6020 Preparation Method: EPA 3010								
Boron	**1570**	ug/L	55.0	16.5	5	10/12/18 06:51	10/16/18 02:12	7440-42-8	
Calcium	**64700**	ug/L	250	69.8	1	10/12/18 06:51	10/12/18 21:33	7440-70-2	
Field Data	Analytical Method:								
Field pH	**7.99**	Std. Units			1		10/01/18 14:56		
Field Specific Conductance	**504**	umhos/cm			1		10/01/18 14:56		
Oxygen, Dissolved	**0.8**	mg/L			1		10/01/18 14:56	7782-44-7	
REDOX	**-96**	mV			1		10/01/18 14:56		
Turbidity	**55.15**	NTU			1		10/01/18 14:56		
Static Water Level	**595.28**	feet			1		10/01/18 14:56		
Temperature, Water (C)	**11.6**	deg C			1		10/01/18 14:56		
2540C Total Dissolved Solids	Analytical Method: SM 2540C								
Total Dissolved Solids	**306**	mg/L	20.0	8.7	1		10/05/18 16:56		

ANALYTICAL RESULTS

Project: 25216068.18 WPL EDGE CLOSE CCR
Pace Project No.: 40176947

Sample: MW-302 **Lab ID: 40176947002** Collected: 10/01/18 14:56 Received: 10/03/18 10:05 Matrix: Water

Parameters	Results	Units	LOQ	LOD	DF	Prepared	Analyzed	CAS No.	Qual
9040 pH	Analytical Method: EPA 9040								
pH at 25 Degrees C	**7.6**	Std. Units	0.10	0.010	1		10/09/18 09:10		H6
300.0 IC Anions 28 Days	Analytical Method: EPA 300.0								
Chloride	**18.6**	mg/L	2.0	0.50	1		10/11/18 01:15	16887-00-6	
Fluoride	**0.81**	mg/L	0.30	0.10	1		10/11/18 01:15	16984-48-8	
Sulfate	**59.2**	mg/L	3.0	1.0	1		10/11/18 01:15	14808-79-8	

Sample: MW-303 **Lab ID: 40176947003** Collected: 10/01/18 12:51 Received: 10/03/18 10:05 Matrix: Water

Parameters	Results	Units	LOQ	LOD	DF	Prepared	Analyzed	CAS No.	Qual
6020 MET ICPMS	Analytical Method: EPA 6020 Preparation Method: EPA 3010								
Boron	**2360**	ug/L	55.0	16.5	5	10/12/18 06:51	10/16/18 02:19	7440-42-8	
Calcium	**139000**	ug/L	250	69.8	1	10/12/18 06:51	10/12/18 21:40	7440-70-2	
Field Data	Analytical Method:								
Field pH	**6.93**	Std. Units			1		10/01/18 12:51		
Field Specific Conductance	**1105**	umhos/cm			1		10/01/18 12:51		
Oxygen, Dissolved	**0.2**	mg/L			1		10/01/18 12:51	7782-44-7	
REDOX	**-93**	mV			1		10/01/18 12:51		
Turbidity	**107.1**	NTU			1		10/01/18 12:51		
Static Water Level	**588.17**	feet			1		10/01/18 12:51		
Temperature, Water (C)	**10.7**	deg C			1		10/01/18 12:51		
2540C Total Dissolved Solids	Analytical Method: SM 2540C								
Total Dissolved Solids	**620**	mg/L	20.0	8.7	1		10/05/18 16:57		
9040 pH	Analytical Method: EPA 9040								
pH at 25 Degrees C	**6.8**	Std. Units	0.10	0.010	1		10/09/18 09:12		H6
300.0 IC Anions 28 Days	Analytical Method: EPA 300.0								
Chloride	**4.3**	mg/L	2.0	0.50	1		10/11/18 01:27	16887-00-6	
Fluoride	**<0.10**	mg/L	0.30	0.10	1		10/11/18 01:27	16984-48-8	
Sulfate	**<1.0**	mg/L	3.0	1.0	1		10/11/18 01:27	14808-79-8	

Sample: 2R-OW **Lab ID: 40176947004** Collected: 10/01/18 10:31 Received: 10/03/18 10:05 Matrix: Water

Parameters	Results	Units	LOQ	LOD	DF	Prepared	Analyzed	CAS No.	Qual
6020 MET ICPMS	Analytical Method: EPA 6020 Preparation Method: EPA 3010								
Boron	**34.7**	ug/L	11.0	3.3	1	10/12/18 06:51	10/16/18 02:26	7440-42-8	
Calcium	**190000**	ug/L	250	69.8	1	10/12/18 06:51	10/12/18 21:47	7440-70-2	

ANALYTICAL RESULTS

Project: 25216068.18 WPL EDGE CLOSE CCR
Pace Project No.: 40176947

Sample: 2R-OW **Lab ID: 40176947004** Collected: 10/01/18 10:31 Received: 10/03/18 10:05 Matrix: Water

Parameters	Results	Units	LOQ	LOD	DF	Prepared	Analyzed	CAS No.	Qual
Field Data	Analytical Method:								
Field pH	**7.03**	Std. Units			1		10/01/18 10:31		
Field Specific Conductance	**2202**	umhos/cm			1		10/01/18 10:31		
Oxygen, Dissolved	**1.6**	mg/L			1		10/01/18 10:31	7782-44-7	
REDOX	**180**	mV			1		10/01/18 10:31		
Turbidity	**7.09**	NTU			1		10/01/18 10:31		
Static Water Level	**604.61**	feet			1		10/01/18 10:31		
Temperature, Water (C)	**13.4**	deg C			1		10/01/18 10:31		
2540C Total Dissolved Solids	Analytical Method: SM 2540C								
Total Dissolved Solids	**1260**	mg/L	20.0	8.7	1		10/05/18 16:57		
9040 pH	Analytical Method: EPA 9040								
pH at 25 Degrees C	**7.0**	Std. Units	0.10	0.010	1		10/09/18 09:14		H6
300.0 IC Anions 28 Days	Analytical Method: EPA 300.0								
Chloride	**462**	mg/L	40.0	10.0	20		10/11/18 11:28	16887-00-6	
Fluoride	**<0.10**	mg/L	0.30	0.10	1		10/11/18 01:39	16984-48-8	
Sulfate	**37.2**	mg/L	3.0	1.0	1		10/11/18 01:39	14808-79-8	

Sample: FIELD BLANK **Lab ID: 40176947005** Collected: 10/01/18 15:00 Received: 10/03/18 10:05 Matrix: Water

Parameters	Results	Units	LOQ	LOD	DF	Prepared	Analyzed	CAS No.	Qual
6020 MET ICPMS	Analytical Method: EPA 6020 Preparation Method: EPA 3010								
Boron	**<3.3**	ug/L	11.0	3.3	1	10/12/18 06:51	10/16/18 00:09	7440-42-8	
Calcium	**<69.8**	ug/L	250	69.8	1	10/12/18 06:51	10/16/18 00:09	7440-70-2	
2540C Total Dissolved Solids	Analytical Method: SM 2540C								
Total Dissolved Solids	**<8.7**	mg/L	20.0	8.7	1		10/05/18 16:57		
9040 pH	Analytical Method: EPA 9040								
pH at 25 Degrees C	**6.4**	Std. Units	0.10	0.010	1		10/09/18 09:19		H6
300.0 IC Anions 28 Days	Analytical Method: EPA 300.0								
Chloride	**<0.50**	mg/L	2.0	0.50	1		10/11/18 01:52	16887-00-6	
Fluoride	**<0.10**	mg/L	0.30	0.10	1		10/11/18 01:52	16984-48-8	
Sulfate	**<1.0**	mg/L	3.0	1.0	1		10/11/18 01:52	14808-79-8	

QUALITY CONTROL DATA

Project: 25216068.18 WPL EDGE CLOSE CCR
Pace Project No.: 40176947

QC Batch: 302988 Analysis Method: EPA 6020
QC Batch Method: EPA 3010 Analysis Description: 6020 MET
Associated Lab Samples: 40176947001, 40176947002, 40176947003, 40176947004, 40176947005

METHOD BLANK: 1769747 Matrix: Water
Associated Lab Samples: 40176947001, 40176947002, 40176947003, 40176947004, 40176947005

Parameter	Units	Blank Result	Reporting Limit	Analyzed	Qualifiers
Boron	ug/L	<3.3	11.0	10/16/18 00:03	
Calcium	ug/L	<69.8	250	10/12/18 18:50	

LABORATORY CONTROL SAMPLE: 1769748

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Boron	ug/L	500	471	94	80-120	
Calcium	ug/L	5000	4930	99	80-120	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 1769749 1769750

Parameter	Units	40176963002 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Boron	ug/L	3460	500	500	3940	3960	98	102	75-125	1	20	
Calcium	ug/L	244000	5000	5000	254000	243000	208	-20	75-125	5	20	P6

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: 25216068.18 WPL EDGE CLOSE CCR
Pace Project No.: 40176947

QC Batch: 302368
QC Batch Method: SM 2540C
Analysis Method: SM 2540C
Analysis Description: 2540C Total Dissolved Solids
Associated Lab Samples: 40176947001, 40176947002, 40176947003, 40176947004, 40176947005

METHOD BLANK: 1766008
Matrix: Water
Associated Lab Samples: 40176947001, 40176947002, 40176947003, 40176947004, 40176947005

Parameter	Units	Blank Result	Reporting Limit	Analyzed	Qualifiers
Total Dissolved Solids	mg/L	<8.7	20.0	10/05/18 16:56	

LABORATORY CONTROL SAMPLE: 1766009

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Total Dissolved Solids	mg/L	615	592	96	80-120	

SAMPLE DUPLICATE: 1766010

Parameter	Units	40176896003 Result	Dup Result	RPD	Max RPD	Qualifiers
Total Dissolved Solids	mg/L	930	954	3	5	

SAMPLE DUPLICATE: 1766011

Parameter	Units	40176924001 Result	Dup Result	RPD	Max RPD	Qualifiers
Total Dissolved Solids	mg/L	394	380	4	5	

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: 25216068.18 WPL EDGE CLOSE CCR
Pace Project No.: 40176947

QC Batch: 302556
Analysis Method: EPA 9040
QC Batch Method: EPA 9040
Analysis Description: 9040 pH
Associated Lab Samples: 40176947001, 40176947002, 40176947003, 40176947004, 40176947005

SAMPLE DUPLICATE: 1767295

Parameter	Units	40176756001 Result	Dup Result	RPD	Max RPD	Qualifiers
pH at 25 Degrees C	Std. Units	8.0	8.1	0	20	H6

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALITY CONTROL DATA

Project: 25216068.18 WPL EDGE CLOSE CCR
Pace Project No.: 40176947

QC Batch: 302451 Analysis Method: EPA 300.0
QC Batch Method: EPA 300.0 Analysis Description: 300.0 IC Anions
Associated Lab Samples: 40176947001, 40176947002, 40176947003, 40176947004, 40176947005

METHOD BLANK: 1766939 Matrix: Water
Associated Lab Samples: 40176947001, 40176947002, 40176947003, 40176947004, 40176947005

Parameter	Units	Blank Result	Reporting Limit	Analyzed	Qualifiers
Chloride	mg/L	<0.50	2.0	10/10/18 20:34	
Fluoride	mg/L	<0.10	0.30	10/10/18 20:34	
Sulfate	mg/L	<1.0	3.0	10/10/18 20:34	

LABORATORY CONTROL SAMPLE: 1766940

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Chloride	mg/L	20	19.7	99	90-110	
Fluoride	mg/L	2	2.0	100	90-110	
Sulfate	mg/L	20	19.7	99	90-110	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 1766941 1766942

Parameter	Units	40177145001 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Chloride	mg/L	27.8	100	100	127	128	100	100	90-110	1	15	
Fluoride	mg/L	<0.50	10	10	10.3	10.4	103	104	90-110	1	15	
Sulfate	mg/L	87.5	100	100	187	188	99	100	90-110	0	15	

MATRIX SPIKE & MATRIX SPIKE DUPLICATE: 1766943 1766944

Parameter	Units	40176959001 Result	MS Spike Conc.	MSD Spike Conc.	MS Result	MSD Result	MS % Rec	MSD % Rec	% Rec Limits	RPD	Max RPD	Qual
Chloride	mg/L	221	400	400	603	595	96	94	90-110	1	15	
Fluoride	mg/L	<2.0	40	40	40.1	39.7	100	99	90-110	1	15	
Sulfate	mg/L	270	400	400	605	602	84	83	90-110	0	15	M0

Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

QUALIFIERS

Project:	25216068.18 WPL EDGE CLOSE CCR
Pace Project No.:	40176947

DEFINITIONS

DF - Dilution Factor, if reported, represents the factor applied to the reported data due to dilution of the sample aliquot.

ND - Not Detected at or above LOD.

J - Estimated concentration at or above the LOD and below the LOQ.

LOD - Limit of Detection adjusted for dilution factor and percent moisture.

LOQ - Limit of Quantitation adjusted for dilution factor and percent moisture.

S - Surrogate

1,2-Diphenylhydrazine decomposes to and cannot be separated from Azobenzene using Method 8270. The result for each analyte is a combined concentration.

Consistent with EPA guidelines, unrounded data are displayed and have been used to calculate % recovery and RPD values.

LCS(D) - Laboratory Control Sample (Duplicate)

MS(D) - Matrix Spike (Duplicate)

DUP - Sample Duplicate

RPD - Relative Percent Difference

NC - Not Calculable.

SG - Silica Gel - Clean-Up

U - Indicates the compound was analyzed for, but not detected at or above the adjusted LOD.

N-Nitrosodiphenylamine decomposes and cannot be separated from Diphenylamine using Method 8270. The result reported for each analyte is a combined concentration.

Pace Analytical is TNI accredited. Contact your Pace PM for the current list of accredited analytes.

TNI - The NELAC Institute.

ANALYTE QUALIFIERS

H6	Analysis initiated outside of the 15 minute EPA required holding time.
M0	Matrix spike recovery and/or matrix spike duplicate recovery was outside laboratory control limits.
P6	Matrix spike recovery was outside laboratory control limits due to a parent sample concentration notably higher than the spike level.

QUALITY CONTROL DATA CROSS REFERENCE TABLE

Project: 25216068.18 WPL EDGE CLOSE CCR
Pace Project No.: 40176947

Lab ID	Sample ID	QC Batch Method	QC Batch	Analytical Method	Analytical Batch
40176947001	**MW-301**	EPA 3010	302988	EPA 6020	303076
40176947002	**MW-302**	EPA 3010	302988	EPA 6020	303076
40176947003	**MW-303**	EPA 3010	302988	EPA 6020	303076
40176947004	**2R-OW**	EPA 3010	302988	EPA 6020	303076
40176947005	**FIELD BLANK**	EPA 3010	302988	EPA 6020	303076
40176947001	**MW-301**				
40176947002	**MW-302**				
40176947003	**MW-303**				
40176947004	**2R-OW**				
40176947001	**MW-301**	SM 2540C	302368		
40176947002	**MW-302**	SM 2540C	302368		
40176947003	**MW-303**	SM 2540C	302368		
40176947004	**2R-OW**	SM 2540C	302368		
40176947005	**FIELD BLANK**	SM 2540C	302368		
40176947001	**MW-301**	EPA 9040	302556		
40176947002	**MW-302**	EPA 9040	302556		
40176947003	**MW-303**	EPA 9040	302556		
40176947004	**2R-OW**	EPA 9040	302556		
40176947005	**FIELD BLANK**	EPA 9040	302556		
40176947001	**MW-301**	EPA 300.0	302451		
40176947002	**MW-302**	EPA 300.0	302451		
40176947003	**MW-303**	EPA 300.0	302451		
40176947004	**2R-OW**	EPA 300.0	302451		
40176947005	**FIELD BLANK**	EPA 300.0	302451		

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CHAIN OF CUSTODY

UPPER MIDWEST REGION
MN: 612-607-1700 WI: 920-469-2436

Page 1 of

40176947

(Please Print Clearly)

Company Name:	SCS Engineers
Branch/Location:	Madison Wis
Project Contact:	Meg Blodgett
Phone:	608-216-7362
Project Number:	25216068.18
Project Name:	WPL Edgewater Closed Ash Fill
Project State:	Wis
Sampled By (Print):	Gary Sterkel
Sampled By (Sign):	Gary Sterkel
PO #:	
Regulatory Program:	

*Preservation Codes
A=None B=HCL C=H2SO4 D=HNO3 E=DI Water F=Methanol G=NaOH
H=Sodium Bisulfate Solution I=Sodium Thiosulfate J=Other

Quote #:	
Mail To Contact:	
Mail To Company:	
Mail To Address:	
Invoice To Contact:	
Invoice To Company:	SCS Engineers
Invoice To Address:	2830 Dairy Dairy Dr Madison WI
Invoice To Phone:	

Data Package Options (billable)
☐ EPA Level III
☐ EPA Level IV

MS/MSD
☐ On your sample (billable)
☐ NOT needed on your sample

Matrix Codes
A = Air W = Water
B = Biota DW = Drinking Water
C = Charcoal GW = Ground Water
O = Oil SW = Surface Water
S = Soil WW = Waste Water
Sl = Sludge WP = Wipe

					FILTERED? (YES/NO) Y/N	N	N	N	N	N	N	N				
					PRESERVATION (CODE)* Pick Letter	D	D	A	A	A	A	A				
PACE LAB #	CLIENT FIELD ID	COLLECTION DATE	COLLECTION TIME	MATRIX	Analyses Requested	Boron	Calcium	Chloride	Fluoride	pH	Sulfate	TDS		CLIENT COMMENTS	LAB COMMENTS (Lab Use Only)	Profile #
001	MW-301	10/1/18	1208	GW		X	X	X	X	X	X	X				
002	MW-302	10/1/18	1456	GW		X	X	X	X	X	X	X				
003	MW-303	10/1/18	1251	GW		X	X	X	X	X	X	X				
004	2R-OW	10/1/18	1031	GW		X	X	X	X	X	X	X				
005	Field Blank	10/1/18	1500	GW		X	X	X	X	X	X	X				

Rush Turnaround Time Requested - Prelims
(Rush TAT subject to approval/surcharge)
Date Needed:

Transmit Prelim Rush Results by (complete what you want):
Email #1:
Email #2:
Telephone:
Fax:

Samples on HOLD are subject to special pricing and release of liability

Relinquished By:	Date/Time:	Received By:	Date/Time:
Gary Sterkel	10/2/18 0800	Mary Fannin	10/2/18 8:45
Mary Fannin	10/2/18 1630		
	10-3-18 1005		10-3-18 1005

PACE Project No. 40176947

Receipt Temp = RDI °C

Sample Receipt pH
[✓ OK] / Adjusted

Cooler Custody Seal
[✓ Present] / Not Present
Intact / Not Intact

Version 6.0 06/14/06

C019a(27Jun2006)

ORIGINAL

Pace Analytical Services, LLC
1241 Bellevue Street, Suite 9
Green Bay, WI 54302

Sample Preservation Receipt Form

Client Name: SCS Engineers Project # 40176947

All containers needing preservation have been checked and noted below: ☒Yes ☐No ☐N/A

Lab Lot# of pH paper: 10US078 Lab Std #ID of preservation (if pH adjusted):

Initial when completed: SKW Date/ Time:

	Glass							Plastic							Vials						Jars			General									
Pace Lab #	AG1U	AG1H	AG4S	AG4U	AG5U	AG2S	BG3U	BP1U	BP2N	BP2Z	BP3U	BP3C	BP3N	BP3S	DG9A	DG9T	VG9U	VG9H	VG9M	VG9D	JGFU	WGFU	WPFU	SP5T	ZPLC	GN	VOA Vials (>6mm) *	H2SO4 pH ≤2	NaOH+Zn Act pH ≥9	NaOH pH ≥12	HNO3 pH ≤2	pH after adjusted	Volume (mL)
001											2		1																		X		2.5 / 5 / 10
002											2		1																		X		2.5 / 5 / 10
003											2		1																		X		2.5 / 5 / 10
004											2		1																		X		2.5 / 5 / 10
005											2		1																		X		2.5 / 5 / 10
006																																	2.5 / 5 / 10
007																																	2.5 / 5 / 10
008																																	2.5 / 5 / 10
009																																	2.5 / 5 / 10
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011																																	2.5 / 5 / 10
012																																	2.5 / 5 / 10
013																																	2.5 / 5 / 10
014																																	2.5 / 5 / 10
015																																	2.5 / 5 / 10
016																																	2.5 / 5 / 10
017																																	2.5 / 5 / 10
018																																	2.5 / 5 / 10
019																																	2.5 / 5 / 10
020																																	2.5 / 5 / 10

Exceptions to preservation check: VOA, Coliform, TOC, TOX, TOH, O&G, WI DRO, Phenolics, Other: ________ Headspace in VOA Vials (>6mm) : ☐Yes ☐No ☒N/A *If yes look in headspace column

AG1U	1 liter amber glass	BP1U	1 liter plastic unpres	DG9A	40 mL amber ascorbic	JGFU	4 oz amber jar unpres
AG1H	1 liter amber glass HCL	BP2N	500 mL plastic HNO3	DG9T	40 mL amber Na Thio	WGFU	4 oz clear jar unpres
AG4S	125 mL amber glass H2SO4	BP2Z	500 mL plastic NaOH, Znact	VG9U	40 mL clear vial unpres	WPFU	4 oz plastic jar unpres
AG4U	120 mL amber glass unpres	BP3U	250 mL plastic unpres	VG9H	40 mL clear vial HCL		
AG5U	100 mL amber glass unpres	BP3C	250 mL plastic NaOH	VG9M	40 mL clear vial MeOH	SP5T	120 mL plastic Na Thiosulfate
AG2S	500 mL amber glass H2SO4	BP3N	250 mL plastic HNO3	VG9D	40 mL clear vial DI	ZPLC	ziploc bag
BG3U	250 mL clear glass unpres	BP3S	250 mL plastic H2SO4			GN:	

Page 1 of 2

F-GB-C-046-Rev.02 (29Mar2018) Sample Preservation Receipt Form

Pace Analytical 1241 Bellevue Street, Green Bay, WI 54302	Document Name: **Sample Condition Upon Receipt (SCUR)**	Document Revised: 25Apr2018
	Document No.: **F-GB-C-031-Rev.07**	Issuing Authority: Pace Green Bay Quality Office

Sample Condition Upon Receipt Form (SCUR)

Client Name: SCS Engineers

Project #:

WO# : 40176947

40176947

Courier: ☑ CS Logistics ☐ Fed Ex ☐ Speedee ☐ UPS ☐ Waltco ☐ Client ☐ Pace Other:

Tracking #:

Custody Seal on Cooler/Box Present: ☑ yes ☐ no Seals intact: ☑ yes ☐ no

Custody Seal on Samples Present: ☐ yes ☑ no Seals intact: ☐ yes ☐ no

Packing Material: ☐ Bubble Wrap ☐ Bubble Bags ☑ None ☐ Other

Thermometer Used SR - N/A **Type of Ice:** [✓ Wet] Blue Dry None ☑ Samples on ice, cooling process has begun

Cooler Temperature Uncorr: ROI /Corr:

Temp Blank Present: ☐ yes ☑ no **Biological Tissue is Frozen:** ☐ yes ☐ no

Temp should be above freezing to 6°C.
Biota Samples may be received at ≤ 0°C.

Person examining contents:
Date: 10-3-18
Initials: SW

Chain of Custody Present: ☑ Yes ☐ No ☐ N/A	1.
Chain of Custody Filled Out: ☐ Yes ☑ No ☐ N/A	2. No pg #, Mail or Invoice info. 10-3-18 SW
Chain of Custody Relinquished: ☑ Yes ☐ No ☐ N/A	3.
Sampler Name & Signature on COC: ☑ Yes ☐ No ☐ N/A	4.
Samples Arrived within Hold Time: ☑ Yes ☐ No - VOA Samples frozen upon receipt ☐ Yes ☐ No	5. Date/Time:
Short Hold Time Analysis (<72hr): ☑ Yes ☐ No	6.
Rush Turn Around Time Requested: ☐ Yes ☑ No	7.
Sufficient Volume: For Analysis: ☑ Yes ☐ No MS/MSD: ☐ Yes ☑ No ☐ N/A	8.
Correct Containers Used: ☑ Yes ☐ No -Pace Containers Used: ☑ Yes ☐ No ☐ N/A -Pace IR Containers Used: ☐ Yes ☐ No ☑ N/A	9.
Containers Intact: ☑ Yes ☐ No	10.
Filtered volume received for Dissolved tests ☐ Yes ☐ No ☑ N/A	11.
Sample Labels match COC: ☑ Yes ☐ No ☐ N/A -Includes date/time/ID/Analysis Matrix: W	12.
Trip Blank Present: ☐ Yes ☐ No ☑ N/A Trip Blank Custody Seals Present ☐ Yes ☐ No ☑ N/A Pace Trip Blank Lot # (if purchased):	13.

Client Notification/ Resolution: If checked, see attached form for additional comments ☐

Person Contacted: Date/Time:

Comments/ Resolution:

Project Manager Review: Rmr for Pm **Date:** 10/3/18

Appendix B

Alternative Source Demonstration Reports

B1 Alternative Source Demonstration, October 2017 Detection Monitoring

SCS ENGINEERS

Alternative Source Demonstration
October 2017 Detection Monitoring

Edgewater Generating Station
Sheboygan, Wisconsin

Prepared for:

Alliant Energy

Prepared by:

SCS ENGINEERS
2830 Dairy Drive
Madison, Wisconsin 53718-6751
(608) 224-2830

April 16, 2018
File No. 25216068.18

Offices Nationwide
www.scsengineers.com

Alternative Source Demonstration
October 2017 Detection Monitoring
Edgewater Generating Station
Sheboygan, Wisconsin

Prepared for:

Alliant Energy

Prepared by:

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Madison, Wisconsin 53718-6751
(608) 224-2830

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PE CERTIFICATION

Sherren C.
Clark
E-29863
Madison,
Wis.

4-16-18

I, Sherren Clark, hereby certify that that the information in this alternate source demonstration is accurate and meets the requirements of 40 CFR 257.94(e)(2). This certification is based on my review of the groundwater and data and related site information available for the Edgewater Generating Station Ash Ponds. I am a duly licensed Professional Engineer under the laws of the State of Wisconsin.

4-16-18

(signature) (date)

Sherren Clark

(printed or typed name)

License number E-29863

My license renewal date is July 31, 2018.

Pages or sheets covered by this seal:

All: Edgewater Generating Station

Alternative Source Demonstration

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1.0 INTRODUCTION

This Alternative Source Demonstration (ASD) was prepared to support compliance with the groundwater monitoring requirements of the “Coal Combustion Residuals (CCR) Final Rule” published by the U.S. Environmental Protection Agency (USEPA) in the *Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities; Final Rule*, dated April 17, 2015 (USEPA, 2015), and subsequent amendments. Specifically, this report was prepared to fulfill the requirements of 40 CFR 257.94(e)(2). The applicable sections of the Rule are provided below in *italics*.

1.1 §257.94(E)(2) ALTERNATIVE SOURCE DEMONSTRATION REQUIREMENTS

The owner and operator may demonstrate that a source other than the CCR Unit caused the statistically significant increase over background levels for a constituent or that the statistically significant increase resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality. The owner or operator must complete the written demonstration within 90 days of detecting a statistically significant increase over background levels.

An ASD is completed when there are exceedances of one or more benchmarks established within the groundwater monitoring program. The ASD is completed to determine if any other sources are likely causes of the identified exceedance(s) of established benchmark(s) at the site. This ASD was performed in response to results indicating a statistically significant increase (SSI) over background levels during detection monitoring under the CCR Rule.

1.2 SITE INFORMATION AND MAP

The Edgewater Generating Station (EDG) is located at 3739 Lakeshore Drive in Sheboygan, Sheboygan County, Wisconsin (**Figure 1**). EDG is an active coal-burning generating station. The EDG property includes a closed landfill and a series of CCR settling ponds, located on the opposite side of Lakeshore Drive from the plant itself (**Figure 1**). The EDG landfill is closed and no longer receives CCR. The groundwater monitoring system at the EDG is a multi-unit system. The EDG has four existing CCR Units which are contiguous:

- EDG Slag Pond (existing CCR surface impoundment)
- EDG North A-Pond (existing CCR surface impoundment)
- EDG South A- Pond (existing CCR surface impoundment)
- EDG B-Pond (existing surface CCR impoundment)

A map showing the CCR Units and all background (or upgradient) and downgradient monitoring wells with identification numbers for the groundwater monitoring program is provided as **Figure 2**.

The closed CCR landfill (Wisconsin Department of Natural Resources [WDNR] Permit No. 2524) is located immediately west of the ponds. The landfill contains primarily fly ash with some slag, and was closed in 1987. Because this CCR landfill did not accept CCR after October 19, 2015, the landfill is not subject to the requirements of 40 CFR 257.50-107. The closed landfill is unlined and is known to be impacting groundwater at the site (SCS Engineers [SCS], 2016). Previous investigations done at the site (BT^2, Inc., 1993; RMT, 1997) concluded that the groundwater impacts downgradient of the landfill and ponds were attributable to groundwater interaction with the landfill rather than to leakage from the ponds.

1.3 STATISTICALLY SIGNIFICANT INCREASES IDENTIFIED

SSIs were identified for boron, fluoride, field pH, and sulfate at one or more wells based on the October 2017 detection monitoring event. A summary of the October 2017 constituent concentrations and the established benchmark concentrations is provided in **Table 1**. The constituent concentrations with SSIs above the background concentration are highlighted in the table. Concentration trends for the parameters with SSIs are shown in **Appendix A**.

1.4 OVERVIEW OF ASD

This ASD report includes:

- Background information (**Section 2.0**)
- Evaluation of potential that SSIs are due to methodology or analysis (**Section 3.0**)
- Evaluation of potential that SSIs are due to natural sources or man-made sources other than the CCR Units (**Section 4.0**)
- ASD conclusions (**Section 5.0**)
- Monitoring recommendations (**Section 6.0**)

The CCR Rule constituent results from background and compliance sampling for detection monitoring parameters (CCR Rule Appendix III) are provided in **Table 2.** Complete laboratory reports for the background monitoring events and the October 2017 detection monitoring event were included in the 2017 Annual Groundwater Monitoring and Corrective Action Report for EDG.

2.0 BACKGROUND

2.1 REGIONAL GEOLOGY AND HYDROGEOLOGY

For the purposes of groundwater monitoring, the unconsolidated sand and gravel aquifer is considered to be the uppermost aquifer, as defined under 40 CFR 257.53, at the EDG ponds. A summary of the regional hydrogeologic stratigraphy and a regional geologic cross section are included in **Appendix B**. The sand and gravel aquifer is present in some parts of Sheboygan County (Skinner and Borman, 1973). Boring logs from monitoring wells at the EDG ponds and for nearby private wells indicate that the unconsolidated material at and near the site contains a significant amount of sand. Private well logs from the surrounding area indicate that the sand

and gravel aquifer has been used as a water source; however, several older sand wells in the area have been replaced with bedrock water supply wells. In a search of area well records, SCS did not find any records indicating that shallow wells are still being used in the area around EDG.

The dolomite aquifer underlies the unconsolidated material at the site. The total thickness of the dolomite aquifer at the site is unknown. The dolomite aquifer is underlain by the Maquoketa shale, which is a confining unit. The Maquoketa shale is underlain by the Cambrian-Ordovician sandstone aquifer. This sequence of sedimentary bedrock units is over 1,500 feet thick in the site vicinity. The sedimentary sequence is underlain by Precambrian crystalline rocks that are not considered an aquifer in eastern Wisconsin.

2.2 CCR MONITORING SYSTEM

The groundwater monitoring system established within the CCR Rule consists of one upgradient (background) monitoring well and three downgradient monitoring wells, as shown on **Figure 2**. The upgradient monitoring well is 2R-OW. The downgradient monitoring wells include MW-301, MW-302, and MW-303. The CCR compliance monitoring wells were installed in the unconsolidated sediments with screens in the uppermost soil layer producing appreciable water, which was a sandy silt unit. Well depths range from approximately 14.5 to 40 feet, measured from the top of the well casing.

2.3 OTHER MONITORING WELLS

Sixteen groundwater monitoring wells currently exist at the EDG site as part of the monitoring system developed for the state monitoring program. The well locations are shown on **Figure 2**. These monitoring wells are used to monitor groundwater conditions at the site under the WDNR state monitoring program.

Monitoring wells for the state monitoring program are installed in the unconsolidated material at the site. This shallow monitoring system includes water table wells and piezometers. Well depths range from approximately 9 to 43 feet, measured from the top of the well casing.

2.4 GROUNDWATER FLOW DIRECTION

Groundwater flow in the area of the EDG site generally flows to the south-southeast, toward Fish Creek, which discharges into Lake Michigan. There is some localized groundwater mounding associated with the EDG ponds. The water table map shown on **Figure 3** represents the site conditions of the unconsolidated deposits during the October 2017 monitoring event for the state monitoring program. The groundwater elevations for the October 2017 monitoring of the state wells are provided in **Table 3**, and the water table flow map is presented on **Figure 3**. The water table map shows a generally south-southeast flow direction, with localized groundwater mounding in the area of the EDG ponds.

Water levels measured in the CCR monitoring wells also indicate a south-southeast flow direction. The CCR monitoring well water levels for October 2017 were not included in the water table contour map on **Figure 3** because the CCR wells do not intersect the water table and they were monitored 15 days after the state program wells. The CCR well water levels are summarized in **Table 4** and are generally consistent with the water table contours and flow directions shown on **Figure 3**.

3.0 METHODOLOGY AND ANALYSIS REVIEW

To evaluate the potential that an SSI is due to a source other than the regulated CCR Unit, SCS used a two-step evaluation process. First, the sample collection, field and laboratory analysis, and statistical evaluation were reviewed to identify any potential error or analysis that led to exceedance of the benchmark. Second, potential alternative sources, including natural variation and man-made sources other than the CCR Unit, were evaluated. This section of the report provides the findings of the methodology and analysis review. **Section 4.0** of the report addresses the potential alternative sources.

3.1 SAMPLING AND FIELD ANALYSIS REVIEW

Field notes and sampling results were reviewed to determine if any sampling error may have caused or contributed to the observed SSIs. Potential field sampling errors or issues could include mislabeling of samples, improper sample handling, missed holding times, cross contamination during sampling, or other field error. Field blank sample results were also reviewed for any indication of potential contamination from sampling equipment or containers. Based on the review of the field notes and results, SCS did not identify any indication that the SSI concentrations were due to a sampling error.

The field pH trend plots were also reviewed for any anomalous results that might indicate a possible sampling or field analysis error (e.g., calibration error or incorrect sample identification). The time series plots are provided in **Appendix A**. The field pH results reported for all wells for the August 2016 background monitoring event were anomalously low, which is most likely due to a calibration error or other problem with the field pH meter for that event. During the statistical evaluation of the background data from well 2R-OW to develop the Upper Prediction Limit (UPL) for field pH, the August 2016 field pH result was identified as an outlier and was not used in the UPL calculation. Although the compliance wells also had outlier pH results for August 2016, the anomalous results for those wells were not considered when evaluating SSI determinations for the October 2017 detection monitoring, because an interwell analysis was used for the SSI evaluation, comparing current compliance well results to UPLs based on background well results.

Because boron, fluoride, and sulfate are laboratory parameters, there is little potential for a field analysis error to contribute to an SSI.

3.2 LABORATORY ANALYSIS REVIEW

Laboratory reports for the background monitoring and the October 2017 detection monitoring were reviewed to determine if any laboratory analysis error or issue may have caused or contributed to the observed SSI for boron, fluoride, or sulfate. The laboratory report review included reviewing the laboratory quality control flags and narrative, verifying that correct methods were used and desired detection limits were achieved, and checking the field and laboratory blank sample results. Laboratory reports were included in the 2017 Annual Groundwater Monitoring and Corrective Action Report for the facility.

Based on the review of the laboratory reports, SCS did not identify any indication that the SSI concentrations were due to a laboratory analysis error. There were no laboratory quality control flags or issues identified in the laboratory report that affect the usability of the data for detection monitoring.

Time series plots of the analytical data were also reviewed for any anomalous results that might indicate a possible sampling or laboratory error (e.g., dilution error or incorrect sample labeling). Time series plots for the parameters with SSIs are provided in **Appendix A**. No indications of sampling or laboratory errors were noted based on the time series review.

3.3 STATISTICAL EVALUATION REVIEW

The review of the statistical results and methods include a quality control check of the following:

- Input analytical data vs. laboratory analytical reports
- Review statistical method and outlier concentration lists for each monitoring well/CCR Unit

Based on the review of the statistical evaluation, SCS did not identify any errors or issues in the statistical evaluation that caused or contributed to the determination of interwell SSIs for the October 2017 monitoring event.

3.4 SUMMARY OF METHODOLOGY AND ANALYSIS REVIEW FINDINGS

In summary, there were no changes to the SSI determinations for the October 2017 monitoring event based on the methodology and analysis review, and no errors or issues causing or contributing to the reported SSIs were identified.

4.0 ALTERNATIVE SOURCES

This section of the report discusses the potential alternative sources for the boron, sulfate, field pH, and fluoride SSIs at MW-301, MW-302, and MW-303; identifies the most likely alternative source(s); and presents the lines of evidence indicating that an alternative source is the most likely cause of the observed SSIs for boron, sulfate, field pH, and fluoride.

4.1 POTENTIAL CAUSES OF SSI

4.1.1 Natural Variation

The statistical analysis was completed using an interwell approach, comparing the October 2017 detection monitoring results to the UPLs calculated based on sampling of the background well (2R-OW). If concentrations of a constituent that is naturally present in the aquifer vary spatially, then the potential exists that the downgradient concentrations may be higher than upgradient concentrations due to natural variation.

Although natural variation is present in the shallow aquifer, it does not appear likely that natural variation is the primary source causing the boron and sulfate SSIs. These parameters were detected at higher concentrations than would likely be present naturally.

Natural variation may have contributed to the SSI for pH at MW-302. The UPL was calculated based on pH results at background well 2R-OW for the eight CCR Rule background monitoring events and the October 24, 2017, detection monitoring event. Based on these results, the calculated UPL was 7.47 and pH at MW-302 was 7.6. Although the result exceeds the UPL, it was within the range historically observed for background well 2R-OW during monitoring for the state program. In addition, the pH measured at 2R-OW on October 9, 2017, for the state monitoring program was 7.66, exceeding both the MW-302 result and the calculated UPL (**Table 5**). This result was not included in the UPL calculation because it was too close in time to the October 24, 2017, CCR monitoring event to be considered an independent sample. Nevertheless, the fact that the MW-302 pH was within the range of recent and historical pH results for upgradient well 2R-OW suggests that the SSI for pH may be partially or completely due to natural variation.

Natural variation may also have caused or contributed to the SSI for fluoride at MW-302. Elevated natural fluoride concentrations significantly higher than those reported for the downgradient wells (above 2 milligrams per liter [mg/L]) have been observed in a region in eastern Wisconsin extending along the Lake Michigan shoreline from Kewaunee County in the north to the Illinois border in the south, as described Luczaj, J., and Masarik, K, 2015, *Groundwater Quantity and Quality Issues in a Water-Rich Region: Examples from Wisconsin, USA* (**Appendix C**). The authors note that most of the wells with elevated fluoride appear to be drawing from the Pleistocene glacial sediments and Silurian dolomite units. Skinner and Borman (1973) and Kammerer (1995) also identify the Lake Michigan shoreline area of eastern Wisconsin as having somewhat elevated fluoride concentrations in groundwater.

The fluoride concentration reported for MW-302 for October 2017 was just above the laboratory's limit of quantitation (LOQ), at 0.84 mg/L. This result is within the range of reported natural concentrations, indicating that the fluoride concentration observed in this well is likely due to natural variability in the glacial sediments and shallow groundwater. As discussed below, there is also a potential that fluoride in MW-302 is associated with impacts from the closed CCR landfill.

4.1.2 Man-Made Alternative Sources

Man-made alternative sources that could potentially contribute to the boron, fluoride, pH, and sulfate SSIs could include the closed CCR landfill, the coal storage area, or other plant operations. Based the groundwater flow directions and on previous investigations at the site, the closed landfill appears to be the most likely cause of the SSIs for wells MW-301, MW-302, and MW-303.

4.2 LINES OF EVIDENCES

The lines of evidence indicating that the SSIs for boron, sulfate, fluoride, and pH in compliance wells MW-301, MW-302, and MW-303, relative to the background well, are due to an alternative source include:

1. A previous study of the CCR ponds and the closed CCR landfill determined that the landfill was the primary source of groundwater impacts in the area, based on multiple lines of evidence.

2. Past and current monitoring performed under the state monitoring program shows that boron, sulfate, fluoride, and elevated pH are all present in the CCR landfill leachate.

3. Past and current monitoring performed under the state monitoring program shows that the highest boron and sulfate concentrations are in the monitoring wells near and downgradient from the CCR landfill.

Lines of evidence regarding natural variability as an additional alternative source of the fluoride and pH SSIs for MW302 are discussed in **Section 4.1.1**.

4.2.1 Previous CCR Pond and Landfill Study

A previous investigation titled *Field Investigation Report: Edgewater Closed Ash Disposal Facility*, completed by BT^2 in 1993, found that groundwater impacts were likely due to the closed landfill (**Figure 2**) located immediately west of the ponds (BT^2, 1993). Portions of the 1993 report are included in **Appendix D** for reference. The purpose of the 1993 investigation was to investigate the likely impact on groundwater quality of lining or abandoning the CCR impoundments (referred to in the report as the WPDES lagoons). The results from the investigation indicated that the CCR impoundments were not the primary source of downgradient groundwater impacts, and that closure or lining was not warranted. The WDNR concurred with that finding in a letter dated April 20, 1994.

The primary lines of evidence from the 1993 report that supported this finding, and support the alternative source determination for boron, sulfate, fluoride, and pH, included:

- Water samples collected from each of the ponds met the Wisconsin groundwater enforcement standards established under NR 140, Wisconsin Administrative Code.

- Although the slag pond and the Wisconsin Pollutant Discharge Elimination System (WDPES) lagoons (North Pond A and South Pond A) were constructed within what had originally been a larger ash pond, soil borings indicated that material below the ponds was almost entirely slag. Thus, water leaking out of the lagoons and moving downward would encounter primarily slag, which is relatively inert, and not fly ash.

- Ash disposal in the closed landfill is primarily fly ash. For seven borings in the landfill, the percent fly ash ranged from 60 to 86 percent.

- Results for water leach testing of site-wide composite samples of fly ash and slag confirmed that the fly ash had a higher potential than slag to impact groundwater. Water leach test results for the fly ash composite sample were higher for boron, sulfate, fluoride, and pH in comparison to the slag composite sample.

- Water leach testing for individual boring samples of fly ash and/or slag also confirmed that fly ash leachate had significantly higher concentrations of boron and sulfate than slag leachate. For example, boron leach test results for seven samples from borings within the landfill, consisting mainly of fly ash, ranged from 624 to 3,370 micrograms per liter (µg/L), with most results over 2,000 µg/L. Boron leach test results for nine samples from borings around and between the ponds, consisting mainly of slag, ranged from less than 16 to 206 µg/L.

- Water sampling within the landfill and pond area, in CCR above the native soil, documented that groundwater/leachate within the landfill had significantly higher concentrations of boron than the groundwater/leachate within the slag berms immediately adjacent to and between the Slag Pond, North/South Pond A, and Pond B.

- Groundwater monitoring results indicated that the highest concentrations of boron and sulfate were in monitoring wells downgradient from the landfill, including 18-OW and 29-OW. Elevated boron and sulfate were also reported for samples from wells 4-OW and 5-OW, located near the southwest and northwest corners of the landfill. Monitoring wells 6-OW and 7-OW, located east and southeast of the ponds, had much lower concentrations of boron and sulfate.

In the April 1994 approval letter, the WDNR approved the 1993 investigation of the WPDES lagoons/CCR impoundments and concurred with the findings of the report (**Appendix E**). The WDNR requested additional monitoring from the four new monitoring wells installed within the CCR (36-OW, 37-OW, 38R-OW, and 39R-OW) and requested the addition of fluoride and arsenic to the monitoring program for these groundwater/leachate head wells.

The results of the additional monitoring were reported to the WDNR in a Groundwater Assessment Report dated September 30, 1997. The WDNR responded to the 1997 report in a letter dated April 16, 1998, which stated, “We agree with the report’s finding that the WPDES ponds [Slag Pond, North Pond A, and South Pond A] do not appear to be significantly contributing to the contaminant plume downgradient of the facility. No further remedial action concerning the influence of the ponds on the landfill is warranted at this time." The WDNR also noted that the leachable constituents migrating from the saturated portion of the closed landfill have stabilized or also decreased since the landfill's closure and capping. The April 1998 WDNR letter is provided in **Appendix E**.

4.2.2 CCR Constituents in Landfill Leachate

Past and current monitoring performed under the state monitoring program shows that boron, sulfate, fluoride, and elevated pH are all present in the CCR landfill leachate. Groundwater and leachate monitoring results for boron, sulfate, and pH in 2016 and 2017 are summarized in **Table 5**. The leachate head wells monitoring conditions within the CCR landfill are 37-OW, 38R-OW, and 39R-OW, listed near the end of the table.

Boron: In 2016 and 2017, leachate head wells 37-OW, 38R-OW, and 39R-OW, all had boron concentrations that were higher than those reported for the CCR monitoring wells.

Sulfate: In 2016 and 2017, leachate head wells 37-OW, 38R-OW, and 39R-OW, all had sulfate concentrations that were generally higher than those reported for the CCR monitoring wells.

Field pH: In 2016 and 2017, field pH results for the three leachate head wells were slightly higher than the UPL calculated from the well 2R-OW background data. Seven of the 12 leachate field pH readings for 2016 and 2017 were higher than the calculated UPL. Five of 12 were higher than the MW-302 field pH result, including all of the results from leachate head well 38R-OW, located near the middle of the landfill, directly west of MW-302. Historically, pH values at leachate head well 39R-OW were in the range of 8 to 9, but pH has followed a gradual decreasing trend at this well since routine monitoring began in 1994.

Fluoride: Fluoride is not part of the routine state monitoring program for the closed CCR landfill, but was sampled from the leachate wells (37-OW, 38R-OW, and 39R-OW) and the pond berm well (36-OW) from 1994 to 1997, as requested by the WDNR. The fluoride concentrations ranged from 0.25 to 0.97 mg/L (**Table 6**). The highest results were for leachate head well 39R-OW, and three of the four samples from this well exceeded the October 2017 fluoride concentration for MW-302.

Based on these results, the fly ash disposal in the closed CCR landfill is a likely historical source of elevated boron, sulfate, pH, and fluoride.

4.2.3 State Program Groundwater Monitoring Results

As discussed in **Section 4.2.1**, historical monitoring results in the 1990s showed that the highest concentrations of boron and sulfate were in monitoring wells downgradient from the landfill. Current monitoring performed under the state monitoring program continues to show that the highest boron and sulfate concentrations are in the monitoring wells near and downgradient from the CCR landfill. State program monitoring results for the CCR Rule detection monitoring parameters that overlap with the state program are summarized in **Table 5**, and well locations are on **Figure 2**.

Consistent with the conditions observed at the time of the 1993 report, the 2016 and 2017 groundwater monitoring results indicate that the highest concentrations of boron and sulfate are in monitoring wells downgradient from the landfill, including 18-OW (recently replaced by 40-OW) and 29-OW. Elevated boron and sulfate also continue to be reported for samples from wells 4-OW and 5-OW, located near the southwest and northwest corners of the landfill. The elevated boron and sulfate concentrations at well 5-OW, located immediately northwest of the landfill, show that localized groundwater mounding has caused impacts from the landfill to move north, away from the ponds and landfill, despite the overall regional flow to the south-southeast. Monitoring wells 6-OW and 7-OW, located immediately east and southeast of the ponds, have much lower concentrations of boron and sulfate than the wells close to the landfill.

5.0 ASD CONCLUSIONS

The lines of evidence discussed above regarding the SSIs reported for boron, fluoride, field pH, and sulfate concentrations in downgradient monitoring wells MW-301, MW-302, and/or MW-303 demonstrate that the SSIs are likely primarily due to leachate from the closed landfill, which is not subject to the requirements of 40 CFR 257.50-107. The landfill is regulated by the WDNR under the solid waste program. The SSIs for fluoride and field pH at MW-302 may also be due to natural variability within the glacial sediment aquifer.

6.0 SITE GROUNDWATER MONITORING RECOMMENDATIONS

In accordance with section 257.94(e)(2) of the CCR Rule, the EDG pond site may continue with detection monitoring based on this ASD. The ASD report will be included in the 2018 Annual Report due January 31, 2019.

7.0 REFERENCES

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Kammerer, P.A. Jr., 1995, Ground-Water Flow and Quality in Wisconsin's Shallow Aquifer System, U.S. Geological Survey, Water-Resources Investigations Report 90-4171.

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TABLES

Table 1
Detection Monitoring Results Summary
Edgewater Generating Station
October 2017

Parameter Name	Units	Interwell Upper Prediction Limit (UPL)	Background Well	Compliance Wells		
			2R-OW	MW-301	MW-302	MW-303
Boron	ug/L	107	55.9	**8820**	**1760**	**3480**
Calcium	mg/L	206247	170000	87200	68100	173000
Chloride	mg/L	378	305	11.9	18.9	20.4
Fluoride	mg/L	LOQ (varies by well)	<0.1 U	<0.1 U	**0.84**	<0.5 U
Field pH	Std. Units	7.47	7.23	7.43	**7.6**	7.14
Sulfate	mg/L	35	29.3	**341**	**72.2**	<5 U
Total Dissolved Solids	mg/L	1145	1010	772	316	566

149 Statistically significant increase at compliance well

Notes:

1. UPL based on parametric prediction limit based on 1-of-2 resampling methodology for all parameters except calcium and fluoride.
2. UPL for fluoride is non-parametric based on quantitation limit. UPL for calcium based on non-parametric prediction limit (highest background value).
3. UPLs calculated from background well results for April 2016 through October 2017.

I:\25216068.00\Reports\2018 ASD Report\Tables\[Results_Oct2017_EDG.xlsx]Table 1

Table 2. Analytical Results - CCR Ponds Detection Monitoring Program
Edgewater Generating Station, Sheboygan, Wisconsin / SCS Engineers Project #25216068.00

Well Group	Well	Collection Date	Boron (µg/L)	Calcium (µg/L)	Chloride (mg/L)	Field pH (Std. Units)	Fluoride (mg/L)	Sulfate (mg/L)	Total Dissolved Solids (mg/L)
Background	2R-OW	4/8/2016	100	205,000	91.7	7.34	<0.2 U	19.5	774
		6/20/2016	22.4	148,000	232	7.02	<0.2 U	28.0	908
		8/9/2016	32.6	145,000	215	6.10	<0.2 U	25.4	974
		10/20/2016	43.1	155,000	217	6.98	<0.1 U	21.6	944
		1/24/2017	31.2	152,000	201	7.15	<0.1 U	23.9	854
		4/6/2017	70.6	143,000	102	7.01	<0.1 U	17.6	750
		6/6/2017	45.2	145,000	115	6.86	<0.1 U	17.8	744
		8/1/2017	35.7	164,000	272	7.00	<0.1 U	28.8	1000
		10/23/2017	55.9	170,000	305	7.23	<0.1 U	29.3	1010
Compliance	MW-301	4/11/2016	8,550	88,700	16.2	7.91	0.33 J	372	838
		6/20/2016	8,190	92,200	15.9	7.48	0.36 J	343	794
		8/9/2016	8,450	84,000	13.7	6.47	0.33 J	368	862
		10/20/2016	8,620	89,400	13.9	7.68	0.34	369	838
		1/23/2017	9,280	89,200	13.8	8.03	0.42	372	826
		4/6/2017	8,370	98,800	12.7	7.98	0.21 J	367	838
		6/6/2017	9,160	94,900	13.5	7.70	<0.1 U	362	804
		8/2/2017	8,610	83,600	12.3	7.58	0.32	340	780
		10/24/2017	8,820	87,200	11.9	7.43	<0.1 U	341	772
	MW-302	4/8/2016	1,950	122,000	18.9	8.01	0.83	75.1	352
		6/20/2016	2,010	116,000	27.2	7.73	1.3 J	89.6	364
		8/9/2016	2,000	75,900	18.0	6.55	0.8	80.7	396
		10/20/2016	2,150	72,100	19.5	7.89	0.8	77.2	348
		1/24/2017	2,000	87,400	18.6	7.98	0.89 J	71.1	328
		4/6/2017	1,970	114,000	18.9	7.99	0.76	85.8	358
		6/6/2017	1,970	72,200	20.0	7.84	0.9	88.5	350
		8/2/2017	1,890	62,600	19.3	7.76	0.78	80.2	360
		10/24/2017	1,760	68,100	18.9	7.60	0.84	72.2	316

Table 2. Analytical Results - CCR Ponds Detection Monitoring Program
Edgewater Generating Station, Sheboygan, Wisconsin / SCS Engineers Project #25216068.00

Well Group	Well	Collection Date	Boron (µg/L)	Calcium (µg/L)	Chloride (mg/L)	Field pH (Std. Units)	Fluoride (mg/L)	Sulfate (mg/L)	Total Dissolved Solids (mg/L)
Compliance	MW-303	4/8/2016	4,210	176,000	21.8	7.04	<0.2 U	3 J	660
		6/20/2016	3,360	138,000	31.5	6.79	<1 U	11.4 J	716
		8/9/2016	3,860	145,000	22.8	6.09	<0.2 U	2.4 J	732
		10/20/2016	3,740	147,000	26.0	6.94	<0.5 U	5.6 J	744
		1/24/2017	4,210	147,000	26.2	6.94	<0.5 U	<5 U	738
		4/6/2017	4,170	135,000	22.7	6.88	<0.5 U	<5 U	700
		6/6/2017	4,570	154,000	25.4	7.00	<0.5 U	<5 U	714
		8/2/2017	3,780	139,000	23.2	6.94	<0.5 U	<5 U	714
		10/24/2017	3,480	173,000	20.4	7.14	<0.5 U	<5 U	566

Abbreviations:

µg/L = micrograms per liter or parts per billion (ppb)
mg/L = milligrams per liter or parts per million (ppm)
-- = not analyzed

U = Not detected
J = Estimated value below laboratory's limit of quantitation (LOQ)

Notes:

1. Complete laboratory reports included in 2017 Annual Groundwater Monitoring and Corrective Action Report, Edgewater Generating Station.

Created by: NDK Date: 3/2/2018
Last revision by: NDK Date: 3/2/2018
Checked by: AJR Date: 3/5/2018

\\Mad-fs01\data\Projects\25216068.00\Reports\2018 ASD Report\Tables\[EDG-closed- All Tables.xlsx]Table 2- CCR Analytical

Table 3. Groundwater Elevations - State Program Water Table Wells
Edgwater Generating Station, Sheboygan, Wisconsin / SCS Engineers Project #25216068.00

	Ground Water Elevation in feet above mean sea level (amsl)															
	1-OW	**2R-OW**	**3R-OW**	**4R-OW**	**5-OW**	**6R-OW**	**7-OW**	**29-OW**	**30-OW**	**31-OW**	**32-OW**	**36-OW**	**37-OW**	**38R-OW**	**39R-OW**	**40-OW**
Well Information																
Top of Casing Elevation	591.72	612.72	591.32	595.6	600.72	590.98	592.51	588.86	590.81	589	589.07	614.63	615.02	620.98	614.04	587.42
Total Depth (from top of casing)	11.1	17.53	15.82	16.48	10.65	10.37	9.93	19.96	14.88	14.98	14.95	21.01	18.55	29	22.29	17.3
Top of Well Screen Elevation	580.62	595.19	575.5	579.12	590.07	580.61	582.58	568.9	575.93	574.02	574.12	593.62	596.47	591.98	591.75	--
Ground Water Elevation in feet above mean sea level (amsl)																
April 8, 2013	588.50	609.92	588.37	586.35	596.66	587.34	589.95	585.78	588.57	584.35	584.50	600.79	600.24	600.16	598.30	--
October 22, 2013	584.88	601.15	580.90	584.46	594.23	584.83	587.24	584.70	582.19	580.40	580.76	599.13	598.22	598.42	596.56	--
April 22, 2014	588.05	609.22	587.99	586.11	595.18	587.37	589.51	585.38	587.53	583.75	583.75	-- (1)	599.67	599.38	598.56	--
October 28, 2014	586.14	607.27	586.30	585.08	595.33	586.99	589.29	585.00	585.48	582.88	582.68	600.07	599.81	599.26	598.37	--
April 7 - 9, 2015	587.90	608.47	587.44	585.52	595.66	587.50	588.50	585.44	586.29	583.21	583.87	599.69	599.21	599.21	597.46	583.77
October 8, 2015	584.78	604.22	583.34	584.52	594.76	585.67	589.71	584.69	584.26	581.60	582.52	600.29	599.47	599.70	598.09	583.01
April 4-5, 2016	588.40	610.02	587.72	586.69	596.70	585.68	587.93	582.95	586.91	584.35	584.47	601.05	601.37	601.18	601.13	579.28
October 17, 2016	587.50	607.27	586.71	585.15	595.41	586.61	587.65	581.25	586.23	583.02	583.83	600.87	600.70	600.74	599.49	579.42
April 12-13, 2017	588.23	609.80	587.95	586.31	596.08	587.32	587.06	583.74	585.36	583.68	584.52	602.01	602.11	602.08	601.29	584.02
October 9, 2017	584.14	600.87	581.00	584.49	594.68	583.51	585.96	583.01	582.76	580.93	581.18	600.18	598.48	599.65	598.07	583.05
Bottom of Well Elevation	580.62	595.19	575.5	579.12	590.07	580.61	582.58	568.9	575.93	574.02	574.12	593.62	596.47	591.98	591.75	570.12

Notes:

Groundwater elevations compiled from field notes during sampling events.

-- = not measured

(1): Well Broken

Created by: NDK Date: 2/28/2018

Last revision by: NDK Date: 2/28/2018

Checked by: AJR Date: 4/5/2018

\\Mad-fs01\data\Projects\25216068.00\Reports\2018 ASD Report\Tables\[EDG-closed- All Tables.xlsx]Table 3. GW Elev- WT

Table 4. Groundwater Elevations - CCR Rule Monitoring Wells
Edgewater Generating Station, Sheboygan, Wisconsin
SCS Engineers Project #25216068.00

Ground Water Elevation in feet above mean sea level (amsl)				
Well Number	**MW-301**	**MW-302**	**MW-303**	**2R-OW**
Top of Casing Elevation (feet amsl)	604.42	615.15	611.99	612.72
Screen Length (ft)	5.00	5.00	5.00	10.00
Total Depth (ft from top of casing)	27.47	40.00	33.26	14.50
Top of Well Screen Elevation (ft)	581.95	580.15	579.60	--
Measurement Date				
April 8, 2016	599.75	596.19	589.04	609.68
June 20, 2016	598.30	595.68	587.22	606.70
August 9, 2016	598.00	595.53	587.72	605.74
October 20, 2016	598.50	595.46	588.37	607.27
January 23-24, 2017	597.10	596.30	588.84	609.64
April 6, 2017	600.04	593.57	589.04	609.72
June 6, 2017	598.77	595.86	588.44	607.63
August 1, 2017	597.40	595.22	587.36	604.59
October 24, 2017	597.20	595.25	587.97	601.74
Bottom of Well Elevation (ft)	576.95	575.15	578.73	598.22

Notes:

Groundwater elevations compiled from field notes during sampling events.

-- = not measured

Created by:	NDK	Date:	2/28/2018
Last rev. by:	NDK	Date:	2/28/2018
Checked by:	AJR	Date:	4/5/2018

\\Mad-fs01\data\Projects\25216068.00\Reports\2018 ASD Report\Tables\[EDG-closed- All Tables.xlsx]Table 4. GW elev - CCR

Table 5. Analytical Results - Closed Landfill State Monitoring Program Wells
WPL - Edgewater (1-4) Closed Ash Disposal Facility / SCS Project #25216068
Sheboygan, Wisconsin

Point Name	Reporting Period	Boron, dissolved (µg/L as B)	ph-Field (standard units)	Sulfate, dissolved (mg/L as SO_4)
Groundwater Monitoring Wells for CCR Landfill				
2R-OW	2016-Apr	26.6	7.45	30.9
	2016-Oct	40.4	6.98	22.9
	2017-Apr	69.3 J	7.3	28.6
	2017-Oct	35.2	7.66	32.9
3R-OW	2016-Apr	392	7.41	533
	2016-Oct	468	7.32	372
	2017-Apr	400	7.35	409
	2017-Oct	389	7.39	637
4R-OW	2016-Apr	7,710	7.69	120
	2016-Oct	17,300	7.71	252
	2017-Apr	12,600	7.44	180
	2017-Oct	15,700	7.31	178
5-OW	2016-Apr	4,330	7.64	215
	2016-Oct	5,970	7.75	210
	2017-Apr	5,490	7.51	258
	2017-Oct	6,040	7.54	230
7-OW	2016-Apr	610	8.14	255
	2016-Oct	964	7.59	251
	2017-Apr	761	8.1	259
	2017-Oct	1,130	7.73	246
29-A	2016-Apr	357	9.07	40.9
	2016-Oct	264	8.54	39.6
	2017-Apr	365	9.09	41.5
	2017-Oct	278	8.97	42.1
29-OW	2016-Apr	10,600	8.03	120
	2016-Oct	10,900	7.69	85.7
	2017-Apr	9,500	8.49	77
	2017-Oct	9,060	8.15	62
30-OW	2016-Apr	79	8.26	4.8
	2016-Oct	113	7.56	4.6
	2017-Apr	176	8.47	7.5
	2017-Oct	135	7.44	16.7
31-OW	2016-Apr	114	7.63	91.2
	2016-Oct	35	7.68	63.3
	2017-Apr	77	7.99	82.4
	2017-Oct	190	7.79	70.3
40-OW	2016-Apr	8,030	8.04	731
	2016-Oct	29,400	7.91	768
	2017-Apr	8,680	7.97	849
	2017-Oct	8,800	7.91	873

Table 5. Analytical Results - Closed Landfill State Monitoring Program Wells
WPL - Edgewater (1-4) Closed Ash Disposal Facility / SCS Project #25216068
Sheboygan, Wisconsin

Point Name	Reporting Period	Boron, dissolved (µg/L as B)	ph-Field (standard units)	Sulfate, dissolved (mg/L as SO_4)
Leachate Head Monitoring Wells Within CCR Landfill				
37-OW	2016-Apr	19,100	7.49	759
	2016-Oct	12,500	7.31	439
	2017-Apr	15,900	8.01	633
	2017-Oct	9,440	7.24	264
38R-OW	2016-Apr	33,800	8.00	1,000
	2016-Oct	17,100	7.71	514
	2017-Apr	21,100	7.86	932
	2017-Oct	10,800	7.72	364
39R-OW	2016-Apr	10,100	7.26	534
	2016-Oct	29,900	7.32	1,390
	2017-Apr	22,400	7.44	1,150
	2017-Oct	32,800	7.52	1,400

Abbreviations:
µg/L = micrograms per liter or parts per billion (ppb)
mg/L = milligrams per liter or parts per million (ppm)

Notes:
1) Table includes only the state monitoring program parameters for which SSIs were identified in the October 2017 CCR rule detection monitoring.

Created by:	SCC	2/24/2014
Last revision by:	MDB	1/8/2018
Checked by:	AJR	2/7/2018

I:\25216068.00\Reports\2018 ASD Report\Tables\[EDG_BR_2016_2017_results.xlsx]Results

Table 6. Analytical Results - Closed Landfill Leachate Fluoride Monitoring
Edgewater Generating Station, Sheboygan, Wisconsin
SCS Engineers Project #25216068.00

Collection Date	**Fluoride (mg/L)**			
	36-OW	**37-OW**	**38R-OW**	**39R-OW**
9/8/1994	0.25	0.62	0.57	0.79
9/14/1995	0.38	0.51	0.71	0.87
9/17/1996	0.56	0.42	0.71	0.97
9/16/1997	0.60	0.44	0.73	0.97

Abbreviations:
mg/L = milligrams per liter or parts per million (ppm)

Notes:
1. Data compiled from WDNR Groundwater Environmental Monitoring System (GEMS) website.

Created by: NDK Date: 3/5/2018
Last revision by: NDK Date: 3/5/2018
Checked by: AJR Date: 4/5/2018

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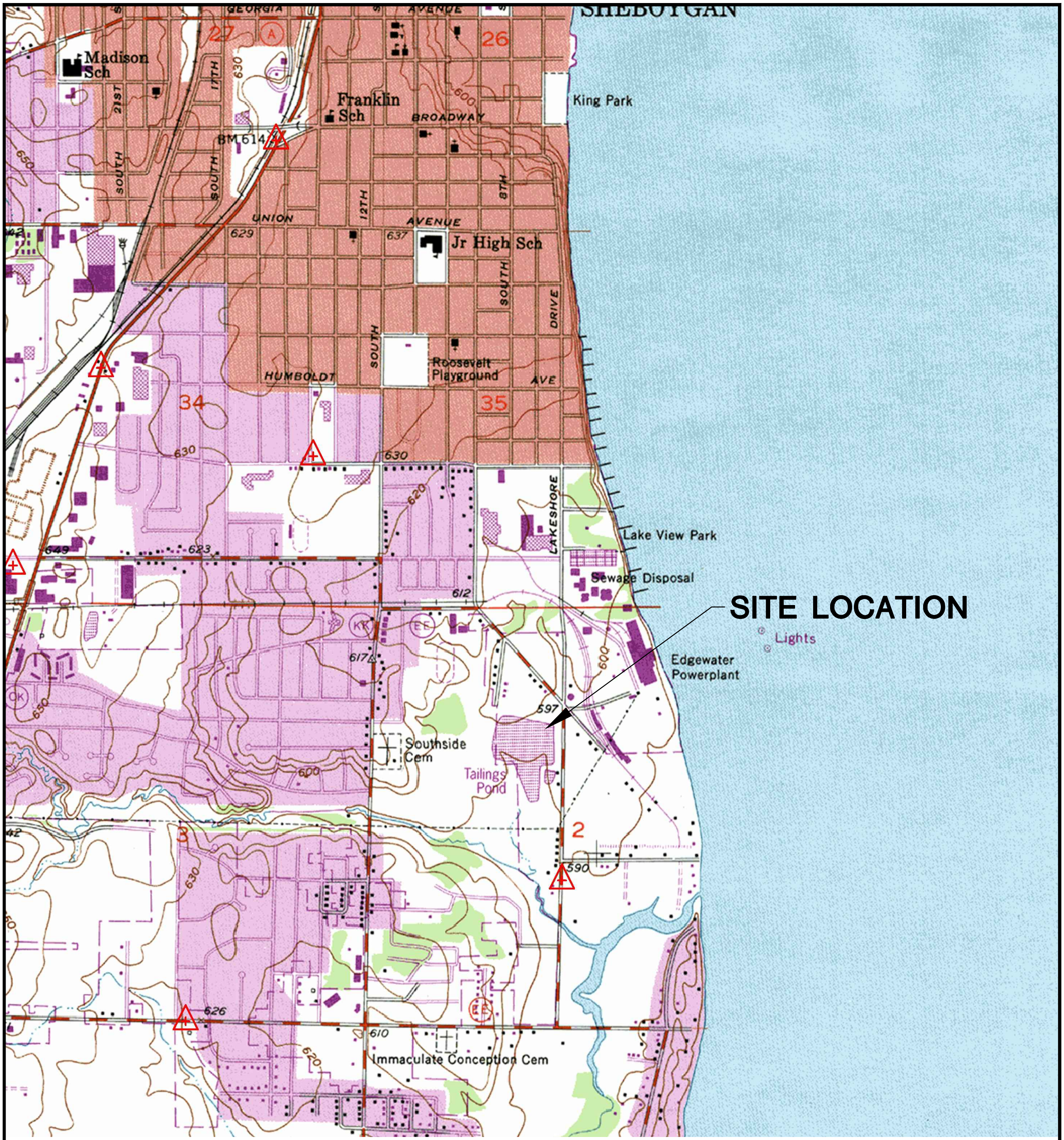
FIGURES



N

SHEBOYGAN SOUTH QUADRANGLE
WISCONSIN–SHEBOYGAN CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)
NW/4 SHEBOYGAN SOUTH 15' QUADRANGLE
1994
SCALE: 1" = 2,000'

CLIENT	WISCONSIN POWER AND LIGHT EDGEWATER GENERATING STATION 3739 LAKESHORE DRIVE SHEBOYGAN, WI 53081	SITE	EDGEWATER 1–4 (CLOSED) ASH DISPOSAL FACILITY	SITE LOCATION MAP	
PROJECT NO.	25213069	DRAWN BY:	KP	ENGINEER	SCS ENGINEERS 2830 DAIRY DRIVE MADISON, WI 53718–6751 PHONE: (608) 224–2830	FIGURE
DRAWN:	02/28/14	CHECKED BY:	MB			1
REVISED:	02/28/14	APPROVED BY:				

N

LEGEND

⊕	ABANDONED MONITORING WELL
●	MONITORING WELL
◉	PIEZOMETER
🔴	CCR RULE MONITORING WELL
▬	CCR RULE LIMITS
— — —	CLOSED LANDFILL

NOTES:

1. AERIAL PHOTOGRAPH FROM THE NATIONAL AGRICULTURE IMAGERY PROGRAM AND PUBLISHED BY THE USDA FSA AERIAL PHOTOGRAPHY FIELD OFFICE. DATE OF IMAGE IS OCTOBER 1, 2013.
2. EXISTING WELL LOCATIONS ARE APPROXIMATE AND ARE BASED ON OCTOBER 2011 WATER TABLE MAP PREPARED BY TRC.
3. CCR RULE LIMITS AND CLOSED LANDFILL LOCATION ARE APPROXIMATE.
4. NEW MONITORING WELL LOCATIONS WERE SURVEYED BY CQM, INC. ON FEBRUARY 12, 2016.

500 0 500

SCALE: 1" = 500'

PROJECT NO. 25216068.00
DRAWN: 02/28/14
REVISED: 03/09/18
DRAWN BY: KP/BJM
CHECKED BY: KAK
APPROVED BY:

ENGINEER
SCS ENGINEERS
2830 DAIRY DRIVE MADISON, WI 53718–6751
PHONE: (608) 224–2830

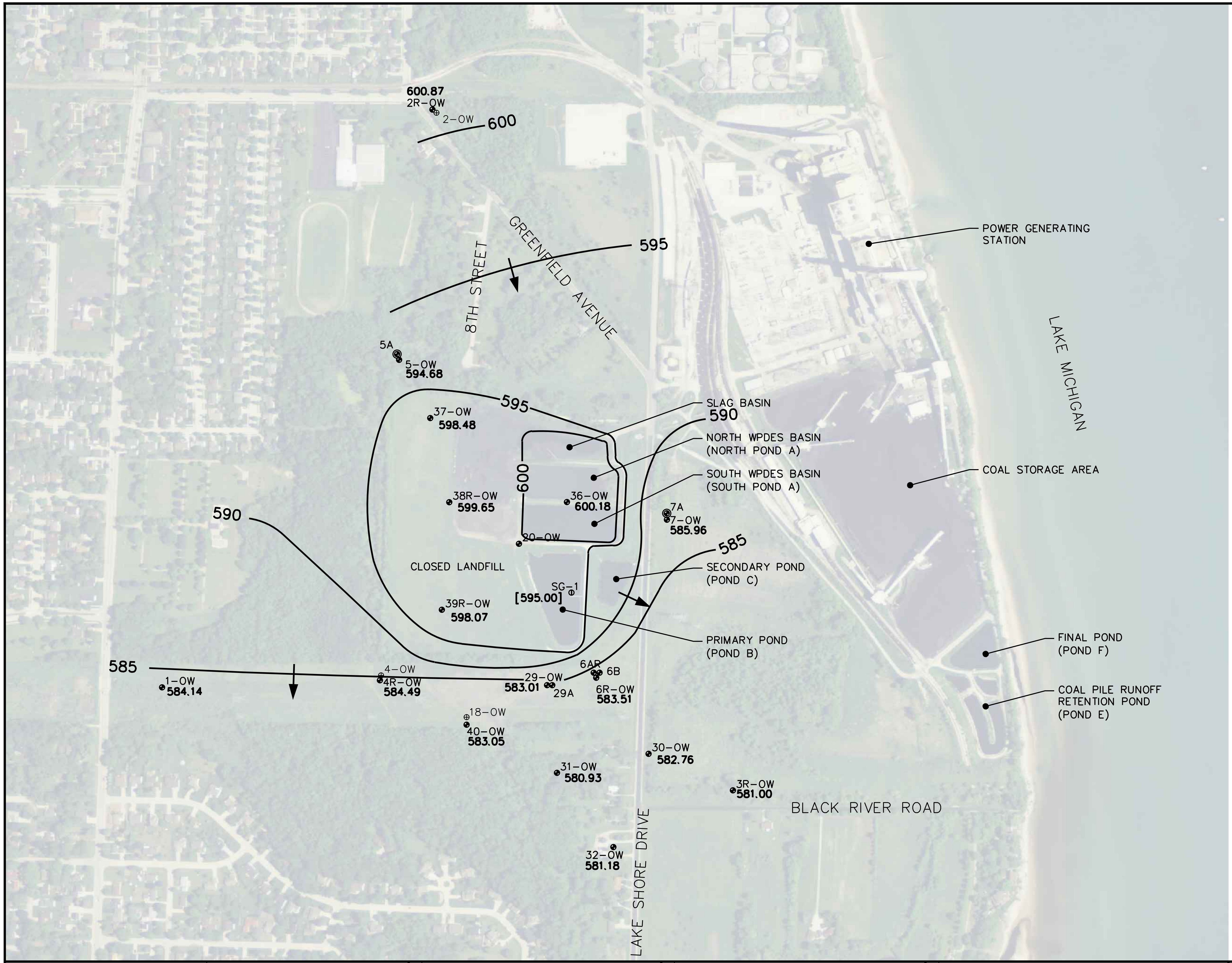
CLIENT
WISCONSIN POWER AND LIGHT
EDGEWATER GENERATING STATION
3739 LAKESHORE DRIVE
SHEBOYGAN, WI 53081

SITE
EDGEWATER 1–4 (CLOSED)
ASH DISPOSAL FACILITY
SHEBOYGAN, WISCONSIN

MONITORING WELL LOCATION MAP

FIGURE
2

I:\25216068.00\Drawings\2 Monitoring Well Location Map.dwg, /9/2018 8: 2:40 M



N

LEGEND

⊕	ABANDONED MONITORING WELL
◕	MONITORING WELL
◉	PIEZOMETER
⦶	STAFF GAUGE
580.90	WATER TABLE ELEVATION
[598.00]	SURFACE WATER ELEVATION
NM	NOT MEASURED
───	WATER TABLE CONTOUR (5' INTERVAL)
→	APPROXIMATE GROUNDWATER FLOW DIRECTION

NOTES:

1. AERIAL PHOTOGRAPH FROM THE NATIONAL AGRICULTURE IMAGERY PROGRAM AND PUBLISHED BY THE USDA FSA AERIAL PHOTOGRAPHY FIELD OFFICE. DATE OF IMAGE IS OCTOBER 1, 2013.
2. WELL LOCATIONS ARE APPROXIMATE AND ARE BASED ON OCTOBER 2011 WATER TABLE MAP PREPARED BY TRC.
3. WATER ELEVATIONS MEASURED OCTOBER 9, 2017.

500 0 500

SCALE: 1" = 500'

PROJECT NO.	25216068.17	DRAWN BY:	KP
DRAWN:	02/28/14	CHECKED BY:	MB
REVISED:	02/09/18	APPROVED BY:	

ENGINEER

SCS ENGINEERS
2830 DAIRY DRIVE MADISON, WI 53718-6751
PHONE: (608) 224-2830

CLIENT

WISCONSIN POWER AND LIGHT
EDGEWATER GENERATING STATION
3739 LAKESHORE DRIVE
SHEBOYGAN, WI 53081

SITE

EDGEWATER 1-4 (CLOSED)
ASH DISPOSAL FACILITY

WATER TABLE MAP
OCTOBER 9, 2017

FIGURE
3

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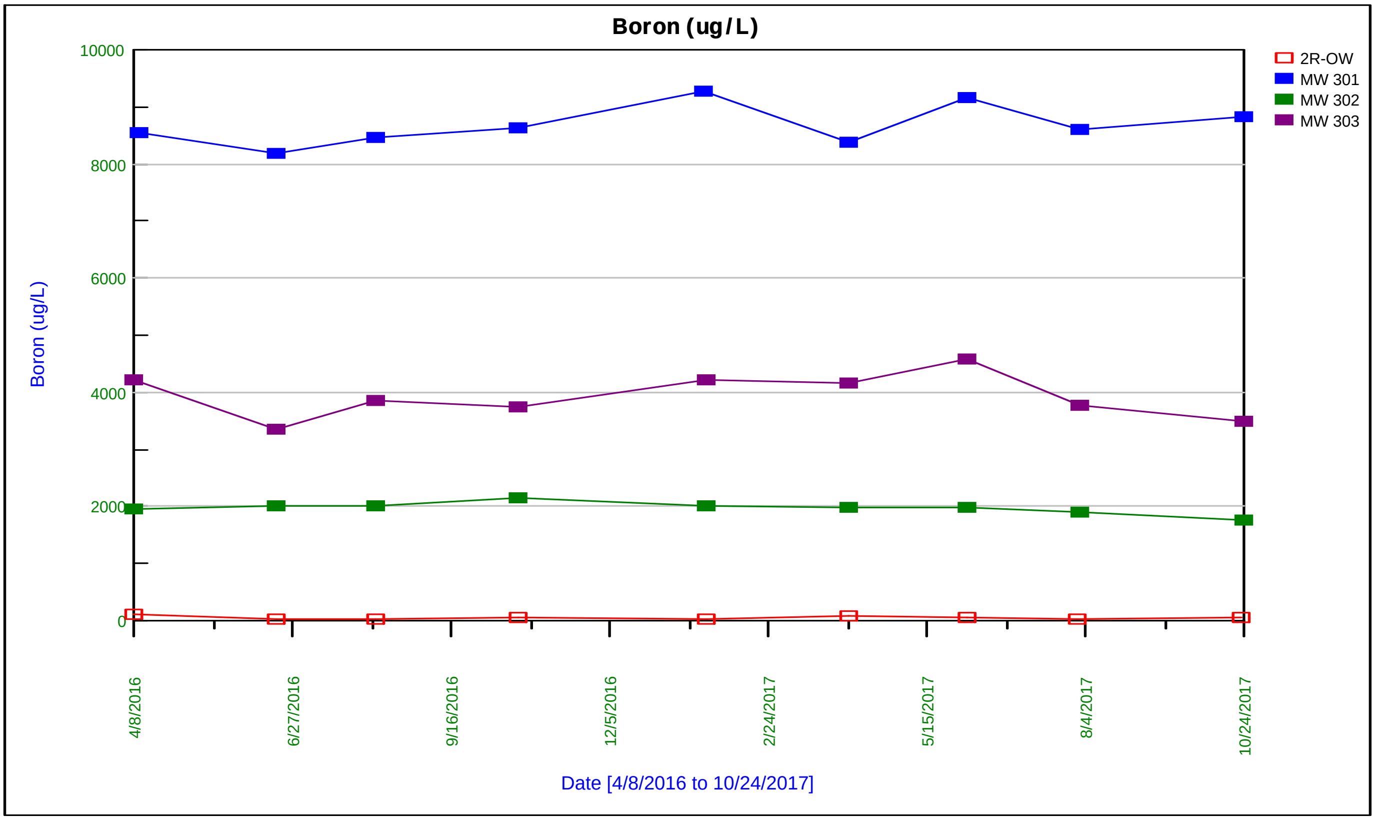
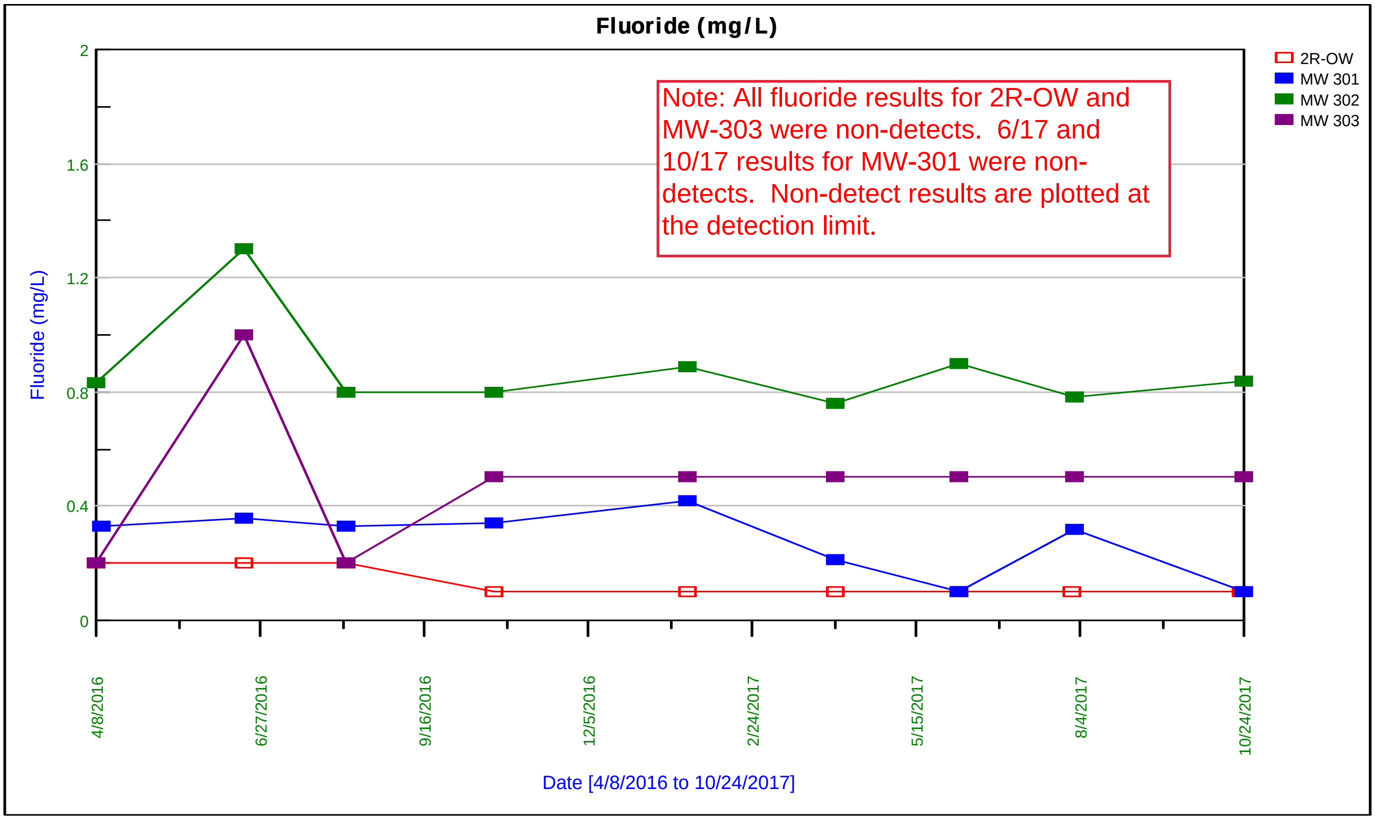
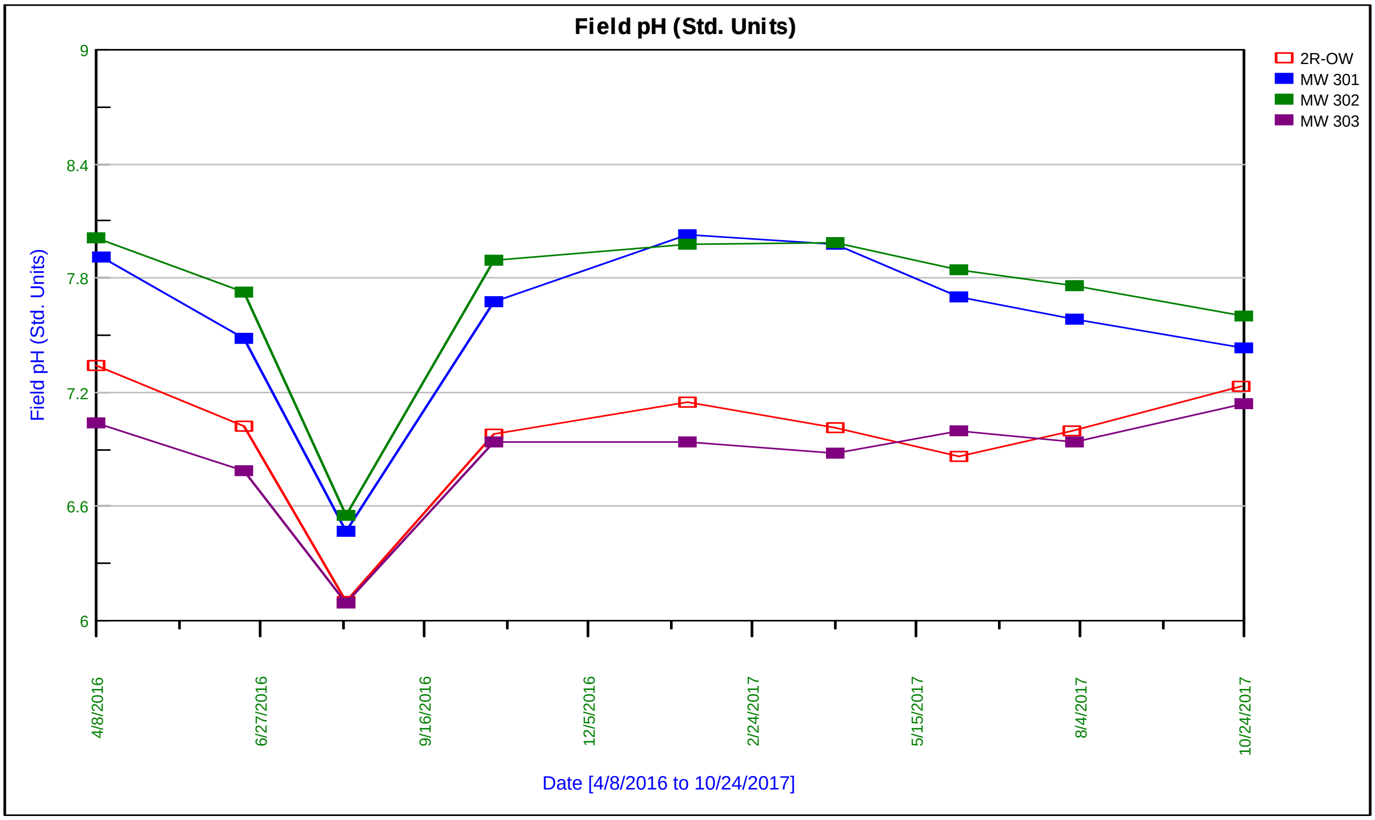
APPENDIX A

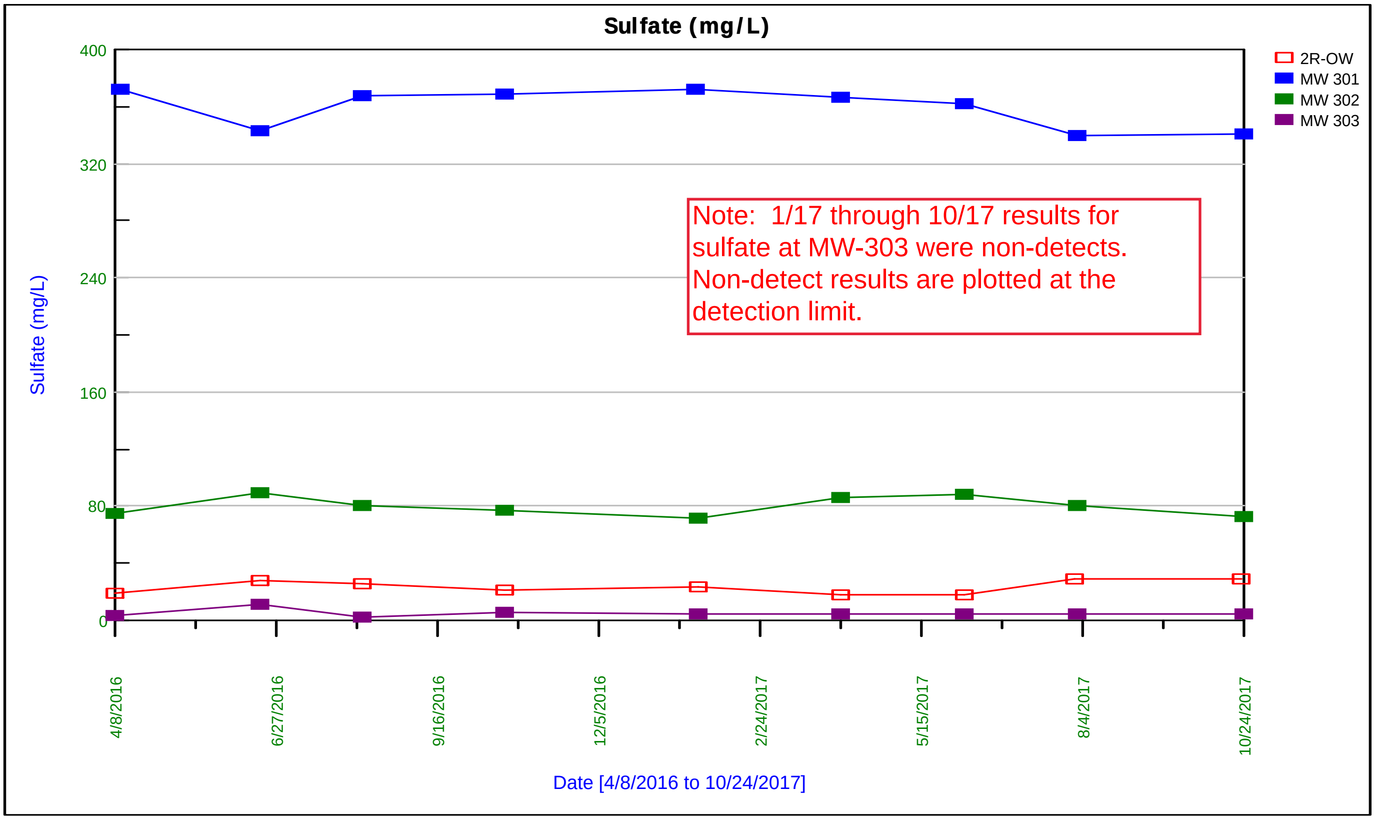
Trend Plots for CCR Wells





Note: All fluoride results for 2R-OW and MW-303 were non-detects. 6/17 and 10/17 results for MW-301 were non-detects. Non-detect results are plotted at the detection limit.





Note: 1/17 through 10/17 results for sulfate at MW-303 were non-detects. Non-detect results are plotted at the detection limit.

APPENDIX B

Regional Geologic and Hydrogeologic Information

Table EGS-3. Regional Hydrogeologic Stratigraphy
Edgewater Generating Station / SCS Engineers Project #25215053

Age	Hydrogeologic Unit	General Thickness (feet)	Name of Rock Unit*	Predominant Lithology
Quaternary	Sand and Gravel Aquifer	0 to 235	Surface sand and gravel	Sand and Gravel
		0 to 300	Buried sand and gravel	
Devonian	Niagara Dolomite Aquifer	0 to 750	Dolomite (undifferentiated)	Dolomite
Silurian				
Ordovician	Confining Unit	0 to 400	Maquoketa Shale	Shale and dolomite
	Sandstone Aquifer	100 to 340	Galena Decorah Platteville	Dolomite
		0 to 330	St. Peter	Sandstone
		0 to 140	Prairie du Chien	Dolomite
Cambrian		0 to 3,500?	Trempeleau Franconia Galesville Eau Claire Mt. Simon	Sandstone, some Dolomite and Shale
Precambrian	Not an Aquifer	Unknown	Crystalline Rocks	Igneous and metamorphic rocks

Source:
Skinner, Earl L. and Ronald G. Borman, Water Resources of Wisconsin-Lake Michigan Basin, Department of the Interior United States Geological Survey Hydrogeologic Investigations Atlas HA-432, 1973.

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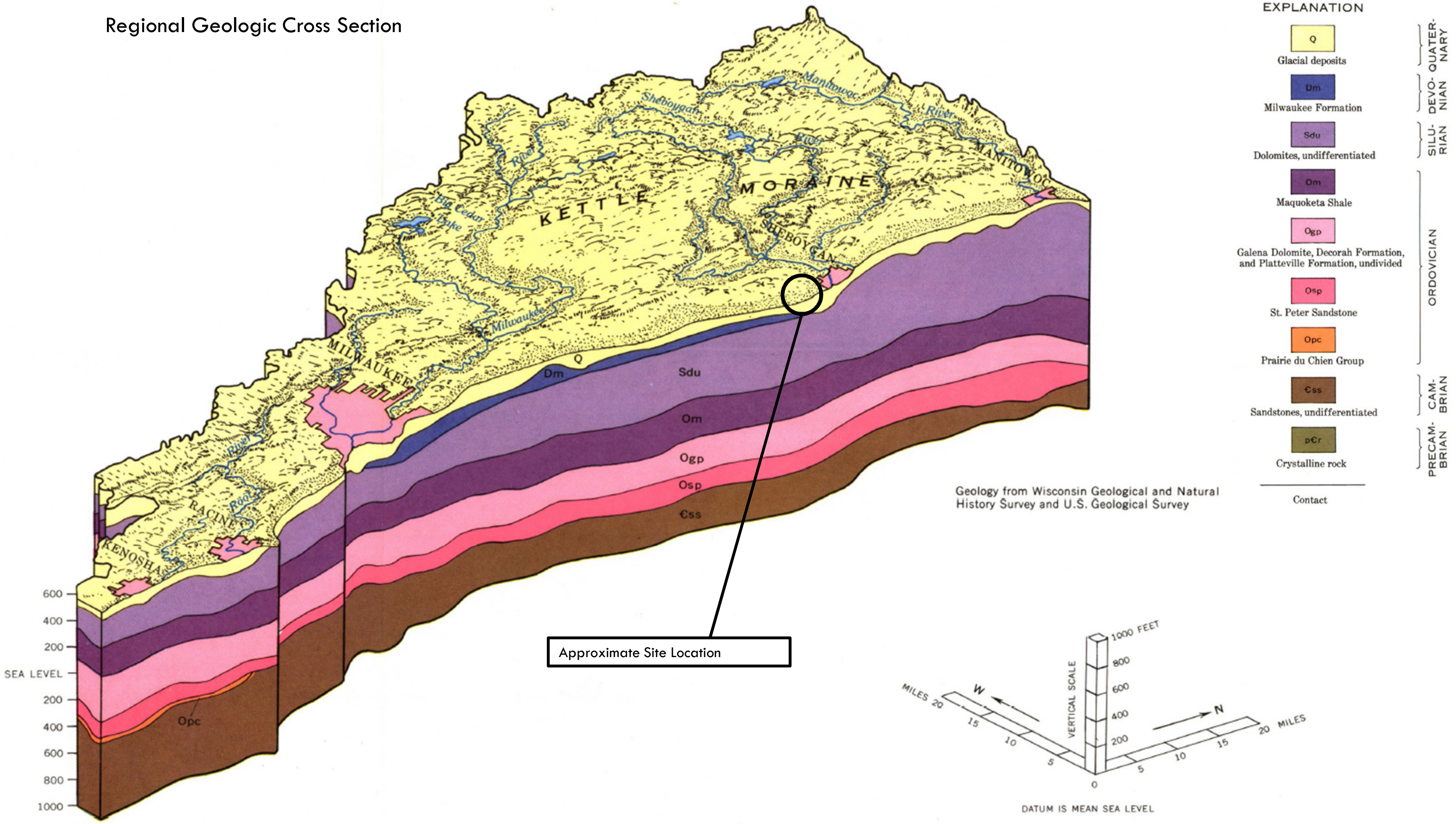
Regional Geologic Cross Section

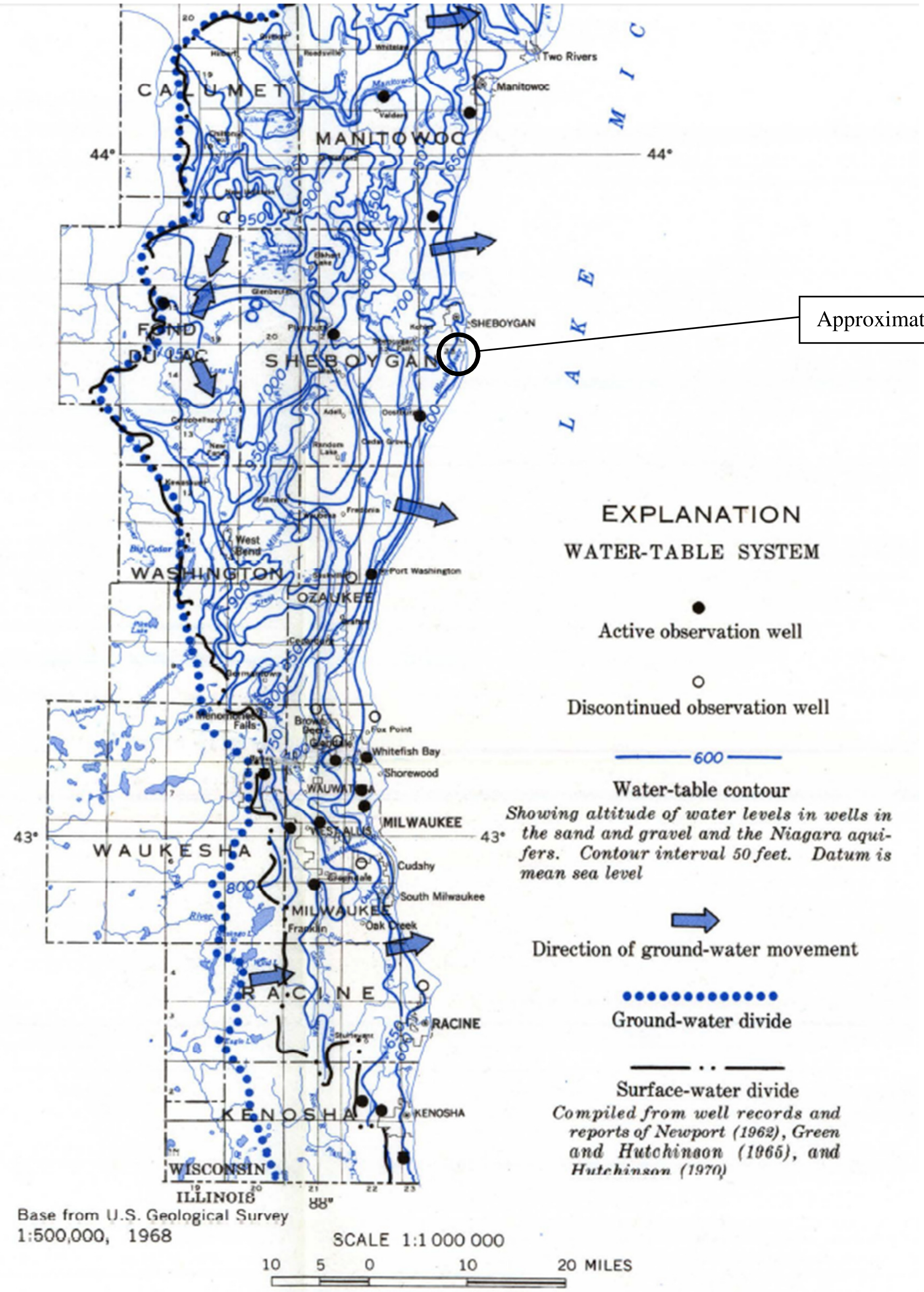


Approximate Site Location

Geology from Wisconsin Geological and Natural History Survey and U.S. Geological Survey

Source: Skinner, Earl L. and Ronald G. Borman, Water Resources of Wisconsin-Lake Michigan Basin, Department of the Interior United States Geological Survey Hydrogeologic Investigations Atlas HA-432, 1973.

Regional Groundwater Flow Map – Uppermost Aquifer



Approximate Site Location

Source: Skinner, Earl L. and Ronald G. Borman, Water Resources of Wisconsin-Lake Michigan Basin, Department of the Interior United States Geological Survey Hydrogeologic Investigations Atlas HA-432, 1973.

APPENDIX C

Regional Water Quality Information

Resources **2015**, *4*, 323-357; doi:10.3390/resources4020323

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Review

Groundwater Quantity and Quality Issues in a Water-Rich Region: Examples from Wisconsin, USA

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Tel.: +1-920-465-5139.

Academic Editor: Andelka Belic

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Abstract: The State of Wisconsin is located in an unusually water-rich portion of the world in the western part of the Great Lakes region of North America. This article presents an overview of the major groundwater quantity and quality concerns for this region in a geologic context. The water quantity concerns are most prominent in the central sand plain region and portions of a Paleozoic confined sandstone aquifer in eastern Wisconsin. Water quality concerns are more varied, with significant impacts from both naturally occurring inorganic contaminants and anthropogenic sources. Naturally occurring contaminants include radium, arsenic and associated heavy metals, fluoride, strontium, and others. Anthropogenic contaminants include nitrate, bacteria, viruses, as well as endocrine disrupting compounds. Groundwater quality in the region is highly dependent upon local geology and land use, but water bearing geologic units of all ages, Precambrian through Quaternary, are impacted by at least one kind of contaminant.

Keywords: groundwater; quality; quantity; Wisconsin; arsenic; strontium; fluoride; nitrate; bacteria; wells

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The SCH has been documented to occur across eastern Wisconsin from the Illinois border in the south to the Michigan border in the north [26,86]. The mineralogy and mechanisms of arsenic release differ in different settings. Oxidative release is thought to be the most important mechanism in eastern Wisconsin (e.g., [87]). Although most attention has been given to the St. Peter Sandstone aquifer, other units in the region, such as the Cambrian sandstones, also contain abundant sulfide mineralization. Oxidative release of arsenic and nickel during aquifer storage and recovery (ASR) testing has resulted in substantial volumes of groundwater contamination near test wells [85].

Another region of the state with significant arsenic problems is southeastern Wisconsin. This area has up to 150 meters of glacial till and outwash of Pleistocene age overlying Silurian age dolomite. This region has had arsenic concentrations up to 100 µg/L documented in portions of the lower sand and gravel aquifer beneath organic-rich glacial till units [80]. In contrast to the Paleozoic rocks of eastern Wisconsin, there appears to be a different mechanism for arsenic release in southeastern Wisconsin. The presence of reducing conditions, low sulfate concentrations, and solid-phase organic matter led Root *et al.* [80] to conclude that arsenic is released to ground water in the lower sand and gravel/dolomite aquifer via microbially mediated reductive dissolution of arsenic-bearing Mn and/or Fe-(hydr)oxides.

A third region with a recognized arsenic problem is Florence County (Figure 5). The origin of arsenic in this area is less understood, but dozens of wells are impacted in the region, and ongoing research is investigating the geologic mechanisms and stratigraphic relationships in the region.

The public health impact of high dissolved arsenic was recently investigated by Knobeloch *et al.* [77] in a study that associated arsenic-contaminated drinking water with the prevalence of skin cancer in eastern Wisconsin. They documented arsenic concentrations and surveyed several thousand residents using over 2200 wells in the region. Their results indicated that for residents over age 35 who had consumed arsenic-contaminated water for at least 10 years, those residents were significantly more likely to report a history of skin cancer than other residents.

In response to public health concern over arsenic in the Fox River Valley region of eastern Wisconsin, the Wisconsin DNR implemented special well casing requirements for wells in Winnebago and Outagamie counties that became effective on 1 October 2004. These requirements are in place to avoid the most sulfide-rich portion of the aquifer near the SCH. However, additional requirements were included that limited the types of well construction methods and disinfection methods that can be used.

It is important to note that while much attention has been given to these two counties, the geologic strata and sulfide mineral distribution are similar throughout eastern Wisconsin [26,86]. Wells drilled in the same units in Marinette, Oconto, Brown, Shawano, and Fond du Lac counties have significant percentages of wells that exceed the 10 µg/L of arsenic in drinking water standard.

4.1.3. Fluoride Problems in Two Distinct Geologic Provinces

Fluoride at optimal levels (0.7 to 1.2 ppm) can reduce the incidence of dental caries. However, excess fluoride can produce dental fluorosis and negatively impact bone health, especially in children [88]. As such, the US EPA has set a MCL for dissolved fluoride of 4.0 mg/L, with a secondary (advisory) MCL of 2.0 mg/L. This value is intended to reduce the risk of severe enamel fluorosis and to minimize the risk of bone fractures and skeletal fluorosis in the adult population [59]. In 2011, the U.S. Department of Health and Human Services proposed to reduce the recommended level to 0.7 mg/L [89].

Wisconsin contains three distinct regions with elevated levels of dissolved fluoride above 1.2 mg/L in groundwater (Figure 6). One of these areas occurs in parts of Marathon County and the adjacent areas of central Wisconsin. Groundwater in this region is obtained principally from Precambrian crystalline bedrock aquifers and Quaternary glacial and alluvial sediments. A recent study focusing on Marathon County wells indicates that fluoride in this region ranges from <0.01 mg/L to at least 7.6 mg/L [90]. In that study, approximately 0.6% of the wells exceeded the EPA MCL of 4 mg/L, and 8.6% exceeded the secondary MCL of 2.0 mg/L. The source of fluoride in groundwater in this region appears to be fluorite and fluorapatite in felsic intrusive rocks, specifically syenite and Na-plagioclase bearing granites [90].

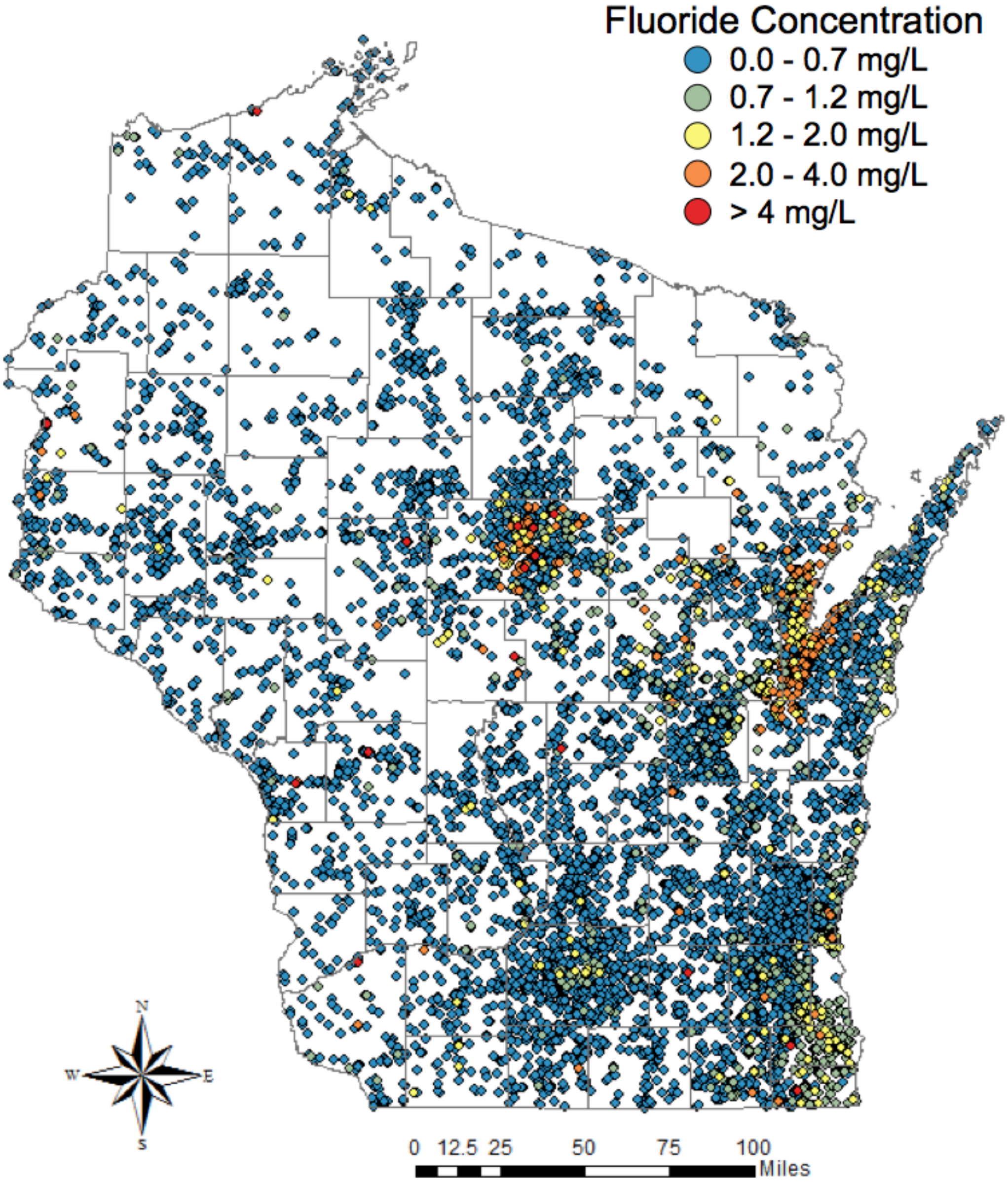


Figure 6. Map showing dissolved fluoride in Wisconsin aquifers. The highest concentrations are present in areas of shallow Precambrian bedrock of central Wisconsin. Another broad region of elevated fluoride occurs in the Cambrian-Ordovician confined aquifer of northeastern Wisconsin. A third region of elevated fluoride occurs in glacial sediments and Silurian bedrock in eastern and southeastern Wisconsin. Data sources include [91–94].

A second region of elevated fluoride occurs in the Cambrian and Ordovician confined aquifer of northeastern Wisconsin along the Fox River Valley and adjacent to the Bay of Green Bay. This anomaly has been known for more than 40 years [64,95], and a study by Krohelski [28] showed a mean concentration of 1.32 mg/L for the Ordovician and Cambrian sandstone aquifers in the region. While few wells appear to exceed the MCL of 4.0 mg/L, hundreds of wells likely exceed the secondary MCL of 2.0 mg/L, and most wells in the confined aquifer likely exceed the target value of 1.2 mg/L suggested by the U.S. EPA. The source of fluoride in this aquifer appears to be fluorite associated with Mississippi Valley-type mineralization in the region [26].

A third region is less well defined and less studied, but it extends along the Lake Michigan shoreline from Kewaunee County in the north to the Illinois border in the south. Many wells exceed the secondary MCL of 2.0 mg/L, and a few exceed 4.0 mg/L. Most of the wells with elevated fluoride appear to be drawing from both Pleistocene glacial sediments and Silurian dolomite units. It is likely that fluorite is also the source of this elevated dissolved fluoride because fluorite mineralization occurs in the Silurian rocks of eastern Wisconsin. More research on this topic is needed to better understand the stratigraphic distribution and origin of dissolved fluoride in eastern Wisconsin.

In Marathon and Lincoln counties (central Wisconsin), county health departments offer test kits for dissolved fluoride. Other municipalities, such as those in the Fox River Valley region, distribute notices to water utility customers advising them of elevated levels above the secondary MCL.

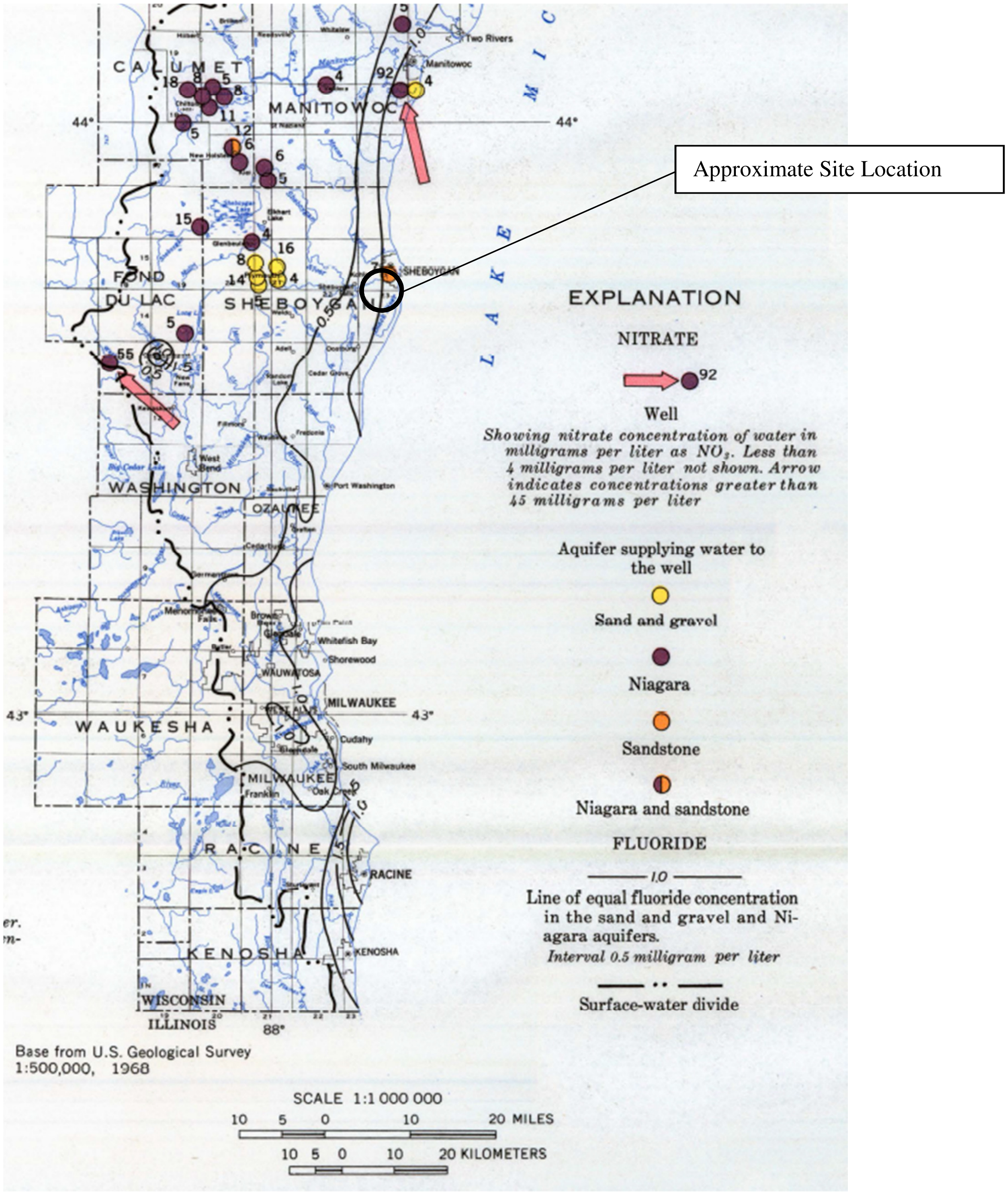
4.1.4. Dissolved Strontium

A region of high dissolved strontium (Sr) occurs in an arc-shaped band throughout eastern Wisconsin inland from the Lake Michigan shoreline where deep wells penetrate the Cambrian-Ordovician sandstone aquifer (Figure 7). Groundwater in parts of eastern Wisconsin contains dissolved Sr levels that exceed lifetime and short-term U.S. EPA Health Advisories of 4 mg/L and 25 mg/L, respectively [64,92–94]. Hundreds of wells are impacted throughout this region, including an area of anomalously high dissolved Sr in parts of Brown, Outagamie, and Calumet counties.

At present, about 11,000 groundwater samples statewide have been analyzed for strontium [92,93]. Until recently, data regarding dissolved Sr in Wisconsin groundwater were limited, and it is now clear that elevated dissolved Sr is present in the deep aquifer throughout much of eastern Wisconsin. While limited evidence for high Sr in the region's groundwater was available for over 50 years [96], little attention was given to this problem until 2013 [92,93]. Affected wells include many municipal wells from the suburban Milwaukee metropolitan area north to Green Bay, with concentrations of strontium in groundwater drinking supplies reaching as high as 52 mg/L [96].

The source of the Sr appears to be the dissolution of heterogeneously distributed celestine ($SrSO_4$), and possibly strontianite ($SrCO_3$) cements in Cambrian and Ordovician rocks in the region [92–94]. These rocks were strongly impacted by dolomitization and mineralization associated with an ancient hydrothermal brine migration from the Michigan basin [26].

Regional Groundwater Quality Map – Fluoride and Nitrate in the Uppermost Aquifer



Source: Skinner, Earl L. and Ronald G. Borman, Water Resources of Wisconsin-Lake Michigan Basin, Department of the Interior United States Geological Survey Hydrogeologic Investigations Atlas HA-432, 1973.

GROUND-WATER FLOW AND QUALITY IN WISCONSIN'S SHALLOW AQUIFER SYSTEM

By P.A. Kammerer, Jr.

U.S. GEOLOGICAL SURVEY
Water-Resources Investigations Report 90-4171

Prepared in cooperation with the
WISCONSIN DEPARTMENT OF NATURAL RESOURCES

U.S. DEPARTMENT OF THE INTERIOR
MARCH 3, 1849

Madison, Wisconsin
1995

4.0 GROUND-WATER QUALITY--Continued

4.1 Chemical characteristics--Continued

4.1.10 Fluoride

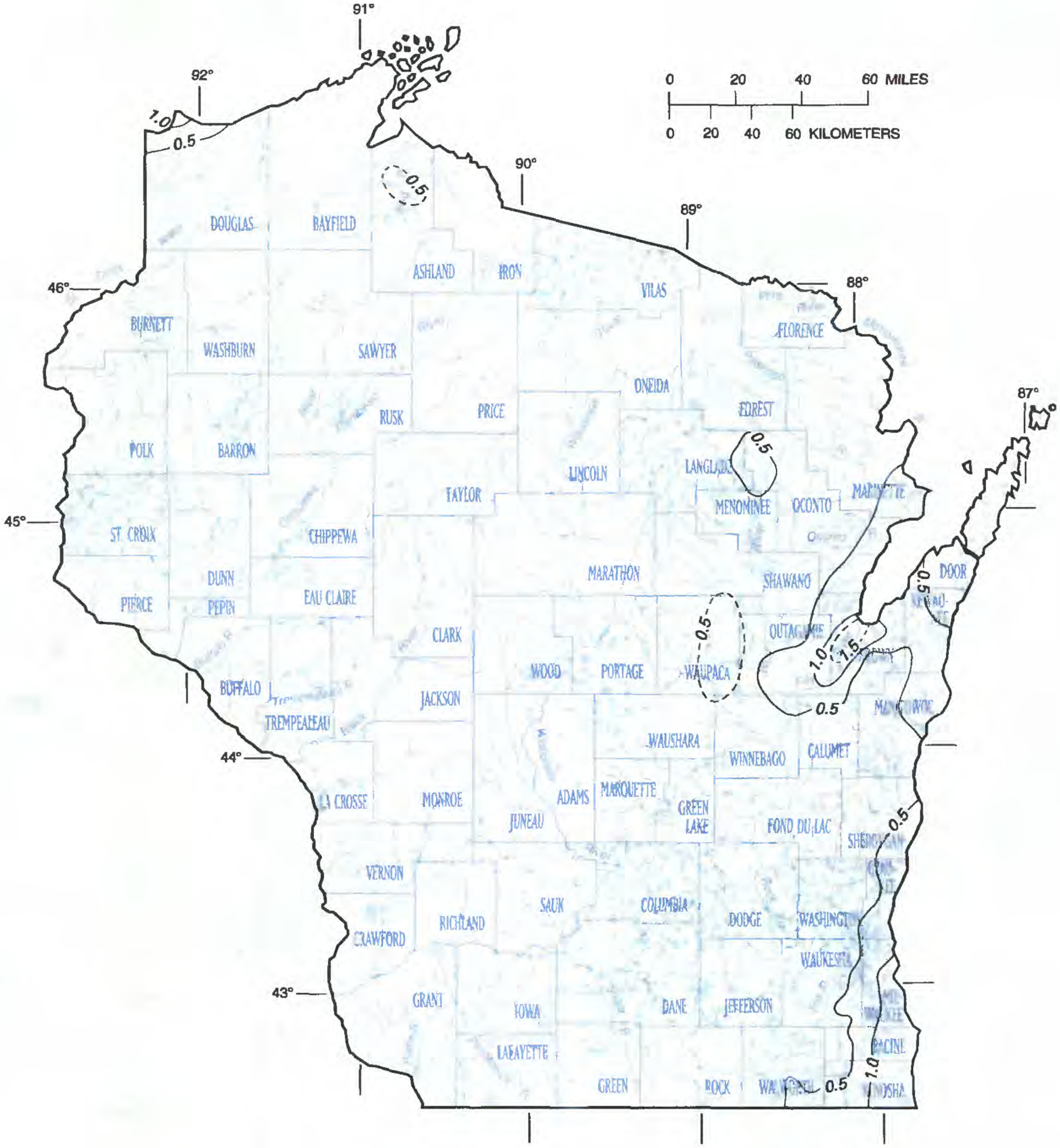
Fluoride concentrations in water from the shallow aquifer system are low in most of the State. Concentrations approach the State drinking-water standard in only a small area in Brown County.

Fluoride-containing minerals are a minor component but are widely distributed in sedimentary and igneous rocks, which are common in the shallow aquifer system. Products of the weathering and the dissolution of these minerals are the most likely sources of fluoride in the ground water. Fluoride concentrations are generally less than 1.0 mg/L in most natural fresh waters (Hem, 1985, p. 120).

Wisconsin's drinking-water standards (Wisconsin Department of Natural Resources, 1978) specify a maximum allowable fluoride concentration of 2.2 mg/L for drinking water. Concentrations exceeding the standard may discolor tooth enamel.

Fluoride in drinking water, however, can be beneficial in reducing the incidence of tooth decay. Supplemental fluoridation is therefore used in many public-water supplies. Optimum fluoride concentration recommended to realize these benefits in Wisconsin is 1.0 to 1.2 mg/L (U.S. Environmental Protection Agency, 1975, p. 67). The optimum concentration is based on annual average maximum daily air temperature and on the assumption that the amount of fluoride consumed by children (who are most susceptible to the effects of fluoride) is determined by their water consumption. Water consumption, in turn, can be related to annual average maximum daily air temperature.

The general range of fluoride concentrations in water from the shallow aquifer system can be seen in the map on the facing page. Concentrations are less than 0.5 mg/L in much of the State. Highest concentrations are in eastern Wisconsin and in a small area in northwestern Wisconsin near Lake Superior. Fluoride concentrations exceed 2.0 mg/L in only a small area of Brown County; the highest concentration observed in this area is 2.8 mg/L. Several municipalities in this heavily populated area depend on this high-fluoride water for public drinking-water supplies.



EXPLANATION

0.5 **Line of equal fluoride concentration —** Dashed where approximately located. Interval 0.5 milligrams per liter

* **Sampling site for fluoride**

Areal distribution of fluoride concentrations in water from Wisconsin's shallow aquifer system

APPENDIX D

BT^2 1993 Investigation Information

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Environmental Engineers and Scientists

Field Investigation Report
Edgewater Closed Ash Disposal Facility
Wisconsin Power & Light Company
WDNR License #2524
June 1993

Prepared For:

Wisconsin Power & Light Company
222 West Washington Avenue
P.O. Box 192
Madison, WI 53701

Prepared By:

BT^2, Inc.
3118 Watford Way
Madison, WI 53713

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1.0 INTRODUCTION

1.1 Background

On October 16, 1992, Wisconsin Power & Light Company (WP&L) and its consultants met with representatives of the Wisconsin Department of Natural Resources (WDNR) to discuss the apparent impact of the Edgewater closed ash disposal facility on groundwater quality. The results of the previous site investigations were reviewed, including an NR 140 Compliance Report (Dames & Moore, 1991) and a Feasibility Study (Dames & Moore, 1992). Potential remedial options to improve groundwater quality were also discussed. (See section 3.0 for a review of the previous investigations and remedial options.)

The remedial options preferred by the WDNR included abandonment or lining of the WPDES lagoons located within the ash disposal facility boundaries in order to decrease infiltration through the ash. WP&L suggested that although lining or abandonment of the lagoons would probably reduce infiltration, the reduction in groundwater impacts might not be significant. WP&L's suggestion was based on two site conditions: 1) water table elevations in relation to existing waste, and 2) extensive leaching that has already occurred. Groundwater level data suggest that even if the lagoons were abandoned, the bottom several feet of ash in the landfill would remain below the water table. If mobile constituents remain in the ash below the water table, then lining the ponds will not eliminate impacts to groundwater which would still pass through the ash. Water has been flowing out of the WPDES lagoons and through the underlying ash for approximately 16 years, which may have leached most of the mobile constituents. If this is the case, then the ash beneath the ponds might no longer provide a significant source of contaminants.

The outcome of the October 16 meeting between WP&L and WDNR was an agreement to perform additional investigation to evaluate the likely impacts of lining or abandoning the lagoons. A study plan describing the proposed approach for the field investigation was submitted to the WDNR in December 1992. The study plan was approved by Philip Fauble, WDNR, in a letter dated January 11, 1993. A field investigation was performed at the Edgewater closed ash disposal facility in accordance with the study plan during February and March 1993. This report presents the findings of the field investigation.

In conjunction with the evaluation of environmental impacts related to the landfill, WP&L is currently performing a preliminary slag utilization investigation for the closed ash disposal facility. To characterize the distribution of slag and fly ash within the landfill, the drilling program was expanded to include seven additional borings. Additional physical and analytical testing was also performed. The results of the slag utilization investigation have been incorporated into the evaluation of facility impacts on groundwater as appropriate. The specific elements of the additional field investigation are described in section 4.0 of the report and the results are presented in section 5.0.

1.2 Purpose and Scope

The purpose of the field investigation was to evaluate the likely impact on groundwater quality of lining or abandoning the Edgewater WPDES lagoons. The scope of the field investigation included the following elements:

- Advancing soil borings within the ash landfill and collecting ash samples;
- Collecting groundwater samples using a HydroPunch sampler;
- Installing monitoring wells screened within the ash and collecting groundwater samples;
- Performing slug tests;
- Physical testing of ash, slag and soil samples;
- Laboratory analysis of ash and groundwater samples; and
- Data analysis and report preparation.

Data from several sources are presented and evaluated in this report. Section 2.0 of the report describes the regional topography, geology and hydrogeology of the site vicinity. Results of previous investigations are summarized in section 3.0. Groundwater monitoring data collected since the submittal of the NR 140 compliance report (Dames & Moore, 1991) are reviewed in section 4.0. Proposed PALs for indicator parameters included in the groundwater monitoring program are also presented in section 4.0. Section 5.0 summarizes the field investigation methods. Results of the field investigation are presented in section 6.0. Section 7.0 provides a discussion of the results of the field investigation and groundwater monitoring data as they relate to the need for abandonment of the WPDES lagoons. Recommendations for further work are presented in section 8.0 and references are provided in section 9.0.

1.3 Facility Information

Facility Name: Edgewater Closed Ash Disposal Facility

Facility License: #2524

Facility Location:
West side of Lakeshore Drive, 3900 and 4000 blocks
Sheboygan, Wisconsin
SE¼, NW¼, Section 2, T 14N, R 23E
Town of Wilson, Sheboygan County
(See **Figure 1**)

Facility Owner:
Wisconsin Power & Light Company
222 W. Washington Avenue
P.O. Box 192
Madison, WI 53701

Facility Contacts:
Ken Koele
Generating Station Manager
(414) 459-6166

Sharon Klinger-Kingsley
Environmental Affairs and Research
(608) 252-5709

Consultant:
BT^{2}, Inc.
3118 Watford Way
Madison, WI 53713

Project Manager:
Sherren Clark
(608) 277-2840

1.4 Facility History

The Edgewater closed ash disposal facility was constructed in 1969 by excavating the native soils, consisting mostly of silty clays, to a design elevation of 586.6 feet and mounding the excavated materials to form a perimeter berm approximately 15 feet high. The site provided ash settling and disposal for Units 1-4 of the Edgewater Generating Station. Ash disposed of at the site included fly ash from Units 1-4, bottom ash from Units 1 and 2, and slag from Units 3 and 4. The disposal facility was initially operated as a large single pond to which ash and slag were sluiced from the plant. An air photograph taken in April 1971 shows the disposal area as a large pond with ash being discharged to the northeast corner.

In 1976, two WPDES settling basins were constructed within the boundaries of the ash disposal site, along the eastern edge. The WPDES lagoons each had an original bottom elevation of approximately 599 feet. Since the design elevation of the base of the ash disposal facility was 586.6 feet, the WPDES lagoons were believed to overly approximately 12 feet of disposed ash and/or slag. The WPDES lagoons originally discharged to the ash settling area in the western half of the site; however, in 1981 a culvert was installed to route the discharge directly to the primary settling pond, located in the southeast corner of the disposal area.

In 1984, a new slag dewatering basin was constructed in the northeast corner of the ash disposal site. The slag basin was constructed with a 3-foot clay liner. Effluent from the slag basin is combined with the effluent from the WPDES lagoons and discharged to the primary pond in the southeast corner of the disposal area. Settled slag is pushed out of the dewatering basin and removed by truck or rail.

Fly ash was sluiced into the site until the spring of 1985, when Units 3 and 4 were converted to dry fly ash handling systems. Fly ash was then disposed of dry to bring the ash disposal area, exclusive of the slag basin, WPDES lagoons and primary pond areas, to the final grades prior to closure. After sluicing of fly ash was discontinued, the west berm of the primary pond was lined with clay, separating it from the ash and slag disposed of in the western portion of the site. An air photograph taken in March 1985 shows the northwest corner of the site capped with red clay. Slag berms separate the southern portion of the site into two ash settling ponds west of the primary pond.

Disposal of dry fly ash at the site continued until the summer of 1986, when all areas of the site except for the primary pond, WPDES ponds and slag basin were brought to final closure grades. The clay cap on the ash landfill was completed in the fall of 1986. Units 1 and 2 were shut down in 1985 when Unit 5 was brought into operation. Fly ash from Units 3, 4 and 5 is now disposed of at the Edgewater Active Ash Disposal Facility, located near Highway I-43. The current site layout is shown in **Figure 2** and on **Plan Sheet 1**.

1.5 Current Wastewater Lagoon Operation

The wastewater lagoon system at Edgewater currently consists of seven lagoons, as shown on **Plan Sheet 1**. Four of the lagoons are located within the boundaries of the ash disposal area, including the slag dewatering basin, the two WPDES lagoons, and the primary pond. The secondary pond is located adjacent to but outside the boundaries of the ash disposal area. The coal pile runoff retention basin and the final effluent pond are located adjacent to Lake Michigan south of the plant buildings.

Plant wastewater discharged to the WPDES lagoons includes slag tank overflow, bottom ash decant overflow, demineralizer regeneration wastewater, air heater wash from generating units 3 and 4, and general plant floor drainage. The average discharge rate to the WPDES ponds is approximately 2.6 million gallons per day (mgd), with the discharge split approximately 70/30 between the south and north basins, respectively (Dames & Moore, 1992). The effluent from the WPDES ponds is combined with the effluent from the slag basin and discharged to the primary pond. From the primary pond, the wastewater flows through the secondary pond and the final effluent pond before discharging to Lake Michigan.

2.0 REGIONAL SETTING

2.1 Topography and Surface Drainage

The closed ash landfill is located approximately 2,000 feet west of Lake Michigan. The land surface between the landfill and the lake is nearly level, except where it has been altered by construction activities at the generating station (roads, railroad tracks, ponds, berms, etc.). Elevations between the landfill and the lake fall mostly in the range from 580 to 590 feet above mean sea level. West of the landfill the terrain is gently rolling, rising from an elevation of approximately 595 feet adjacent to the landfill to 620 feet approximately 1,200 feet west of the landfill. The landfill is a local topographic high point, with a maximum elevation of approximately 620 feet in the center of the capped portion of the disposal site. The elevation at the top of the perimeter berm bounding the landfill, slag basin, WPDES lagoons and primary pond is approximately 610 feet.

Natural surface water drainage in the landfill vicinity is primarily to Fish Creek, located to the south of the ash disposal area. Fish Creek flows to the southeast, under Lakeshore Drive, and discharges to the Black River, which in turn discharges to Lake Michigan. At its closest point, Fish Creek is located approximately 300 feet south of the landfill. Some of the area between the landfill and the creek is a wet area characterized by cattail growth and very shallow groundwater. Surface water drainage in the landfill area is also influenced by roadside ditches. The slag basin, WPDES ponds, primary pond and secondary pond each receive surface water runoff from small drainage areas immediately surrounding the ponds.

Before the ash disposal facility was constructed, the land surface was fairly level. Surface drainage was to an intermittent stream which flowed south through the approximate center of the current ash disposal area. The intermittent stream discharged to Fish Creek south of the current disposal facility boundaries.

2.2 Geology

Unconsolidated materials in the site vicinity consist of glacial sediments deposited during the Pleistocene Epoch. Glacial deposits in the site vicinity are primarily glacial till, with some lacustrine and alluvial deposits. The uppermost till unit in the site area is one of the units of the Kewaunee Formation, probably either the Haven Member or the Valders Member. These till units are comprised of silt with some sand and clay and are typically reddish brown in color.

Bedrock is present at depths ranging from 80 to 140 feet in the site vicinity, with the bedrock surface generally sloping to the south (Dames & Moore, 1991). The uppermost bedrock units beneath the site are probably the Silurian dolomites, although a small thickness of Devonian Milwaukee formation (mostly dolomite) may be present overlying the Silurian units. The Silurian dolomites are underlain by the Ordovician Maquoketa Shale, Galena Dolomite, Decorah Formation, Platteville Formation, and St. Peter Sandstone. The Ordovician units have a combined thickness of approximately 600 feet. Underlying the Ordovician units are the Cambrian sandstones and Precambrian crystalline rock. The sedimentary rock units dip gently to the southeast.

Native soils in the site area are mapped as the Poygan silty clay loam, Saugatuck fine sand, Superior fine sandy loam, Ewen silty clay loam and Carlisle muck (Geib et al., 1929). The soil map for the county shows a finger of Saugatuck fine sand extending approximately from the current southeast corner of the ash disposal facility to the northwest corner. This sandy soil is bounded on the east and west by the Poygan silty clay loam. To the southeast, the Saugatuck fine sand is bounded by the Superior fine sandy loam, which extends southeast to the Black River.

When the ash disposal facility was constructed, native soils were excavated to depths of approximately 5 to 12 feet, so soils at the base of the disposal facility may not correspond to the surface soils mapped prior to excavation.

2.3 Hydrogeology

Three major aquifers are present in the Sheboygan area: the sand and gravel aquifer, the Niagara aquifer, and the sandstone aquifer (Skinner and Borman, 1973). The sand and gravel aquifer is present in areas of outwash deposits, sandy till and beach deposits. The thickness of the sand and gravel aquifer varies widely. In the vicinity of the ash disposal facility, the sand and gravel aquifer is thin and provides only limited quantities of water. The Niagara aquifer, which includes the Devonian and Silurian dolomites, is the uppermost bedrock aquifer in eastern Wisconsin. Where the overlying glacial deposits are relatively impermeable, as in the Sheboygan area, the Niagara aquifer is confined. The underlying sandstone aquifer includes the Ordovician units between the Maquoketa Shale and the Precambrian bedrock, but most of the water obtained from this aquifer is provided by the Cambrian sandstones and St. Peter Sandstone. The Maquoketa Shale forms an aquitard separating the two bedrock aquifers.

On a large regional scale, groundwater flow in the Sheboygan area is probably to the east, towards Lake Michigan. In the site vicinity, however, the natural shallow groundwater flow direction appears to be to the south, towards Fish Creek. Infiltration from the WPDES lagoons causes local groundwater mounding in the vicinity of the ash disposal facility. Shallow groundwater flow is influenced by the distribution of sand, silt and clay in the glacial deposits.

In the site vicinity, residential wells obtain water from the shallow sand and gravel aquifer and from the dolomite aquifer. When the NR 140 Compliance Report for the site was compiled by Dames & Moore in 1991, there were a total of five wells in the site vicinity that were screened in the sand and gravel aquifer, including two upgradient and three downgradient wells. Two of the shallow downgradient wells were subsequently replaced by WP&L with bedrock wells. The remaining three shallow wells include two upgradient wells (635 Greenfield Ave. and 3702 S. 8th St.) and one downgradient well (4324 S. Lakeshore Dr.). The downgradient shallow well is located approximately 1,750 feet south-southeast of the ash disposal facility, immediately north of Fish Creek. The rest of the homes in the site vicinity obtain water from wells screened in the dolomite aquifer.

Drillers' logs for some of the private wells completed in bedrock in the site vicinity show a static water level of zero feet below ground surface, suggesting that an upward gradient exists between the dolomite and the glacial aquifer. An upward gradient would be consistent with the site's location in a regional discharge area, with water from the dolomite aquifer moving upward to discharge into Lake Michigan.

3.0 PREVIOUS INVESTIGATION RESULTS

3.1 NR 140 Compliance Report

On March 7, 1990, the WDNR issued a conditional plan modification for the Edgewater closed ash disposal facility. The plan modification required that WP&L conduct sampling at private wells located within 1,200 feet of the landfill during March, June and September of 1990. This sampling was required because groundwater monitoring results for the site indicated elevated concentrations of indicator parameters (conductivity, hardness and boron) and public welfare standard exceedances (iron and sulfate). Also required were reevaluation of the previous groundwater monitoring data, statistical analysis of groundwater quality data, analysis of possible remedial measures, evaluation of the nature, persistence and likely fate of the contaminants, and evaluation of potential environmental and health effects of the contamination.

To meet the requirements of the plan modification, an NR 140 compliance report was prepared by Dames & Moore and submitted to the WDNR in February 1991. The report contained a summary and evaluation of the groundwater monitoring data for the Edgewater closed ash disposal facility. Conclusions based on the data evaluation included the following:

- Groundwater in the vicinity of the ash disposal facility generally flows to the southeast, but is locally influenced by groundwater mounding caused by the WPDES lagoons.

- Total dissolved solids (TDS), boron and sulfate are present at elevated concentrations in monitoring wells located downgradient of the ash disposal facility.

- NR 140 Preventive Action Limit (PAL) or Enforcement Standard exceedances outside the Design Management Zone (DMZ) have been reported for iron, sulfate and TDS. The Enforcement Standards for iron and TDS have been exceeded at upgradient as well as downgradient monitoring wells, due to high natural background concentrations. [Note: Since the submittal of the NR 140 compliance report in

February 1991, TDS has been changed from a public welfare parameter to an indicator parameter.] The calculated PAL for boron has not been exceeded outside the DMZ.

- Water quality is generally improving on the western edge of the ash disposal facility, but is deteriorating in the southeastern corner of the site. During the period from 1985 to 1990, TDS, boron and sulfate concentrations increased substantially at wells 18OW and 29OW, located at the southern edge of the ash disposal area. These same parameters decreased significantly at wells 4OW and 5OW, located at the southwestern and northwestern corners of the ash landfill.

- Variations in iron concentration across the site appear to be more strongly related to natural variations than to proximity to the ash disposal area.

- Private wells completed in the dolomite aquifer do not appear to be impacted by the ash disposal facility.

- Groundwater contamination related to the landfill does not appear to represent a public health threat to area residents. The contaminants of interest are sulfate, which is a public welfare parameter, and TDS and boron, which are indicator parameters. [Note: Two shallow private wells which had sulfate concentrations significantly greater than background were voluntarily replaced by WP&L with bedrock wells following submittal of the NR 140 compliance report.]

The report also included a very preliminary evaluation of potential remedial measures. However, since impacts from the ash disposal facility on private wells were not confirmed, it was concluded that the expense of source control or groundwater interception measures was not warranted.

3.2 Preliminary NR 213 Evaluation of the Lagoons

In response to the promulgation of NR 213, Wis. Admin Code, WP&L was required to perform a preliminary assessment of the compliance of each of the lagoons with the design standards, material requirements, and performance criteria of the rule. A compliance assessment report was prepared by Simon Hydro-Search, Inc. (1992). The findings of the compliance assessment were that the lagoons do not meet the design criteria of NR 213, but that the water quality in the lagoons is sufficiently good that the lagoons are not a threat to groundwater quality. The design criteria were not met because, with the exception of the slag basin, the lagoons are not lined. The slag basin was constructed with a 3-foot clay liner, but does not meet the requirement for a 5-foot separation between the bottom of the lagoon and the water table. To assess water quality in the lagoons, a grab sample was collected from each lagoon during October 1991. The analytical results, summarized in **Table 1**, indicated that the water in the WPDES lagoons met NR 140 groundwater standards, except that the iron concentrations in the north WPDES lagoon and the primary pond slightly exceeded the preventive action limit (PAL) and enforcement standard (ES), respectively. Although the iron concentrations were slightly above the NR 140 standards, groundwater monitoring results from upgradient well 2OW indicate background iron concentrations greater than the iron concentrations in the lagoons. Based on the water quality results, WP&L requested an exemption from the design requirements of NR 213.

3.3 Wastewater Treatment Lagoon Feasibility Study

On July 25, 1991, the WDNR issued another conditional plan modification for the closed ash disposal facility. This plan modification required WP&L to provide a detailed analysis of potential remedial measures for the landfill. Additional requirements of the plan modification were to install three new downgradient monitoring wells and add them to the quarterly groundwater monitoring program, to sample the bedrock replacement wells installed at two of the private residences, and to properly abandon the shallow wells that were replaced.

To comply with the requirement for an analysis of remedial measures, a feasibility study was performed by Dames & Moore. The remedial measures evaluated in the feasibility study included the following:

Alternative #1:	Eliminate the slag dewatering basin and the WPDES treatment lagoons
Alternative #2:	Redesign the existing treatment lagoons to eliminate seepage
Alternative #3:	Construct a new slag dewatering basin and wastewater treatment lagoons on an area removed from the closed ash landfill
Alternative #4:	Construct new treatment lagoons away from the closed ash landfill, but leave the existing slag dewatering basin in operation without modification

Alternative #5: Supply municipal water to replace potentially affected private water supply wells

Since most of the potential remedial measures involved some change in the lagoon system, the feasibility study objectives were to evaluate the impacts of each alternative on groundwater quality and on the operation of the lagoon system. The scope of the feasibility study included a review of historical operating data for the lagoon system, a field study to gather information on the lagoon system operation (discharge rates, lagoon volumes, treatment performance), and the evaluation of remedial measures.

Findings and conclusions of the feasibility study included the following:

- With the exception of the final effluent pond, sedimentation in the wastewater treatment lagoons has been significant. Current liquid storage volumes and detention times are significantly reduced relative to design conditions.

- In general, the lagoon system is larger than needed to achieve the wastewater treatment objectives.

- PH in the wastewater is stabilized in the lagoon system and the range of fluctuation in pH decreases with each successive pond. Sharp decreases in the wastewater pH are associated with the air heater wash which is typically performed once or twice per year.

- Oil and grease removal in the wastewater treatment system is very good. Most of the oil and grease removal occurs in the WPDES lagoons.

- The lagoons are effective in the removal of suspended solids from the wastewater, with most of the removal occurring in WPDES lagoons and slag basin.

- Groundwater level measurements confirm the presence of a groundwater mound, apparently caused by exfiltration from the WPDES lagoons. The water surfaces in the primary and secondary ponds appear to intersect the water table.

- Estimates of the groundwater levels which would occur if the WPDES ponds were eliminated as a source of water indicate that the water table would still be above the base of the ash disposal facility.

- Of the five remedial alternatives evaluated, supply of municipal water to replace potentially affected private water supply wells (Alternative #5) was the least expensive, at an estimated cost of $552,000. Of the remaining four alternatives, which would all significantly reduce or eliminate seepage from the WPDES lagoons, lining the lagoons (Alternative #2) was the least expensive, at an estimated cost of $1,524,000 to $1,715,000.

On October 16, 1992, WP&L met with the WDNR to discuss the findings of the feasibility study. During this discussion, replacement of private wells with a municipal water supply was eliminated from further consideration because those wells which were potentially affected by the landfill have already been replaced with deep bedrock wells. At this point, the motivation for remedial measures is primarily due to environmental concerns and regulatory issues, rather than public health issues. As was described more fully in section 1.1, the outcome of this meeting between WP&L and the WDNR was a decision to perform additional investigation to evaluate whether the potential benefits associated with lining the lagoons would warrant the high cost of this remedial measure.

4.0 GROUNDWATER MONITORING DATA AND PROPOSED PALS

4.1 Recent Groundwater Monitoring Results

The NR 140 compliance report (Dames & Moore, 1991) was based on groundwater monitoring data collected through September 1990. Quarterly monitoring has continued since that time and three new downgradient wells have been added to the monitoring program. Reporting on the quarterly monitoring results did not include any data analysis during 1991 or 1992, except for the identification of NR 140 PAL and ES exceedances. The March 1993 quarterly monitoring data report, which is provided in **Appendix A**, includes a historical summary of the last eight quarters of sampling results.

Analysis of the groundwater monitoring data collected since the NR 140 compliance report indicates some changes in the groundwater quality trends observed in the earlier data. TDS, boron and sulfate concentration data for the last five years of groundwater monitoring are shown in **Figures 3**, **4** and **5**.

(These graphs were prepared using the same format as the time vs. concentration graphs in the NR 140 compliance report (Dames & Moore, 1991) to facilitate comparison of the more recent data with the earlier data evaluated in that report.) The increasing trends in TDS and sulfate concentrations previously observed at wells 18OW and 29OW, located south of the ash disposal area, appear to have leveled off. Boron concentrations still appear to be increasing slightly, but the rate of increase is lower than was observed in the earlier data. At wells 4OW and 5OW, located at the southwestern and northwestern corners of the landfill, the decreasing trends in TDS, boron and sulfate concentrations observed in the earlier data appear to have continued. Concentrations of these parameters at wells 4OW and 5OW, located at the southwestern and northwestern corners of the landfill, appear to have continued the decreasing trend observed in the earlier data.

Three new monitoring wells (30OW, 31OW and 32OW) were installed south and southeast of the landfill in August 1991. Monitoring results for wells 31OW and 32OW, located south of the landfill on the west side of Lakeshore Drive, indicate that water quality at these wells is similar to background, with no apparent landfill impacts. At monitoring well 30OW, located southeast of the landfill on the east side of Lakeshore Drive, the NR 140 PAL for selenium and the ES for sulfate were exceeded. These exceedances suggest that the landfill is impacting groundwater quality in this area; however, the water table map (**Plan Sheet 2**) does not show this well as being directly downgradient of the ash disposal facility.

The extent and degree of groundwater contamination and its relationship to the ash disposal facility are discussed further in sections 6.5 and 7.0.

4.2 Proposed NR 140 PALs for Indicator Parameters

Under s. NR 140.20, Wis. Admin. Code, PALs for indicator parameters are specific to an individual facility and are to be calculated by the DNR based on background water quality data. PALs have not yet been calculated for the indicator parameters included in the monitoring program at the Edgewater closed ash disposal facility, which include alkalinity, boron, conductivity, pH, sodium and TDS. Since some of these indicator parameters are the primary parameters of interest for the site, proposed PALs were calculated as part of this investigation.

Quarterly groundwater monitoring data for the 5-year period from March 1987 through December 1992 were used to calculate the PALs. Some earlier data exists, but was not included in the PAL calculation because some of the parameters were not sampled for on a regular basis and because the early data were generally less consistent than the more recent data. Sampling procedures are less well documented for the earlier sampling rounds, so inconsistencies may reflect fluctuations in procedure (e.g., filtering or not filtering samples) rather than fluctuations in groundwater quality. The 5-year period used to calculate PALs included at least 37 observations for each parameter, which should be sufficient to characterize water quality at the background wells.

The PALs were calculated using monitoring data from monitoring wells 1OW, located west of the site, and 2OW, located north of the site. Both of these monitoring wells are water table observation wells completed in the shallow glacial deposits. As shown by the water table map (**Plan Sheet 2**), well 2OW is clearly upgradient of the site. Well 1OW was probably intended as an upgradient well, based on an assumed easterly groundwater flow direction. However, since local groundwater flow in the immediate vicinity of the ash disposal facility is primarily toward the south, well 1OW is actually in a side-gradient position relative to the landfill. Although it not located directly upgradient of the landfill, well 1OW does appear to represent background water quality. It is located approximately 1,100 feet west of the landfill and has never shown any apparent landfill impacts. Natural water quality within the glacial aquifer appears to be quite variable. Inclusion of data from both 1OW and 2OW, which have somewhat different water chemistry, in the PAL calculation incorporates some of the effects of natural spatial variation.

Prior to calculation of the PALs, the 5-year data set for well 1OW and 2OW was inspected for outliers. Outliers were assumed to be data points which differed from the mean by more than three standard deviations. The only value identified as an outlier and removed from the final data set was a reported alkalinity value of 1,620 mg/l for well 2OW during September 1989. Typical alkalinity values for well 2OW are in the 300 to 500 mg/l range.

Some of the boron and sodium results were reported as less than the detection limit. For calculation of the PALs, values which were reported as less than detection were replaced with a value equal to one half of the detection limit.

The PALs were calculated in accordance with s. NR 140.20(2), Wis. Admin Code. For pH, the PAL was calculated as one pH unit above or below the mean pH for the background wells. For all other indicator parameters, the PAL was calculated as the mean background value for the given parameter plus three standard deviations or the mean value plus the increase listed in s. NR 140.20(2)(c), whichever was greater. The proposed PALs and the statistical parameters of the background water quality data set are summarized in **Table 2**. The data used to calculate the proposed PALs are provided in **Appendix B**.

5.0 FIELD INVESTIGATION METHODS

5.1 Overview and Investigation Chronology

The field investigation was performed by BT^2 and Miller Engineers and Scientists, Inc. (MES) during February and March 1993. In accordance with the study plan, the field investigation included soil borings within the ash disposal area, HydroPunch groundwater sampling, monitoring well installation and sampling, slug testing and surveying. In addition, the field investigation was expanded somewhat beyond the scope of the study plan. The additional investigation included seven soil borings and an expanded program of physical and chemical testing of the ash and slag.

Field activities were performed according to the following schedule:

Task	Dates Performed
Soil borings, ash/slag sampling, HydroPunch sampling and monitoring well replacement	February 15 - 19, 1993
Additional monitoring well installation	March 4, 1993
Slug testing	March 12, 1993
Monitoring well sampling	March 19, 1993

The ash, slag and groundwater samples were submitted to Robert E. Lee & Associates, Inc. for chemical analysis. Physical testing of selected ash, slag and soil samples was performed by MES.

The methods used in each of the field investigation tasks are summarized in the following sections.

5.2 Soil Borings and Ash Sampling

A total of 13 soil borings were advanced at the locations shown in **Figure 2** and on **Plan Sheet 1**. Three of the borings (SB101, SB102 and SB103) were located adjacent to the WPDES lagoons.

Three borings (SB104, SB105 and SB106) were proposed in the study plan for the western portion of the site, which has been capped and closed. As part of the slag utilization investigation, seven additional borings (SB107 through SB113) were advanced in the western portion of the site.

The soil borings were advanced using an Acker drill rig with 4¼-inch ID hollow-stem augers. Soil/ash samples were collected at 2-foot intervals using a split-spoon sampler. A hydrogeologist supervised the drilling and logged the borings. Boring logs are provided in **Appendix C**. Each boring was advanced until native soils beneath the ash were encountered. On completion, borings SB101, SB103, and SB107 through SB113 were abandoned in accordance with NR 141. Borehole abandonment forms are included in **Appendix D**. Borings SB102, SB104, SB105 and SB106 were converted to monitoring wells as described in section 5.3. Each boring location was surveyed to determine its elevation and location with respect to the site grid.

In each of the three borings located adjacent to the WPDES lagoons (SB101 - SB103), ash/slag samples were collected at three depths for laboratory leach testing and total constituent analysis: one immediately below the water table, one midway to the base of the ash, and one near the base of the ash. The work plan stated that HydroPunch samples would be collected at approximately the same depths as the ash samples. Due to some sampling problems with the HydroPunch and a deeper water table than had been anticipated, the number of groundwater samples from each of these borings was reduced to two. The first sample was collected approximately 3 to 4 feet below the water table and the second was collected near the base of the ash/slag. The first attempt to collect a HydroPunch sample in boring SB103 failed due to poor recovery in the HydroPunch. A groundwater sample was then collected by advancing the augers approximately 3 feet below the water table, pulling the augers up 1 foot, and sampling from the augers with a bailer.

Immediately following collection of each HydroPunch sample, field measurements of pH and conductivity were collected. Groundwater samples for metals were field filtered and preserved with nitric acid. Samples for alkalinity, sulfate and chloride were field filtered, but no preservatives were added. Samples for TDS were neither filtered nor chemically preserved. All samples were placed in a cooler and maintained at or below a temperature of 4°C. Water sampling procedure records documenting water sampling procedures are included in **Appendix E**.

The three study plan borings located in the western portion of the site (SB104 - SB106) were sampled for laboratory testing at approximately the same elevations as the borings near the lagoons. The study plan stated that three samples would be collected from each boring for laboratory analysis; however, only two samples were collected from borings SB104 and SB106 because native soil was encountered before the depth proposed for the third sample was reached. HydroPunch sampling was not performed in these borings.

For quality control, one duplicate ash sample, one duplicate HydroPunch sample, one HydroPunch field blank and a trip blank were collected for laboratory analysis.

The seven borings advanced for the slag utilization study (SB107 - SB113) were also sampled at 2-foot intervals with a split-spoon sampler. However, a different approach was used in the collection of samples for physical and analytical testing, based on the objectives of the slag utilization investigation. From each boring, a boring composite sample (also referred to as a vertical composite) was prepared by collecting subsamples of approximately equal volume from each split-spoon sample. The boring composite samples were analyzed for grain size distribution to provide an estimate of the proportions of ash and slag at each boring location. To characterize the composition of the ash and slag, a site-wide ash composite sample and a site-wide slag sample were also prepared for laboratory analysis. The site-wide composite samples were prepared by collecting subsamples of approximately equal volume from each split-spoon which contained a sufficient volume of "pure" slag or fly ash (i.e. slag with no fly ash mixed in and vice versa). For comparison with the samples from the study plan borings, three horizontal composite samples were collected from the slag utilization study borings. The horizontal composite samples were prepared by collecting subsamples of approximately equal volume from split-spoon samples collected at approximately the same elevations as the analytical samples from the study plan borings.

As described in section 5.3, two of the monitoring wells initially installed in the ash landfill were dry or contained too little water for sampling and had to be replaced. The soil borings for the well replacements (SB114 and SB115) were advanced approximately 5 feet from the original monitoring wells. These borings were advanced without split-spoon sampling. In each boring, MES attempted to obtain a Shelby tube sample of fly ash for hydraulic conductivity testing from an interval selected based on the boring log for the adjacent boring. In boring SB114, adjacent to SB106, this attempt was successful. In boring SB115, adjacent to boring SB105, red clay was recovered in the Shelby tube. The source of the clay is not known and clay was not observed at the corresponding depth in boring SB105.

5.3 Monitoring Well Installation

Soil borings SB102, SB104, SB105 and SB106 were converted to monitoring wells 36OW, 37OW, 38OW and 39OW, respectively. These monitoring well numbers are not the same as those used in the study plan because the well numbers 33OW and 34OW, shown in the study plan, were already used for two monitoring wells installed adjacent to the final effluent lagoon.

The objective in setting the wells was to intercept the water table so that the depth of water in the well would be approximately 6 feet. However, the three wells initially installed in the western portion of the facility were installed at too shallow a depth. The well depths were selected based on the observation of saturated fly ash; however, after the wells were installed it became apparent that, although the ash appeared saturated at the depth over which the wells were screened, the water was held under capillary tension and would not flow into the wells.

After the water levels reached equilibrium, monitoring well 37OW, located at the north end of the landfill, contained approximately 2.5 feet of water. Well 38OW, located in the center of the landfill, was essentially dry and well 39OW, at the south end of the landfill, contained a few inches of water. Deeper replacement wells were subsequently installed adjacent to 38OW and 39OW and labeled as 38ROW and 39ROW. Well 37OW was not replaced because it contained sufficient water to permit sampling and because the bottom of the well was only 2 feet above native soil. The replacement wells were installed such that the water table was 5 to 8 feet above the bottom of the well.

The monitoring wells were constructed of 2-inch Schedule 40 PVC with 10-foot screens. The wells were constructed and developed in accordance with NR 141. Due to the slow recovery of wells 37OW, 38ROW and 39ROW, these wells were developed over a period of several days. The top-of-casing elevation for each new well was surveyed to ±0.01 feet. Monitoring well construction and development forms are included in **Appendix F**. An updated Monitoring Well Information Form is also included in **Appendix F**.

5.4 In Situ Hydraulic Conductivity Testing

In-situ hydraulic conductivity tests (slug tests) were performed in the new wells to obtain estimates of the hydraulic conductivity of the ash. Slug tests were also performed on existing well 20OW. Well 20OW was initially selected for slug testing because the boring log (**Appendix C**) indicated that it was screened in the slag at a total depth of 24.5 feet. However, when the well depth was measured prior to the slug test, it was 42.3 feet from top-of casing, or approximately 40 feet below ground surface. Based on this depth measurement and the boring log, well 20OW appears to be screened in the native soil underlying the ash disposal facility.

Slug tests were performed by lowering a solid PVC cylinder, or slug, into the well, allowing the water level in the well to equilibrate, then rapidly removing the slug and measuring the rate of recovery of the water level. Water levels were recorded using a pressure transducer and data logger. Due to the low water level in well 37OW (about 2.5 feet) and the anticipated slow response, the slug test for this well was performed by quickly bailing the well almost dry, then measuring the recovery using an electronic water level indicator. The slug test data were evaluated using the AQTESOLV software package (Geraghty & Miller, 1989). Results are presented in section 6.3. Slug test data and graphs are provided in **Appendix G**.

5.5 Groundwater Sampling

The four monitoring wells were purged and sampled on March 19, 1993. Immediately following sample collection, field measurements of pH and conductivity were taken. Groundwater samples for metals were field filtered and preserved with nitric acid. Samples for alkalinity, sulfate and chloride were field filtered, but no preservatives were added. Samples for TDS were neither filtered nor chemically preserved. All samples were placed in a cooler and maintained at or below a temperature of 4°C. Water sampling procedure records documenting field procedures are included in **Appendix E**. For quality control, one field blank sample and one duplicate sample were collected during the monitoring well sampling.

5.6 Laboratory Analysis

5.6.1 Physical Testing

Selected ash, slag and soil samples were subjected to physical testing to characterize the physical properties of the wastes and the underlying soil. Physical testing was performed by MES and included moisture content, grain size distribution (sieve and hydrometer) and permeability. Moisture content was measured for all of the split-spoon samples, the site-wide fly ash composite, the site-wide slag composite, and the three horizontal composites from the slag utilization study borings (see section 5.2). Grain size distribution was evaluated for the site-wide fly ash composite, the site-wide slag composite, the three horizontal composites, the seven vertical composites from the slag utilization study borings, and three native soil samples collected below the ash disposal facility. A falling head permeability test was performed on a Shelby tube sample of fly ash collected from boring SB 115. MES also attempted to run Atterberg Limits tests on selected fly ash samples, but found the material to be non-plastic.

The results of the physical testing program are presented in section 6.1. The physical testing laboratory reports are provided in **Appendix H**. Moisture content determination results for individual split-spoon samples are also shown on the soil boring logs in **Appendix C**.

5.6.2 Chemical Testing

As proposed in the study plan, ash/slag samples from borings SB101 through SB106 were analyzed for total boron, iron, sodium and selenium. For boron, iron and sodium, the samples were digested following method SW846-3050, then analyzed by ICP (SW846-6010). Selenium analysis followed method SW846-7741. These analyses were intended to provide an estimate of the maximum leachable concentrations of the target analytes. A total of 17 ash/slag samples were analyzed, including one duplicate sample.

Ash/slag samples collected from the study plan borings at the same depths as the samples collected for total metals analysis were analyzed using the ASTM D 3987-85 leaching procedure. The leachate was analyzed for the same parameters as the quarterly groundwater monitoring samples: pH, conductivity, alkalinity, boron, chloride, iron, selenium, sodium, sulfate and total dissolved solids.

The horizontal composite samples collected from the slag utilization study borings were analyzed for the same parameters as the individual ash/slag samples from the study plan borings, including both the totals analyses and the leachate analyses.

The site-wide ash composite and slag composite collected as part of the slag utilization study were analyzed for bulk chemical composition (total metals) and mineral composition. Leachate testing was also performed for the site-wide ash and slag composites.

The groundwater samples collected with the HydroPunch sampler and from the new monitoring wells were analyzed for the same parameters as the quarterly groundwater monitoring samples: pH (field), conductivity (field), alkalinity, boron, chloride, iron, selenium, sodium, sulfate and total dissolved solids. A total of 14 groundwater samples were analyzed, including six HydroPunch samples, four monitoring well samples, one HydroPunch duplicate, one HydroPunch field blank, one monitoring well duplicate and one monitoring well field blank.

All chemical analysis was performed by Robert E. Lee & Associates, Inc., Wisconsin Certification Number 405043870. The anlaytical methods used are shown on the laboratory reports, which are provided in **Appendix I**.

6.0 FIELD INVESTIGATION RESULTS

6.1 Waste Characterization for Fly Ash and Slag

This section provides a general description of the two major waste types present at the site: fly ash and slag. This description is based primarily on the results of physical and chemical analysis of the site-wide ash and slag composites. The distribution of slag and fly ash within the disposal facility is discussed in section 6.2. Analytical results for the individual ash samples from the study plan borings, HydroPunch samples, and monitoring well samples are presented in section 6.4 and 6.5.

6.1.1 Physical Characteristics

Fly ash is a nonplastic fine-grained material with a silt-like texture. Based on the grain size distribution curve for the site-wide ash composite, 90 percent of the fly ash particles have a diameter of less than 0.05 mm and 10 percent are finer than 0.0023 mm. The uniformity coefficient (D60/D10) is 4.3. MES attempted to run Atterberg limits tests on samples of fly ash, however, the material was found to be nonplastic, so the tests were not appropriate. Plastic materials, like most clay, can be molded and remolded over a range of water contents. Atterberg limits tests determine the upper limit (liquid limit) and lower limit (plastic limit) of water content between which a material behaves as a plastic. Nonplastic materials, like sand, cannot be molded without crumbling. The fly ash samples tended to crumble when MES attempted to mold them in accordance with Atterberg limit test procedures.

Slag has a coarser grain size, equivalent to a medium sand in the Unified Soil Classification System (USCS). In the site-wide composite, 90 percent of the slag particles had a diameter less than 2.4 mm and 10 percent were finer than 0.11 mm. The slag was slightly less uniform than the fly ash, with a uniformity coefficient of 10. The grain size distribution curves for the composite samples indicate that fly ash and slag can be separated approximately using a #200-mesh sieve (passing 0.075 mm diameter). The #200-mesh sieve retained 92 percent of the slag and passed 93 percent of the fly ash.

The hydraulic conductivity of slag is much higher than that of fly ash. A falling head permeability test performed on a Shelby tube sample of fly ash yielded an estimated hydraulic conductivity of 4.5 x 10^{-8} cm/s. A slug test performed on well 36OW, screened entirely in slag, yielded an estimated hydraulic conductivity of 1.9 x 10^{-1} cm/s. Some of the difference between these two results may be due to the fact that laboratory permeameter tests typically yield lower estimates of hydraulic conductivity than slug tests for the same material. However, the difference in the hydraulic conductivities of the two materials is still substantial.

The moisture content of the site-wide fly ash composite was 36.8 percent, while the slag composite sample had a moisture content of only 7.2 percent. The moisture content individual fly ash samples varied significantly, however, the moisture content of fly ash is typically higher than slag, especially above the water table. During drilling and sampling, the fly ash appeared saturated several feet above what was later determined to be the water table, causing the first wells installed in the ash to be set too shallow. The consistency of the saturated fly ash was very soft to soupy, with split-spoon blow counts typically less than one per 6 inches.

The physical characteristics of fly ash and slag are summarized in **Table 3** and the physical testing laboratory reports are included in **Appendix H**.

6.1.2 Chemical Characteristics

As part of the slag utilization investigation, the site-wide fly ash and slag composites were collected for bulk chemical analysis, mineral analysis, and ASTM water leach testing. The results of these analyses provide a general characterization of the chemical composition of the fly ash and slag in the ash disposal facility. The analysis of individual samples from the study plan borings, discussed in section 6.4, identifies variations within the fly ash and slag.

The bulk chemical analysis and mineral analysis results for the site-wide fly ash and slag composites, summarized in **Tables 4** and **5**, respectively, identify some of the chemical differences between slag and fly ash. The fly ash composite typically had higher concentrations of metals, while the slag composite had higher levels of calcium and silicon. Of the metals included in the groundwater monitoring program, the fly ash composite contained substantially higher levels of boron and selenium and slightly higher iron and sodium concentrations than the slag composite. Sulfur was not detected in either the fly ash or the slag at a detection limit of 250 mg/kg.

The ASTM water leach test results for the fly ash and slag composites, provided in **Table 6**, show that the slag is relatively inert, while the fly ash has more leachable constituents. For those parameters that were analyzed for in both composite samples, the concentration reported for the fly ash leachate was greater than or equal to that reported for the slag leachate, with the exception of iron.

To attempt to investigate changes in the ash leachate with time, the results of the ASTM leach tests for the fly ash and slag composite samples were compared with leach tests performed in the past for waste characterization. Prior leach tests were performed on ash and slag samples in October 1980 (Donohue, 1980) and September 1981 (Donohue, 1983) using the EP toxicity test. EP toxicity tests were run at both pH 5 and pH 7. The pH 7 results were selected as the most comparable to the ASTM results. The EP and ASTM methods differ in that pH is not adjusted in the ASTM procedure. The sample collection procedures for the previous waste characterization samples are not well documented. The samples are believed to have been collected from sluiced ash and slag which had recently entered the disposal site. As such, the samples do not represent fresh ash and slag, since some leaching had probably occurred during transport through the sluice lines; however, they do represent ash and slag as it was placed in the disposal facility.

The results of the prior leaching tests, shown in **Table 6**, indicate that the quality of the leachate generated from the fly ash is generally better for the recent samples collected from the ash disposal facility than for the previous waste characterization samples. For the majority of the analytical parameters, concentrations reported for the previous EP tests were higher than the recent ASTM test results. Sulfate showed a large decrease, with the two previous waste characterization results at 1,740 and 2,300 mg/l and the recent ASTM result at 320 mg/l. For boron and selenium, the ASTM results were slightly higher than the previous EP test findings. For most of the parameters, differences between the previous EP toxicity leach test results for fly ash and the recent ASTM results are probably not significant. For the slag samples, the three sets of leach test results were fairly similar for most parameters, with some parameter concentrations decreasing and others increasing from the previous results to the recent samples.

Interpretation of the comparison of the previous leach test results with the results of the leach tests performed as part of this investigation is not straightforward. Sample collection methods for the waste characterization samples collected in 1980 and 1981 are not well documented. The EP toxicity method involves pH adjustment to pH 7, while the ASTM method does not include pH adjustment. The unadjusted pH of the ASTM method samples was above 8, so the EP toxicity method would have required the addition of acid to the samples to lower the pH. Thus, some differences in concentrations between the previous and recent leach tests may reflect differences in the methods, rather than true differences in the waste. In addition, it is not known how the ash chemistry may have changed over time during operation of the ash disposal facility. Thus, the samples collected in 1980 and 1981 may or may not be representative of the materials disposed of in the facility.

The leach test results were compared to the NR 140 groundwater standards to evaluate the relative impacts of slag and fly ash on groundwater quality (**Table 6**). The slag composite leachate slightly exceeded the PALs for pH and selenium, but did not exceed any enforcement standards. The fly ash leachate exceeded the PALs for arsenic, boron, fluoride, and pH, and exceeded the enforcement standards for selenium and sulfate.

Analytical laboratory reports are provided in **Appendix I**.

6.2 Site Geology and Waste Distribution

Among the objectives of the field investigation were to characterize the distribution of different waste types within the ash disposal facility and to identify the underlying native soil types. In effect, one goal was to define the man-made "geology" of the site in order to improve our understanding of the movement of water through the site. This goal was accomplished by advancing a total of thirteen soil borings to the depth of native soil within the limits of the ash disposal facility. To illustrate the limits and distribution of slag and fly ash in the facility, three cross sections were prepared. North-south trending cross sections A-A' and B-B' are shown on **Plan Sheet 3**. Cross section C-C', trending east-west, is shown on **Plan Sheet 4**. Boring logs are included in **Appendix C**.

As shown in cross section B-B' (**Plan Sheet 3**), the eastern portion of the disposal facility, between and beneath the WPDES lagoons, appears to be filled almost entirely with slag. Fly ash was encountered only within a few feet of the disposal facility base, with a maximum fly ash thickness of approximately 2½ feet in boring SB102. Approximately 1 foot of fly ash was encountered immediately above native soil in boring SB101 and no fly ash was encountered in boring SB103. Although samples were not collected directly beneath the WPDES lagoons, the available information suggests that the eastern portion of the site is filled primarily with slag.

The western portion of the site contains both fly ash and slag, with fly ash in the majority. For each of the slag utilization study borings (SB107 - SB113), a vertical boring composite sample was collected and analyzed for grain size distribution to estimate the proportions of fly ash and slag at each boring location. The results, summarized in **Table 7**, ranged from 60 percent fly ash in boring SB110 to 83 percent fly ash in boring SB108. The horizontal composite samples collected from the slag utilization borings were also analyzed for grain size distribution to identify changes in the average proportions of slag and fly ash with depth. The shallow horizontal composite, composed of samples from borings SB107 through SB113 at elevations from 605 to 610 ft MSL, contained a slight majority of slag, at 52 percent. This higher proportion of slag reflects the fact that in most areas of the site, a layer of slag was placed over the fly ash prior to placement of the clay cap. The mid-depth horizontal composite, including samples from elevations ranging from 597 to 602 ft, contained a large majority of fly ash, at 82 percent. At elevations of 587 to 592 ft, the deep horizontal composite sample contained 62 percent fly ash.

As the borings were advanced in the western portion of the site, slag and fly ash were typically encountered as discrete layers. Mixtures of slag and fly ash were encountered only in a few locations. However, thin but discrete layers or lenses of slag (2 to 6 inches thick) were observed within thicker layers of fly ash, and vice versa. As shown in cross sections A-A' (**Plan Sheet 3**) and C-C' (**Plan Sheet 4**), slag and fly ash units typically do not appear to be continuous from one boring location to another, with the exception of the top slag layer which was encountered in most of the borings immediately below the clay cap. The boring logs (**Appendix C**) provide more detailed descriptions of the distribution of fly ash and slag at each boring location.

The depth to the base of the ash disposal facility was less than had been anticipated at the north end of the western portion of the site. The design base elevation was believed to be 586.6, however, at boring SB104 (well 37OW), native soil was encountered at an elevation of 595 feet. The base slopes southward, reaching an elevation of approximately 589 feet at boring SB105 (see cross section A-A' on **Plan Sheet 3**).

The native soil encountered at the base of the ash disposal facility was typically a silty fine-grained sand. Thin alternating layers of silt and fine uniform sand were observed in several borings. Clay layers were encountered in a few borings. Three soil samples were analyzed for grain size distribution (see **Appendix H**). The proportion of silt and clay in the three samples ranged from 26.0 to 58.6 percent. The median grain size (D50) ranged from 0.058 to 0.14 mm. The soil boring log for well 20OW (**Appendix C**), located at the northwest corner of the primary pond, describes the soils encountered below the base of the ash disposal facility as silt and clayey silt with little to some fine sand.

The soil boring log for monitoring well 18OW, one of the wells located south of the ash disposal facility that has shown apparent ash impacts, indicates that silt with fine sand is present in the screened interval of the well. Wells 6ROW and 7OW, which are located immediately southeast and east of the landfill and have not shown evidence of groundwater contamination, appear to be screened in clay with some silt. Wells 4OW and 5OW, located at the southwest and northwest corners of the ash disposal facility, are screened in silty sand, with some peat observed at well 4OW. Boring logs were not available for wells 29OW or 29A.

6.3 Site Hydrogeology

Since the water table is currently above the base of the ash disposal facility, there is no physical separation between what might typically be considered as leachate versus groundwater. For this reason, all water below the water table is referred to as groundwater in the following discussion.

To assist in the evaluation of groundwater flow within the ash disposal facility, estimates of the hydraulic conductivity of the fly ash and slag were obtained through slug tests and a laboratory permeameter test. The results of the hydraulic conductivity testing are summarized in **Table 8**. As previously described in section 6.1.1, the hydraulic conductivity test results indicate that the hydraulic conductivity of the slag is several orders of magnitude greater than that of the slag. The slug tests performed in well 36OW, screened entirely in slag, yielded an estimated slag hydraulic conductivity of 1.9 x 10^{-1} cm/s. In contrast, the fly ash hydraulic conductivity was estimated at 4.5 x 10^{-8} cm/s based on a laboratory falling head permeameter test on a Shelby tube sample. These were the only two tests that were representative of just slag or fly ash. The other wells in which slug tests were performed are screened in both fly ash and slag. Some of the difference between the estimated slag and fly ash hydraulic conductivities may be related to the fact that slug tests generally yield higher estimates of hydraulic conductivity than laboratory tests for the same material. However, even if the difference in hydraulic conductivity between the slag and fly ash is somewhat less than suggested by the two tests, the slag is clearly significantly more permeable than the fly ash.

Slug tests performed on wells 37OW, 38ROW and 39ROW, screened across layers of both slag and fly ash, yielded estimated hydraulic conductivity values between those estimated for the two waste types. The differences in slug test results for these three wells appear to be related to the relative thickness of slag layers within the screened interval. Well 38ROW, with a 5.5-foot slag layer intersecting the well screen, yielded the highest result, at 6.9 x 10^{-2} cm/s. Lower hydraulic conductivity estimates were obtained from well 37OW and 39ROW, which were screened primarily in fly ash with some thin slag layers. The slug test results for wells 37OW and 39ROW were 4.8 x 10^{-5} and 6.3 x 10^{-4} cm/s, respectively.

Slug tests were also performed in existing well 20OW. This well was initially included in the slug testing program because it was believed to be screened within the slag berm. The soil boring log for well 20OW describes installation of the well at a depth of 24.5 feet, which would place the bottom of the well approximately 3 feet above the base of the ash disposal facility. However, when it was measured prior to the slug test, the well depth was found to be approximately 40 feet below ground surface. If the well was constructed with a 10-foot screen, as indicated on a prior version of the DNR well information form, this would place the entire screened interval for this well in the native soils, described as silt in the soil boring log.

To add to the uncertainty regarding well 20OW, the estimated hydraulic conductivity at this well, based on the slug tests, was relatively high, at 2.9 x 10^{-2} cm/s. This result is higher than would be expected for a silt, based on literature values. There appear to be two possible explanations for this anomalously high hydraulic conductivity. One possibility is that the well screen and/or the filter pack extend up into the slag berm, so that the relatively rapid response of the well is due to the high hydraulic conductivity of the slag. The other alternative is that the soils description in the log for well 20OW is not accurate, and sandier material is actually present at this depth. Although sand was observed at the base of the ash disposal facility in several of the borings, it was very fine grained and typically contained some silt. This material would probably would not have a hydraulic conductivity as high as was reported for well 20OW. Thus, the most logical explanation of the relatively high hydraulic conductivity at well 20OW appears to be that the screen and/or filter pack extends into the slag berm. Accurate well construction information for this well is not available. The updated DNR well information form included in **Appendix F** has been modified to show the measured depth of well 20OW.

Previous slug test results for wells 1OW through 7OW ranged from 2.5 x 10^{-6} at 7OW, which is screened in silty clay, to 2.0 x 10^{-3} at well 1OW, screened in fine silty sand (Donohue, 1976).

Groundwater flow patterns estimated based on this investigation were generally similar to those based on previous work. A water table map for March 1993 is provided on **Plan Sheet 2**. Water level measurements collected for the new and existing monitoring wells during March 1993 are summarized in **Table 9**. Water level measurements for the existing wells for the previous eight quarters are provided in **Appendix A**. Groundwater flow is generally to the south, but is influenced by groundwater mounding within the ash disposal facility.

The water level at monitoring well 36OW, located between the two WPDES basins, was lower than had been anticipated. At approximately 602 feet, the water level within the slag berm was approximately 8 feet below the water level in the WPDES lagoons. The water level in well 36OW was the highest level measured at the site, consistent with the assumption that the WPDES lagoons are the primary source of water causing the groundwater mound. The significant difference between the lagoon water level and the water table suggests that sediments deposited in the lagoons are providing some resistance to leakage out of the lagoons.

Water levels in wells 37OW, 38ROW and 39ROW, located in the western portion of the site, were slightly lower than at well 36OW, but still showed significant groundwater mounding effects. The water level in well 20OW, now believed to be screened at or below the slag/native soil boundary, was 599.31. Although this well does not appear to be screened at the water table, it was included in the water table map because vertical gradients within the slag are assumed to be small, given the high permeability. Elimination of this well from the water table map would not significantly change the estimated groundwater flow directions.

Water levels in the monitoring wells located outside of the ash disposal facility indicate that, in the absence of groundwater mounding due to the WPDES lagoons, groundwater flow would be to the south. The average horizontal hydraulic gradient beyond the limits of groundwater mounding is approximately 0.008 ft/ft. Southeast of the ash disposal facility, in the vicinity of wells 30OW, 31OW, 32OW and 3ROW, groundwater flow appears to be to the south-southwest.

Information on vertical gradients in the native soils is limited and somewhat conflicting. Monitoring well 29A is the only piezometer included in the quarterly groundwater monitoring program. As was reported in the NR 140 compliance report (Dames & Moore, 1991), groundwater monitoring data for well nest 29OW/29A indicated downward gradients prior to June 1990. However, water level measurements from June 1990 through March 1993 indicate significant upward gradients. This sharp change in vertical gradients is believed to be an artifact of repairing and/or resurveying the wells, not an actual change in hydrogeologic conditions. Well nest 29OW/29A appears to be located in a natural discharge area, so an upward gradient would be expected in the absence of the ash disposal facility; however, groundwater mounding near the facility could potentially reverse the natural vertical gradient. The more recent data, indicating upward gradients, is probably more accurate, since it is presumed to be based on a more recent survey. Previous water level measurements from well nests generally indicate upward gradients within the glacial aquifer, but downward gradients were reported for a few well nests (Donohue, 1982).

6.4 Analytical Results for Ash/Slag Samples

The analytical results for the ash and slag samples indicate that the distribution of total and leachable metals within the ash disposal facility is related primarily to the distribution of ash and slag. The total metals results for the individual ash/slag samples collected from the study plan borings (SB101 - SB106) and the horizontal composite samples collected from the slag utilization study borings (SB107 - SB113) are summarized in **Table 10**. The table also shows whether each sample was composed of slag, fly ash, or a mixture. The slag samples typically had much lower concentrations of boron, selenium and sodium. Iron concentrations were typically slightly lower in the slag samples. Intermediate results were obtained for the samples containing both fly ash and slag. Analytical laboratory reports are provided in **Appendix I.**

The ASTM water leach test results for the ash and slag samples, shown in **Table 11**, show a pattern similar to the total metals results. The concentrations of boron, selenium, sodium and sulfate in the leachate from fly ash samples were typically higher than in slag sample leachate. The conductivity of the fly ash leachate was also higher than that of the slag leachate. Differences in TDS concentrations are difficult to evaluate because the laboratory detection limit for TDS was relatively high. A trip blank and two field blanks analyzed for TDS with the groundwater samples had reported TDS results of 120 to 170 mg/l, although the field-measured conductivity values for the blanks were only 10 to 20 μmho/cm. TDS and conductivity are typically well correlated, with TDS values equal to approximately 0.55 to 0.9 times the conductivity (Sawyer and McCarty, 1978). The correlation factor varies with different water chemistry, but the TDS predicted from the field conductivity measurements for the blanks would be less than 18 mg/l. Given the laboratory detection limit problems for TDS, the conductivity values are probably a more reliable indication of the relative levels of dissolved solids in the leachate than are the actual reported TDS values.

Comparison of the water leach test results for the ash and slag samples with NR 140 groundwater standards indicates that PALs were exceeded in one or more samples for boron (proposed PAL), iron, pH (proposed PAL), selenium and sulfate. The enforcement standards for selenium and sulfate were also exceeded at least once. The proposed PAL for boron was exceeded in the leachate from most of the samples collected in the western portion of the site, but none of the samples collected adjacent to the WPDES lagoons (SB101 - SB103). The PAL for iron was exceeded for one slag sample and one ash sample, but neither sample had an iron concentration exceeding the enforcement standard. PH levels exceeding the proposed PAL were reported for the leachate from approximately one third of the samples, including some slag and some fly ash samples. Selenium concentrations above the PAL were reported for all of the samples collected in the western portion of the site and some of the samples collected near the WPDES lagoons. Enforcement standard exceedances for selenium were reported only for samples from the western portion of the site. Sulfate standard exceedances were similarly concentrated in the western portion of the site, with three samples exceeding the PAL and one sample exceeding the enforcement standard. Enforcement standards do not apply within the design management zone, but are useful as a point of comparison.

Comparison of the water leach test results within each boring does not indicate any consistent trends in concentration with depth. Where changes do occur with depth, they are often related to changes in waste type. For example, the deepest samples from borings SB101 and SB102 had somewhat higher boron and selenium concentrations than the shallower samples from the same borings. These deep samples included some fly ash which was present just above the base of the ash disposal facility, while the shallower samples contained only slag.

6.5 Analytical Results for Groundwater Samples

Groundwater samples collected during the field investigation include HydroPunch samples collected at various depths in the borings adjacent to the WPDES lagoons (SB101 - SB103) and samples from the new monitoring wells (36OW - 39ROW). The groundwater analytical results are summarized in **Table 12** and laboratory reports are provided in **Appendix I**. In general, the same correspondence in contaminant concentrations to waste types was observed in the groundwater samples as in the ash samples and leach tests. Groundwater samples collected from wells 37OW, 38ROW and 39ROW, screened at least partially in fly ash, had higher concentrations of boron, sulfate and TDS than the groundwater samples collected from the slag berms adjacent to the WPDES lagoons. In contrast with the leach test and total metals results, selenium concentrations in the groundwater samples were not very well correlated with the waste type from which the samples were collected. Iron concentrations were typically higher in samples from the slag than from the fly ash.

The reliability of the reported groundwater analytical results for TDS and pH appears to be questionable. As described in the preceding section, the laboratory detection level for TDS was relatively high, at approximately 130 mg/l, so TDS concentrations not significantly greater than this level may not be accurately measured. The field pH measurements appear to be suspect based on comparison with leach test results and previous groundwater monitoring results. The pH of groundwater within the ash disposal facility was anticipated to be at least 7, but the reported results ranged from 4.92 to 6.67. Based on previous experience with difficulties in field pH measurement during very cold weather, it appears possible that the low pH values reported by MES reflect a pH meter malfunction and not the true groundwater pH.

Comparison of the groundwater sample analytical results with NR 140 standards indicates that proposed PALs for boron, conductivity, and TDS and existing PALs for iron, selenium and sulfate were exceeded in one or more samples. Some of the reported pH values were below the proposed lower PAL for pH, however, the validity of these pH measurement appears questionable. Enforcement standards for iron, selenium and sulfate were exceeded in one or more groundwater samples; however, the enforcement standards do not apply at these wells, since they are located within the design management zone.

Boron concentrations of 16.9 to 33.4 mg/l were reported for samples from monitoring wells 37OW, 38ROW and 39ROW. Although these concentrations are well above the proposed PAL of 2.1 mg/l, they are less than the maximum boron concentrations previously reported for monitoring well 29OW, suggesting that boron concentrations have been reduced over time through leaching. Boron concentrations in the slag berms adjacent to the WPDES lagoons were below the proposed PAL.

The distribution of sulfate appears to be similar to that of boron. Concentrations ranging from 540 to 1,100 mg/l were reported for samples from wells 37OW, 38ROW and 39ROW. These concentrations exceed the enforcement standard for this public welfare parameter, but are equal to or less than concentrations reported for the most recent sampling at downgradient monitoring wells 18OW (1,100 mg/l) and 29OW (1,300). Sulfate concentrations for groundwater samples from the slag berms ranged from 71 to 220 mg/l. Although some the these results exceeded the PAL for sulfate, none exceeded the enforcement standard.

TDS and conductivity were also elevated in the groundwater samples from the wells in the western portion of the facility, but equal to or less than downgradient monitoring well concentrations. TDS ranged from 1,000 to 1,600 mg/l in wells 37OW, 38ROW and 39ROW, exceeding the proposed PAL. The TDS concentrations at downgradient wells 18OW and 29OW were 1,700 and 2,100 mg/l, respectively in the most recent groundwater monitoring. The most recent conductivity results for wells 18OW and 29OW were 1,520 and 1,980 μmho/cm, respectively, in comparison with results of

1,300 to 1,730 in the new monitoring wells screened in the ash. The TDS and conductivity levels reported for groundwater samples collected from the slag berms were below the proposed PALs.

The distribution of selenium and iron were somewhat different than the pattern observed for boron, sulfate, TDS and conductivity. Selenium concentrations exceeding the PAL were reported for most of the groundwater samples collected within the ash disposal facility. The enforcement standard for selenium was slightly exceeded in two samples: one Hydropunch sample from boring SB103 and a groundwater sample from monitoring well 39ROW. At 16 mg/l, the maximum selenium concentration reported for groundwater samples collected within the ash disposal facility was less than two times the enforcement standard. Selenium concentrations at downgradient wells 18OW and 29OW are below the detection limit; however, selenium has been detected at concentrations between the PAL and the enforcement standard at well 30OW, located southeast of the ash disposal facility. Relative to boron and sulfate, selenium is somewhat more strongly adsorbed by soil (higher retardation factor), so selenium will tend to move more slowly through the glacial aquifer than the more conservative contaminants.

The distribution of iron in the groundwater samples was somewhat erratic and contained some apparent inconsistencies. In general, higher iron concentrations were reported for the HydroPunch samples than for the monitoring well samples, with several samples exceeding the enforcement standard for iron. Viewed independently, the results suggest that iron is more concentrated in the groundwater within the slag than in the fly ash; however, the leach test results and total metals results for iron did not indicate a significant difference between fly ash and slag. In addition, the iron concentration reported for the sample from well 36OW was below detection (<0.005), while the HydroPunch sample from approximately the same depth interval in the same boring contained a reported iron concentration of 0.129 mg/l.

Another interesting observation regarding the iron concentrations is that high iron levels in the groundwater tend to correlate with low selenium concentrations and vice versa. This apparent correlation may reflect geochemical interactions between iron and selenium. In the presence of iron, selenium may be coprecipitated with pyrite, may form ferroselite ($FeSe_2$) or may be adsorbed on ferric oxyhydroxides (Hem, 1985). It is possible that, where iron concentrations are high in the ash or slag, selenium is taken out of solution through precipation or adsorbtion; however, these processes have not been researched as part of this investigation. These processes might also explain why selenium has not been detected at downgradient monitoring wells 18OW and 29OW. In column leaching tests on fly ash samples, Warren and Dudas (1986) found that selenium was relatively leachable, but was attenuated through precipitation or reaction with secondary minerals in the ash.

7.0 DISCUSSION

The purpose of the field investigation was to investigate the likely impact on groundwater quality of lining or abandoning the WPDES lagoons. To accomplish this objective, several types of data were evaluated, including historical groundwater monitoring data, regional and site geology and hydrogeology, and physical and analytical test results for ash/slag samples and groundwater samples. This section of the report summarizes the findings of the field investigation as they relate to the evaluation of the likely impact on groundwater of lining or abandoning the lagoons.

The objective of lining or abandoning the WPDES lagoons would be to eliminate leakage from the lagoons as a source of water infiltrating into the ash disposal facility. Although the water quality in the lagoons is quite good, meeting NR 140 groundwater standards, the infiltration of water from the lagoons causes groundwater mounding within the ash disposal facility. The water table is currently 5 to 15 feet above the base of the disposal facility.

The material underlying the WPDES lagoons appears to be primarily slag. Prior to the field investigation, it was believed that the WPDES lagoons might overly several feet of ash deposited prior to construction of the lagoons. However, borings adjacent to the WPDES lagoons encountered almost entirely slag, with a thin layer of fly ash just above native soil in two of the three borings. Thus, water leaking out to the lagoons and moving downward encounters primarily slag, which is relatively inert, and not fly ash.

The hydraulic conductivity of the slag is much greater than that of the fly ash, so most water movement through the waste disposal facility is probably occurring in the slag. Although the WPDES lagoons cause the water table to be elevated in the western portion of the site, the low hydraulic conductivity of the fly ash probably limits the rate of water movement in this area. The continuing improvement in water quality at monitoring wells 4OW and 5OW also suggests that flow of contaminated water out of the western portion of the landfill is limited.

Water which is leaking out of the WPDES ponds, moving downward through the slag beneath the ponds, and entering the glacial aquifer appears to contain relatively low levels of contaminants. Contaminant concentrations in groundwater samples collected from the slag adjacent to the WPDES lagoons exceeded NR 140 enforcement standards only for iron and, in a single sample, selenium. At 13 μg/l, the maximum selenium concentration was only slightly above the enforcement standard of 10 μg/l. The results for iron were conflicting, with HydroPunch sample results exceeding the enforcement standard and monitoring well concentrations below detection. ASTM leach test results for slag samples collected from borings SB101, SB102 and SB103 did not include any enforcement standard exceedances.

Contaminant concentrations at monitoring well 20OW, believed to be screened in the native soils immediately below the slag, are below the PALs (including proposed indicator parameters PALs) for all parameters except iron and sulfate. Sulfate concentrations at well 20OW are below the enforcement standard, but iron levels at this well typically exceed the enforcement standard. In general, groundwater quality at this well is much better than at the downgradient wells, so vertical leakage from the lagoons, through the underlying slag and into the native soil does not appear to be a significant source of the groundwater contamination at the south end of the site.

Contaminant concentrations in the groundwater/leachate in the western portion of the site exceed NR 140 groundwater standards for some parameters, but generally are lower than contaminant concentrations at the downgradient monitoring wells. Groundwater samples from monitoring wells 37OW, 38ROW and 39ROW contained concentrations of boron, conductivity and TDS above the proposed PALs; however, the concentrations at these wells were lower than those reported for wells 18OW and 29OW, the most contaminated downgradient wells. A similar pattern was observed for sulfate concentrations, which exceeded the enforcement standard at the wells installed within the landfill, but were lower at these wells than at the downgradient wells. These results suggest that the worst contamination has already reached the downgradient wells.

The groundwater monitoring data for downgradient wells 18OW and 29OW also suggest that contaminant concentrations are at or near their peak. TDS and sulfate concentrations at these wells, which had been increasing for several years, appear to have leveled off and/or decreased during the last three years. Boron concentrations appear to have leveled off at well 18OW. At well 29OW, boron levels are still increasing slightly, but the rate of increase appears to have slowed.

If infiltration from the WPDES lagoons was eliminated, the water table would still be above the base of the ash disposal facility, based on water levels at the surrounding monitoring wells. However, the thickness of submerged ash would be somewhat less than was previously estimated by Dames & Moore (1992) based on assumed landfill base elevation of 586.6 feet MSL. As shown in cross section A-A' (**Plan Sheet 3**), the base of the landfill slopes upward toward the north end of the landfill, so that the ash/soil contact was at an elevation of 595 feet MSL. Even without infiltration from the WPDES lagoons, a slight groundwater mound would probably be present because the ash disposal facility is a local topographic high point.

Outside the design management zone, NR 140 standards have been exceeded at wells 3ROW, 30OW and 32OW. At well 3ROW, located southeast of the disposal facility on the north side of Black River Road, sulfate concentrations exceeding the enforcement standard and TDS levels above the PAL have been reported. At well 30OW, located southeast of the disposal facility on the east side of Lakeshore Drive, selenium concentrations above the PAL and sulfate levels above the enforcement standard have been reported. At well 32OW, located south of the facility, iron concentrations have been erratic, changing from above the enforcement standard to below the detection limit to above the PAL for successive sampling rounds.

The source of contaminants southeast of the facility at wells 3ROW and 30OW is not clear. Based on the water table maps prepared for this and previous investigations, these wells are not located downgradient of wells 29OW and 18OW, which have showed the highest levels of contamination. The groundwater flow direction in the vicinity of wells 3ROW and 30OW appears to be to the south-southwest. Based on the water table, if the ash disposal facility is the source of the contaminants at these wells, then contaminants must have moved east out of the northern portion of the facility, then moved with the groundwater in an arc curving clockwise towards the south. Given the relatively low permeability of most of the site soils, the travel time along this path would be expected to be long. However, monitoring well 7OW, on the east side of the ash disposal facility has typically not shown PAL exceedances. No other potential sources of contamination have been identified upgradient of wells 3ROW and 30OW. If the ash disposal facility is the source, contamination is most likely related to leaching of ash during early site operation, prior to construction of the WPDES basins. Currently, groundwater beneath the WPDES basins on the east side of the disposal facility does not appear to be a major source of contaminants.

In summary, lining or abandonment of the lagoons does not appear to be warranted at this time. The lagoons overlie mostly slag, with very little fly ash. Since slag is much more permeable than the fly ash disposed of in the western portion of the site, most of the water leaking out of the lagoons probably moves vertically down through the slag, which is relatively inert, and into the glacial aquifer. In the western portion of the site, much of the available contamination appears to have already been leached out of the ash, since groundwater/leachate contaminant concentrations within the landfill are lower than the concentrations reported for downgradient monitoring wells within the design management zone. The only contaminants which have exceeded enforcement standards outside the design management zone are sulfate and iron, which are public welfare parameters. The enforcement standard for iron has been periodically exceeded at well 32OW and sulfate concentrations above the enforcement standard have been reported at wells 3ROW and 30OW. The PAL for selenium has been exceeded at well 30OW. Based on the estimated groundwater flow pattern, NR 140 standard exceedances for sulfate and selenium southeast of the ash disposal facility (wells 3ROW and 30OW) appear to be related to contaminant discharges from the east side of the ash disposal facility prior to construction of the WPDES lagoons. Since construction of the lagoons, the ash disposal facility does not appear to provide a continuing source for contaminants at these locations.

8.0 RECOMMENDATIONS

To continue to evaluate groundwater impacts related to the closed ash disposal facility, the following approach is recommended:

1) Continue current quarterly groundwater monitoring program.

2) Collect water samples from the four wells installed within the ash disposal facility annually for three years, beginning in September 1993. Sample surface water in one of the WPDES lagoons on the same schedule. Analyze the samples for the same parameters included in the current groundwater monitoring program. Submit the results to the DNR with the quarterly monitoring program data.

3) Collect water level measurements from wells 36OW, 37OW, 38ROW and 39ROW for four quarters beginning in September 1993, to evaluate variability in water levels within the landfill. After the first four quarters of water level measurements, meaure

water levels annually in conjunction with the groundwater sampling. Submit the results to the DNR with the quarterly monitoring program data.

4) After three years of additional monitoring, review the data and prepare a follow-up report for submittal to the DNR. The report should evaluate how the data support or oppose the hypotheses developed in this report regarding anticipated decreases in downgradient concentrations. The report should also identify NR 140 exceedances and discuss their cause and significance.

An additional recommendation for immediate implementation is to abandon monitoring wells 38OW and 39OW in accordance with NR 141, since these wells are dry or nearly dry and will not be used for any future sampling.

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TABLES

Table 1

Lagoon Water Quality Data

Parameter	Slag Basin	North WPDES Lagoon	South WPDES Lagoon	Primary Pond	Secondary Pond	Final Effluent Pond	Coal Pile Retention Basin
Arsenic (μg/l)	--	--	--	--	--	--	ND
Barium (mg/l)	--	--	--	--	--	--	0.056
Boron (mg/l)	0.49	0.63	0.74	0.66	0.78	0.63	--
Cadmium (μg/l)	--	--	--	--	--	--	ND
Calcium (mg/l)	40	53	49	53	50	49	--
Chromium (μg/l)	--	--	--	--	--	--	ND
Iron (mg/l)	ND	0.20	ND	0.36	0.03	ND	0.02
Lead (μg/l)	--	--	--	--	--	--	ND
Magnesium (mg/l)	11	12	11	11	11	11	--
Manganese (mg/l)	--	--	--	--	--	--	0.03
Mercury (μg/l)	--	--	--	--	--	--	ND
Potassium (mg/l)	1.7	2.5	1.8	2.2	2.2	2.1	--
Selenium (μg/l)	--	--	--	--	--	--	ND
Silver (μg/l)	--	--	--	--	--	--	ND
Sodium (mg/l)	5.9	19.7	10.3	16.6	13.2	12.6	--
Sulfate (mg/l)	27	125	68	100	81	97	590
Alkalinity (mg/l)	103	73	93	90	93	92	--
COD (mg/l)	ND	9	ND	ND	7	ND	--
Hardness (mg/l)	145	180	165	180	170	170	--
TDS (mg/l)	108	198	162	194	178	178	--
Conductivity (μmhos/cm)	281	412	330	381	355	351	1,049
pH (standard units)	7.46	7.28	7.49	7.52	7.68	7.78	7.96
Temperature (°C)	12.5	15.25	18.0	17.0	14.5	14.75	12.5

Note: Samples collected on October 10, 1991 and reported by Simon Hydro-Search, Inc. (1992).

Table 2

Proposed PALs and Background Water Quality Statistics

	Alkalinity	Boron	Conductivity	PH	Sodium	TDS
Number of Observations	44	45	45	43	37	45
Minumum	100	<0.05	440	6.60	5	310
Maximum	635	0.79	1428	8.10	82	770
Mean	331	0.12	812	7.13	26	509
Standard Deviation	79	0.12	258	0.28	22	131
Minimum increase per s. NR 140.20(2)	100	2	200	±1.0	10	200
Proposed PAL	570	2.1	1600	>8.1 or <6.1	92	900

Notes:

1) Background water quality data summary based on groundwater monitoring results from wells 1OW and 2OW during the 5-year period from March 1987 through December 1992.

2) Proposed PALs are rounded to two significant figures.

Table 3

Physical Characteristics of Fly Ash and Slag

Parameter	Fly Ash	Slag
Grain Size Distribution		
D90 (mm)	0.05	2.4
D60 (mm)	0.01	1.1
D30 (mm)	0.007	0.48
D10 (mm)	0.0023	0.11
Uniformity Coefficient (D60/D10)	4.3	10
Hydraulic Conductivity (cm/s)	4.5×10^{-8}	1.9×10^{-1}
Moisture Content (percent)	36.8	7.2

Notes:

1) Grain size distribution based on sieve and hydrometer analysis of site-wide ash composite and slag composite samples. D90 indicates 90th percentile for grain size (i.e. 90% of particles are finer than D90 particle size).

2) Hydraulic conductivity of fly ash based on laboratory falling head test of Shelby tube ash sample. Hydraulic conductivity of slag based on slug test at well 36OW, which was screened entirely in slag.

3) Moisture content shown is for site-wide ash and slag composite samples. Moisture content varies significantly between individual samples (see boring logs in **Appendix A**); however, the fly ash typically has a higher moisture content than the slag, especially above the water table.

Table 4

Bulk Chemical Analysis Results for Fly Ash and Slag Composites

Parameter	Concentration (mg/kg)	
	Fly Ash Composite	Slag Composite
Aluminum	57,200	32,500
Antimony	<5.0	NA
Arsenic	105	5.85
Barium	236	112
Beryllium	18.2	NA
Boron	771	99.2
Cadmium	20.8	2.16
Calcium	13,500	18,900
Chloride	67	<1.0
Chromium	184	53.7
Cobalt	44.3	NA
Copper	149	20.5
Fluoride	1.76	NA
Iron	41,800	36,300
Lead	546	33.7
Magnesium	2,330	2,090
Manganese	189	241
Mercury	0.08	<0.02
Molybdenum	56.6	NA
Nickel	177	41.9
Nitrate/Nitrite	0.47	NA
Phosphorous	900	200
Potassium	1,250	5,100
Selenium	9.4	0.8
Silicon	4,850	8,080
Silver	0.52	<0.1
Sodium	1,130	797
Strontium	317	87.6
Sulfur	<250	<250
Tin	6.17	NA
Titanium	3,310	1,280
TOC	34,000	NA
TOX	65	NA
Vanadium	307	NA
Zinc	2,190	145

NA - Sample not analyzed for given parameter

Table 5

Mineral Analysis Results for Fly Ash and Slag Composites

Parameter	Composition (percent)	
	Fly Ash Composite	Slag Composite
Aluminum oxide	21.60	12.27
Barium oxide	0.03	0.01
Calcium oxide	1.89	2.64
Iron oxide	11.98	10.31
Manganese oxide	0.08	0.08
Phosphorous pentoxide	0.41	0.04
Potassium oxide	0.30	1.23
Silicon dioxide	2.19	3.65
Sodium oxide	0.31	0.21
Strontium oxide	0.06	0.01
Sulfur trioxide	0.01	0.01
Titanium dioxide	0.55	0.21
Undetermined	60.59	69.33
Silicon, dry basis	0.485	0.808
Silicon, as received	0.361	0.767
Boron, dry basis	0.077	0.0099
Boron, as received	0.057	0.0094
Sulfur, dry basis	<0.025	<0.025

Table 6

Water Leach Test Results for Fly Ash and Slag

Parameter	Concentration (mg/l)						NR 140 Standards (mg/l)		
	Fly Ash			Slag			PAL	ES	Type
	Feb 93	Sep 81	Oct 80	Feb 93	Sep 81	Oct 80			
	ASTM	EP Tox @ pH 7	EP Tox @ pH 7	ASTM	EP Tox @ pH 7	EP Tox @ pH 7			
Alkalinity	37	NA	20.2	6	NA	9.9	570	–	IN
Aluminum	1.1	NA	NA	NA	NA	NA	–	–	–
Antimony	0.029	NA	NA	NA	NA	NA	–	–	–
Arsenic	0.026	0.010	<0.01	0.005	0.001	<0.01	0.005	0.050	PH
Barium	0.078	0.8	<0.2	0.006	0.5	<0.2	0.2	5.0	PH
Beryllium	<0.002	NA	NA	NA	NA	NA	–	–	–
Boron	4.49	2.2	4.15	NA	<0.05	1.72	2.1	–	IN
Cadmium	<0.001	0.03	<0.04	<0.001	<0.01	<0.04	0.001	0.010	PH
Calcium	81.4	300	211	NA	0.54	0.34	NC	–	IN
Chloride	2.5	2.0	1.0	<1.0	1.0	<0.5	125	250	PW
Chromium	0.0011	0.06	0.02	NA	0.03	<0.02	0.005	0.050	PH
Cobalt	<0.015	NA	NA	NA	NA	NA	–	–	–
Conductivity (μmho/cm)	480	3,720	2,880	47	38	19	1600	–	IN
Copper	<0.002	0.03	0.04	<0.002	0.02	<0.04	0.5	1.0	PW
Fluoride	0.85	1.9	0.79	NA	<0.1	<0.05	0.44	4.0	PH
Hardness	210	1,170	895	18	25	8	NC	–	IN
Iron	0.011	0.13	0.05	0.035	0.43	0.57	0.15	0.3	PW
Lead	<0.005	0.01	<0.05	<0.005	<0.01	<0.05	0.005	0.050	PH
Magnesium	2.66	18	9.25	1.04	0.16	0.19	NC	–	IN
Manganese	0.011	NA	0.26	NA	NA	<0.04	0.025	0.05	PW
Mercury	<0.0002	0.0003	0.0002	<0.0002	0.0002	<0.0002	0.0002	0.002	PH
Molybdenum	514	NA	NA	NA	NA	NA	–	–	–
Nickel	0.014	0.12	0.08	<0.018	0.03	<0.03	–	–	–
Nitrate/Nitrite	0.03	<0.1	0.10	NA	<0.1	0.09	2	10	PH
pH (S.U.)	8.83	7.0	7.0	8.13	7.0	7.0	8.1	–	IN
Phosphorous	<0.1	NA	<0.1	NA	NA	<0.1	–	–	–

(continued on next page)

Table 6 (continued)

Parameter	Concentration (mg/l)						NR 140 Standards (mg/l)		
	Fly Ash			Slag			PAL	ES	Type
	Feb 93	Sep 81	Oct 80	Feb 93	Sep 81	Oct 80			
	ASTM	EP Tox @ pH 7	EP Tox @ pH 7	ASTM	EP Tox @ pH 7	EP Tox @ pH 7			
Potassium	4.1	114	26.2	0.9	0.85	2.5	NC	–	IN
Selenium	0.031	0.005	<0.01	0.003	<0.001	<0.01	0.001	0.010	PH
Silicon	672	NA	NA	NA	NA	NA	–	–	–
Silver	<0.0008	NA	<0.01	<0.0008	NA	<0.01	0.010	0.050	PH
Sodium	4.55	70	130	1.57	5.8	7.2	92	–	IN
Strontium	0.731	NA	NA	NA	NA	NA	–	–	–
Sulfate	320	2,300	1,740	NA	1.0	<2	125	250	PW
TDS	420	3,570	NA	130	38	NA	900	–	IN
Tin	<0.080	NA	NA	NA	NA	NA	–	–	–
TOC	1.9	NA	NA	NA	NA	NA	NC	–	IN
TOX	0.013	NA	NA	NA	NA	NA	NC	–	IN
Vanadium	0.054	NA	NA	NA	NA	NA	–	–	–
Zinc	0.010	<0.01	6.75	0.010	<0.01	2.75	2.5	5	PW

NR 140 Standard Types: PH - Public Health, PW - Public Welfare, IN - Indicator (proposed PALs)
NA - Sample not analyzed for given parameter.
NC - PAL not calculated for given indicator parameter, because parameter is not included in groundwater monitoring program.

Notes:

1) February 1993 results are for ASTM leach testing for site-wide ash and slag composite samples.

2) September 1981 results are for fresh fly ash and slag samples using the EP Toxicity leaching procedure with the pH adjusted to 7 (Donohue, 1983).

3) October 1980 results are for fresh ash and slag samples using the EP Toxicity leaching procedure with the pH adjusted to 7 (Donohue, 1980).

4) For samples analyzed using the EP Toxicity procedure, reported concentrations of hardness, TDS and conductivity may be elevated due to the addition of acids and bases used to adjust the leachate pH (Donohue, 1983).

Table 7

Percentage of Fly Ash and Slag in Composite Samples

Sample ID	Description	Percent Fly Ash	Percent Slag
H-1	Horizontal composite - shallow depth	48	52
H-2	Horizontal composite - mid-depth	82	18
H-3	Horizontal composite - deep	62	38
SB107	Vertical composite	77	33
SB108	Vertical composite	83	17
SB109	Vertical composite	80	20
SB110	Vertical composite	60	40
SB111	Vertical composite	86	14
SB112	Vertical composite	68	32
SB113	Vertical composite	63	37

Note: The percentage of fly ash in each sample was assumed equal to the percent passing a #200 sieve (0.075 mm). This size was selected as the dividing point because, grain size analysis of the site-wide slag composite and fly ash composite samples indicated that the #200 sieve passes 93% of the fly ash and retains 92% of the slag.

Table 8

Hydraulic Conductivity Test Results

Well/Boring	Type of Material Tested	Test Description	Hydraulic Conductivity	
			(ft/min)	(cm/s)
36OW	Slag	Slug Test #1	3.9×10^{-1}	2.0×10^{-1}
		Slug Test #2	3.7×10^{-1}	1.9×10^{-1}
		Mean	3.8×10^{-1}	1.9×10^{-1}
37OW	Fly Ash/Slag	Slug Test	9.4×10^{-5}	4.8×10^{-5}
38ROW	Slag/Fly Ash	Slug Test #1	1.6×10^{-1}	8.0×10^{-2}
		Slug Test #2	1.1×10^{-1}	5.8×10^{-2}
		Mean	1.4×10^{-1}	6.9×10^{-2}
39ROW	Fly Ash/Slag	Slug Test	1.2×10^{-3}	6.3×10^{-4}
20OW	Silt/Sand/Clay	Slug Test #1	5.7×10^{-2}	2.9×10^{-2}
		Slug Test #2	5.1×10^{-2}	2.6×10^{-2}
		Slug Test #3	6.1×10^{-2}	3.1×10^{-2}
		Mean	5.6×10^{-2}	2.9×10^{-2}
SB114	Fly Ash - Shelby Tube Sample	Falling Head Permeability Test	8.9×10^{-8}	4.5×10^{-8}

Table 9

Water Level Measurements

Monitoring Point	Top-of-Casing Elevation (ft MSL)	Date	By	Depth to Water (ft)	Water Elevation (ft MSL)
NEW WELLS					
36OW	615.76	3/04/93 3/19/93	MES MES	13.28 13.78	602.48 601.98
37OW	616.12	3/04/93 3/19/93	MES MES	16.04 15.62	600.08 600.50
38ROW	622.03	3/05/93 3/19/93	MES MES	21.98 21.35	600.05 600.68
39ROW	615.17	3/05/93 3/19/93	MES MES	16.72 16.86	598.45 598.31
EXISTING WELLS					
1OW	--	3/05/93	RMT	--	588.19
2OW	--	3/05/93	RMT	--	607.65
3ROW	--	3/05/93	RMT	--	585.78
4OW	--	3/05/93	RMT	--	584.05
5OW	--	3/05/93	RMT	--	596.26
6ROW	--	3/05/93	RMT	--	Frozen
7OW	--	3/05/93	RMT	--	Frozen
18OW	--	3/05/93	RMT	--	584.31
20OW	--	3/05/93	RMT	--	599.31
29OW	--	3/05/93	RMT	--	Frozen
29A	--	3/05/93	RMT	--	Frozen
30OW	--	3/05/93	RMT	--	585.35
31OW	--	3/05/93	RMT	--	583.95
32OW	--	3/05/93	RMT	--	583.88
LAGOONS					
Slag basin	--	Typical	D&M	--	606
WPDES lagoons	--	Typical	D&M	--	610
Primary pond	--	Typical	D&M	--	600
Secondary pond	--	Typical	D&M	--	589

Notes:

1) Lagoon elevations shown were taken from the Dames & Moore Feasibility Study (1992) and are based on measurements and design information. Elevations were rounded to the nearest foot and are assumed to be typical.

2) New well water levels measured March 4-5, 1993 were measured prior to well development. Water levels dated March 19, 1993 were measured prior to sampling the wells, approximately one week after development was completed.

Table 10

Ash/Slag Sample Total Metals Results

Sample Number	Sample Depth (ft)	Sample Elevation (ft MSL)	Sample Description	Boron (mg/kg)	Iron (mg/kg)	Selenium (mg/kg)	Sodium (mg/kg)
SB101-5	10-12	602-604	Slag	87.4	42,800	0.6	693
SB101-9	20-22	592-594	Slag	34.1	22,300	0.2	375
SB101-12	26-28	586-588	Slag/Fly Ash	246	56,900	7.2	1,110
SB102-5	10-12	602-604	Slag	49.6	20,100	0.4	413
SB102-9	18-20	594-596	Slag	57.7	29,600	0.4	606
SB102-12	24-26	588-590	Slag/Fly Ash	264	46,200	5.4	969
SB103-6	12-14	599-601	Slag	66.7	29,800	0.4	588
SB103-9	18-20	593-595	Slag	47.4	32,100	0.6	612
SB103-13	26-28	585-587	Slag	53.5	30,900	0.6	701
SB104-5	10-12	602-604	Fly Ash/Slag	288	43,300	5.6	1,220
SB104-9	18-20	594-596	Fly Ash	434	53,300	5.4	2,230
SB105-6	12-14	606-608	Fly Ash	922	53,700	11.0	3,040
SB105-11	22-24	596-598	Fly Ash	621	49,100	8.0	1,900
Duplicate				464	46,600	5.5	1,770
SB105-15	30-32	588-590	Fly Ash	688	56,400	8.5	1,770
SB106-4	8-10	603-605	Fly Ash	510	45,900	15.0	1,390
SB106-9	18-20	593-595	Fly Ash/Slag	512	48,700	9.7	1,830
Composite H1	Various	605-610	Slag/Fly Ash	318	38,000	6.8	1,390
Composite H2	Various	597-602	Fly Ash/Slag	460	45,400	4.8	940
Composite H3	Various	587-592	Fly Ash/Slag	705	46,900	8.0	766

Table 11

Ash/Slag Sample Water Leach Test Results

Sample Number	Sample Depth (ft)	Sample Elevation (ft MSL)	Sample Description	Alkalinity (mg/l)	Boron (mg/l)	Chloride (mg/l)	Conductivity (µmho/cm)	Iron (mg/l)	pH (S.U.)	Selenium (µg/l)	Sodium (mg/l)	Sulfate (mg/l)	TDS (mg/l)
SB101-5	10-12	602-604	Slag	8	0.084	<1.0	22	<0.010	8.15	4	0.79	<3	140
SB101-9	20-22	592-594	Slag	8	0.026	<1.0	12	0.134	8.10	<1	0.87	<3	100
SB101-12	26-28	586-588	Slag/Fly Ash	16	0.206	1.0	240	<0.010	7.59	6	0.98	84	210
SB102-5	10-12	602-604	Slag	16	0.018	2.5	32	0.010	7.81	<1	0.74	4	120
SB102-9	18-20	594-596	Slag	11	<0.016	<1.0	29	0.212	7.83	1	0.93	5	90
SB102-12	24-26	588-590	Slag/Fly Ash	20	0.158	<1.0	35	0.062	7.72	7	0.50	11	38
SB103-6	12-14	599-601	Slag	11	0.022	1.0	17	<0.010	7.70	<1	0.84	5	170
SB103-9	18-20	593-595	Slag	7	0.016	<1.0	20	<0.010	7.62	<1	0.43	4	160
SB103-13	26-28	585-587	Slag	23	0.026	1.5	38	0.094	8.39	2	0.95	4	150
SB104-5	10-12	602-604	Fly Ash/Slag	19	0.624	<1.0	95	<0.010	7.77	4	0.90	22	130
SB104-9	18-20	594-596	Fly Ash	29	2.34	<1.0	150	0.254	7.63	2	1.27	38	130
SB105-6	12-14	606-608	Fly Ash	12	3.37	1.5	500	<0.010	7.40	17	1.54	280	340
SB105-11	22-24	596-598	Fly Ash	24	3.04	<1.0	240	<0.010	8.33	12	1.37	72	260
Duplicate				24	2.18	1.0	170	<0.010	8.35	11	1.32	130	130
SB105-15	30-32	588-590	Fly Ash	36	2.57	<1.0	240	<0.010	7.67	5	0.41	63	180
SB106-4	8-10	603-605	Fly Ash	22	2.05	<1.0	190	<0.010	7.58	18	6.40	86	140
SB106-9	18-20	593-595	Fly Ash/Slag	31	2.83	2.0	280	<0.010	8.12	26	3.40	180	210
Composite H1	Various	605-610	Slag/Fly Ash	11	1.99	<1.0	370	<0.010	7.65	9	4.10	150	260
Composite H2	Various	597-602	Fly Ash/Slag	41	2.50	2.5	160	0.028	9.31	37	1.27	50	210
Composite H3	Various	587-592	Fly Ash/Slag	32	3.00	1.0	190	<0.010	8.95	18	0.51	51	220
NR 140 PAL	--	--	--	570	2.1	125	1600	0.15	<6.1 or >8.1	1	92	125	900
NR 140 ES	--	--	--	--	--	250	--	0.3	--	10	--	250	--

Notes:

1) PALs shown for indicator parameters are proposed.

2) TDS results may not be reliable due to a relatively high detection limit of 52 mg/l. High TDS results (>100 mg/l) were also reported for a trip blank and two field blanks submitted with the groundwater samples. Conductivity is probably a better indicator of relative TDS concentrations than the TDS results themselves.

Table 12

Groundwater Analytical Results

Sample Number	Sample Depth (ft)	Sample Elevation (ft MSL)	Ash/Slag Sample Description	Alkalinity (mg/l)	Boron (mg/l)	Chloride (mg/l)	Conductivity (μmho/cm)	Iron (mg/l)	pH (S.U.)	Selenium (μg/l)	Sodium (mg/l)	Sulfate (mg/l)	TDS (mg/l)
HYDROPUNCH SAMPLES													
SB101-HP1	14-16	598-600	Slag	84	0.218	14	430	0.129	6.20	9	14.9	72	400
SB101-HP2	24-26	588-590	Slag	150	1.59	17	660	0.475	6.51	1	27.1	140	550
SB102-HP1	14-16	598-600	Slag	120	0.163	16	440	0.755	6.58	2	16.7	71	380
SB102-HP2	24-26	588-590	Slag/Fly Ash	120	0.354	14	480	1.11	6.67	<1	23.0	110	390
SB103-HP1	14-16	597-599	Slag	130	0.564	14	640	0.202	6.57	13	41.6	200	320
SB103-HP2	24-26	587-589	Slag	140	0.462	18	720	4.37	6.47	2	32.4	220	470
Duplicate				130	0.476	16	–	3.40	–	2	33.2	190	200
Field Blank				2	<0.008	<1.0	10	<0.005	6.45	<1	0.279	<3	170
Trip Blank				2	<0.008	<1.0	–	<0.005	–	<1	0.275	3	120
MONITORING WELL SAMPLES													
36-OW	11-16	598-603	Slag	110	0.111	19	530	<0.005	5.15	3.2	21.9	120	310
Duplicate				100	0.154	18	–	<0.005	–	3.5	27.3	110	320
37-OW	15-17	597-599	Fly Ash/Slag	110	21.4	47	1,380	<0.005	5.38	5.0	19.8	540	1,200
38R-OW	20-28	592-600	Fly Ash/Slag	200	16.9	12	1,300	1.54	5.02	<0.8	15.2	610	1,000
39R-OW	15-20	593-598	Fly Ash/Slag	99	33.4	20	1,730	<0.005	4.92	16	21.3	1,100	1,600
Field Blank	–	–	–	<1	0.012	<1.0	20	<0.005	6.30	<0.8	0.27	<3	140
NR 140 PAL	–	–	–	570	2.1	125	1600	0.15	<6.1 or >8.1	1	92	125	900
NR 140 ES	–	–	–	–	–	250	–	0.3	–	10	–	250	–

Notes:

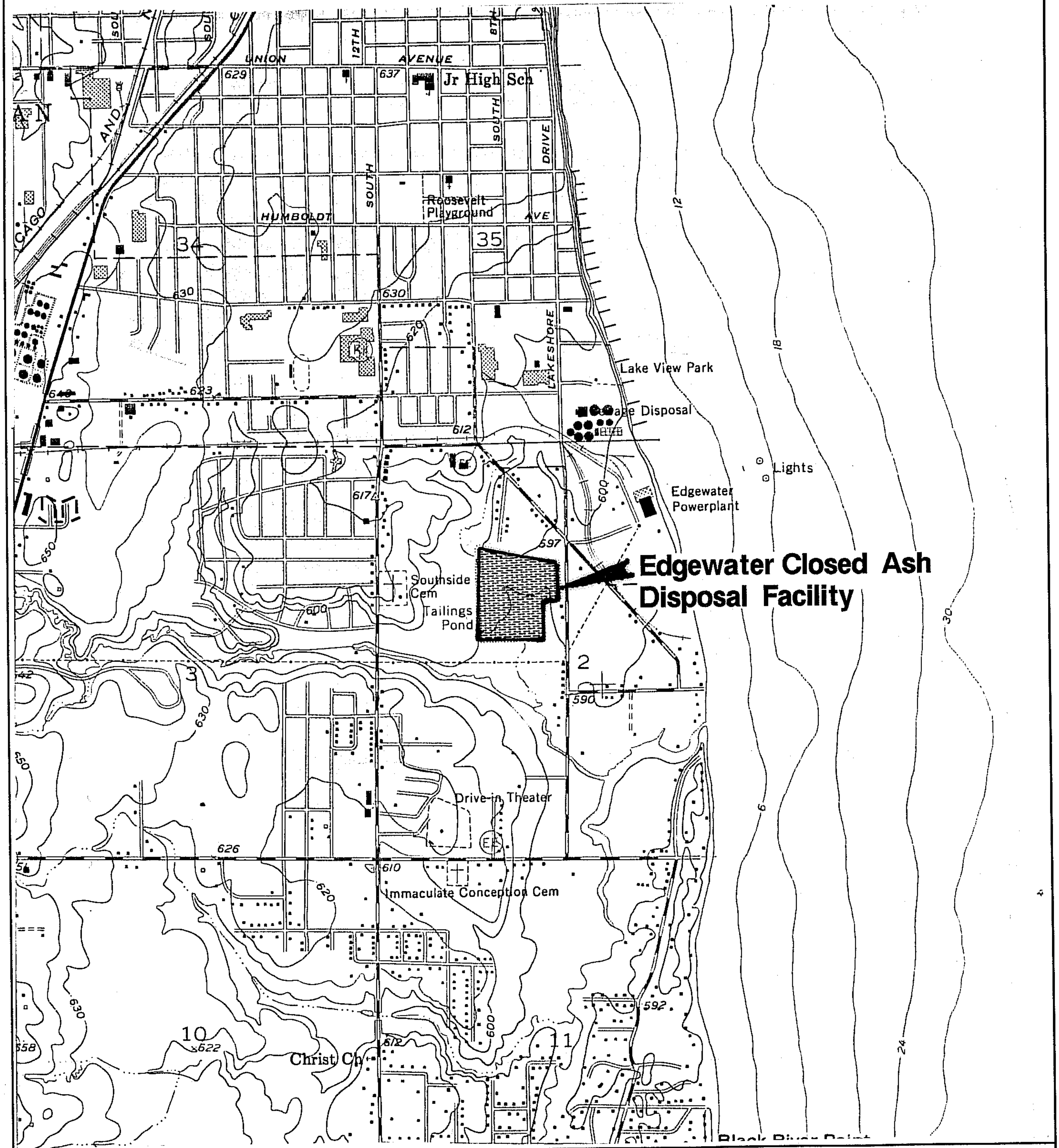
1) PALs shown for indicator parameters are proposed.

2) TDS results may not be reliable, especially at lower concentrations (see **Table 11**, Note 2).

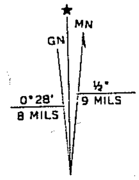
3) Reported field-measured pH values are anomalously low relative to leach test results and previous groundwater monitoring results. The low values are believed to be the result of a pH meter malfunction, and not not truly representative of groundwater conditions.

FIGURES

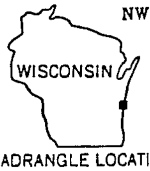
Figure 1



WP&L Edgewater – Site Location Map



UTM GRID AND 1973 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET



QUADRANGLE LOCATION

SHEBOYGAN SOUTH, WIS.
NW/4 SHEBOYGAN SOUTH 15' QUADRANGLE
N4337.5—W8737.5/7.5

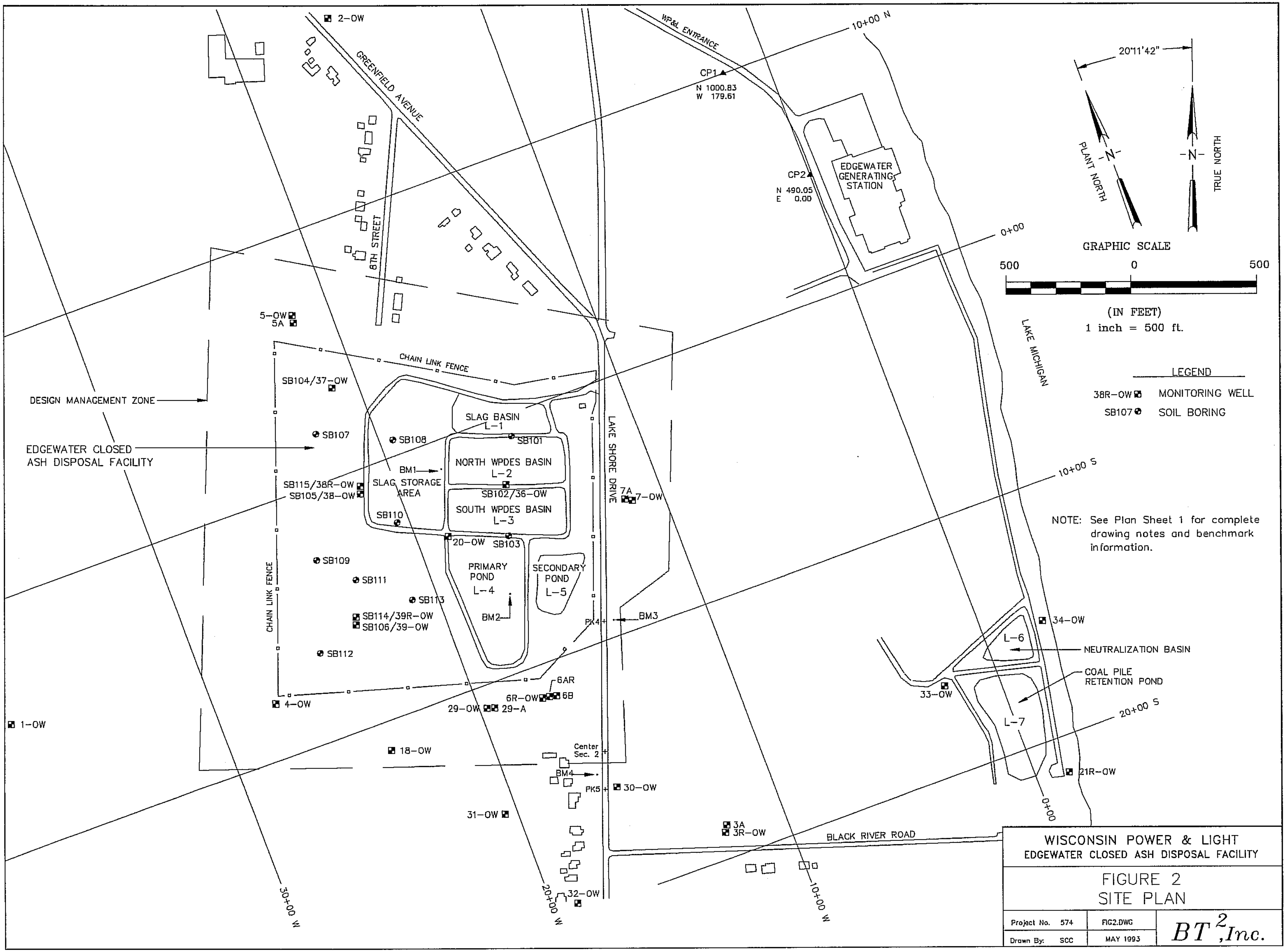
1954

PHOTOREVISED 1973

AMS 3471 II NW—SERIES V861

Scale: 1" = 2000'	fig1.dwg
Project No. 574	11/24/92

BT², Inc.

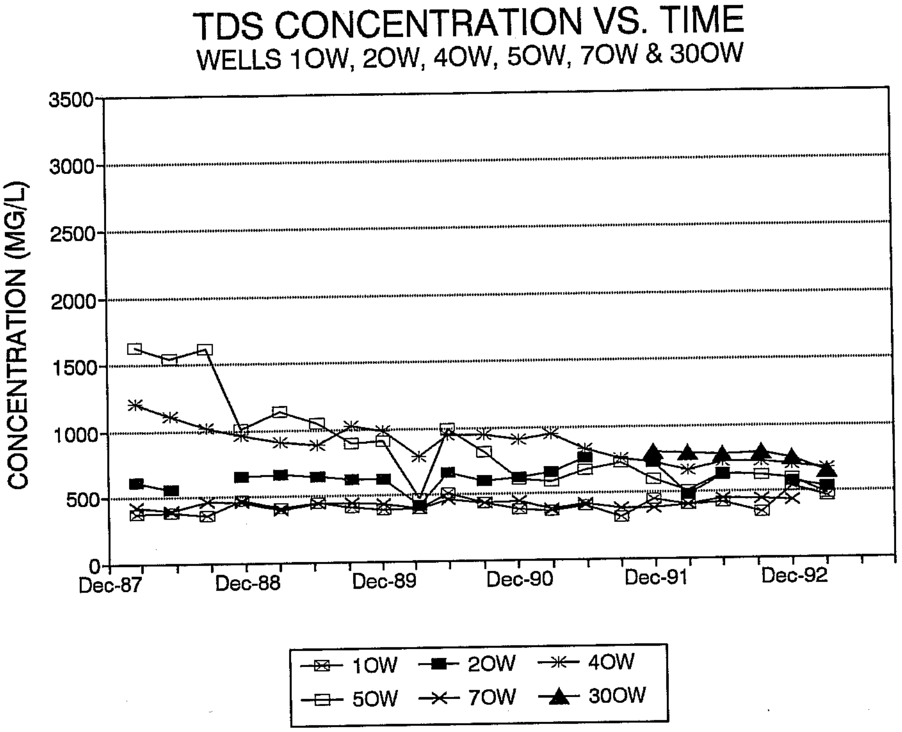


NOTE: See Plan Sheet 1 for complete drawing notes and benchmark information.

WISCONSIN POWER & LIGHT
EDGEWATER CLOSED ASH DISPOSAL FACILITY

FIGURE 2
SITE PLAN

Project No.	574	FIG2.DWG	BT^2,Inc.
Drawn By:	SCC	MAY 1993	



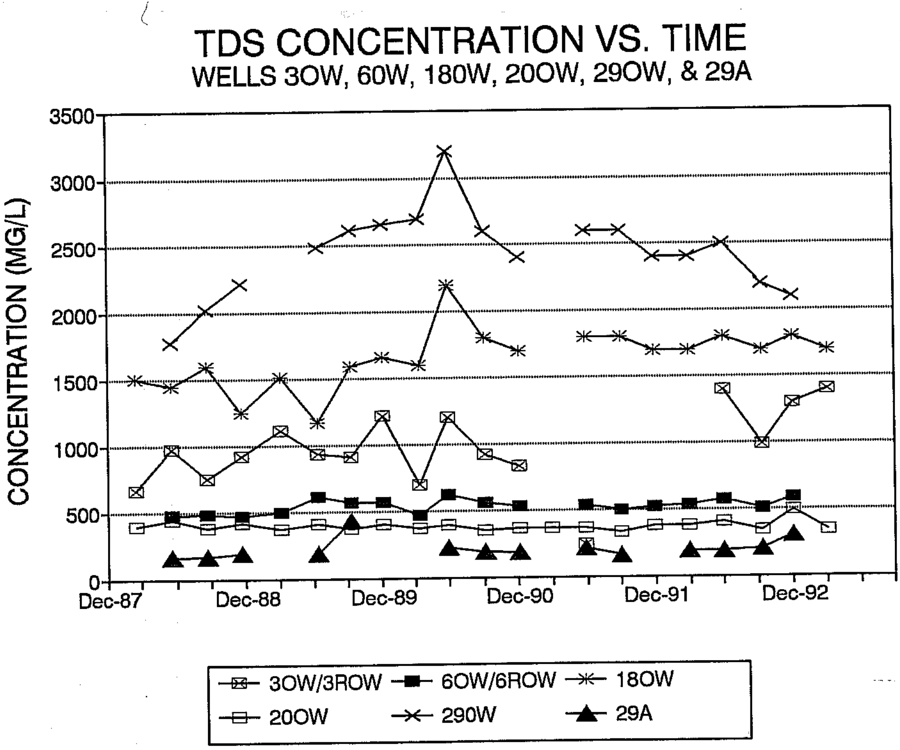


Figure 3

TDS Concentration vs. Time Plots for Monitoring Wells

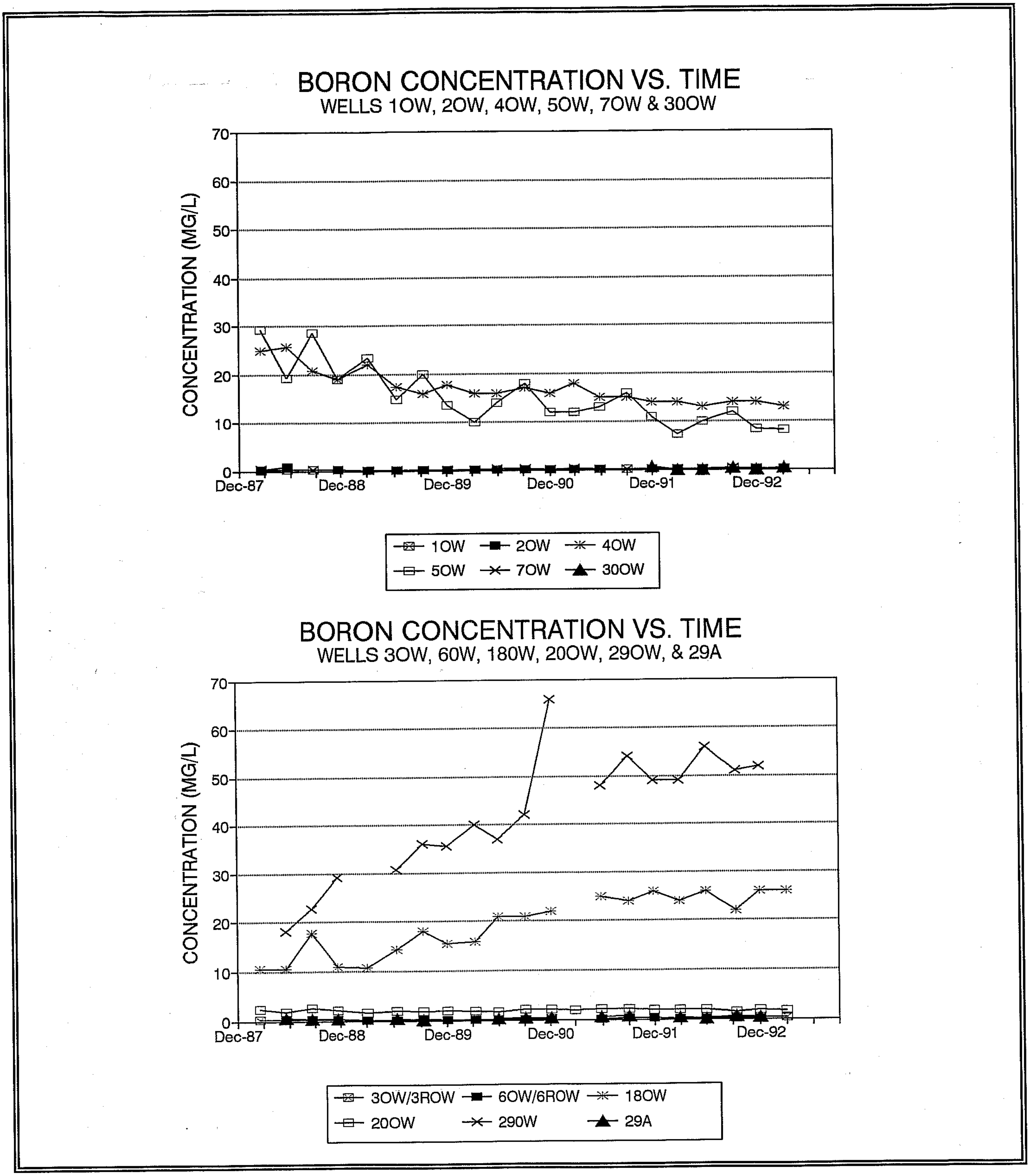
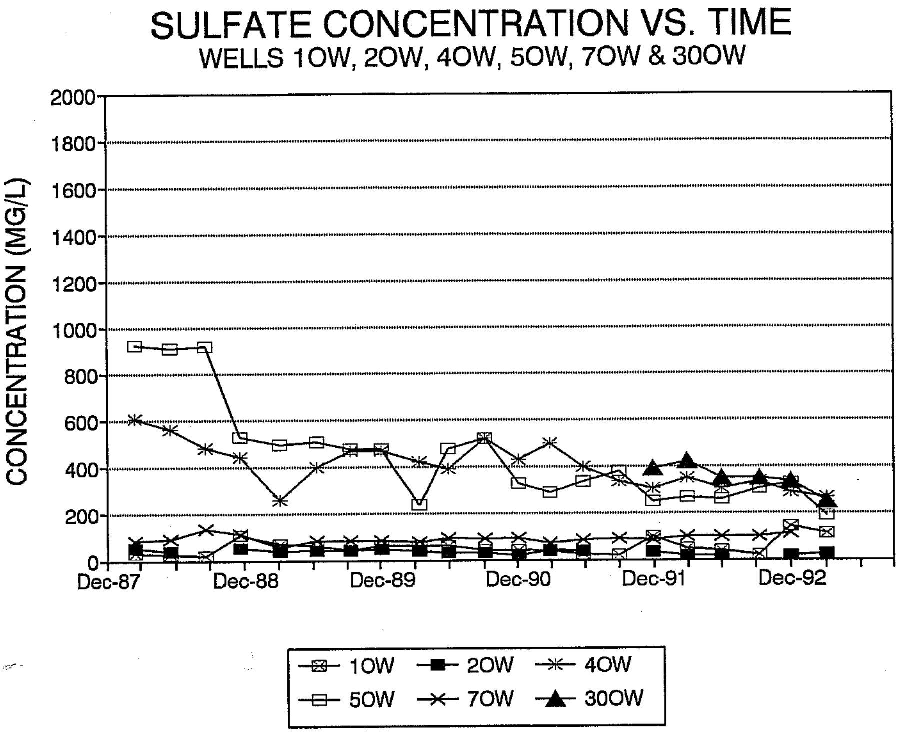


Figure 4

Boron Concentration vs. Time Plots for Monitoring Wells



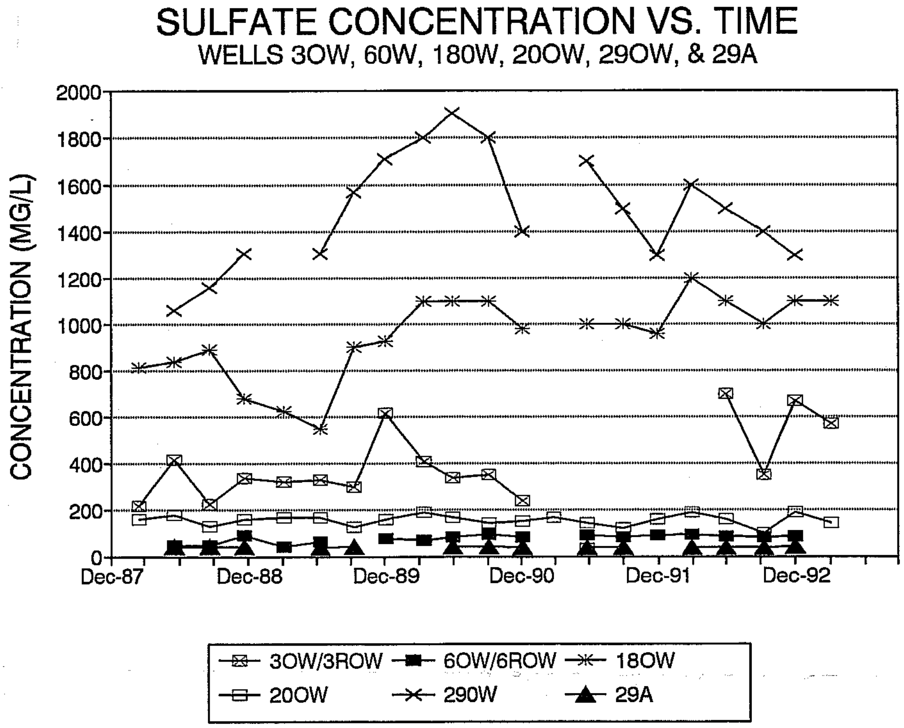


Figure 5

Sulfate Concentration vs. Time Plots for Monitoring Wells

LEGEND

◐ Soil Boring
▣ Monitoring Well
☒ Replacement Monitoring Well
▲ Control Monument

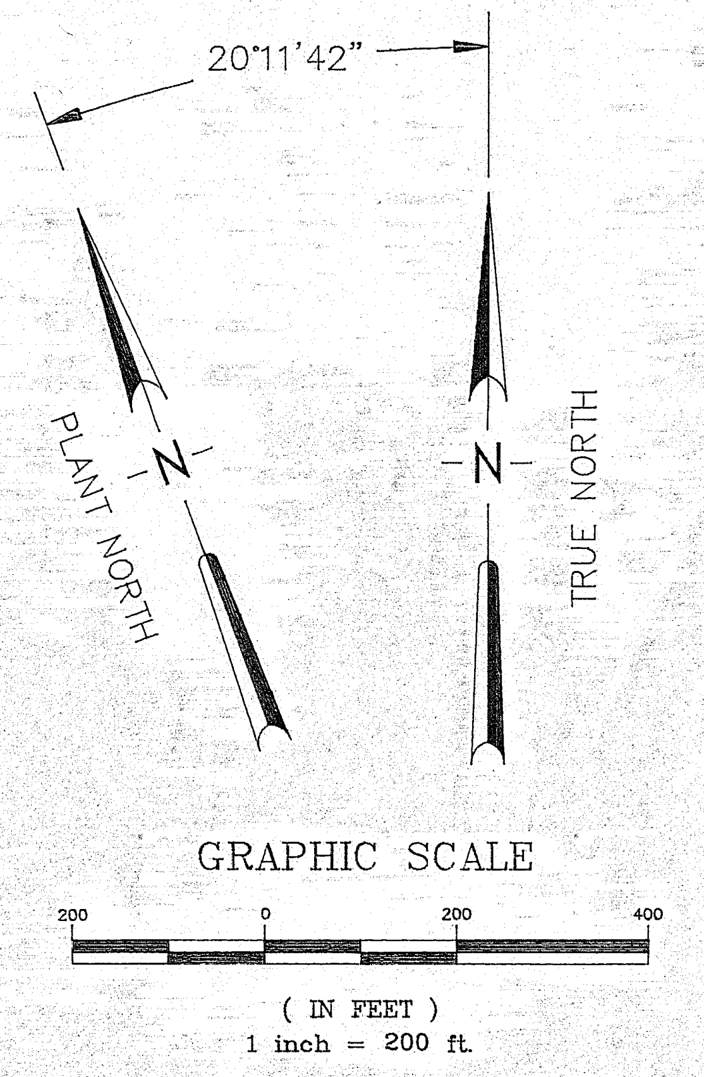
BENCH MARKS

BM1	NE corner of concrete pad for existing shed at sluice box. Elev. = 612.75'
BM2	Chiseled concrete square at top of existing discharge structure. Elev. = 610.62'
BM3	Nail in west face of anchor pole on east side of Lake Shore Drive, across from SE corner of Unit 3 & 4 fence. Elev. = 593.98'
BM4	Nail in east face of power pole on west side of Lake Shore Drive, across from house 4104. Elev. = 592.07'

NOTES

1. Base map prepared by Miller Engineers & Scientists and provided to BT2, Inc. as an AutoCAD file. Some minor revisions made by BT2, Inc.
2. Base map information compiled and digitized from Dames & Moore base map (no date) and Hydro–Search, Inc. Water Table Map, June 3, 1991.
3. Grids and coordinates for the shown observation wells were established in the field by Miller Engineers & Scientists using plant control monuments no. 1 and 2 (CP1 and CP2).
4. Elevations shown hereon are based on U.S.G.S. datum. To obtain plant datum, add 0.79 feet.
5. Observation well elevations, coordinates and construction information can be obtained in the Ground Water Monitoring Well Information Form (W.D.N.R. Form 4400–89); in the Appendix of the Project Manual (M.E.S. Job No. 12197E).
6. Observation well text examples:

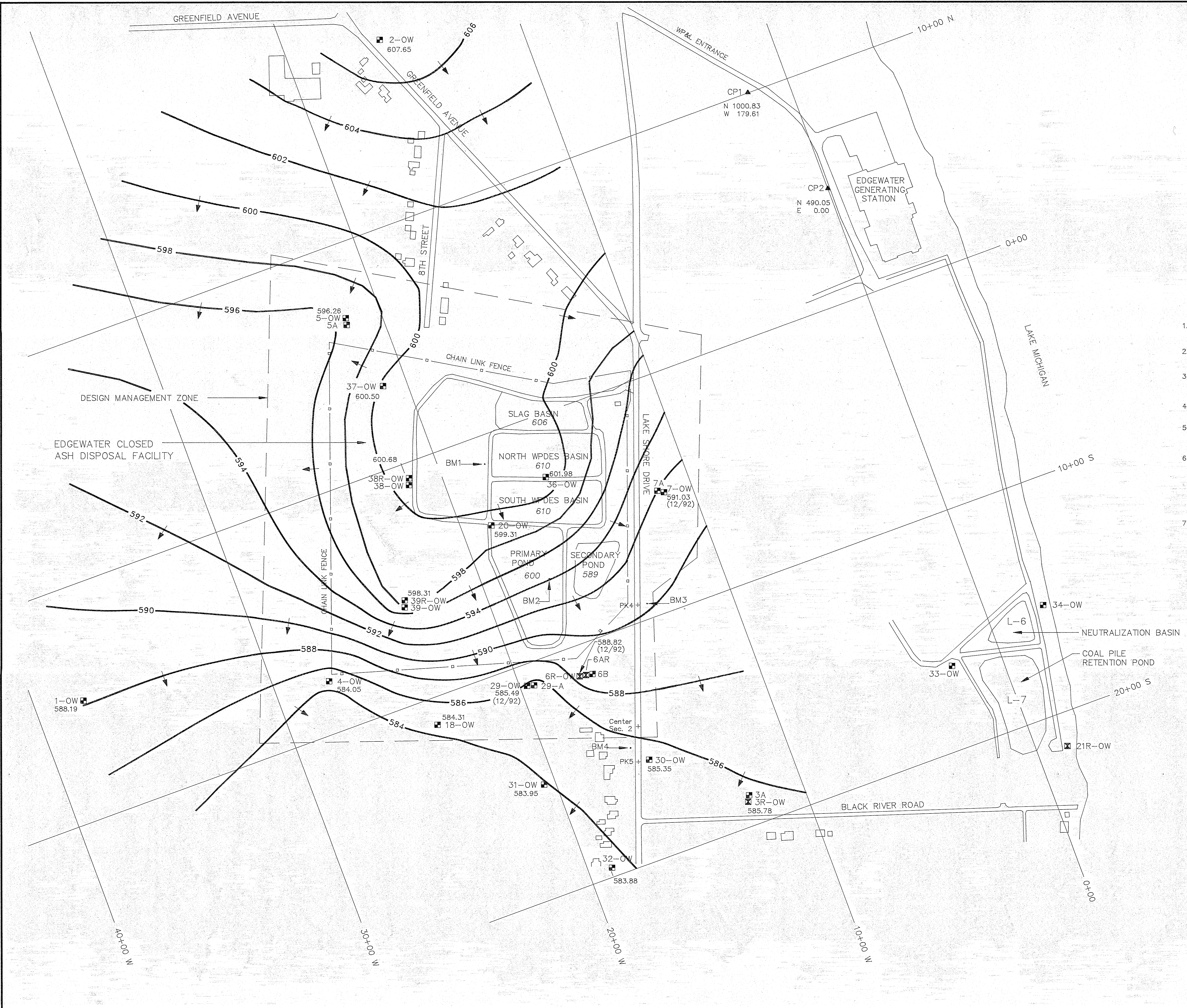
7–OW	Observation Well
7A or B	Piezometer
6R–OW	Replacement observation well
6AR	Replacement piezometer
SB101	Soil boring



WISCONSIN POWER & LIGHT
EDGEWATER CLOSED ASH DISPOSAL FACILITY

SITE PLAN

Project No. 574
Drawn By: SCC
s1–bwloc.dwg
MAY 1993
BT^2,Inc.
SHEET 1 OF 4



LEGEND

■	Monitoring Well
⊠	Replacement Monitoring Well
▲	Control Monument
601.98	Monitoring well water level (ft MSL), measured March 1993 except where a different measurement date is shown in parentheses. (See Note 7.)
606	Lagoon water level, typical (ft MSL)
—600—	Water table contour
→	Approximate groundwater flow direction

BENCH MARKS

BM1	NE corner of concrete pad for existing shed at sluice box. Elev. = 612.75'
BM2	Chiseled concrete square at top of existing discharge structure. Elev. = 610.62'
BM3	Nail in west face of anchor pole on east side of Lake Shore Drive, across from SE corner of Unit 3 & 4 fence. Elev. = 593.98'
BM4	Nail in east face of power pole on west side of Lake Shore Drive, across from house 4104. Elev. = 592.07'

NOTES

1. Base map prepared by Miller Engineers & Scientists and provided to BT2, Inc. as an AutoCAD file. Some minor revisions made by BT2, Inc.

2. Base map information compiled and digitized from Dames & Moore base map (no date) and Hydro-Search, Inc. Water Table Map, June 3, 1991.

3. Grids and coordinates for the shown observation wells were established in the field by Miller Engineers & Scientists using plant control monuments no. 1 and 2 (CP1 and CP2).

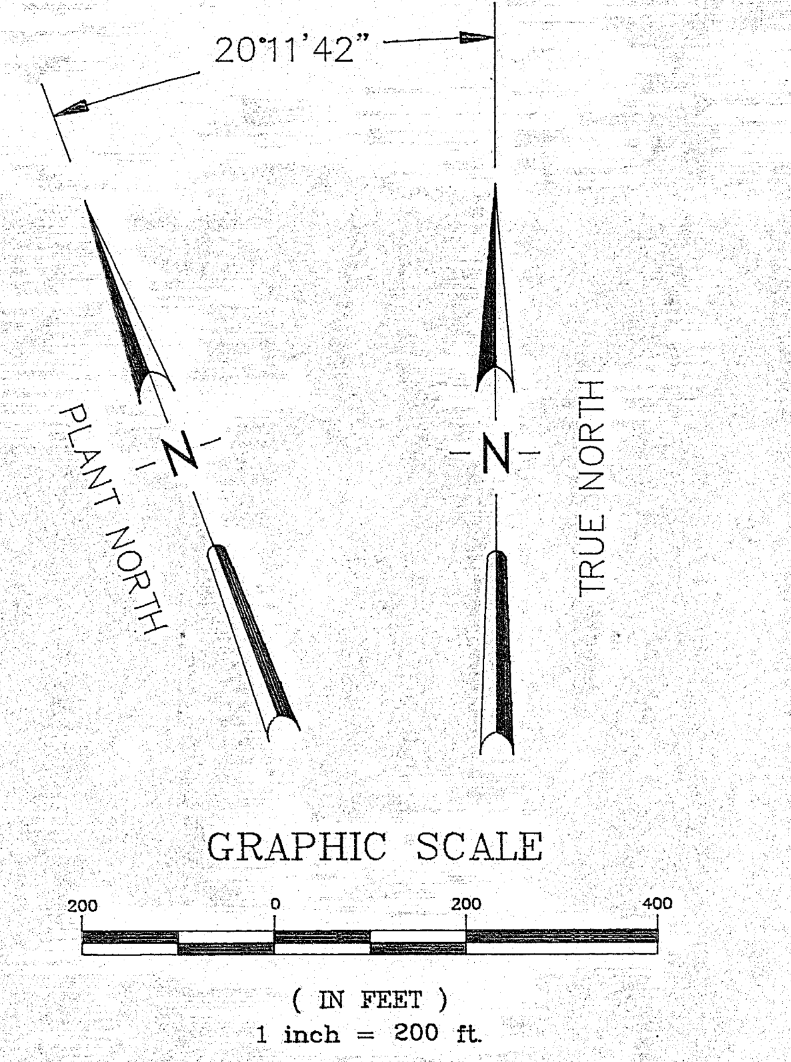
4. Elevations shown hereon are based on U.S.G.S. datum. To obtain plant datum, add 0.79 feet.

5. Observation well elevations, coordinates and construction information can be obtained in the Ground Water Monitoring Well Information Form (W.D.N.R. Form 4400-89); in the Appendix of the Project Manual (M.E.S. Job No. 12197E).

6. Observation well text examples:

7-OW	Observation Well
7A or B	Piezometer
6R-OW	Replacement observation well
6AR	Replacement piezometer
SB101	Soil boring

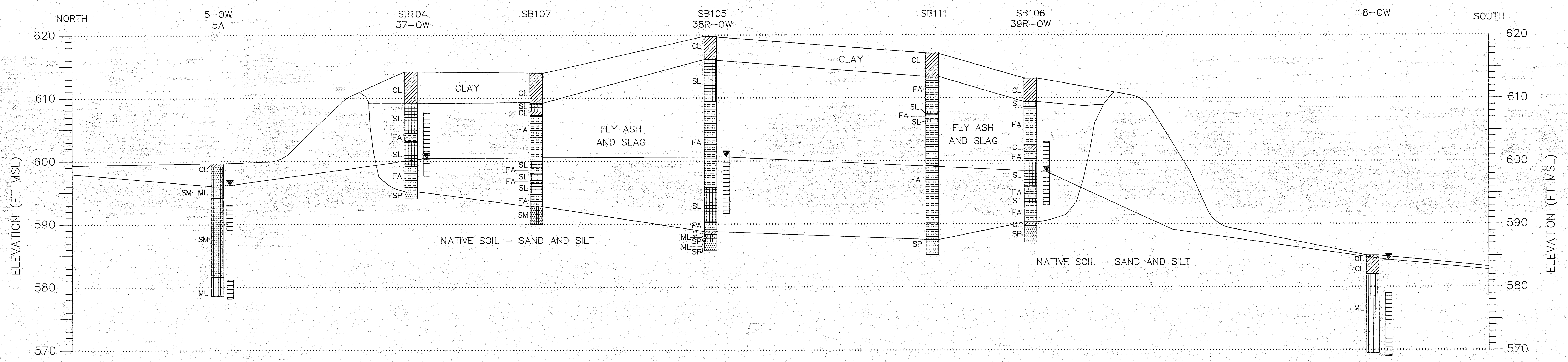
7. Water levels shown for monitoring wells 36-OW through 39R-OW were measured on March 19, 1993 by Miller Engineers & Scientists. Water levels for other monitoring wells were measured on March 5, 1993 by RMT, Inc., except for wells 6OW, 7OW and 29OW, which were frozen on that day. Water levels measured by RMT during the December quarterly sampling are shown for these wells with the measurement date shown in parenthesis. Lagoon water elevations were taken from the Feasibility Study report prepared by Dames & Moore (1992) and are assumed to be typical.



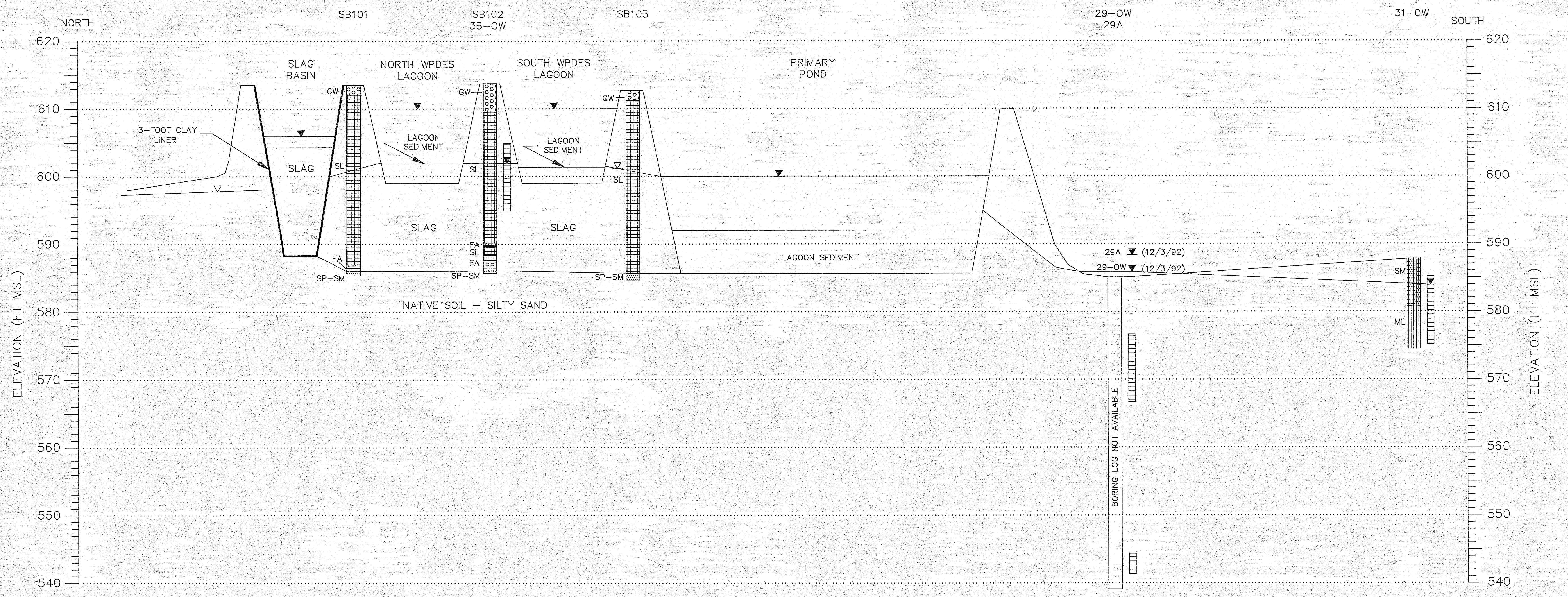
WISCONSIN POWER & LIGHT
EDGEWATER CLOSED ASH DISPOSAL FACILITY

WATER TABLE MAP

Project No. 574	watr-tbl.dwg	BT^2, Inc.	SHEET 2 OF 4
Drawn By: SCC	MAY 1993		



SECTION A–A'



SECTION B–B'

LEGEND

BA	Bottom ash	OL	Organic clay, low plasticity
CL	Clay, low plasticity	SL	Slag
FA	Fly ash	SM	Silty sand
GW	Gravel, well–graded	SP	Sand, poorly graded
ML	Silt	TS	Topsoil

Monitoring well screened interval

▼ Measured water level for monitoring wells or typical lagoon water level At well nests, water level is for shallow well, unless otherwise indicated.

▽ Estimated water table elevation

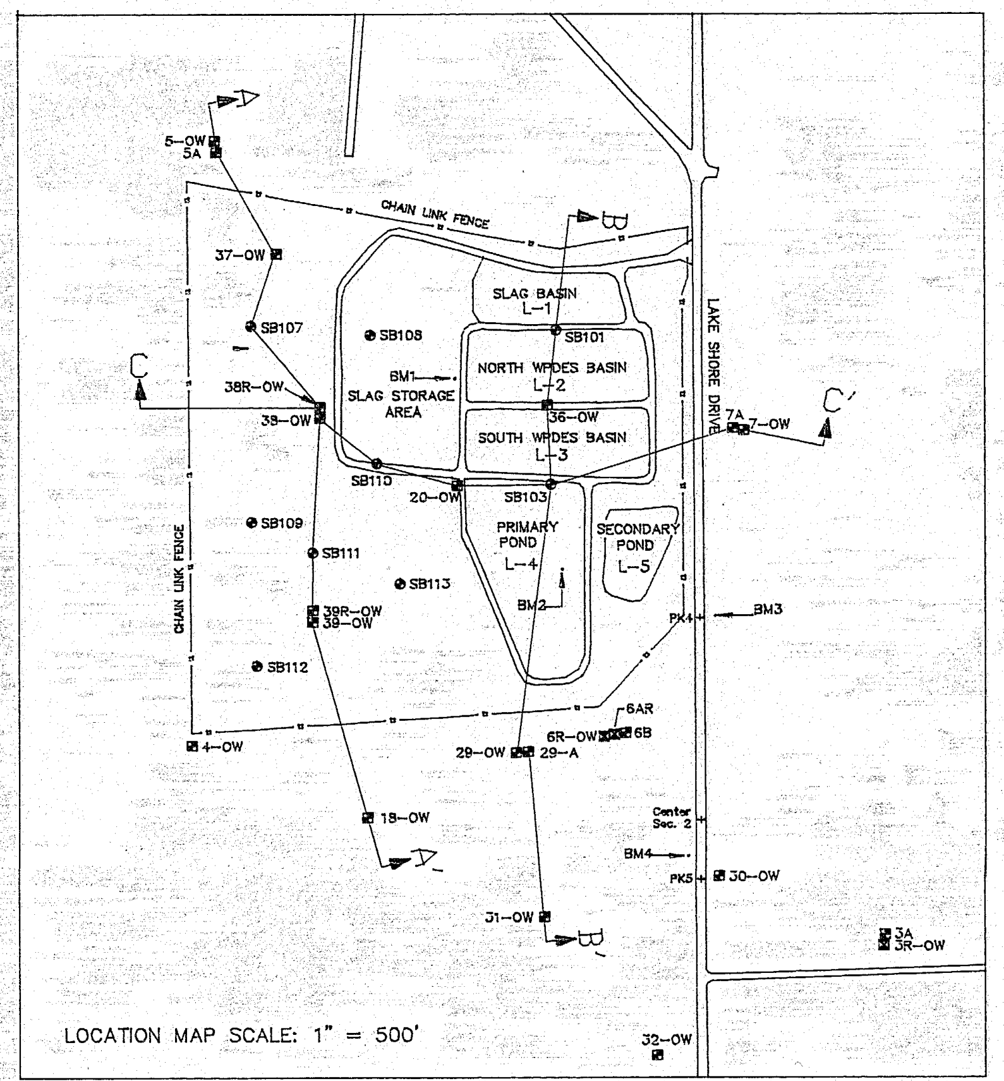
NOTES

1) Cross sections developed using information obtained during the field investigation as well as from the following sources:

- "Feasibility Study, Closed Ash Disposal Facility, Wastewater Treatment Lagoons, Wisconsin Power & Light Company, Edgewater Generating Station, Sheboygan, Wisconsin," Dames & Moore, June 1992.
- March 1993 quarterly groundwater monitoring data collected by RMT, Inc.
- DNR Ground Water Monitoring Well Information Form prepared by Miller Engineers and Scientists, April 1993.
- "Wisconsin Power & Light Company, Edgewater Closed Ash Disposal Facility, NR 140 Compliance Report, WDNR License #2524," Dames & Moore, February 1991.

2) Water levels shown for monitoring wells 36–OW through 39R–OW were measured on March 19, 1993 by Miller Engineers and Scientists. Water levels shown for the remaining wells were measured on March 5, 1993 by RMT, Inc., except for wells 7–OW, 29–OW and 29A, which were frozen during the March sampling round. For these three wells, water levels measured during the December sampling round are shown with the measurement date indicated adjacent to the water level symbol.

CROSS SECTION LOCATION MAP



LOCATION MAP SCALE: 1" = 500'

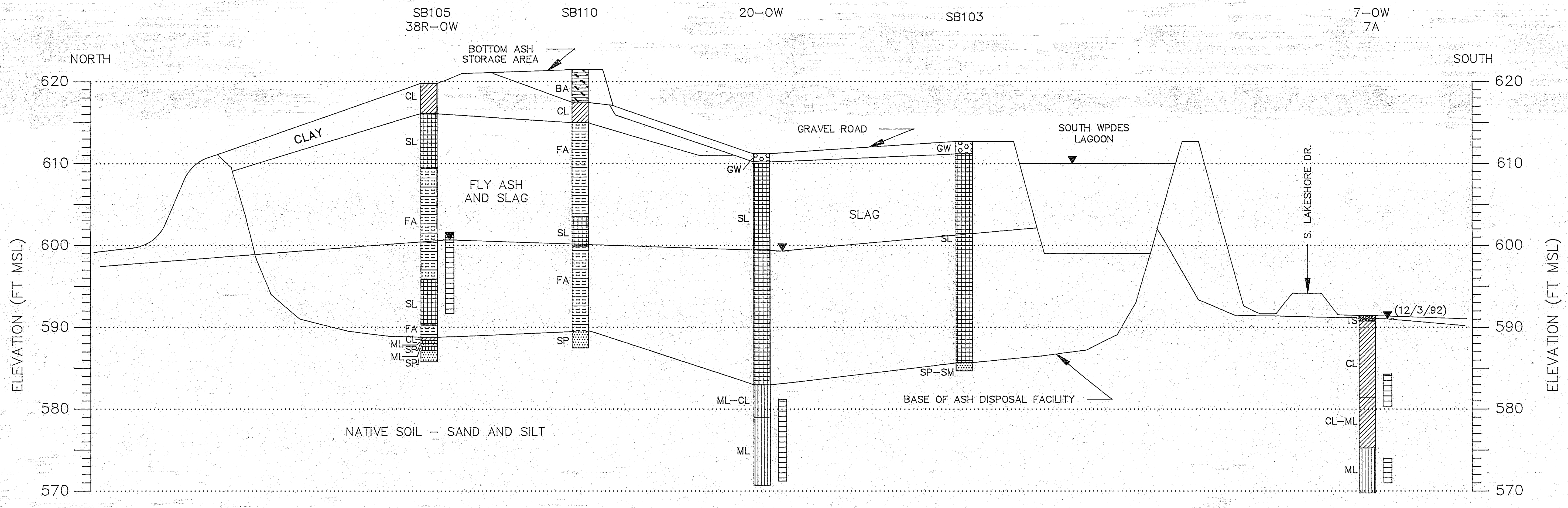
100 0 100

HORIZONTAL SCALE: 1" = 100'
VERTICAL SCALE: 1" = 10'
VERTICAL EXAGGERATION: 10X

WISCONSIN POWER & LIGHT
EDGEWATER CLOSED ASH DISPOSAL FACILITY

CROSS SECTIONS A–A' AND B–B'

Project No. 574	XSEC.DWG	BT^2, Inc.	SHEET 3 OF 4
Drawn By: KP/SCC	MAY 1993		



SECTION C–C'

LEGEND

BA ▤ Bottom ash	OL ▩ Organic clay, low plasticity
CL ▨ Clay, low plasticity	SL ▦ Slag
FA ▤ Fly ash	SM ▥ Silty sand
GW ▣ Gravel, well–graded	SP ▒ Sand, poorly graded
ML ▥ Silt	TS ▩ Topsoil

▯ Monitoring well screened interval

▼ Measured water level for monitoring wells or typical lagoon water level
At well nests, water level is for shallow well, unless otherwise indicated.

▽ Estimated water table elevation

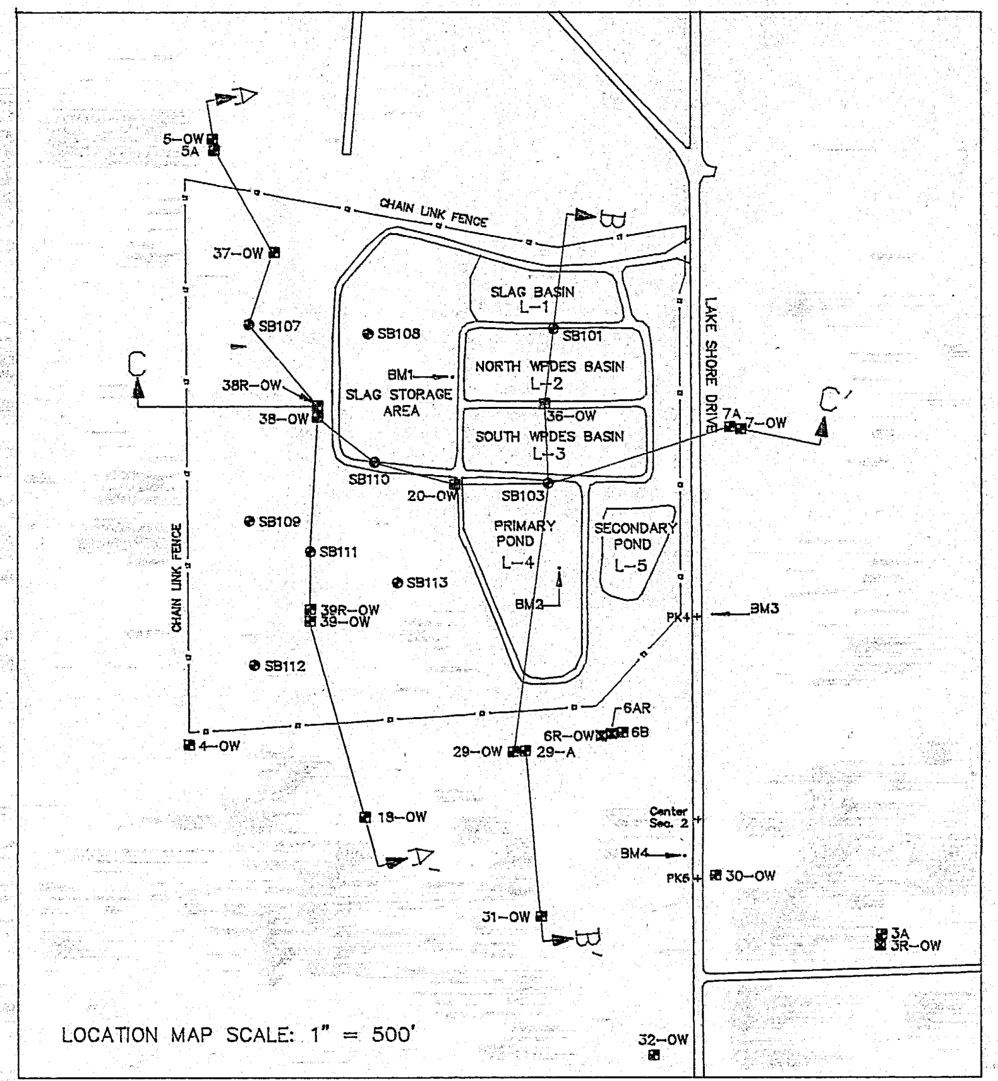
NOTES

1) Cross sections developed using information obtained during the field investigation as well as from the following sources:

- "Feasilibility Study, Closed Ash Disposal Facility, Wastewater Treatment Lagoons, Wisconsin Power & Light Company, Edgewater Generating Station, Sheboygan, Wisconsin," Dames & Moore, June 1992.
- March 1993 quarterly groundwater monitoring data collected by RMT, Inc.
- DNR Ground Water Monitoring Well Information Form prepared by Miller Engineers and Scientists, April 1993.
- "Wisconsin Power & Light Company, Edgewater Closed Ash Disposal Facility, NR 140 Compliance Report, WDNR License #2524," Dames & Moore, February 1991.

2) Water levels shown for monitoring wells 36–OW through 39R–OW were measured on March 19, 1993 by Miller Engineers and Scientists. Water levels shown for the remaining wells were measured on March 5, 1993 by RMT, Inc., except for wells 7–OW, 29–OW and 29A, which were frozen during the March sampling round. For these three wells, water levels measured during the December sampling round are shown with the measurement date indicated adjacent to the water level symbol.

CROSS SECTION LOCATION MAP



LOCATION MAP SCALE: 1" = 500'

100 0 100

HORIZONTAL SCALE: 1" = 100'
VERTICAL SCALE: 1" = 10'
VERTICAL EXAGGERATION: 10X

WISCONSIN POWER & LIGHT
EDGEWATER CLOSED ASH DISPOSAL FACILITY

CROSS SECTION C–C'

Project No. 574	XSEC.DWG	BT²,Inc.	SHEET 4 OF 4
Drawn By: KP/SCC	MAY 1993		

APPENDIX E

WDNR 1994 and 1998 Correspondence

WISCONSIN
DEPT. OF NATURAL RESOURCES

George E. Meyer
Secretary

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

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DNR TELEFAX 608-267-3579
DNR TDD 608-267-6897
SOLID WASTE MGMT 608-266-2111
SOLID WASTE TELEFAX 608-267-2768

APR 20 1994

F.I.D.#: 460021980

Ms. Sharon Klinger-Kingsley
Wisconsin Power and Light Co.
222 W. Washington Ave.
P.O. Box 192
Madison, WI 53701-0192

SUBJECT: Response To The Field Investigation Report and Plan Modification, Edgewater 1-4 Ash Disposal Site, DNR License #2524

Dear Ms. Klinger-Kingsley:

The Department of Natural Resources, Bureau of Solid and Hazardous Waste Management has reviewed your June, 1993 report entitled, "Field Investigation Report, Edgewater Closed Ash Disposal Facility". The report was prepared by BT^2 and submitted in response to an agreement made between the Department and WP&L in an October 16, 1992 meeting. At this meeting, we agreed that WP&L would conduct further ground water investigations to determine the exact nature of contamination coming from the old landfill and to evaluate the effectiveness of proposed remedial actions designed to reduce ground water mounding within the landfill.

In response to your report, the Department is issuing a conditional modification to your closure plan approval. This approval requires the addition of 4 new monitoring wells to the facility's ground water monitoring system, submission of a follow-up ground water report after 3 additional years of water quality data have been collected, and the establishment of preventive action limits (PALs) for indicator parameters. You should attach this conditional modification to your February 29, 1984 abandonment plan approval.

We mailed you a draft of this letter and the attached approval on March 2, 1994. On April 18, 1994 we received a letter dated March 22, 1994 containing comments to this plan modification. The comments received have been considered and changes were incorporated into the text of the plan modification when they were deemed appropriate. The remainder of this letter will hopefully provide a brief overview of the Department's reasoning and rational behind the acceptance or denial of several of the comments regarding the plan modification requests.

WP&L requested that the new ground water monitoring wells (36-OW, 37-OW, 38R-OW, and 39R-OW) commence quarterly sampling beginning with the June 1994 sampling quarter rather than the March 1994 sampling quarter specified in the draft plan modification. WP&L justified this request by pointing out that the 30 day comment period fell within the March sampling quarter and that it would be too difficult to revise the planned sampling activities for March at this late date.

The Department agrees with this comment and will include a comment within the final plan modification stating that quarterly sampling will begin with the June 1994 sampling quarter.

WP&L also requested, for the reasons stated above, that the 12 rounds of sampling data required for the October 1997 follow-up report commence beginning with the June 1994 sampling round. The Department agrees with this comment, but it will not be necessary to change Condition #3 of the plan modification. Statements in the cover letter, however, will be changed to clarify this point.

Field Investigation Report Comments

The results of the field investigation indicate that the bulk of the contaminants have already leached out of the waste and that the increasing contaminant trends found at the downgradient monitoring wells is the result of a slug of contaminated water moving through the shallow ground water system. The contaminated water most likely was generated before or soon after the landfill was closed and capped. Ground water beneath the landfill and settling basins contained contaminant levels that were significantly lower than the contaminant levels detected at downgradient monitoring wells. This would tend to support the theory that the clay cap is reducing infiltration from the surface and that most contamination available for leaching has already been leached out of the waste materials by liquid introduced prior to closure. Contaminant levels in the downgradient wells should gradually decrease as the less contaminated water from beneath the landfill works it's way downgradient.

This scenario is also supported by recent ground water quality data collected from the most contaminated downgradient wells. Contaminant levels that had been rising rapidly in the past 6 years now appear to be either leveling off or decreasing. Water quality at less impacted sidegradient wells has also been steadily improving.

Geotechnical investigations at the facility indicate that the waste within the landfill is composed mostly of fly ash while the settling basins are constructed mostly in slag. There is evidence of water mounding within the landfill, but the very low hydraulic conductivity of the fly ash indicates that water movement within the landfill is very slow. Water movement through the slag beneath the basins is relatively rapid but, in comparison with the fly ash, the slag deposits contain less quantities of leachable contaminants. The water quality within the settling basins was tested and found to meet the ground water quality standards in ch. NR 140, Wis. Adm. Code.

Based on the information presented in the report, it is reasonable to conclude that further ground water quality testing may show a decrease in the contaminant levels over time, even if no further remedial actions are performed at the site. Therefore, the Department will accept WP&L's recommendations to re-evaluate the status of ground water contamination at the Edgewater 1-4 Facility after 3 additional years of water quality data has been collected. This would correspond with 12 sampling quarters starting with the June, 1994 sampling quarter and ending with the March, 1997 sampling quarter. If, at that time, the ground water quality downgradient of the facility has not significantly improved, the

Department may require additional remedial measures.

To further define contamination beneath the landfill, 4 monitoring wells constructed for the field investigation will be included in the regular monitoring system for the facility. As recommended in the report, these wells will be sampled quarterly for a reduced number of parameters and then annually for an expanded list of parameters. The recommendations were slightly modified to provide some additional information. In addition to water levels, field conductivity measurements, corrected to 25° C, will be performed quarterly at the 4 wells. This analysis is easy to perform and can reveal more detail concerning long and short term trends than using only annual water quality testing. We have also added fluorine and arsenic to the list of parameters that are required for annual testing. This was done because water leach tests performed on composite samples of waste material indicated levels of both fluorine and arsenic that exceeded the ground water quality standards of ch. NR 140, Wis. Adm. Code. It is important to determine whether or not these compounds are impacting the ground water beneath the site.

PAL Calculations

We have also assigned preventative action limits (PALs) for indicator parameters that will apply to all monitoring wells at the Edgewater 1-4 Facility. We relied on BT^2 calculations derived from water quality testing at wells 1-OW and 2-OW to set the PALs. Both wells appear to be representative of background water quality within the shallow glacial aquifer. We have decided not to calculate preventive action limits for pH and, therefore, have not included it in the conditions.

If you have any questions or comments concerning this letter or plan modification, please feel free to contact Roger Klett at (414) 263-8648 or Philip Fauble at (608) 267-3538.

Sincerely,

Lakshmi Sridharan

Lakshmi Sridharan, Ph.D, P.E., Chief
Solid Waste Management Section
Bureau of Solid & Hazardous Waste Management

LS:PF:edgemod5

cc: Jack Connelly - SW/3
Roger Klett - SED
Susan Fisher - SW/3
Philip Fauble - SW/3
Larry Benson - WW/2

BEFORE THE
STATE OF WISCONSIN
DEPARTMENT OF NATURAL RESOURCES

CONDITIONAL PLAN MODIFICATION FOR THE EDGEWATER 1-4 CLOSED ASH DISPOSAL FACILITY
DNR LICENSE #2524

FINDINGS OF FACT

The Department finds that:

1. Wisconsin Power and Light Company operated a non-hazardous solid waste disposal facility in the SE¼ of Section 2, T14N, R23E, Town of Wilson, Sheboygan County, Wisconsin.

2. A conditional plan approval was issued by the Department for the facility on November 29, 1976. An abandonment plan approval was issued by the Department for the facility on February 29, 1984 and clay cap was installed by the fall of 1986.

3. On May 3, 1988, the Department received a report, entitled "NR 140 Compliance Report, Edgewater 1-4 Ash Disposal Facility.", that was prepared by Warzyn Engineering in response to the April 27, 1987 site closure documentation approval letter.

4. On March 7, 1990, a conditional plan modification for the Edgewater 1-4 disposal facility was issued by the Department.

5. In response to the conditions of the March 7, 1990 plan modification, the Department received a report prepared by Dames & Moore titled, "Edgewater Closed Ash Disposal Facility, NR 140 Compliance Report". This report was received by the Department on February 15, 1991.

6. A response to the NR 140 compliance report and a conditional plan modification for the Edgewater 1-4 disposal facility was issued by the Department on July 25, 1991.

7. As the result of an October 16, 1992 meeting with representatives of the Department, WP&L submitted a report, prepared by BT^2, titled "Field Investigation Report, Edgewater Closed Ash Disposal Facility". This report was received by the Department on June 8, 1993.

8. The Department considers the following facts to be significant in it's decision:

   a. An analysis of ground water samples taken from on-site monitoring wells downgradient of the landfill are showing elevated levels of indicator parameters (conductivity, hardness, TDS and boron). These monitoring wells are also showing public welfare standard exceedences for iron and sulfate.

   b. Ground water monitoring wells to the northwest and southwest of the facility (40W and 50W) show decreasing trends in the concentration of TDS, sulfate and boron over the past 14 years. Wells to the south and southeast of the facility (180W and 290W) had shown a steady increase in the concentration of TDS, sulfate and, especially, boron, but concentrations appear to have leveled off and/or decreased in the most recent sampling.

c. A detailed study of the ground water/leachate quality indicates that the contaminant concentrations within and beneath the landfill are generally lower than the contaminant levels reported at the downgradient monitoring wells.

d. A private water supply well at 447 Black River Road, a shallow well down-gradient of the facility, has had concentrations of both sulfate and iron in exceedence of the enforcement standards (ES) for those compounds set in NR 140.12, Wis. Adm. Code. A private water supply well at 4130 Lakeshore Drive, also a shallow well down-gradient of the facility, has shown ES exceedences for iron and infrequent preventative action limit (PAL) exceedences for sulfate and chloride. Both of these private wells were abandoned and replaced with deeper wells by WP&L in May of 1991.

e. Two active WPDES settling basins and a slag dewatering basin located directly adjacent to the closed ash disposal area are contributing to ground water mounding beneath the landfill. However, it appears that the basins were constructed mostly on slag deposits rather than ash materials. The slag has a much lower potential for leaching contaminants than the ash, based on water leach tests. The low hydraulic conductivities found within the landfill's ash deposits suggest that ground water flow from the basins through the landfill would be very limited.

9. BT^2 has determined the background water quality in the vicinity of the landfill by using sampling results from monitoring wells 1-OW and 2-OW. These background wells are at locations and depths which are representative of background water quality at or near the facility. The background wells are sufficient to yield ground water samples.

10. In determining background water quality, BT^2 averaged at least 8 sample results from each background monitoring well.

11. The preventive action limits for indicator parameters are listed in Condition #4.

12. The indicator parameter preventive action limits and special conditions set forth below are needed to assure that the facility will not pose a substantial hazard to public health or welfare.

CONCLUSIONS OF LAW

1. The Department has authority to require a response under s. 160.23, Stats., and s. NR 140.24(4), Wis. Adm. Code, if a preventative action limit for a substance of public health or welfare concern has been attained or exceeded at a point of standards application.

2. The Department has authority to require a response under s. 160.25, Stats., and NR 140.26(2), Wis. Adm. Code, if an enforcement standard for a substance of public health or welfare concern has been attained or exceeded at a point of standards application.

3. In accordance with the foregoing, the Department has authority under s. 144.44(3), ss. 160.23 and 160.25, Stats., and ss. 140.24 and 140.26, Wis. Adm. Code, Ch. NR 500-520, Wis. Adm. Code, to issue the following conditional plan modification, which requires responses to exceedences of ground water standards.

4. The Department has authority under s. 160.15(3) Stats., and s. NR 140.20, Wis. Adm. Code, to establish preventative action limits for indicator parameters.

CONDITIONAL APPROVAL

The Department hereby modifies the Conditional Site Closure Documentation Approval dated April 20, 1987 for Wisconsin Power & Light Company's Edgewater 1-4 Ash Disposal Facility (License #2524) by adding the following conditions:

1. WP&L shall add monitoring wells 36-OW, 37-OW, 38R-OW, and 39R-OW to the ground water monitoring network for the Edgewater 1-4 Ash Disposal Facility. DNR identification numbers shall be assigned to each well as follows:

Well Name	DNR I.D.#
36-OW	260
37-OW	261
38R-OW	262
39R-OW	263

2. The new monitoring wells required above shall be sampled annually, beginning with the September 1994 sampling quarter, during the September quarter for the following parameters:

   chloride (00307)
   sodium, diss. (00930)
   sulfate, diss. (00946)
   boron, diss. (01020)
   alkalinity (39036)
   selenium, diss. (01145)
   arsenic, diss. (01000)
   pH, field (00400)
   grd. water elev. (00842)
   conductivity (25°) (00872)
   iron, diss. (01046)
   TDS (00360)
   fluoride, diss. (00950)

   The new monitoring wells shall also be sampled quarterly, beginning with the June 1994 sampling quarter, during the months of March, June, September and December for the following parameters:

   grd. water elev. (00842)
   conductivity (25°) (00872)

   The sampling results shall be submitted to the Department on Department approved forms such as TADs or electronically, and shall include a preliminary analysis of the cause and significance of any ground water standard exceedances.

3. WP&L shall prepare and submit a follow-up report to the Department by October 1, 1997 after a minimum of 3 years (12 quarters) of additional ground water quality data has been collected at the Edgewater 1-4 Closed Ash Disposal Facility. This report shall contain, at a minimum, the following:

   a. a summary of all ground water quality data collected at the site with any s. NR 140 Wis. Adm. Code exceedances noted;

   b. time vs. concentration graphs for all contaminants of concern;

   c. an evaluation of the ground water quality data including an assessment of the degree and extent of contamination, performance of the landfill cap and settling basins, and the nature of trends observed in the monitoring data.

4. The preventative action limits for indicator parameters at all monitoring wells shall be established as follows:

Parameter	Indicator PAL
conductivity (25°), field (00872)	1600 umhos/cm
total dissolved solids (00360)	900 mg/l
alkalinity (39036)	570 mg/l
boron, diss. (01020)	2.1 mg/l
sodium, diss. (00930)	92 mg/l

5. Preventive action limits and enforcement standards for all other substances shall be as specified in Tables 1 and 2, ch. NR 140, Wis. Adm. Code.

The Department reserves the right to require the submittal of additional information and to modify this approval at any time, if in the Department's opinion, modifications are necessary. Unless specifically noted, the conditions of this approval do not supersede or replace any previous conditions of approval for this facility.

NOTICE OF APPEAL RIGHTS

If you believe that you have a right to challenge this decision, you should know that Wisconsin statutes and administrative rules establish time periods within which requests to review Department decisions must be filed.

For judicial review of a decision pursuant to sections 227.52 and 227.53, Stats., you have 30 days after the decision is mailed, or otherwise served by the Department, to file your petition with the appropriate circuit court and serve the petition on the Department. Such a petition for judicial review must name the Department of Natural Resources as the respondent.

This notice is provided pursuant to section 227.48(2), Stats.

Dated: APR 20 1994

DEPARTMENT OF NATURAL RESOURCES
For the Secretary

Lakshmi Sridharan

Lakshmi Sridharan, Ph.D., P.E., Chief
Solid Waste Management Section
Bureau of Solid & Hazardous Waste Management

Philip Fauble

Philip Fauble, Hydrogeologist
Solid Waste Management Section
Bureau of Solid & Hazardous Waste Management

pf:wp&l\edgemod4

WISCONSIN
DEPT. OF NATURAL RESOURCES

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

Tommy G. Thompson, Governor
George E. Meyer, Secretary

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April 16, 1998

FILE REF: 460021980

Linda Lynch
Wisconsin Power & Light
222 W. Washington Ave.
P.O. Box 192
Madison, WI 53701-0192

SUBJECT: Plan Approval Modification for Ground Water Monitoring, WP&L Edgewater 1-4 Ash Disposal Facility, Lic.# 02524

Dear Ms. Lynch:

On October 1, 1997, Wisconsin Power & Light (WP&L) submitted a ground water assessment report in fulfillment of Condition #3 of the April 20, 1994 plan modification approval for the Edgewater 1-4 Ash Disposal Facility in Sheboygan, Wisconsin. The report also contained a proposal to modify the ground water monitoring portion of the plan approval for the Edgewater facility. After reviewing the report, we believe that the proposal, as modified by the attached conditional approval, will provide an acceptable monitoring program at your facility. Please attach this letter and approval to your Conditional Site Closure Documentation Approval which was issued on April 20, 1987.

On March 10, 1998, the Department issued a draft copy of the proposed Plan Approval Modification to solicit your comments. WP&L's comments concerning the conditions of the draft approval were received by the Department on April 3, 1998 in a letter dated April 1, 1998.

In reply to your first comment, the Department agrees and also stipulates that soil sampling per s. NR 507.05(1),(2) Wis. Adm. Code and baseline ground water sampling per s. NR 507.18 Wis. Adm. Code, will not be required for replacement monitoring wells 4R-OW (265) and 2R-OW (264). The existing borehole logs and historic ground water quality data should be adequate for these purposes. However, WP&L will still be responsible for fulfilling the requirements of ss. NR 507.06 and 507.07 Wis. Adm. Code. Our files indicate that hydraulic conductivity tests were not historically performed on wells 4-OW or 2-OW. Also, because the wells will not be sampled as they are drilled, it will be important to verify that the screens are placed in the conductive silty-sand zone and that the wells have been properly developed.

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As for your second comment, the Department approves of changing the ground water monitoring reports from annual to biannual and a condition has been added to reflect that change. Biannual reporting is adequate now that the site is converting to semiannual ground water sampling.

The Department also agrees to eliminate alkalinity and hardness from the monitoring program for the WP&L Edgewater 1-4 landfill. As you stated, the site has been extensively characterized and it does not appear from the historic ground water quality data that either hardness or alkalinity are very useful in delineating the extent of ground water impacts from the landfill. This decision is also consistent with the monitoring requirements at other WP&L ash disposal facilities.

We acknowledge that wells 37-OW, 38R-OW and 39R-OW are screened in waste materials within the interior of the landfill and are, therefore, technically not subject to the ground water quality standards of ch. NR 140 Wis. Adm. Code. However, this facility does not possess a liner and there is no barrier between leachate generated within the waste mass and the shallow ground water system. Therefore, elevated levels of any public health parameters detected in water within the waste, such as arsenic, must be further investigated to determine whether or not they have spread beyond the boundaries of the waste mass.

The major change in your ground water monitoring program is that sampling will be done semi-annually during the months of April and October, rather than quarterly. Ground water quality results contained in your October 1, 1997 report seem to indicate that the contaminant plume from the landfill still exists, but the levels of sulfate and boron downgradient of the facility have leveled off or slightly decreased in the past three years. This would indicate that the amount of leachable constituents migrating from the saturated portion of the waste mass has either stabilized or decreased since the landfill was closed and capped. We agree with the report's findings that the WPDES ponds do not appear to be significantly contributing to the contaminant plume downgradient of the facility. No further remedial action concerning the influence of the ponds on the landfill is warranted at this time.

However, the levels of dissolved arsenic detected in a series of interior wells were very high. Arsenic and fluoride were added to the testing requirements for interior wells 36-OW, 37-OW, 38R-OW, and 39R-OW as part of Condition #2 of the April 20, 1994 Plan Approval Modification. These parameters were added to the sampling program because water leach tests performed on composite samples of the waste material indicated levels of fluorine and arsenic that exceeded ground water quality standards. The s. NR 140 Wis. Adm. Code ground water quality standard for arsenic is 5 parts per billion (Preventive Action Limit) and 50 ppb (Enforcement Standard).

After 3 years of annual sampling for dissolved arsenic, the levels in the water exceeded the PAL in each sampling round at each well and exceeded the ES 6 times in 3 different wells. Well 38R-OW consistently had the highest levels of dissolved arsenic with one sample result of 540 ppb, or over ten times the ES of 50 ppb. While these wells are completed within

6

waste, there is no physical separation (i.e. a liner) between liquids within the waste mass and the shallow ground water table. Unfortunately, the possible cause and significance of these very high levels were not addressed in the October 1, 1997 Groundwater Assessment Report.

These elevated levels of arsenic warrant further sampling to determine the degree and extent of the arsenic contamination. Only the interior wells have been sampled for dissolved arsenic so it is unknown whether the contaminant has spread beyond the waste fill limits or the property boundary. For that reason, we are requiring, as a condition of this approval, that additional ground water monitoring for dissolved arsenic be conducted twice a year at all monitoring wells specified in Table 1. After samples have been collected and analyzed from the April and October, 1998 sampling quarters, WP&L will be required to submit a preliminary report evaluating the results.

The attached approval summarizes the wells, parameters and frequency of your ground water monitoring program as modified by this approval. Other environmental monitoring (such as leachate, lysimeter, gas or surface water monitoring) will remain as previously approved.

If you have any questions about this letter, please contact Philip Fauble, Hydrogeologist, at (608) 267-3538.

Sincerely,

Franklin Schultz
Waste Management Team Supervisor
Southeast Region

cc: Philip Fauble - WA/3
Jack Connelly - WA/3

1

BEFORE THE
STATE OF WISCONSIN
DEPARTMENT OF NATURAL RESOURCES

CONDITIONAL PLAN APPROVAL MODIFICATION
FOR THE
EDGEWATER 1-4 CLOSED ASH DISPOSAL FACILITY
DNR LICENSE #02524

The Department finds that:

1. Wisconsin Power and Light Company operated a non-hazardous solid waste disposal facility in the SE¼ of Section 2, T14N, R23E, Town of Wilson, Sheboygan County, Wisconsin.

2. A conditional plan approval was issued by the Department for the facility on November 29, 1976. An abandonment plan approval was issued by the Department for the facility on February 29, 1984 and a clay cap was installed by the fall of 1986.

3. In response to ground water quality exceedances downgradient of the Edgewater facility, the Department issued a conditional plan modification approval on April 20, 1994. The plan modification required ground water monitoring and an evaluation of the results after collecting 3 years of additional ground water quality data.

4. On October 1, 1997, WP&L submitted a report to the Department prepared by RMT, Inc. titled, "Groundwater Assessment Report, Edgewater Closed Ash Disposal Facility" and dated September 30, 1997.

5. The report proposed the following, which would require a modification of the landfill's ground water monitoring plan approval:

    a. To measure ground water elevations in April and October in all ground water monitoring wells.

    b. To sample 11 wells semi-annually in April and October for a select list of inorganic parameters including pH, conductivity, temperature, ground water elevation, boron and sulfate.

6. The Department considered the following documents in connection with the proposed plan modification:

    a. Plan approvals dated March 7, 1990, July 25, 1991, and April 20, 1994 and Department files for the WP&L Edgewater 1-4 Landfill, license #02524.

    b. The report titled, "Field Investigation Report, Edgewater Closed Ash Disposal Facility" prepared by BT^2 and received by the Department on June 8, 1993.

c. The Department's electronic ground water monitoring database.

7. The Department considers the following facts to be significant in it's decision:

a. The landfill only accepted combustion residues (ash, slag, etc.) generated by the WP&L Edgewater Generating Station in Sheboygan, Wisconsin. The landfill was closed and covered with a 2-foot clay cap in 1986.

b. Analysis of ground water samples taken from monitoring wells downgradient of the landfill are showing elevated levels of indicator parameters such as conductivity, hardness, TDS and boron. These monitoring wells are also showing continued public welfare standard exceedances for iron and sulfate.

c. Recent ground water monitoring results indicate that the concentrations of boron and sulfate at the downgradient wells nearest to the edge of the waste fill limits (29-OW, 18-OW, 4-OW, 5-OW and 29-A) are either declining or have stabilized.

d. Ground water elevations indicate that the two active WPDES settling basins and the slag dewatering basin located adjacent to the closed ash disposal area are still contributing to ground water mounding beneath the landfill. However, ground water quality results from wells near the basins seem to show that the basins are not significantly contributing to the ground water contaminant plume downgradient of the fill area.

e. Arsenic testing was required in monitoring wells completed through the waste because water leach tests performed on composite waste samples indicated levels of arsenic that exceeded the ground water quality standards. Arsenic levels were consistently above the s. NR 140.10 Wis. Adm. Code preventive action limit (PAL) of 5 parts per billion (ppb) at all the monitoring wells tested (36-OW, 37-OW, 38R-OW, and 39R-OW) and levels as high as 540 ppb were noted in well 38R-OW. Although these wells are not subject to s. NR 140 Wis. Adm. Code ground water standards because they are screened within the waste mass, there is no liner at this landfill to seperate leachate from the shallow ground water system. Also, none of the monitoring wells located outside of the limits of waste have been sampled for arsenic.

f. During their assessment of the monitoring well system, RMT noted that two monitoring wells were not adequately functioning and should be replaced. Well 4-OW was difficult to sample because of excessive amounts of sediment in the well and well 2-OW was frequently dry.

8. The special conditions set forth below are needed to detect any detrimental effects on ground water quality from waste disposal operations and to ensure that the landfill does not pose a substantial hazard to the environment or to public health or welfare.

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CONCLUSIONS OF LAW

The Department concludes that:

1. The Department has authority under s. 289.30(6), Stats. and ss. NR 507.04 and 514.08, Wis. Adm. Code, to modify a plan approval if the modification is needed to minimize the detrimental effects which the landfill may have upon ground water and surface water quality.

2. The Department has authority to require a response under s. 160.23, Stats., and s. NR 140.24(4), Wis. Adm. Code, if a preventative action limit for a substance of public health or welfare concern has been attained or exceeded at a point of standards application.

3. In accordance with the foregoing, the Department has authority under s. 289.30(6), and ss. 160.23, Stats., and ss. 140.24 and Ch. NR 500-520, Wis. Adm. Code, to issue the following conditional plan modification, which requires responses to exceedances of ground water standards.

CONDITIONAL PLAN APPROVAL MODIFICATION

The Department hereby modifies the Conditional Site Closure Documentation Approval dated April 20, 1987 for Wisconsin Power & Light Company's (WP&L) Edgewater 1-4 Ash Disposal Facility (License #02524) by adding the following special conditions:

1. Beginning with the first sampling period after the date of this approval, WP&L shall collect and analyze samples from ground water monitoring wells as follows:

   a. Water level elevation readings shall be obtained from all ground water monitoring wells listed below. The elevations shall be reported in feet above mean sea level (msl) to an accuracy of 0.01 foot.

Well Name	DNR I.D.#
1-OW	201
6R-OW	254
20-OW	220
32-OW	255
36-OW	260
5-A	206
6-A	208
7-A	211

   b. Samples shall be collected and analyzed from wells as listed in Table 1 (attached).

   c. All wells shall be sampled semi-annually during the months of April and October.

2. WP&L shall report sampling results to the Department as specified in ss. NR 507.26 through NR 507.30, Wis. Adm. Code.

3. WP&L shall properly abandon monitoring wells 4-OW (219) and 2-OW (202) in accordance with the requirements of s. NR 141.25, and s. NR 507.14, Wis. Adm. Code.

4. WP&L shall install replacement wells within 10 feet (if possible) of both 4-OW and 2-OW. The design and installation of these replacement wells shall be performed in accordance with s. NR 507.06, s. NR 507.07, and NR 507.14(5), Wis. Adm. Code. The replacement wells shall be designated as follows:

Old Well Name	New Well Name
4-OW (219)	4R-OW (265)
2-OW (202)	2R-OW (264)

5. WP&L shall submit a report to the Department by January 31, 1999, assessing the degree and extent of dissolved arsenic concentrations in the ground water both within and surrounding the disposal facility. This report shall also contain a preliminary assessment of the cause and significance of the increased arsenic concentrations in accordance with s. NR 140.24(1)(b), Wis. Adm. Code.

6. WP&L shall submit to the Department a monitoring summary report by March 15 of each even-numbered year. The report shall cover the previous two calendar years and shall, at a minimum, include the following information:

    a. an updated water table map for the entire facility, prepared from observation well and surface water elevation on the same date, showing the monitoring sample points, the water table contours, and the approximate design management zone boundary;

    b. an evaluation of water quality data collected during the biennium (including any water supply well data) and an assessment of trends in water quality compared to previous years;

    c. a discussion of possible causes for any values that exceed preventive action limits or enforcement standards;

    d. any changes made to the monitoring network during the biennium; <u>and</u>

    e. any proposed future modifications to the monitoring program, including recommendations for adding monitoring wells to the water quality monitoring program due to anticipated construction of new landfill modules/phases.

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6. WP&L shall remit a total of $1,500.00 to the Department in accordance with s. NR 520, Table 3, Wis. Adm. Code for review of the October 1, 1997 "Groundwater Assessment Report, Edgewater Closed Ash Disposal Facility".

The Department reserves the right to require the submittal of additional information and to modify this approval at any time, if, in the Department's opinion, modifications are necessary. Unless specifically noted, the conditions of this approval do not supersede or replace any previous conditions of approval for this facility.

NOTICE OF APPEAL RIGHTS

If you believe that you have a right to challenge this decision, you should know that Wisconsin statutes and administrative rules establish time periods within which requests to review Department decisions must be filed.

For judicial review of a decision pursuant to sections 227.52 and 227.53, Stats., you have thirty (30) days after the decision is mailed, or otherwise served by the Department, to file your petition with the appropriate circuit court and serve the petition on the Department. Such a petition for judicial review shall name the Department of Natural Resources as the respondent.

This notice is provided pursuant to s. 227.48(2), Stats.

Dated: April 21, 1998 DEPARTMENT OF NATURAL RESOURCES
For the Secretary

Franklin C. Schultz
Waste Management Team Supervisor
Southeast Region

Philip Fauble

Philip Fauble, PG
Southeast Region Hydrogeologist

Attachment: Table 1

Table 1 - Ground Water Monitoring Program
WP&L Edgewater Closed Landfill
License #02524

Parameters		pH, field	Field Conductivity @ 25°C	Temp. field	Ground water Elev.	Boron diss.	Sulfate diss.	Arsenic diss.
Well Name	DNR ID#	00400	00094	00010	72020	01020	00946	01000
2R-OW	264	S/A	S/A	S/A	S/A	S/A	S/A	S/A
3R-OW	256	S/A	S/A	S/A	S/A	S/A	S/A	S/A
4R-OW	265	S/A	S/A	S/A	S/A	S/A	S/A	S/A
5-OW	205	S/A	S/A	S/A	S/A	S/A	S/A	S/A
7-OW	210	S/A	S/A	S/A	S/A	S/A	S/A	S/A
18-OW	223	S/A	S/A	S/A	S/A	S/A	S/A	S/A
29-OW	224	S/A	S/A	S/A	S/A	S/A	S/A	S/A
29-A	225	S/A	S/A	S/A	S/A	S/A	S/A	S/A
30-OW	253	S/A	S/A	S/A	S/A	S/A	S/A	S/A
31-OW	257	S/A	S/A	S/A	S/A	S/A	S/A	S/A
37-OW	261	S/A	S/A	S/A	S/A	S/A	S/A	S/A
38R-OW	262	S/A	S/A	S/A	S/A	S/A	S/A	S/A
39R-OW	263	S/A	S/A	S/A	S/A	S/A	S/A	S/A

S/A - Semi-annual monitoring in April and October
A - Annual monitoring in April

B2 Alternative Source Demonstration, April 2018 Detection Monitoring

Alternative Source Demonstration
April 2018 Detection Monitoring

Edgewater Generating Station
Sheboygan, Wisconsin

Prepared for:

Alliant Energy

SCS ENGINEERS

25216068.18 | October 30, 2018

2830 Dairy Drive
Madison, WI 53718-6751
608-224-2830

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Appendix A Trend Plots for CCR Wells

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PE CERTIFICATION

Sherren C.
Clark
E-29863
Madison,
Wis.

I, Sherren Clark, hereby certify that that the information in this alternate source demonstration is accurate and meets the requirements of 40 CFR 257.94(e)(2). This certification is based on my review of the groundwater data and related site information available for the Edgewater Generating Station Ash Ponds. I am a duly licensed Professional Engineer under the laws of the State of Wisconsin.

Sh Clark 10-29-18
(signature) (date)

Sherren Clark
(printed or typed name)

License number E-29863

My license renewal date is July 31, 2020.

Pages or sheets covered by this seal:

Alternative Source Demonstration
April 2018 Detection Monitoring
Edgewater Generating Station

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1.0 INTRODUCTION

This Alternative Source Demonstration (ASD) was prepared to support compliance with the groundwater monitoring requirements of the "Coal Combustion Residuals (CCR) Final Rule" published by the U.S. Environmental Protection Agency (USEPA) in the *Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities; Final Rule*, dated April 17, 2015 (USEPA, 2015), and subsequent amendments. Specifically, this report was prepared to fulfill the requirements of 40 CFR 257.94(e)(2). The applicable sections of the Rule are provided below in *italics*.

1.1 §257.94(E)(2) ALTERNATIVE SOURCE DEMONSTRATION REQUIREMENTS

The owner and operator may demonstrate that a source other than the CCR Unit caused the statistically significant increase over background levels for a constituent or that the statistically significant increase resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality. The owner or operator must complete the written demonstration within 90 days of detecting a statistically significant increase over background levels.

An ASD is completed when there are exceedances of one or more benchmarks established within the groundwater monitoring program. The ASD is completed to determine if any other sources are likely causes of the identified exceedance(s) of established benchmark(s) at the site. This ASD was performed in response to results indicating a statistically significant increase (SSI) over background levels during detection monitoring under the CCR Rule.

This ASD report is evaluating the SSIs observed in the statistical evaluation of the April 2018 detection monitoring event at the Edgewater Generating Station (EDG). An ASD was previously prepared for this facility evaluating the SSIs observed in the statistical evaluation of the October 2017 detection monitoring event (SCS, 2018b). The October 2017 ASD (dated April 2018) concluded that several lines of evidence demonstrated that SSIs reported for boron, fluoride, pH, and sulfate concentrations in the downgradient monitoring wells (MW-301, MW-302, and MW 303) were likely due to leachate from the closed landfill, which is not subject to the requirements of 40 CFR 257.50-107.

As discussed in more detail in **Section 4.2** of this ASD, the findings for the April 2018 monitoring event were consistent with those for the previous event.

1.2 SITE INFORMATION AND MAP

The EDG is located at 3739 Lakeshore Drive in Sheboygan, Sheboygan County, Wisconsin (**Figure 1**). EDG is an active coal-burning generating station. The EDG property includes a closed landfill and a series of CCR settling ponds, located on the opposite side of Lakeshore Drive from the plant itself (**Figure 1**). The EDG landfill is closed and no longer receives CCR. The groundwater monitoring system at the EDG is a multi-unit system. The EDG has four existing CCR Units which are contiguous:

- EDG Slag Pond (existing CCR surface impoundment)
- EDG North A-Pond (existing CCR surface impoundment)
- EDG South A- Pond (existing CCR surface impoundment)
- EDG B-Pond (existing surface CCR impoundment)

A map showing the CCR Units and all background (or upgradient) and downgradient monitoring wells with identification numbers for the groundwater monitoring program is provided as **Figure 2**.

The closed CCR landfill (Wisconsin Department of Natural Resources [WDNR] Permit No. 2524) is located immediately west of the ponds. The landfill contains primarily fly ash with some slag, and was closed in 1987. Because this CCR landfill did not accept CCR after October 19, 2015, the landfill is not subject to the requirements of 40 CFR 257.50-107. The closed landfill is unlined and is known to be impacting groundwater at the site (SCS Engineers [SCS], 2016) Previous investigations done at the site (BT2, Inc., 1993; RMT, 1997) concluded that the groundwater impacts downgradient of the landfill and ponds were attributable to groundwater interaction with the landfill, rather than to leakage from the ponds.

1.3 STATISTICALLY SIGNIFICANT INCREASES IDENTIFIED

SSIs were identified for boron, fluoride, field pH, and sulfate at one or more wells based on the April 2018 detection monitoring event. A summary of the April 2018 constituent concentrations and the established benchmark concentrations is provided in **Table 1**. The October 2017 results are also included for comparison. The constituent concentrations with SSIs above the background concentration are highlighted in the table.

1.4 OVERVIEW OF ASD

This ASD report includes:

- Background information (**Section 2.0**)
- Evaluation of potential that SSIs are due to methodology or analysis (**Section 3.0**)
- Evaluation of potential that SSIs are due to natural sources or man-made sources other than the CCR Units (**Section 4.0**)
- ASD conclusions (**Section 5.0**)
- Monitoring recommendations (**Section 6.0**)

The boron results from background and compliance sampling are provided in **Table 2**. The laboratory report for the April 2018 detection monitoring event was previously transmitted to WPL and will be included in the 2018 annual report due in January 2019. Complete laboratory reports for the background monitoring events and the October 2017 detection monitoring event were included in the 2017 Annual Groundwater Monitoring and Corrective Action Report.

2.0 BACKGROUND

To provide context for the ASD evaluation, the following background information is provided in this section of the report, prior to the ASD evaluation sections:

- Geologic and hydrogeologic setting
- CCR Rule monitoring system
- Other monitoring wells
- Groundwater Flow Direction

A more detailed discussion of the background information for the site is provided in the ASD for the October 2017 event (SCS, 2018b).

2.1 REGIONAL GEOLOGY AND HYDROGEOLOGY

For the purposes of groundwater monitoring, the unconsolidated sand and gravel aquifer is considered to be the uppermost aquifer, as defined under 40 CFR 257.53, at the EDG ponds. The sand and gravel aquifer is present in some parts of Sheboygan County (Skinner and Borman, 1973). Boring logs from monitoring wells at the EDG ponds and for nearby private wells indicate that the unconsolidated material at and near the site contains a significant amount of sand. Private well logs from the surrounding area indicate that the sand and gravel aquifer has been used as a water source; however, several older sand wells in the area have been replaced with bedrock water supply wells.

The dolomite aquifer underlies the unconsolidated material at the site. The total thickness of the dolomite aquifer at the site is unknown. The dolomite aquifer is underlain by the Maquoketa shale, which is a confining unit. The Maquoketa shale is underlain by the Cambrian-Ordovician sandstone aquifer. This sequence of sedimentary bedrock units is over 1,500 feet thick in the site vicinity.

The regional groundwater flow in the unconsolidated sand and gravel aquifer in the vicinity of the site is to the east and slight southeast.

2.2 CCR MONITORING SYSTEM

The groundwater monitoring system established under the CCR Rule consists of one upgradient (background) monitoring well and three downgradient monitoring wells, as shown on **Figure 2**. The upgradient monitoring well is 2R-OW. The downgradient monitoring wells include MW 301, MW-302, and MW-303. The CCR compliance monitoring wells were installed in the unconsolidated sediments with screens in the uppermost soil layer producing appreciable water, which was a sandy silt unit. Well depths range from approximately 14.5 to 40 feet, measured from the top of the well casing.

2.3 OTHER MONITORING WELLS

Sixteen groundwater monitoring wells currently exist at the EDG site as part of the monitoring system developed for the state monitoring program for the closed landfill. The well locations are shown on **Figure 2**. These monitoring wells are used to monitor groundwater conditions at the site under the WDNR state monitoring program.

Monitoring wells for the state monitoring program are installed in the unconsolidated material at the site. This shallow monitoring system includes water table wells and piezometers. Well depths range from approximately 9 to 43 feet, measured from the top of the well casing.

2.4 GROUNDWATER FLOW DIRECTION

Groundwater flow in the area of the EDG site generally flows to the south-southeast, toward Fish Creek, which discharges into Lake Michigan. There is some localized groundwater mounding associated with the EDG ponds. The water table map shown on **Figure 3** represents the site conditions of the unconsolidated deposits during the April 2018 detection monitoring event. The water table map shows a generally south-southeast flow direction, with localized groundwater mounding in the area of the EDG ponds. The groundwater elevations at the CCR wells during the April 2018 detection monitoring event are in **Table 3.**

3.0 METHODOLOGY AND ANALYSIS REVIEW

To evaluate the potential that an SSI is due to a source other than the regulated CCR Unit, SCS used a two-step evaluation process. First, the sample collection, field and laboratory analysis, and statistical evaluation were reviewed to identify any potential error or analysis that led to exceedance of the benchmark. Second, potential alternative sources, including natural variation and man-made sources other than the CCR unit, were evaluated. This section of the report provides the findings of the methodology and analysis review. **Section 4.0** of the report addresses the potential alternative sources.

3.1 SAMPLING AND FIELD ANALYSIS REVIEW

Field notes and sampling results were reviewed to determine if any sampling error may have caused or contributed to the observed SSIs. Potential field sampling errors or issues could include mislabeling of samples, improper sample handling, missed holding times, cross contamination during sampling, or other field error. Field blank sample results were also reviewed for any indication of potential contamination from sampling equipment or containers. Based on the review of the field notes and results, SCS did not identify any indication that the SSI concentrations were due to a sampling error.

The field pH trend plots were also reviewed for any anomalous results that might indicate a possible sampling or field analysis error (e.g., calibration error or incorrect sample identification). The time series plots are provided in **Appendix A**. The field pH results reported for all wells for the August 2016 background monitoring event were anomalously low, which is most likely due to a calibration error or other problem with the field pH meter for that event. During the statistical evaluation of the background data from well 2R-OW to develop the Upper Prediction Limit (UPL) for field pH, the August 2016 field pH result was identified as an outlier and was not used in the UPL calculation. Although the compliance wells also had outlier pH results for August 2016, the anomalous results for those wells were not considered when evaluating SSI determinations for the April 2018 detection monitoring, because an interwell analysis was used for the SSI evaluation, comparing current compliance well results to UPLs based on background well results.

Because boron, fluoride, and sulfate are laboratory parameters, there is little potential for a field analysis error to contribute to an SSI.

3.2 LABORATORY ANALYSIS REVIEW

The laboratory report for the April 2018 detection monitoring was reviewed to determine if any laboratory analysis error or issue that may have caused or contributed to the observed SSI for boron, fluoride, or sulfate. The laboratory report review included reviewing the laboratory quality control flags and narrative, verifying that correct methods were used and desired detection limits were achieved, and checking the field and laboratory blank sample results. Laboratory reports for the background monitoring and the October 2017 detection monitoring event were included in the 2017 Annual Groundwater Monitoring and Corrective Action Report for the facility, and were reviewed as part of the ASD preparation for the October 2017 detection monitoring event.

Based on the review of the laboratory reports, SCS did not identify any indication that the SSI concentrations were due to a laboratory analysis error. There were no laboratory quality control flags or issues identified in the laboratory report that affect the usability of the data for detection monitoring.

Time series plots of the analytical data were also reviewed for any anomalous results that might indicate a possible sampling or laboratory error (e.g., dilution error or incorrect sample labeling). Time series plots for the parameters with SSIs are provided in **Appendix A**. No indications of sampling or laboratory errors were noted based on the time series review. The April 2018 boron, pH, fluoride, and sulfate results for MW-301, MW-302, and MW-303 are consistent with the historical data. A new pH SSI was observed from MW-301 during the April 2018 monitoring event. This pH at MW-301 was 8.02, which is similar to previous results and the UPL (**Table 1**).

3.3 STATISTICAL EVALUATION REVIEW

The review of the statistical results and methods include a quality control check of the following:

- Input analytical data vs. laboratory analytical reports
- Review statistical method and outlier concentration lists for each monitoring well/CCR Unit

Based on the review of the statistical evaluation, SCS did not identify any errors or issues in the statistical evaluation that caused or contributed to the determination of interwell SSIs for the April 2018 detection monitoring event.

3.4 SUMMARY OF METHODOLOGY AND ANALYSIS REVIEW FINDINGS

In summary, there were no changes to the SSI determinations for the April 2018 monitoring event based on the methodology and analysis review, and no errors or issues causing or contributing to the reported SSIs were identified.

4.0 ALTERNATIVE SOURCES

This section of the report discusses the potential alternative sources for the boron, sulfate, field pH, and fluoride SSIs at MW-301, MW-302, and MW-303; identifies the most likely alternative source(s); and presents the lines of evidence indicating that an alternative source is the most likely cause of the observed SSIs for boron, sulfate, field pH, and fluoride.

4.1 POTENTIAL CAUSES OF SSI

4.1.1 Natural Variation

The statistical analysis was completed using an interwell approach, comparing the April 2018 detection monitoring results to the UPLs calculated based on sampling of the background well (2R-OW). If concentrations of a constituent that is naturally present in the aquifer vary spatially, then the potential exists that the downgradient concentrations may be higher than upgradient concentrations due to natural variation.

Although natural variation is present in the shallow aquifer, it does not appear likely that natural variation is the primary source causing the boron and sulfate SSIs. These parameters were detected at higher concentrations than would likely be present naturally.

Natural variation may have contributed to the SSI for pH at MW-301 and MW-302. The UPL was calculated based on pH results at background well 2R-OW for the eight CCR Rule background monitoring events and the October 24, 2017, detection monitoring event. Based on these results the calculated UPL was 7.47, and the reported pH at MW-301 was 8.02 and at MW 302 was 7.78. Although the results exceed the UPL, the historical pH results for 2R-OW include pH values up to 7.98, indicating variability in the background. This suggests that the SSIs for pH may be partially or completely due to natural variation.

Natural variation may also have caused or contributed to the SSI for fluoride at MW-302. Elevated natural fluoride concentrations significantly higher than those reported for the downgradient wells (above 2 milligrams per liter [mg/L]) have been observed in a region in eastern Wisconsin extending along the Lake Michigan shoreline from Kewaunee County in the north to the Illinois border in the south, as described Luczaj, J., and Masarik, K, 2015, *Groundwater Quantity and Quality Issues in a Water-Rich Region: Examples from Wisconsin, USA*. The authors note that most of the wells with elevated fluoride appear to be drawing from the Pleistocene glacial sediments and Silurian dolomite units. Skinner and Borman (1973) and Kammerer (1995) also identify the Lake Michigan shoreline area of eastern Wisconsin as having somewhat elevated fluoride concentrations in groundwater.

The fluoride concentrations reported for MW-302 for October 2017 and April 2018 were just above the laboratory's limit of quantitation (LOQ), at 0.84 mg/L in October 2017 and 0.78 mg/L in April 2018. These results are within the range of reported natural concentrations, indicating that the fluoride concentration observed in this well is likely due to natural variability in the glacial sediments and shallow groundwater. As discussed below, there is also a potential that fluoride in MW-302 is associated with impacts from the closed CCR landfill.

4.1.2 Man-Made Alternative Sources

Man-made alternative sources that could potentially contribute to the boron, fluoride, pH, and sulfate SSIs could include the closed CCR landfill, the coal storage area, or other plant operations. Based the groundwater flow directions and on previous investigations at the site, the closed landfill appears to be the most likely cause of the SSIs for wells MW-301, MW-302, and MW-303.

4.2 LINES OF EVIDENCES

The lines of evidence indicating that the SSIs for boron, sulfate, fluoride, and pH in compliance wells MW-301, MW-302, and MW-303, relative to the background well, are due to an alternative source include:

1. A previous study of the CCR ponds and the closed CCR landfill determined that the landfill was the primary source of groundwater impacts in the area, based on multiple lines of evidence.

2. Past and current monitoring performed under the state monitoring program shows that boron, sulfate, fluoride, and elevated pH are all present in the CCR landfill leachate.

3. Past and current monitoring performed under the state monitoring program shows that the highest boron and sulfate concentrations are in the monitoring wells near and downgradient from the CCR landfill.

Lines of evidence regarding natural variability as an additional alternative source of the fluoride and pH SSIs are discussed above in **Section 4.1.1**.

Each of these lines of evidence and the supporting data were discussed in detail in the ASD for the October 2017 detection monitoring event (SCS, 2018b). The lines of evidence are discussed briefly below, focusing on any updated information collected since the previous ASD, with references to the previous ASD for additional details.

4.2.1 Previous CCR Pond and Landfill Study

A previous investigation titled *Field Investigation Report: Edgewater Closed Ash Disposal Facility*, completed by BT2 in 1993, found that groundwater impacts were likely due to the closed landfill (**Figure 2**) located immediately west of the ponds (BT2, 1993). The purpose of the 1993 investigation was to investigate the likely impact on groundwater quality of lining or abandoning the CCR impoundments (referred to in the report as the Wisconsin Pollutant Discharge Elimination System [WPDES] lagoons). The results from the investigation indicated that the CCR impoundments were not the primary source of downgradient groundwater impacts, and that closure or lining was not warranted. The WDNR concurred with that finding in a letter dated April 20, 1994.

The primary lines of evidence from the 1993 report that supported this finding, and support the alternative source determination for boron, sulfate, fluoride, and pH, included

- Water samples collected from each of the ponds met the Wisconsin groundwater enforcement standards established under NR 140, Wisconsin Administrative Code.

- Soil borings installed in the material below the larger ash pond, where the slag pond and the WDPES lagoons (North Pond A and South Pond A) were constructed is almost entirely slag material. Water leaking out of the lagoons and moving downward would encounter primarily slag, which is relatively inert, and not fly ash. Additionally, results for water leach testing of site-wide composite samples of fly ash and slag confirmed that the fly ash had a higher potential than slag to impact groundwater. Water leach test results for the fly ash composite sample were higher for boron, sulfate, fluoride, and pH in comparison to the slag composite sample.

- Water leach testing for individual boring samples of fly ash and/or slag also confirmed that fly ash leachate had significantly higher concentrations of boron and sulfate than slag leachate. Boron leach test results for nine samples from borings around and between the ponds, consisting mainly of slag, ranged from less than 16 to 206 μg/L.

- Water sampling within the landfill and pond area, in CCR above the native soil, documented that groundwater/leachate within the landfill had significantly higher concentrations of boron than the groundwater/leachate within the slag berms immediately adjacent to and between the Slag Pond, North/South Pond A, and Pond B.

- Groundwater monitoring results indicated that the highest concentrations of boron and sulfate were in monitoring wells downgradient from the landfill, including 18 OW and 29-OW. Elevated boron and sulfate were also reported for samples from wells 4 OW and 5-OW, located near the southwest and northwest corners of the landfill. Monitoring wells 6-OW and 7-OW, located east and southeast of the ponds, had much lower concentrations of boron and sulfate.

In the April 1994 approval letter, the WDNR approved the 1993 investigation of the WPDES lagoons/CCR impoundments and concurred with the findings of the report. The WDNR requested additional monitoring from the four new monitoring wells installed within the CCR (36-OW, 37-OW, 38R-OW, and 39R-OW) and requested the addition of fluoride and arsenic to the monitoring program for these groundwater/leachate head wells.

The results of the additional monitoring were reported to the WDNR in a Groundwater Assessment Report dated September 30, 1997. The WDNR responded to the 1997 report in a letter dated April 16, 1998, which stated, “We agree with the report’s finding that the WPDES ponds [Slag Pond, North Pond A, and South Pond A] do not appear to be significantly contributing to the contaminant plume downgradient of the facility. No further remedial action concerning the influence of the ponds on the landfill is warranted at this time." The WDNR also noted that the leachable constituents migrating from the saturated portion of the closed landfill have stabilized or also decreased since the landfill's closure and capping.

4.2.2 CCR Constituents in Landfill Leachate

Past and current monitoring performed under the state monitoring program shows that boron, sulfate, fluoride, and elevated pH are all present in the CCR landfill leachate. Recent groundwater and leachate monitoring results for boron, sulfate, and pH in samples from the state monitoring program wells are summarized in **Table 4** (April 2016 through April 2018). The leachate head wells monitoring conditions within the CCR landfill are 37-OW, 38R-OW, and 39R-OW, listed near the end of the table.

Boron: Boron concentrations in samples from leachate head wells 37-OW, 38R-OW, and 39R-OW have generally exceeded those reported for the CCR monitoring wells.

Sulfate: Sulfate concentrations in samples from, leachate head wells 37-OW, 38R-OW, and 39R-OW have generally exceeded those reported for the CCR monitoring wells.

Field pH: Field pH results for the three leachate head wells continue to have pH measurements that are slightly higher than the pH UPL calculated from the well 2R-OW background data. Ten of the 15 leachate field pH readings for April 2016 through April 2018 were higher than the calculated UPL. While slightly higher pH values were reported for the CCR well samples in April 2018, the range of pH values for the CCR compliance wells has generally been similar to recent pH results for leachate wells 37-OW and 38R-OW. Historically pH values at leachate head well 39R-OW were in the range of 8 to 9, but pH has followed a gradual decreasing trend at this well since routine monitoring began in 1994.

Fluoride: Fluoride is not part of the routine state monitoring program for the closed CCR landfill, but was sampled from the leachate wells (37-OW, 38R-OW, and 39R-OW) and the pond berm well (36-OW) from 1994 to 1997, as requested by the WDNR. The fluoride concentrations ranged from 0.25 to 0.97 mg/L (**Table 5**). The highest results were for leachate head well 39R-OW, and all four samples from this well exceeded the April 2018 fluoride concentration for MW-302.

Based on these results, the fly ash disposal in the closed CCR landfill is a likely historical source of elevated boron, sulfate, pH, and fluoride.

4.2.3 State Program Groundwater Monitoring Results

Current monitoring performed under the state monitoring program continues to show that the highest boron and sulfate concentrations are in the monitoring wells near and downgradient from the CCR landfill. State program monitoring results for the CCR Rule detection monitoring parameters that overlap with the state program are summarized in **Table 4**, and well locations are on **Figure 2**.

Consistent with the conditions observed at the time of the 1993 report, the recent groundwater monitoring results indicate that the highest concentrations of boron and sulfate are in monitoring wells downgradient from the landfill, including 18-OW (recently replaced by 40 OW) and 29 OW. Elevated boron and sulfate also continue to be reported for samples from wells 4-OW and 5-OW, located near the southwest and northwest corners of the landfill.

5.0 ASD CONCLUSIONS

The lines of evidence discussed above regarding the SSIs reported for boron, fluoride, field pH, and sulfate concentrations in downgradient monitoring wells MW-301, MW-302, and/or MW 303 demonstrate that the SSIs are likely primarily due to leachate from the closed landfill, which is not subject to the requirements of 40 CFR 257.50-107. The landfill is regulated by the WDNR under the solid waste program. The SSIs for fluoride and field pH at MW-301 and MW 302 may also be partially due to natural variability within the glacial sediment aquifer.

6.0 SITE GROUNDWATER MONITORING RECOMMENDATIONS

In accordance with section 257.94(e)(2) of the CCR Rule, the EDG pond site may continue with detection monitoring based on this ASD. The ASD report will be included in the 2018 Annual Report due January 31, 2019.

7.0 REFERENCES

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Tables

Table 1
Detection Monitoring Results Summary - October 2017 & April 2018
Edgewater Generating Station

Parameter Name	**Units**	**Interwell Upper Prediction Limit (UPL)**	**Background Well**		**Compliance Wells**					
			2R-OW		**MW-301**		**MW-302**		**MW-303**	
			10/24/2017	4/2/2018	10/24/2017	4/2/2018	10/24/2017	4/2/2018	10/24/2017	4/2/2018
Boron	ug/L	107	55.9	19.7	**8820**	**7,950**	**1760**	**1,800**	**3480**	**3,040**
Calcium	mg/L	206,247	170,000	121,000	87,200	78,900	68,100	68,000	173,000	146,000
Chloride	mg/L	378	305	108	11.9	11.2	18.9	18.5	20.4	19.7
Fluoride	mg/L	LOQ (varies by well)	<0.1 U	0.12 J	<0.1 U	0.25 J	**0.84**	**0.78**	<0.5 U	<0.5 U
Field pH	Std. Units	7.47	7.23	7.29	7.43	**8.02**	**7.6**	**7.78**	7.14	6.86
Sulfate	mg/L	35	29.3	17.2	**341**	**332**	**72.2**	**72.7**	<5 U	<5.0 U
Total Dissolved Solids	mg/L	1145	1010	680	772	752	316	314	566	630

149 Statistically significant increase at compliance well

Notes:

1. UPL based on parametric prediction limit based on 1-of-2 resampling methodology for all parameters except calcium and fluoride.
2. UPL for fluoride is non-parametric based on quantitation limit. UPL for calcium based on non-parametric prediction limit (highest background value).
3. UPLs calculated from background well results for April 2016 through October 2017.

I:\25216068.00\Reports\2018 ASD Report No. 2\Tables\[EDG-closed- Tables 1,2, and 3.xlsx]Table 1

Table 2. Analytical Results - CCR Ponds Detection Monitoring Program
Edgewater Generating Station, Sheboygan, Wisconsin / SCS Engineers Project #25216068.18

Well Group	Well	Collection Date	Boron (µg/L)	Calcium (µg/L)	Chloride (mg/L)	Field pH (Std. Units)	Fluoride (mg/L)	Sulfate (mg/L)	Total Dissolved Solids (mg/L)
Background	2R-OW	4/8/2016	100	205,000	91.7	7.34	<0.2 U	19.5	774
		6/20/2016	22.4	148,000	232	7.02	<0.2 U	28.0	908
		8/9/2016	32.6	145,000	215	6.10	<0.2 U	25.4	974
		10/20/2016	43.1	155,000	217	6.98	<0.1 U	21.6	944
		1/24/2017	31.2	152,000	201	7.15	<0.1 U	23.9	854
		4/6/2017	70.6	143,000	102	7.01	<0.1 U	17.6	750
		6/6/2017	45.2	145,000	115	6.86	<0.1 U	17.8	744
		8/1/2017	35.7	164,000	272	7.00	<0.1 U	28.8	1000
		10/23/2017	55.9	170,000	305	7.23	<0.1 U	29.3	1010
		4/2/2018	19.7	121,000	108	7.29	0.12 J	17.2	680
Compliance	MW-301	4/11/2016	8,550	88,700	16.2	7.91	0.33 J	372	838
		6/20/2016	8,190	92,200	15.9	7.48	0.36 J	343	794
		8/9/2016	8,450	84,000	13.7	6.47	0.33 J	368	862
		10/20/2016	8,620	89,400	13.9	7.68	0.34	369	838
		1/23/2017	9,280	89,200	13.8	8.03	0.42	372	826
		4/6/2017	8,370	98,800	12.7	7.98	0.21 J	367	838
		6/6/2017	9,160	94,900	13.5	7.70	<0.1 U	362	804
		8/2/2017	8,610	83,600	12.3	7.58	0.32	340	780
		10/24/2017	8,820	87,200	11.9	7.43	<0.1 U	341	772
		4/2/2018	7,950	78,900	11.2	8.02	0.25 J	332	752
	MW-302	4/8/2016	1,950	122,000	18.9	8.01	0.83	75.1	352
		6/20/2016	2,010	116,000	27.2	7.73	1.3 J	89.6	364
		8/9/2016	2,000	75,900	18.0	6.55	0.8	80.7	396
		10/20/2016	2,150	72,100	19.5	7.89	0.8	77.2	348
		1/24/2017	2,000	87,400	18.6	7.98	0.89 J	71.1	328
		4/6/2017	1,970	114,000	18.9	7.99	0.76	85.8	358
		6/6/2017	1,970	72,200	20.0	7.84	0.9	88.5	350
		8/2/2017	1,890	62,600	19.3	7.76	0.78	80.2	360
		10/24/2017	1,760	68,100	18.9	7.60	0.84	72.2	316
		4/2/2018	1,800	68,000	18.5	7.78	0.78	72.7	314

Table 2. Analytical Results - CCR Ponds Detection Monitoring Program
Edgewater Generating Station, Sheboygan, Wisconsin / SCS Engineers Project #25216068.18

Well Group	Well	Collection Date	Boron (µg/L)	Calcium (µg/L)	Chloride (mg/L)	Field pH (Std. Units)	Fluoride (mg/L)	Sulfate (mg/L)	Total Dissolved Solids (mg/L)
Compliance	MW-303	4/8/2016	4,210	176,000	21.8	7.04	<0.2 U	3 J	660
		6/20/2016	3,360	138,000	31.5	6.79	<1 U	11.4 J	716
		8/9/2016	3,860	145,000	22.8	6.09	<0.2 U	2.4 J	732
		10/20/2016	3,740	147,000	26.0	6.94	<0.5 U	5.6 J	744
		1/24/2017	4,210	147,000	26.2	6.94	<0.5 U	<5 U	738
		4/6/2017	4,170	135,000	22.7	6.88	<0.5 U	<5 U	700
		6/6/2017	4,570	154,000	25.4	7.00	<0.5 U	<5 U	714
		8/2/2017	3,780	139,000	23.2	6.94	<0.5 U	<5 U	714
		10/24/2017	3,480	173,000	20.4	7.14	<0.5 U	<5 U	566
		4/2/2018	3,040	146,000	19.7	6.86	<0.5 U	<5 U	630

Abbreviations:

µg/L = micrograms per liter or parts per billion (ppb)
mg/L = milligrams per liter or parts per million (ppm)
-- = not analyzed

U = Not detected
J = Estimated value below laboratory's limit of quantitation (LOQ)

Notes:

1. Complete laboratory reports included in 2017 Annual Groundwater Monitoring and Corrective Action Report, Edgewater Generating Station.

Created by: NDK Date: 3/2/2018
Last revision by: NDK Date: 9/10/2018
Checked by: AJR Date: 9/19/2018

I:\25216068.00\Reports\2018 ASD Report No. 2\Tables\[EDG-closed- Tables 1,2, and 3.xlsx]Table 2- CCR Analytical

Table 3. Groundwater Elevations - CCR Rule Monitoring Wells
Edgewater Generating Station, Sheboygan, Wisconsin
SCS Engineers Project #25216068.18

Ground Water Elevation in feet above mean sea level (amsl)				
Well Number	**MW-301**	**MW-302**	**MW-303**	**2R-OW**
Top of Casing Elevation (feet amsl)	604.42	615.15	611.99	612.72
Screen Length (ft)	5.00	5.00	5.00	10.00
Total Depth (ft from top of casing)	27.47	40.00	33.26	14.50
Top of Well Screen Elevation (ft)	581.95	580.15	579.60	--
Measurement Date				
April 8, 2016	599.75	596.19	589.04	609.68
June 20, 2016	598.30	595.68	587.22	606.70
August 9, 2016	598.00	595.53	587.72	605.74
October 20, 2016	598.50	595.46	588.37	607.27
January 23-24, 2017	597.10	596.30	588.84	609.64
April 6, 2017	600.04	593.57	589.04	609.72
June 6, 2017	598.77	595.86	588.44	607.63
August 1, 2017	597.40	595.22	587.36	604.59
October 24, 2017	597.20	595.25	587.97	601.74
April 2, 2018	598.54	595.71	588.77	607.87
Bottom of Well Elevation (ft)	576.95	575.15	578.73	598.22

Notes:

Groundwater elevations compiled from field notes during sampling events.

-- = not measured

Created by:	NDK	Date:	2/28/2018
Last rev. by:	NDK	Date:	9/17/2018
Checked by:	AJR	Date:	9/19/2018

I:\25216068.00\Reports\2018 ASD Report No. 2\Tables\[EDG-closed- Tables 1,2, and 3.xlsx]Table 3. GW elev - CCR

Table 4. April 2018 Groundwater Analytical Results - Closed Landfill State Monitoring Program Wells

WPL - Edgewater Generating Station / SCS Project #25216068

Sheboygan, Wisconsin

Point Name	Reporting Period	ph-Field (standard units)	Boron, dissolved (µg/L as B)	Sulfate, dissolved (mg/L as SO_4)
Monitoring Wells				
2R-OW	2016-Apr	7.45	26.6	30.9
2R-OW	2016-Oct	6.98	40.4	22.9
2R-OW	2017-Apr	7.3	69.3 J	28.6
2R-OW	2017-Oct	7.66	35.2	32.9
2R-OW	2018-Apr	7.29	23.3	18.2
3R-OW	2016-Apr	7.41	392	533
3R-OW	2016-Oct	7.32	468	372
3R-OW	2017-Apr	7.35	400	409
3R-OW	2017-Oct	7.39	389	637
3R-OW	2018-Apr	7.24	351	498
4R-OW	2016-Apr	7.69	7,710	120
4R-OW	2016-Oct	7.71	17,300	252
4R-OW	2017-Apr	7.44	12,600	180
4R-OW	2017-Oct	7.31	15,700	178
4R-OW	2018-Apr	7.51	12,700	164
5-OW	2016-Apr	7.64	4,330	215
5-OW	2016-Oct	7.75	5,970	210
5-OW	2017-Apr	7.51	5,490	258
5-OW	2017-Oct	7.54	6,040	230
5-OW	2018-Apr	7.90	3,900	143
7-OW	2016-Apr	8.14	610	255
7-OW	2016-Oct	7.59	964	251
7-OW	2017-Apr	8.1	761	259
7-OW	2017-Oct	7.73	1,130	246
7-OW	2018-Apr	8.08	818	243
29-A	2016-Apr	9.07	357	40.9
29-A	2016-Oct	8.54	264	39.6
29-A	2017-Apr	9.09	365	41.5
29-A	2017-Oct	8.97	278	42.1
29-A	2018-Apr	8.72	264	39.4
29-OW	2016-Apr	8.03	10,600	120
29-OW	2016-Oct	7.69	10,900	85.7
29-OW	2017-Apr	8.49	9,500	77
29-OW	2017-Oct	8.15	9,060	62
29-OW	2018-Apr	7.97	8,640	102
30-OW	2016-Apr	8.26	79	4.8
30-OW	2016-Oct	7.56	113	4.6
30-OW	2017-Apr	8.47	176	7.5
30-OW	2017-Oct	7.44	135	16.7
30-OW	2018-Apr	7.96	94.5	21.5

Table 4. April 2018 Groundwater Analytical Results - Closed Landfill State Monitoring Program Wells

WPL - Edgewater Generating Station / SCS Project #25216068

Sheboygan, Wisconsin

Point Name	Reporting Period	ph-Field (standard units)	Boron, dissolved (µg/L as B)	Sulfate, dissolved (mg/L as SO_4)
31-OW	2016-Apr	7.63	114	91.2
31-OW	2016-Oct	7.68	35	63.3
31-OW	2017-Apr	7.99	77	82.4
31-OW	2017-Oct	7.79	190	70.3
31-OW	2018-Apr	7.71	30.8	51.5
40-OW	2016-Apr	8.04	8,030	731
40-OW	2016-Oct	7.91	29,400	768
40-OW	2017-Apr	7.97	8,680	849
40-OW	2017-Oct	7.91	8,800	873
40-OW	2018-Apr	7.93	9,790	771
Leachate Monitoring Wells				
37-OW	2016-Apr	7.49	19,100	759
37-OW	2016-Oct	7.31	12,500	439
37-OW	2017-Apr	8.01	15,900	633
37-OW	2017-Oct	7.24	9,440	264
37-OW	2018-Apr	7.68	5,890	159
38R-OW	2016-Apr	8.00	33,800	1,000
38R-OW	2016-Oct	7.71	17,100	514
38R-OW	2017-Apr	7.86	21,100	932
38R-OW	2017-Oct	7.72	10,800	364
38R-OW	2018-Apr	7.72	4,250	123
39R-OW	2016-Apr	7.26	10,100	534
39R-OW	2016-Oct	7.32	29,900	1,390
39R-OW	2017-Apr	7.44	22,400	1,150
39R-OW	2017-Oct	7.52	32,800	1,400
39R-OW	2018-Apr	7.76	28,800	772

Abbreviations:

µg/L = micrograms per liter or parts per billion (ppb)
mg/L = milligrams per liter or parts per million (ppm)
-- : not measured
MSL = mean sea level

Notes:

-- : not measured

Laboratory Notes:

J: Estimated concentration above the adjusted method detection limit and below the adjusted reporting limit.

Created by:	SCC	Date:	2/24/2014
Last revision by:	JR	Date:	9/21/2018
Checked by:	NDK	Date:	9/21/2018

I:\25216068.00\Reports\2018 ASD Report No. 2\Tables\[EDG-closed- Tables 1,2, and 3.xlsx]Table 4. GW quality Data

Table 5. Analytical Results - Closed Landfill Leachate Fluoride Monitoring
Edgewater Generating Station, Sheboygan, Wisconsin
SCS Engineers Project #25216068.00

Collection Date	Fluoride (mg/L)			
	36-OW	37-OW	38R-OW	39R-OW
9/8/1994	0.25	0.62	0.57	0.79
9/14/1995	0.38	0.51	0.71	0.87
9/17/1996	0.56	0.42	0.71	0.97
9/16/1997	0.60	0.44	0.73	0.97

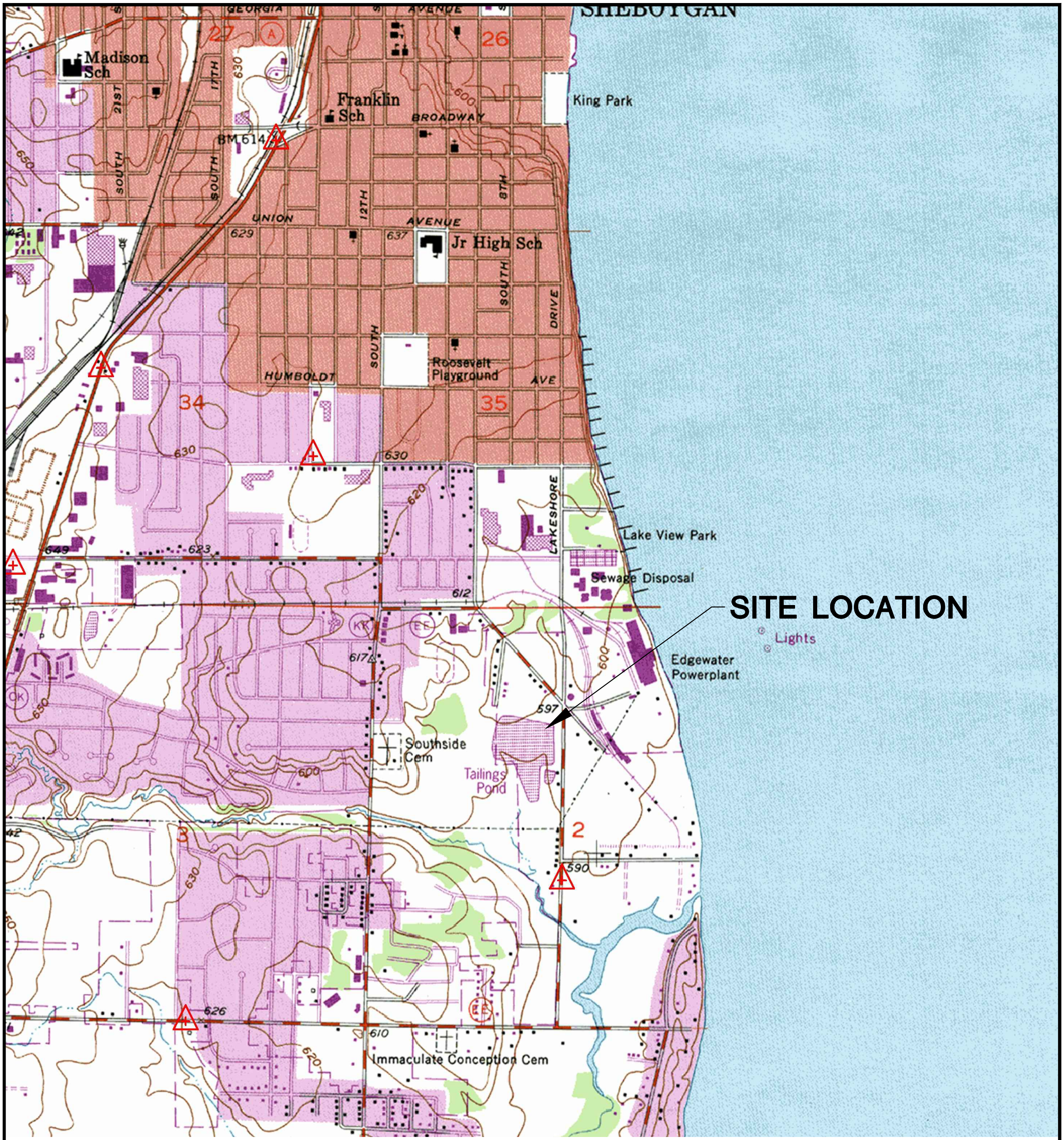
Abbreviations:
mg/L = milligrams per liter or parts per million (ppm)

Notes:
1. Data compiled from WDNR Groundwater Environmental Monitoring System (GEMS) website.

Created by: NDK Date: 3/5/2018
Last revision by: NDK Date: 3/5/2018
Checked by: AJR Date: 4/5/2018

I:\25216068.00\Reports\2018 ASD Report No. 2\Tables\[EDG-closed- Tables 1,2, and 3.xlsx]Table 5- Fl resu

Figures

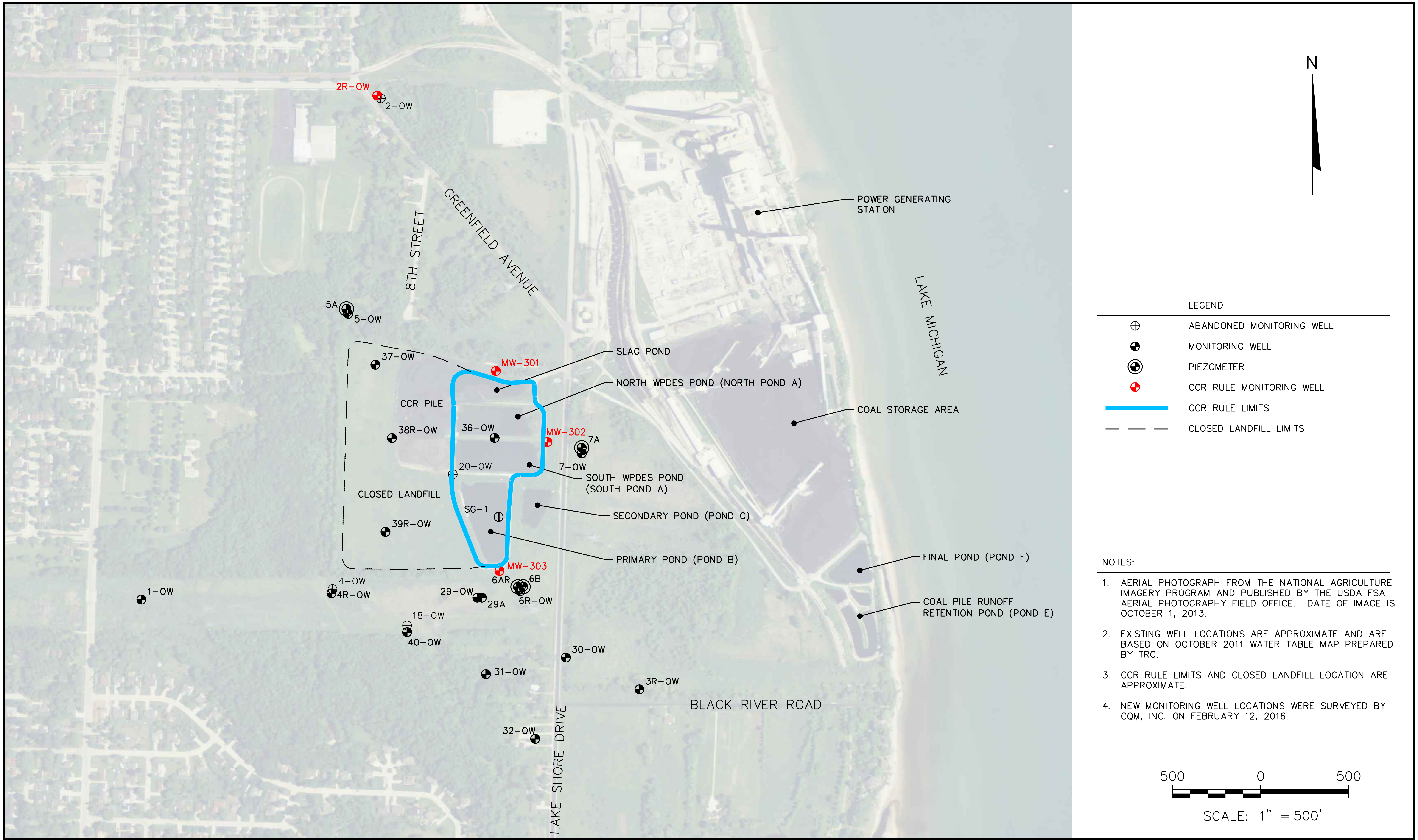


N

SHEBOYGAN SOUTH QUADRANGLE
WISCONSIN–SHEBOYGAN CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)
NW/4 SHEBOYGAN SOUTH 15' QUADRANGLE
1994
SCALE: 1" = 2,000'

CLIENT	WISCONSIN POWER AND LIGHT EDGEWATER GENERATING STATION 3739 LAKESHORE DRIVE SHEBOYGAN, WI 53081	SITE	EDGEWATER 1–4 (CLOSED) ASH DISPOSAL FACILITY	SITE LOCATION MAP	

PROJECT NO.	25213069	DRAWN BY:	KP	ENGINEER	SCS ENGINEERS 2830 DAIRY DRIVE MADISON, WI 53718–6751 PHONE: (608) 224–2830	FIGURE
DRAWN:	02/28/14	CHECKED BY:	MB			1
REVISED:	02/28/14	APPROVED BY:				



NOTES:

1. AERIAL PHOTOGRAPH FROM THE NATIONAL AGRICULTURE IMAGERY PROGRAM AND PUBLISHED BY THE USDA FSA AERIAL PHOTOGRAPHY FIELD OFFICE. DATE OF IMAGE IS OCTOBER 1, 2013.
2. EXISTING WELL LOCATIONS ARE APPROXIMATE AND ARE BASED ON OCTOBER 2011 WATER TABLE MAP PREPARED BY TRC.
3. CCR RULE LIMITS AND CLOSED LANDFILL LOCATION ARE APPROXIMATE.
4. NEW MONITORING WELL LOCATIONS WERE SURVEYED BY CQM, INC. ON FEBRUARY 12, 2016.

PROJECT NO.	25216068.18	DRAWN BY:	KP/BJM/RJG
DRAWN:	02/28/14	CHECKED BY:	KAK
REVISED:	10/09/18	APPROVED BY:	

ENGINEER

SCS ENGINEERS
2830 DAIRY DRIVE MADISON, WI 53718-6751
PHONE: (608) 224-2830

CLIENT

WISCONSIN POWER AND LIGHT
EDGEWATER GENERATING STATION
3739 LAKESHORE DRIVE
SHEBOYGAN, WI 53081

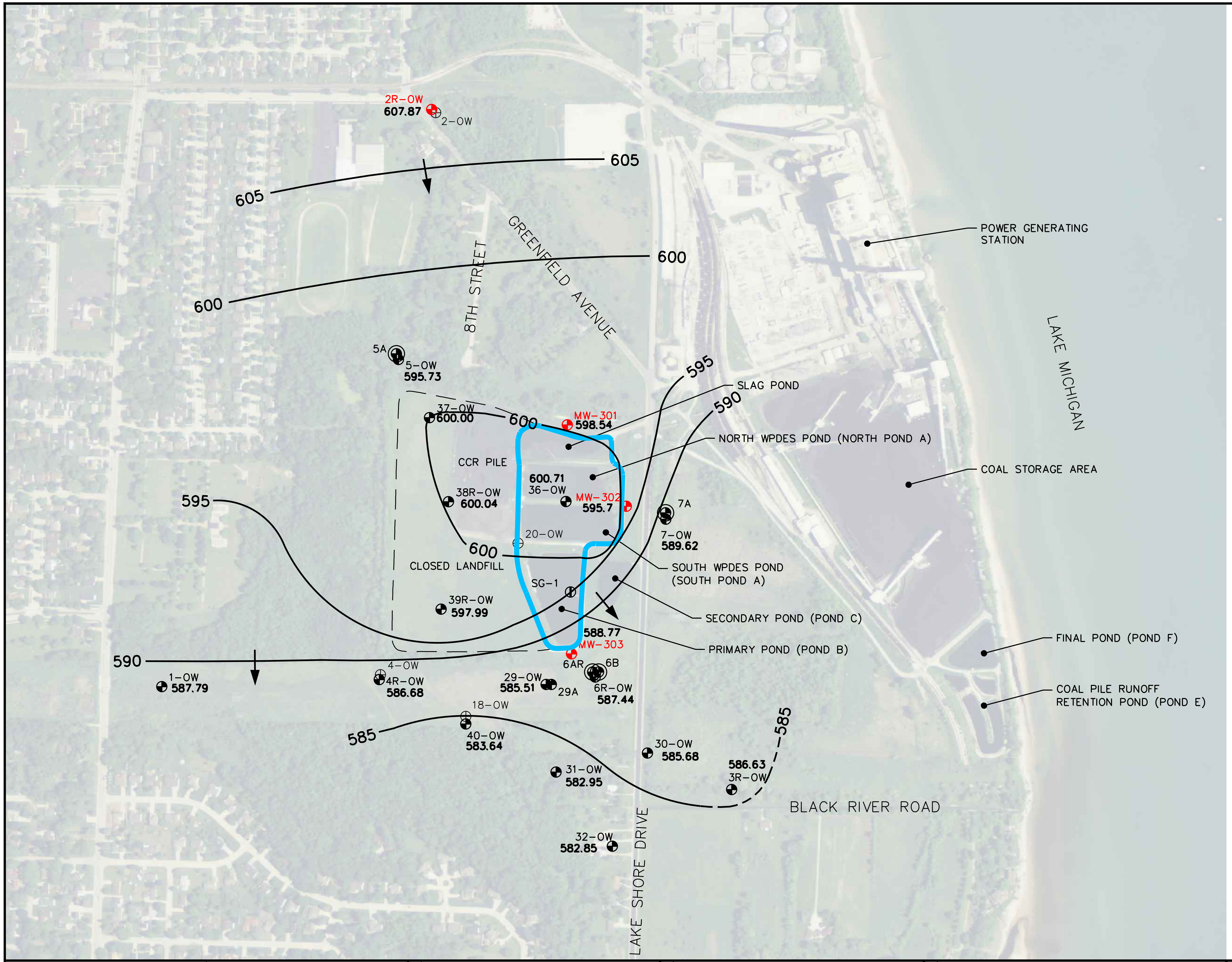
SITE

EDGEWATER 1-4 (CLOSED)
ASH DISPOSAL FACILITY
SHEBOYGAN, WISCONSIN

MONITORING WELL LOCATION MAP

FIGURE
2

I:\25216068.00\Drawings\2_Monitoring Well Location Map.dwg, 10/9/2018 1:45:2 PM



LEGEND

⊕	ABANDONED MONITORING WELL
◕	MONITORING WELL
◉	PIEZOMETER
🔴	CCR RULE MONITORING WELL
▬	CCR RULE LIMITS
— — —	CLOSED LANDFILL LIMITS
598.54	WATER TABLE ELEVATION (APRIL 2, 2018)
———	WATER TABLE CONTOUR (5' INTERVAL)
→	APPROXIMATE GROUNDWATER FLOW DIRECTION

NOTES:

1. AERIAL PHOTOGRAPH FROM THE NATIONAL AGRICULTURE IMAGERY PROGRAM AND PUBLISHED BY THE USDA FSA AERIAL PHOTOGRAPHY FIELD OFFICE. DATE OF IMAGE IS OCTOBER 1, 2013.
2. EXISTING WELL LOCATIONS ARE APPROXIMATE AND ARE BASED ON OCTOBER 2011 WATER TABLE MAP PREPARED BY TRC.
3. DESIGN MANAGEMENT ZONE LOCATION IS APPROXIMATE.
4. NEW MONITORING WELL LOCATIONS WERE SURVEYED BY CQM, INC. ON FEBRUARY 12, 2016.

500 0 500

SCALE: 1" = 500'

PROJECT NO.	25216068.18	DRAWN BY:	BSS/RJG
DRAWN:	09/11/18	CHECKED BY:	NK/SC
REVISED:	10/09/18	APPROVED BY:	TK

ENGINEER

SCS ENGINEERS
2830 DAIRY DRIVE MADISON, WI 53718-6751
PHONE: (608) 224-2830

CLIENT

WISCONSIN POWER AND LIGHT
EDGEWATER GENERATING STATION
3739 LAKESHORE DRIVE
SHEBOYGAN, WI 53081

SITE

EDGEWATER 1-4 (CLOSED)
ASH DISPOSAL FACILITY
SHEBOYGAN, WISCONSIN

WATER TABLE MAP
APRIL 2, 2018

FIGURE
3

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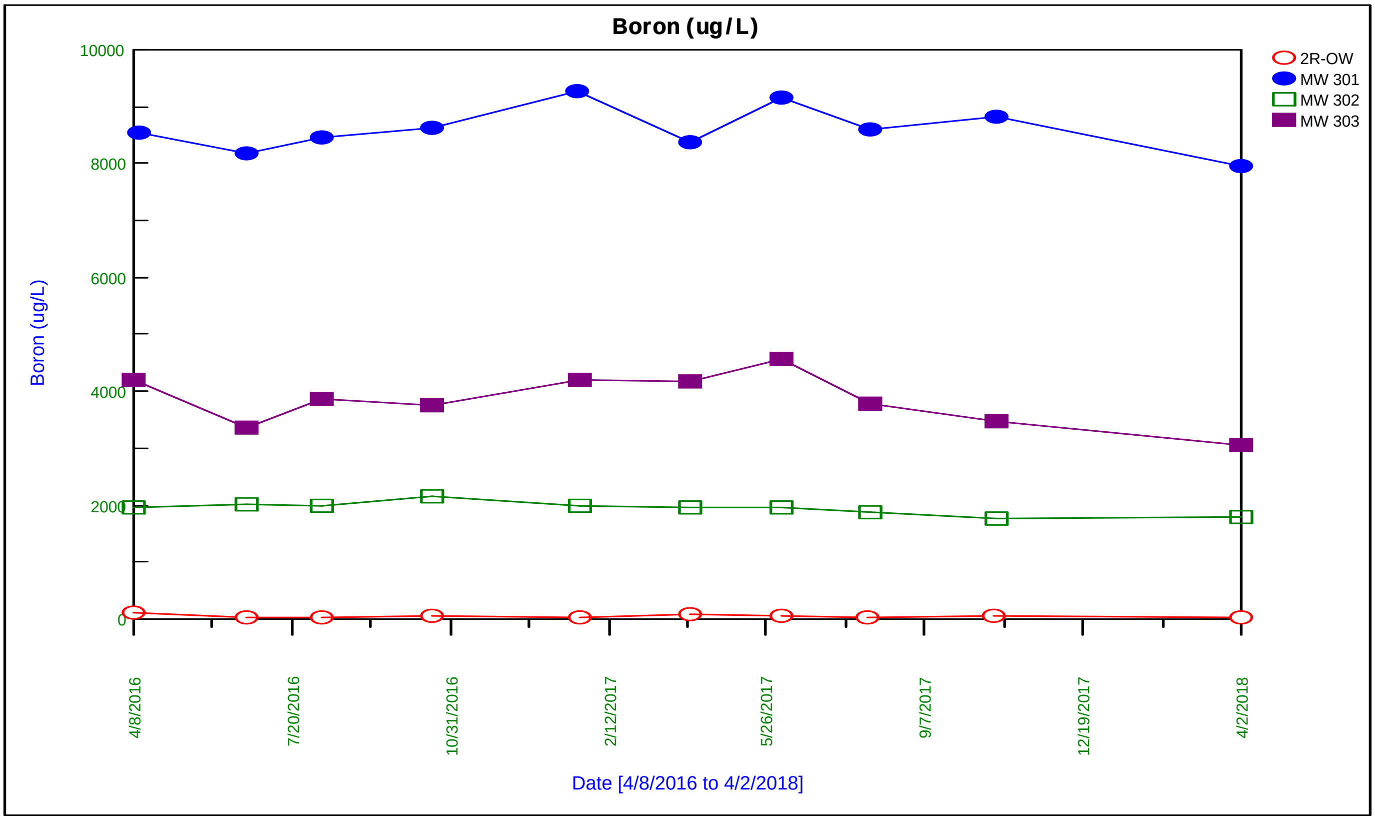
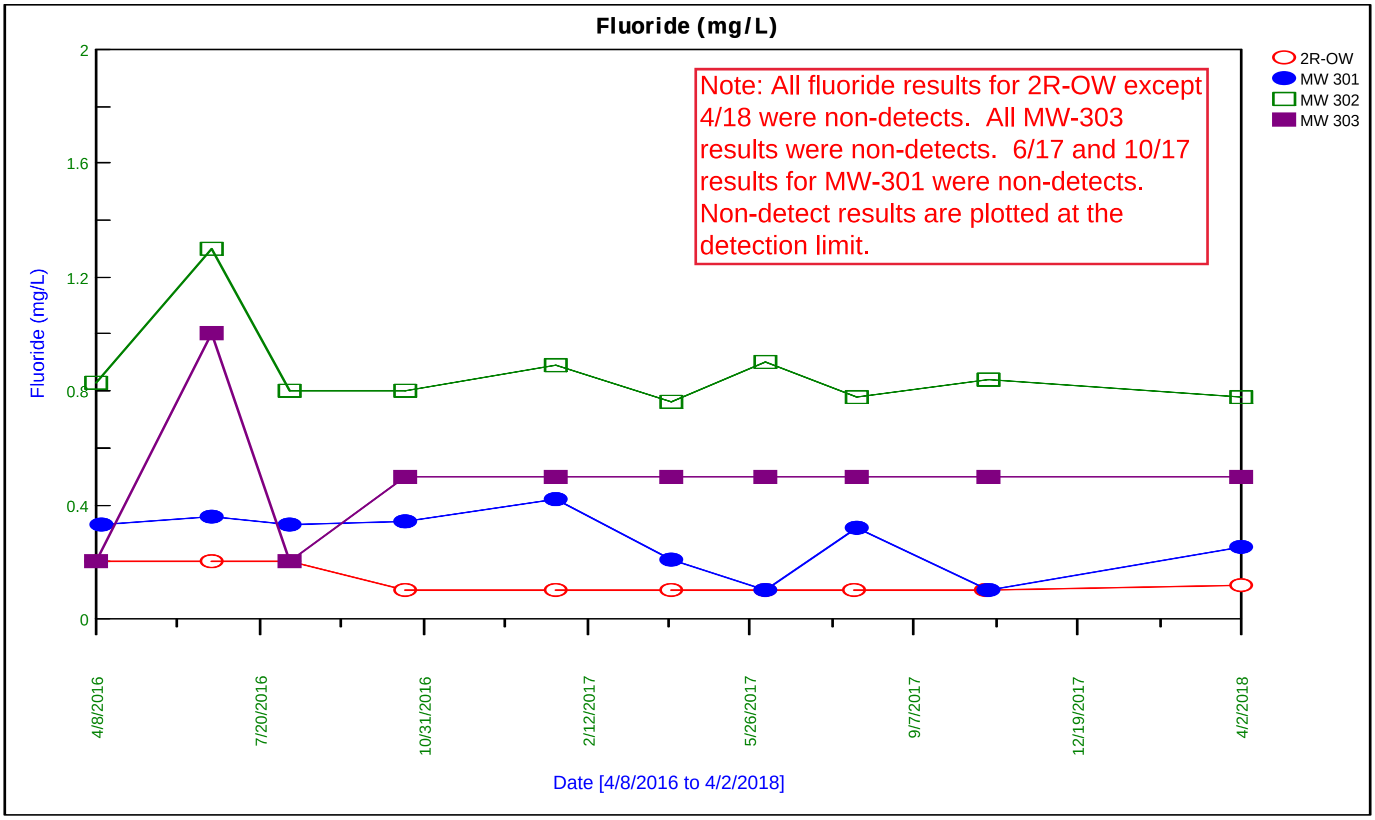
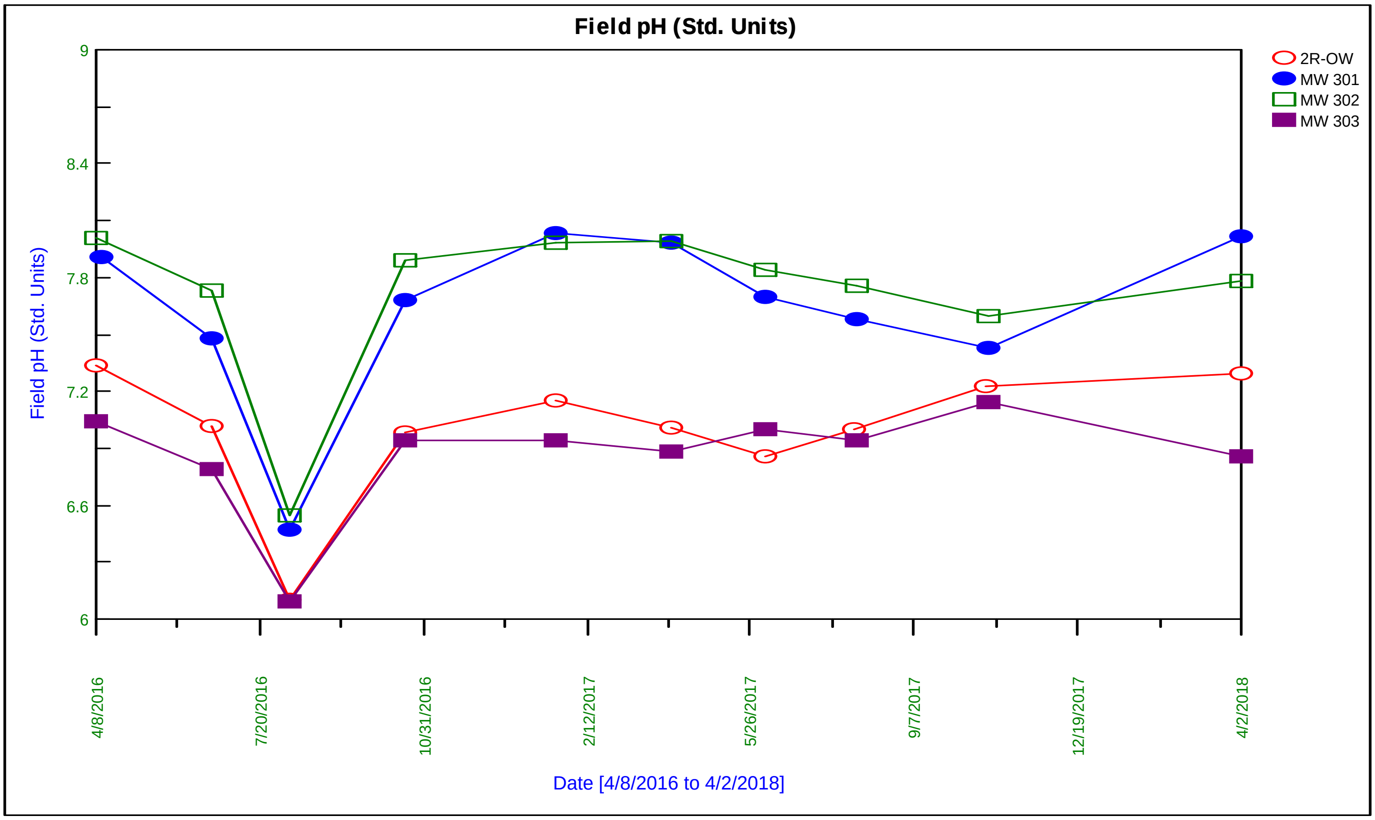
Appendix A

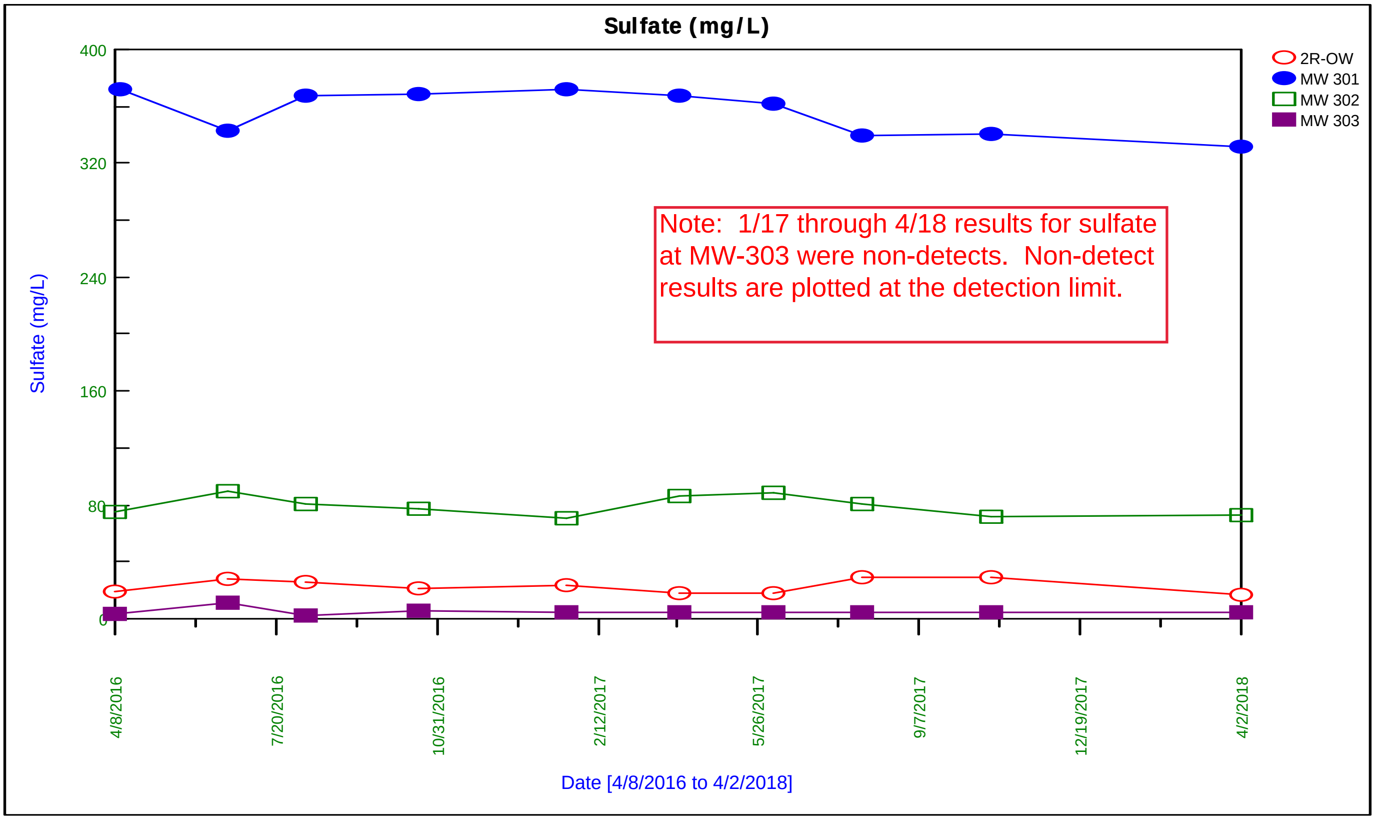
Trend Plots for CCR Wells





Note: All fluoride results for 2R-OW except 4/18 were non-detects. All MW-303 results were non-detects. 6/17 and 10/17 results for MW-301 were non-detects. Non-detect results are plotted at the detection limit.





Note: 1/17 through 4/18 results for sulfate at MW-303 were non-detects. Non-detect results are plotted at the detection limit.