**BEFORE THE ILLINOIS POLLUTION CONTROL BOARD**

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| In the Matter of: | ) | |
| | ) | |
| SIERRA CLUB, ENVIRONMENTAL LAW AND POLICY CENTER, PRAIRIE RIVERS NETWORK, and CITIZENS AGAINST RUINING THE ENVIRONMENT | ) | |
| | ) | |
| Complainants, | ) | |
| | ) | |
| v. | ) | PCB No-2013-015 |
| | ) | (Enforcement – Water) |
| MIDWEST GENERATION, LLC, | ) | |
| | ) | |
| Respondents | ) | |

**NOTICE OF FILING**

TO: John Therriault, Assistant Clerk
Illinois Pollution Control Board
James R. Thompson Center
100 West Randolph Street, Suite 11-500
Chicago, IL 60601

Attached Service List

PLEASE TAKE NOTICE that I have filed today with the Illinois Pollution Control Board Complainants' Response to Respondent's Motion to Strike the Discussion of the Federal CCR Rules, copies of which are herewith served upon you.

Jennifer L. Cassel
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jcassel@elpc.org

Dated: January 12, 2016

**BEFORE THE ILLINOIS POLLUTION CONTROL BOARD**

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| In the Matter of: | ) | |
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| SIERRA CLUB, ENVIRONMENTAL LAW AND POLICY CENTER, PRAIRIE RIVERS NETWORK, and CITIZENS AGAINST RUINING THE ENVIRONMENT | ) | |
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| MIDWEST GENERATION, LLC, | ) | |
| | ) | |
| Respondents | ) | |

**COMPLAINANTS' RESPONSE TO RESPONDENT'S MOTION TO STRIKE THE DISCUSSION OF THE FEDERAL CCR RULES**

Complainants submit this Response to Respondent Midwest Generation's (MWG) Motion to Strike the Discussion of the Federal CCR Rules ("Motion to Strike.") The Hearing Officer should deny the Motion to Strike because: (1) contrary to MWG's allegations, Complainants do not seek to insert federal claims or have the Board enforce federal law; (2) expert Dr. James Kunkel's citations to the Federal Coal Combustion Residual (CCR) rules, 40 CFR § 257.50 – § 257.107, are perfectly consistent with the Board's October 3, 2013 Order; and (3) Dr. Kunkel's discussion of the Federal CCR Rules falls squarely within the purpose of a Reply Report – to support opinions raised in his initial expert report, and to "explain[], repel[], contradict[], [and] disprove[]" the Respondent expert's report. Memo in Support of Motion to Strike at 5.

## I. PROCEDURAL BACKGROUND

On October 3, 2012, Complainants filed a complaint against MWG alleging violations of Illinois law. The complaint inadvertently appeared to allege violations of federal law, but Complainants did not, and do not now, seek to have the Board enforce federal law.

On November 5, 2012, Respondents filed a Motion to Dismiss the Complaint in part because the apparent allegations of federal law were outside the Board's authority. Respondent's Motion to Dismiss at ¶ 18.

The Board denied the Motion to Dismiss, but granted MWG's request to strike the language in counts 1 through 3 that alleged violations of federal law. *Sierra Club et al v. Midwest Generation*, No. 13-15, slip op. at 25 (Oct. 3, 2013). In the Board's discussion of Complainants' references to federal regulations, the Board decided that many of the references were appropriate. Specifically, the Board stated that:

> The remaining paragraphs [other than those that were partially struck] referencing provisions of 40 C.F.R. part 257 simply provide background . . . or list "violations," i.e., exceedances, of MCLs for various contaminants. These references are more in the nature of evidence than claims of a violation . . . [T]he Board declines to strike portions of the complaint that reference the RCRA regulations as background or identify purported MCL exceedances in the groundwater under the generating stations.

*Id.* at 25.

The U.S. EPA released a pre-publication version of the Federal CCR Rules on December 19, 2014, and, after making some revisions,[1] published the final rule in the Federal Register on April 17, 2015. U.S. EPA, *Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals From Electric Utilities; Final Rule*, 80 Fed. Reg. 21,302 (Apr. 17, 2015).

[1] A redline version of the rule showing the revisions between the pre-publication version of the rule and the final version can be found at http://www.epa.gov/sites/production/files/2015-04/documents/redline_version_of_ccr_final_rule.pdf.

On July 1, 2015, Complainants served their expert report, authored by Dr. James Kunkel. Dr. James Kunkel, *Expert Report on Ground-water Contamination* (July 1, 2015) ("Kunkel Report," attached as Ex. A). In that report, Dr. Kunkel expressed several opinions directly relevant to the Motion to Strike. Among other things, Dr. Kunkel argued that boron, sulfate, and manganese should be used "as indicators of ground-water contamination from the ash ponds" (Ex. A at 7); that "ash and [] pond bottom liners are at or below the ground-water table," which makes them susceptible to leaks, (*Id.* at 34; *see also id.* at 18, 25, and 32); and that "the ash pond liners have leaked and likely continue to leak" (*Id.* at 32; *see also id.* at 2, 4, 12, 18, and 25).

On November 2, 2015, Respondent Midwest Generation submitted its *Expert Report of John Seymour, P.E.* ("Seymour Report," attached as Ex. B). In that report, John Seymour presented alternative groundwater indicator contaminants (*Id.* at 51), arguing that Dr. Kunkel had defined his list of indicators using sources that were inappropriate because they "are not specific to the four MWG sites." *Id.* Seymour also repeatedly argued that the pond liners "are consistent with remediation-industry-accepted approaches." *See, e.g., id.* at 35.

On December 8, 2015, Complainants submitted *Kunkel's Rebuttal Report to Expert Report of John Seymour, P.E.* ("Reply Report," attached as Ex. C). The Reply Report cited and discussed parts of recently promulgated federal solid waste rules for coal ash disposal and storage, 40 C.F.R. Part 257 ("Federal CCR Rules"), as evidence and background for Dr. Kunkel's rebuttal of Seymour's arguments. On December 22, 2015, Respondent Midwest Generation moved to strike "the discussion of the Federal CCR Rules, 40 CFR § 257.50-257.107, from the Rebuttal Report to Expert Report of John Seymour, P.E. ("Motion to Strike").

## II. DISCUSSION

### A. The Kunkel Report Relies on the Federal CCR Rules for the Same Evidentiary Purposes that the Board Held Were Permissible in its October 3, 2013 Ruling.

In its Motion to Strike, MWG argues that Complainants are "attempt[ing] to re-insert allegations of violations of Federal regulations through its [sic] expert's Reply Report." Memo in Support of Motion to Strike at 5. This is incorrect. Complainants are not seeking to raise federal claims, or seeking to have the Board enforce federal law. Instead, consistent with the Board's October 3, 2013 Order denying Respondent's Motion to Dismiss, the Reply Report appropriately cites federal law as factual background evidence to rebut the Seymour Report.[2]

In the Reply Report, Dr. Kunkel's citations to the Federal CCR Rules are in direct response to arguments raised by Seymour in the Seymour Report. In response to Seymour's argument that the liners "are consistent with remediation-industry-accepted approaches," (Ex. B at 35), Dr. Kunkel observes that the liners are <u>not</u> consistent with national standards on coal ash management – the Federal CCR Rules. The point is clear: approaches inconsistent with federal law cannot be "remediation-industry-accepted approaches." Similarly, after Seymour suggested that Dr. Kunkel had used the wrong set of indicator pollutants and questioned the sources that Dr. Kunkel cited in his initial report (*Id.* at 51), Dr. Kunkel cited the Federal CCR Rules as one of several sources that support his list of indicator pollutants:

> USEPA proposes using the following indicator constituents of ground-water contamination: B, chloride (Cl), conductivity, fluoride (F), pH, $SO_4$, sulfide ($S^{2-}$), and total dissolved solids. EPA makes special note of B and $SO_4$: 'The high mobility of boron and sulfate explains the prevalence of these constituents in damage cases that are associated with groundwater impacts.'

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[2] Complainants are not aware of any legal vehicle for introducing new claims through an expert report. If Complainants intended to raise new claims, they would do so through a motion to amend the complaint.

Ex. C at 2 (internal citations omitted). In sum, Dr. Kunkel cites the Federal CCR Rules as evidence of industry standards and as background, consistent with the Board's Oct. 3, 2013 Order.

Dr. Kunkel's citations to the Federal CCR Rules are further consistent with the Board's Order because the Board's October 3, 2013 Order only struck language from the complaint to the extent that it raised legal claims of violations of federal law. The Reply Report does not claim any violations of federal law. Nowhere does Dr. Kunkel use the words "violate" or "violation." Even if Dr. Kunkel had stated that the ash ponds "violate" specific requirements of the Federal CCR Rules, such statements would still be consistent with the October 3, 2013 Board Order, in which the Board declined to strike discussions of "violations" where the use of the word was "more in the nature of evidence than claims of a violation." *Sierra Club et al. v. Midwest Generation*, No. 13-15, slip op. at 25 (October 3, 2013).

Contrary to MWG's arguments, Dr. Kunkel's reliance on the Federal CCR Rule was not an attempt to "re-insert allegations" of violations of federal law. Memo in Support of Motion to Strike at 5. Instead, Dr. Kunkel relies upon the Federal CCR Rule for evidentiary purposes. Dr. Kunkel observes that "[n]one of the coal ash pond liners meet the engineering standards given by the [CCR Rule]," that "[t]here is no evidence in the record that MWG's coal ash ponds meet the [] definition[] of a lined pond in the [CCR Rules]" and that, with some possible exceptions, "none of the MWG coal ash ponds can attain [the required five-foot distance between pond liners and groundwater] under their present locations." Ex. C at 7, 9, and 10. Again, Dr. Kunkel cites the Federal CCR Rules as evidence in direct response to opinions expressed in the Seymour Report. Dr. Kunkel's references to the Federal CCR Rules are consistent with the purposes of a reply report and consistent with the Board's October 3, 2013 Order.

**B. The Reply Report Cites the Federal CCR Rules as Evidence in Response to Contentions in the Seymour Report and in Support of Opinions Already Expressed in the Kunkel Report.**

MWG also argues that Dr. Kunkel inappropriately "presented a new and previously undisclosed opinion in the Reply Report." Memo in Support of Motion to Strike at 5. This too is false. As MWG observes in its Motion to Strike, "[r]ebuttal evidence is admissible if it explains, repels, contradicts or disproves the evidence of defendant." *Id.*, citing *Lagestee v. Days Inn Mgmt. Co.*, 303 Ill. App. 3d 935, 942, 709 N.E.2d 270, 276 (1st Dist. 1999). As described above, Dr. Kunkel's references to the Federal CCR Rules serve exactly this purpose by presenting evidence contradicting Seymour's statement that the coal ash pond liners "are consistent with remediation-industry-accepted approaches" (Ex. B at 35), and, in response to Seymour's critique of Dr. Kunkel's list of coal ash indicator pollutants, by providing evidence in support of Dr. Kunkel's list.

In support of its argument that Dr. Kunkel inappropriately introduced new opinions in his Reply Report, MWG cites – selectively – *Sloan Valve Co. v. Zurn Industries, Inc.*, et al., 10 C 204, U.S. Northern District of Illinois (June 19, 2013 Order by Judge St. Eve). A more careful reading of that Order reveals that it in fact supports Complainants' position. Although the Court struck a "new opinion" from the report that consisted of "a new, alternative collateral sales calculation," it declined to strike other new material from the reply report at issue in that case. *Id*. at 4. Specifically, the Court declined to strike a new calculation that the expert had included in his reply report "to refute Mr. Hofmann's criticisms," because that calculation was "responsive to the criticism and proper" for a reply report. *Id*. at 3. Similarly, the Court declined to strike a revised estimate of costs that it found to be "directly responsive to Mr. Hofmann's criticism." *Id*. New evidence is therefore permissible in a reply report as long as it is responsive to the opposing expert's report. *Id*. Dr. Kunkel's references to the Federal CCR Rules are directly responsive to Seymour's arguments, and therefore exactly the kind of material that the *Sloan Valve* Court would decline to strike.

Regardless of whether Dr. Kunkel's references to the Federal CCR Rules constitute new evidence, they are clearly not new opinions. Dr. Kunkel's opinion of the coal ash pond liners at the MWG plants was clear in the initial Kunkel Report – he found them to be inadequate. Seymour argued that the liners meet industry standards. In response, Dr. Kunkel cited an industry standard that they do not meet – the Federal CCR Rules. Similarly, Dr. Kunkel identified a set of coal ash indicator pollutants in his initial report. Seymour responded by critiquing Kunkel's list and proposing alternative sets of coal ash indicators. In order to rebut Seymour's critique, Dr. Kunkel referred to the coal ash indicators that EPA decided to include in the Federal CCR Rules. Nothing about Dr. Kunkel's opinions changed from his initial report to his Reply Report. Dr. Kunkel simply cited a new, relevant source of information to respond to Seymour's arguments.

Dr. Kunkel did not allege violations of federal law or present new opinions, and Midwest Generation's remaining argument – that Seymour was unfairly presented with a surprise reference – cannot be taken seriously. Memo in Support of Motion to Strike at 7. To begin with, as someone who purports to be an expert in coal ash disposal and storage, Seymour should be aware of, and indeed familiar with, federal law governing the disposal and storage of coal ash. The references to the Federal CCR Rules should not be a surprise.

More importantly, however, MWG's argument implies that reply reports must be limited to the evidence cited in an initial report. To restrict an expert in this way would severely undermine the purpose of reply reports. As the *Sloan Valve* Court observed, "[t]he proper function of rebuttal evidence is to contradict, impeach, or defuse the impact of evidence offered by an adverse party." *Sloan Valve*, 10 C 204, at 2, citing *Peals v. Terre Haute Police Dep't*, 535 F.3d 621, 630 (7th Cir. 2008). The Court's use of the phrase "rebuttal evidence," and the fact that that Court declined to strike new evidence from the reply report, provides a clear indication that reply reports may include new evidence.

*Naleway v. Agnich* does not support MWG's position. 386 Ill. App. 3d 635, 649, 897 N.E.2d 902, 917 (2nd Dist. 2008), cited in Memo in Support of Motion to Strike at 6. In *Naleway*, plaintiffs sought to recall a witness (the defendant) to obtain additional testimony about a document that they had not questioned the defendant about in their case-in-chief. The trial court excluded the document and refused to allow plaintiffs to recall the defendant as a witness:

> In challenging the trial court's decision not to allow them to question defendant regarding the JIB complaint as rebuttal, plaintiffs fail to direct us to any portion of defendant's evidence that the JIB evidence would have served to rebut. In fact, plaintiff's response to defendant's point that the JIB evidence was improper rebuttal concedes this very point: in their reply brief, plaintiffs assert that they were "seeking to recall Defendant in an effort to obtain additional testimony regarding malice." The purpose of rebuttal, of course, is not to provide a second opportunity to introduce evidence that could have been introduced in a plaintiff's case-in-chief. Rather, rebuttal evidence is admissible if it tends to explain, repel, contradict, or disprove the evidence of the defendant. Because plaintiffs have not identified for us any portion of defendant's evidence that the JIB evidence would have rebutted, we conclude that they have not their burden to establish reversible error. *Id*.

In *Naleway*, the Appellate Court's decision clearly rested not on whether the evidence was "new," but whether it served the purpose of rebutting defendant's evidence. Dr. Kunkel's Reply Report, in contrast to the evidence in the *Naleway* case, appropriately cites the Federal CCR Rules to rebut specific arguments in the Seymour Report.

Finally, it is not even clear that the Federal CCR Rules are "new" evidence. Complainants cited the then-current version of the same rule – 40 C.F.R. Part 257 – in their complaint. The rule has therefore been a part of the proceedings – with the Board's approval – since the outset of the case.

To summarize, the Reply Report's references to the Federal CCR Rules do not constitute a new and previously undisclosed opinion. Rather, the rules were used to contradict contentions made by Seymour and to provide support for opinions already expressed in the original Kunkel Report. Dr. Kunkel's reference to these rules was no surprise given Mr. Seymour's purported expertise in the field and Complainants citation to these rules in their complaint. Finally, although the federal regulation at issue might not even constitute "new" evidence given its presence in the complaint, an expert's use of new evidence in a reply report is clearly permissible if it is for the purpose of rebutting the opposing party's expert report.

## III. CONCLUSION

Contrary to Respondent's assertions, the Reply Report does not "attempt to re-insert allegations of violations of federal regulations," (Memo in Support of Motion to Strike at 5); does not in any way raise legal claims related to federal law; and does not seek to have the Board enforce federal regulations. Nor does the Reply Report raise new opinions. Instead, the Reply Report appropriately cites federal rules as factual evidence in order to rebut the Respondent expert's report. Since the Reply Report's citations to the Federal CCR Rules are perfectly consistent with both the purpose of rebuttal reports and the Board's October 3, 2013 Order, Complainants respectfully request that the Board deny Midwest Generation's Motion to Strike.

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Dated: January 12, 2016

*Attorney for CARE*

**CERTIFICATE OF SERVICE**

The undersigned certifies that a true copy of the foregoing Notice of Filing and Complainants' Response to Respondent's Motion to Strike the Discussion of the Federal CCR Rules was filed electronically on January 12, 2016 with the following:

John Therriault, Assistant Clerk
Illinois Pollution Control Board
James R. Thompson Center
100 West Randolph Street, Suite 11-500
Chicago, IL 60601

and that true copies were mailed by First Class Mail, postage prepaid, on January 12, 2016 to the parties listed on the attached Service List.

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Dated: January 12, 2016

***SIERRA CLUB, ET AL. V. MIDWEST GENERATION, LLC* PCB 13-15**

**RESPONSE TO MOTION TO STRIKE**

# EXHIBIT A

# EXPERT REPORT ON GROUND-WATER CONTAMINATION BY JAMES KUNKEL, Ph.D, P.E.

James R. Kunkel, Ph.D., P.E.
11341 West Exposition Drive
Lakewood, CO 80226

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| In the Matter of: | |
| SIERRA CLUB, ENVIRONMENTAL LAW AND POLICY CENTER, PRAIRIE RIVERS NETWORK, and CITIZENS AGAINST RUINING THE ENVIRONMENT | |
| | PCB 2013-015 |
| Complainants, | |
| | (Enforcement – Water) |
| v. | |
| MIDWEST GENERATION, LLC, | |
| Respondent. | |

# Expert Report on Ground-water Contamination

## James R. Kunkel, Ph.D., P.E.

## July 1, 2015

Tel: 303-986-0562 Cel: 720-443-9136

This expert report provides my professional technical analyses and opinions related to data and information concerning four coal-fired power plants (Joliet #29, Powerton, Waukegan, and Will County) in Illinois owned by Midwest Generation, LLC (MWG). My professional analyses and opinions are presented in the following paragraphs for each of the four power plants. The available data show that there has been and continues to be ground-water contamination from MWG's ash ponds and/or other coal ash disposal areas at the four power plant sites.

## SUMMARY OF CONCLUSIONS

### General

- Boron (B), manganese (Mn), and sulfate ($SO_4$) are indicators of coal ash leachate;
- At all of the power plant sites, the concentrations of B, Mn, and $SO_4$ measured in ground water match the leachate characteristics of coal ash;
- At all of the power plant sites, coal ash has been deposited in ash ponds whose liners have leaked and continue to leak due to poor liner construction techniques, poor coal ash removal/maintenance practices and/or high water tables which cause failure of the soils supporting the liners or cause hydrostatic uplift, all of which can cause liner punctures and failure of the liner seams;
- At all of the power plant sites, coal ash was utilized for fill/construction materials or stored at many locations outside the ash ponds, and this coal ash is being leached by precipitation and the leachate is percolating into the ground water beneath the sites;
- Ground-water elevations at all of the power plant sites are strongly influenced by changes in adjacent surface-water elevations causing leaching of indicator pollutants through continued wetting and drying of coal ash used for fill/construction purposes;
- Ground water at all of the power plant sites would require treatment in order to be used as drinking water which is its potential use under the IEPA Class I ground-water protection standards;
- The proposed Compliance Commitment Agreement remedies for each of the four sites will not reduce existing or future ground-water contamination from coal ash deposits and leaky liners; and
- Relining the ash ponds will not reduce the potential for liner damage and subsequent liner leakage as long as dredging of coal ash continues as in the past.

### Joliet #29

- Concentrations of B in ground water (up to 2.6 mg/L) at the Joliet #29 plant site have been higher than the IEPA Class I ground-water standard of 2 mg/L and also much higher than background B concentrations (0.12 mg/L) in IEPA sand and gravel network wells;
- Concentrations of Mn in ground water (up to 1.6 mg/L) at the Joliet #29 plant site are higher than the IEPA Class I ground-water standard of 0.15 mg/L and also much higher than background Mn concentrations (0.072 mg/L) in IEPA sand and gravel network wells;
- Concentrations of $SO_4$ in ground water (up to 1600 mg/L) at the Joliet #29 plant site are higher than the IEPA Class I ground-water standard of 400 mg/L and also much higher than background $SO_4$ concentrations (54 mg/L) in IEPA sand and gravel network wells;
- The ground-water contamination at the Joliet #29 site is the result of past/current ash pond liner leaks and/or leaching of coal ash deposits outside the ash ponds; and
- Coal ash from the Joliet #9 plant was deposited in a large area up-gradient from the current Joliet #29 plant and this coal ash is being leached by precipitation and being eroded into the Des Plaines River during high river discharge events.

**Powerton**

- Concentrations of B in ground water (up to 4.3 mg/L) at the Powerton plant site are higher than the IEPA Class I ground-water standard of 2 mg/L and also much higher than background B concentrations (0.20 mg/L) in the site background well MW-16;
- Concentrations of Mn in ground water (up to 13 mg/L) at the Powerton plant site are higher than the IEPA Class I ground-water standard of 0.15 mg/L and also much higher than background Mn concentrations (0.003 mg/L) in the site background well MW-16;
- Concentrations of $SO_4$ in ground water (up to 1400 mg/L) at the Powerton plant site are higher than the IEPA Class I ground-water standard of 400 mg/L and also much higher than background $SO_4$ concentrations (43 mg/L) in the site background well MW-16;
- The ground-water contamination at the Powerton site is the result of current and former fly ash/slag storage at abandoned/unlined and lined ash ponds, using coal ash as a construction material at and near the ash ponds and leaks in the ash pond liners;
- Ash pond water surface elevations are periodically below ground-water table elevations which likely has resulted, and will likely result in the future, in hydrostatic uplift and liner failure; and
- Ground-water elevations rise and fall in response to Illinois River water-surface elevations periodically inundating the pond bottom liners.

**Waukegan**

- Concentrations of B in ground water (up to 49 mg/L) at the Waukegan plant site are higher than the IEPA Class I ground-water standard of 2 mg/L and also much higher than background B concentrations (0.12 mg/L) in IEPA sand and gravel network wells;
- Concentrations of Mn in ground water (up to 0.99 mg/L) at the Waukegan plant site are higher than the IEPA Class I ground-water standard of 0.15 mg/L and also much higher than background Mn concentrations (0.072 mg/L) in IEPA sand and gravel network wells;
- Concentrations of $SO_4$ in ground water (up to 1200 mg/L) at the Waukegan plant site are higher than the IEPA Class I ground-water standard of 400 mg/L and also much higher than background $SO_4$ concentrations (54 mg/L) in IEPA sand and gravel network wells;
- The ground-water contamination at the Waukegan site is due to past and ongoing leachate from the former fly ash/slag storage area west of the ash ponds, leachate from coal ash used in construction of the ash pond berms and other miscellaneous fill/construction using coal ash, and past and current leaks in the East and West ash pond liners at the Waukegan site;
- The ash pond bottom liners are always below the surface-water elevations in Lake Michigan and also the ground-water table which results in hydrostatic uplift pressures which likely has caused, and will likely cause in the future, liner leaks; and
- Ground-water contamination by the indicator pollutants at the site is due to liner leaks and coal ash deposits outside the ash ponds and not due to contaminated ground-water from up-gradient.

**Will County**

- Concentrations of B in ground water (up to 6.2 mg/L) at the Will County plant site are higher than the IEPA Class I ground-water standard of 2 mg/L and also much higher than background B concentrations in IEPA sand and gravel (0.12 mg/L) and bedrock (0.28 mg/l) network wells;
- Concentrations of Mn in ground water (up to 1.0) at the Will County plant site are higher than the IEPA Class I ground-water standard of 0.15 mg/L and also much higher than background Mn concentrations in IEPA sand and gravel (0.072 mg/L) and bedrock (0.029 mg/L) network wells;

- Concentrations of $SO_4$ in ground water (up to 4800 mg/L) at the Will County plant site are higher than the IEPA Class I ground-water standard of 400 mg/L and also much higher than background $SO_4$ concentrations in IEPA sand and gravel (54 mg/L) and bedrock (106 mg/L) network wells;
- The ground-water contamination at the Will County site at and near the ash ponds is the result of current and former coal ash/slag storage in both unlined and lined ash ponds, using coal ash as a construction material, and leaks in the ash pond liners; and
- Ground-water and Des Plaines River surface-water elevations are always above the bottom of the liners which likely has caused, and likely will cause in the future, hydrostatic uplift and liner failure.

## INTRODUCTION

This report is written to analyze whether ground water at the four power plant sites has been contaminated by coal ash and to discuss the sources of contamination by, among other things, comparing the contaminant concentrations to Illinois Class I ground-water protection standards and comparing the contaminant concentrations to background concentrations. This report also will evaluate if the proposed Compliance Commitment Agreement (CCA) remedies for each of the four sites will reduce existing or future ground-water contamination.

The results of the evaluation indicate that the ash ponds have leaked in the past and likely will continue to leak resulting in discharge of contaminants to the underlying ground water at the four sites. Past practices by MWG that utilized coal ash for construction of pond dikes, fill material, general construction material, and storage of coal ash on site, but outside the ash ponds continue to be sources of ground-water contamination. The result has been coal ash residues deposited at various locations at the four plant sites and not necessarily within the ash ponds. This historical disposal of coal ash on land adjacent to and at the existing ash ponds also is a source of ground-water contamination from leaching of the coal ash by rainfall, snowmelt and high ground-water table elevations.

MWG operates four coal-fired power plants which are of concern for this report. These four power plants are located along rivers, canals and Lake Michigan. This report evaluates a large dataset of analytical results for surface water elevations and ground-water elevations and water-quality analytical results taken at or adjacent to the plant ash ponds on the plant property by MWG.

This report also evaluates specific coal ash leachate water quality results from the U.S. Environmental Protection Agency (USEPA), generic coal ash leachate water quality results from the Electric Power Research Institute (EPRI) and compares the site specific ground-water quality results to Illinois ground-water standards and background Illinois ground-water water-quality data in order to assess the degree of ground-water contamination from the on-site and off-site coal ash. Finally, this report discusses why the Compliance Commitment Agreements (CCAs) proposed by MWG for the individual power plant sites will not solve the problem of past and on-going ground-water contamination by leaky pond liners, construction using coal ash and historical coal ash deposits.

### Definitions of Terms Used in this Report

Throughout this report several technical terms are used to demonstrate the occurrence of contaminants from the leaky ash ponds and/or near-surface coal ash deposited outside the ash ponds. The following is a partial list of definitions for these technical terms:

- "Ash" means boiler slag, bottom ash and fly ash. *Boiler slag* means the molten bottom ash collected at the base of slag tap and cyclone type furnaces that is quenched with water. It is made up of hard, black, angular particles that have a smooth, glassy appearance (USEPA, 2014). *Bottom ash* means the agglomerated, angular ash particles formed in pulverized coal furnaces that are too large to be carried in the flue gases and collect on the furnace walls or fall through open grates to an ash hopper at the bottom of the furnace (USEPA,

2014). *Fly ash* means a very fine, powdery material composed mostly of silica made from the burning of finely ground coal in a boiler (USEPA, 2014).

- "Background" " means the concentration of chemical constituents migrating through ground water sampled prior to construction and operation of the ash ponds, or contemporary data from wells that are un-impacted by the ash ponds.

- "Concentration" means mass of solute per unit volume (mass) of solution, such as milligrams per liter (mg/L) for the dilute solutions in this report.

- "Cross-gradient" means perpendicular to the direction that ground water flows.

- "Down-gradient" means in the direction that ground water flows.

- "Geoprobe" means a probing device used for sampling soil.

- "Ground-water Mounding" means a phenomenon usually created by the recharge to ground water from a manmade structure, such as a surface impoundment, into a permeable geologic material, resulting in outward and upward expansion of the free water table. Mounding can alter ground-water flow rates and direction; however, the effects are usually localized and may be temporary, depending upon the frequency and duration of the surface recharge events (USEPA, 2014). Mounding also can be the result of rising and falling adjacent surface-water elevations which laterally recharge the ground water. This mounding is most obvious when the surface-water elevations drop faster than the ground-water elevations.

- "HDPE (high density polyethylene)" means a hydrocarbon polymer prepared from ethylene/petroleum by a catalytic process. It is a kind of thermoplastic which is famous for its tensile strength.

- "Head(s)" means hydraulic head(s) or piezometric head(s), a specific measurement of liquid pressure above a geodetic datum. It is usually measured as a liquid surface elevation, expressed in units of length, at the entrance (or bottom) of a piezometer.

- "Homogeneity" in a porous medium or fractured rock means that the hydraulic characteristics of the medium are the same at all points in the medium. "Non-homogeneity" means that the hydraulic characteristics vary with location of the measurement.

- "Hydraulic Conductivity" means the rate at which water can move through a permeable medium. It is the product of intrinsic permeability of the medium and the properties of the fluid moving through the medium (USEPA, 2014).

- "Hypalon (chlorosulfonated polyethylene)" (a Trade name) means a kind of synthetic rubber made of chlorinated and sulfonated polyethylene.

- "Hydrostatic Uplift" means an uplift pressure defined (Ohio EPA, 2004) as the force of water pushing a liner upward when the weight of the ground-water outside the bottom of the lined pond is greater than the sum of the weight of coal ash and water inside the pond. This typically occurs when the water table is higher than the pond water surface. Hydrostatic uplift pressure causes buoyancy. This is what happens when a body is immersed partially or fully below the surface of the water, in our case the high ground-water table.

- "Isotropy" in a porous medium or fractured rock means that the hydraulic characteristics of the medium are the same in all directions at the point of measurement. "Anisotropy" means the hydraulic characteristics change with direction.

- "Leachate" means any liquid, including any suspended components in the liquid that has been or is in direct contact with, percolated through or drained from coal combustion waste (IEPA, 2013).

- "Monitoring Well" means a well designed and installed to obtain representative ground-water quality samples and hydrogeologic information.

- "Poz-o-Pac" (a Trade name) means a mixture of fly ash (and sometimes Portland cement or lime), aggregate (crushed rock or ash) and water used to provide a hard and stable base for ash ponds.

- "Up-gradient" means opposite the direction that ground water flows.

**Background**

The Joliet #29 generating station has been operational since 1965. Eleven ground-water monitoring wells were installed around the ash ponds in October 2010 (Patrick Engineering, 2011a). Ground-water sampling and analyses from these wells showed that the ground water in the vicinity of the 11 monitoring wells had concentrations of antimony (Sb), B, chloride (Cl), iron (Fe), Mn, $SO_4$ and total dissolved solids (TDS) higher than the Illinois Class I ground-water protection standards.

The Powerton generating station has been operational since 1972. Ten ground-water monitoring wells were installed around the ash ponds in October 2010 (Patrick Engineering, 2011b). Five additional monitoring wells were previously installed by Patrick Engineering and included in the 15-well ground-water monitoring network. Ground-water sampling and analyses from these wells showed that the ground water in the vicinity of the 15 monitoring wells had concentrations of arsenic (As), B, Cl, Fe, mercury (Hg), Mn, nitrate-nitrogen ($NO_3$), lead (Pb), selenium (Se), $SO_4$, thallium (Tl), potential hydronium ion (pH) and TDS higher (or lower in the case of pH) than the Illinois Class I ground-water protection standards.

The Waukegan generating station has been operational since 1952. Five ground-water monitoring wells were initially installed around the ash ponds in October 2010 (Patrick Engineering, 2011c). Ground-water sampling and analyses from these wells showed that the ground water in the vicinity of the 5 monitoring wells had concentrations of Sb, As, B, Cl, Fe, Mn, $SO_4$, pH and TDS higher than the Illinois Class I ground-water protection standards.

The Will County generating station has been operational since 1955. Ten ground-water monitoring wells were initially installed around the ash ponds in October 2010 (Patrick Engineering, 2011d). Ground-water sampling and analyses from these wells showed that the ground water in the vicinity of the 10 monitoring wells had concentrations of Sb, B, Cl, Mn, $SO_4$, pH and TDS higher than the Illinois Class I ground-water protection standards.

On June 11, 2012, the Illinois Environmental Protection Agency (IEPA) sent MWG Violation Notices describing violations of Section 12 of the Illinois Environmental Protection Act, 415 ILCS 5/12, and ground-water quality regulations at Joliet #29, Powerton, Waukegan, and Will County power plant ash ponds. In the Violation Notices IEPA identified ground-water monitoring results that exceeded Illinois Class I ground-water protection standards (IEPA, 2014). However, prior to June 11, 2012, both IEPA and MWG were aware of potential ground-water contamination at the four power plant sites (Bates Nos. 14096-14101 and 37957-37983). For example, on January 7, 2011, Richard Frendt of Patrick Engineering, Inc. sent an e-mail to Maria Race of MWG presenting ground-

water quality concentration data at all four plant sites which were higher than the IEPA Class I ground-water protection standards (Bates Nos. 14096-14101). Additionally, during the meeting of May 5, 2010 between IEPA and MWG, it was agreed that ground-water monitoring would be done at all four power plant sites (Bates Nos. 37979-37983).

On October 24, 2012, in response to the Violation Notices, IEPA and MWG agreed to the CCAs for all four power plants. These agreements stated, in short, that:

- The ash ponds would not be permanent coal ash disposal sites,
- Pond operations would be protective of the pond liners,
- During coal ash removal visual inspections of the liners would be made,
- Quarterly ground-water monitoring would continue, and
- Other specific actions would be taken at each power plant site to reduce the contamination from leaky ponds.

**<u>Methodology</u>**
My approach for establishing if the MWG ash ponds have caused or continue to impact ground water at each of the four plant sites is to: (1) determine whether coal ash leaching indicator pollutants are present, (2) determine whether the concentrations of these contaminants are greater than IEPA/USEPA ground-water quality standards and background ground-water quality data, and (3) identify the direction(s) of ground-water flow. I also evaluate whether the CCAs are sufficiently protective of future ground-water quality.

**Coal Ash Leaching Indicator Pollutants.**
I selected B, $SO_4$, and Mn as indicators of ground-water contamination from the ash ponds. I selected these indicator pollutants because EPRI and IEPA deem them to be of concern at all four of the power plant sites and they are typically present in high concentrations in coal ash leachate, as will be discussed below.

Coal ash leachate is characterized by one or more of the following constituents: B, molybdenum (Mo), lithium (Li), $SO_4$, bromide (Br), potassium (K), sodium (Na), and fluoride (F), but also may include calcium (Ca) and Cl (EPRI, 2012). Kosson and others (2009) indicate that the following constituents, in addition to the EPRI (2012) suite, may be present in leachate from coal combustion ash: Sb, As, Ba, Cd, Cr, Hg, Pb, Mo, Se, and Tl. Higher concentrations of these constituents may be accompanied by high concentrations of total dissolved solids (TDS) and alkaline pH. As is discussed below, Mn also is considered to be an indicator pollutant due to its high concentrations in coal ash leachate (Kosson and others, 2009). IEPA (2010), in their October 2010 coal ash impoundment strategy progress report, indicated concern about B, Mn and $SO_4$ as well as Cl, Fe and TDS concentrations in the ground water at each of the four power plant sites. USEPA (2010) and EPRI (2010) recognize that the ground-water quality pollutants indicated above often pose a health risk to people and the environment.

It is highly unlikely that all of the above constituents and, in particular, the combination of B, $SO_4$, and Mn, in concentrations higher than IEPA ground-water protection standards or background water-quality concentrations beneath or down-gradient from ash ponds, would come from any other source. This report will show that water-quality constituents present in bottom ash leachate at coal ash landfills also are present in the ground water at and near the ash ponds.

**Ground-water Quality Standards.** Based on measured ground-water quality concentration data beneath the ash ponds at each of the MWG plant sites, I compared the ground-water quality concentrations to IEPA ground-water protection standards, USEPA drinking water standards and Illinois and site background water quality. The purpose of this comparison was to assess the degree of contamination caused by leaking coal ash ponds and/or other coal

ash fill at each of the MWG plant sites and to assess whether water treatment may be required for the intended use of the ground water.

IEPA Class I ground-water protection standards were utilized to assess if ground-water contamination is occurring or has occurred at each power plant site. Table 1 presents IEPA (2014) Class I and Class II ground-water protection standards and compares them to the USEPA (2012) primary drinking water Maximum Contaminant Levels (MCLs) and secondary drinking water MCLs (SMCLs). The IEPA Class I ground-water protection standard for B is 2.0 milligrams per liter (mg/L), for Mn it is 0.15 mg/L and for $SO_4$ it is 400 mg/L. Concentrations of these indicator pollutants higher than the indicated standards implies that the ground water would have to be treated to be used as drinking water which is its potential use under the IEPA Class I ground-water protection standards. Whereas B, Mn and $SO_4$ are utilized in this report as ground-water indicator pollutants, there are many other ground-water pollutants which can occur from leaching of coal ash as indicated in the above paragraphs.

**Coal Ash Leachate Quality Characterization.** MWG, in an unreferenced document (Bates Numbers 12846-12849), partially redacted, states that "all Illinois plants burn the same coal: North Antelope Rochelle Mine, located in Campbell County, Wyoming." This section of the report presents laboratory analytical analyses of leachate from Wyoming coal ash. These laboratory results are presented in a USEPA coal ash leaching report (Kosson and others, 2009), and confirmed by the USEPA draft coal waste risk assessment report (USEPA, 2010) and the EPRI (2012) abstract on ground-water signatures from coal ash.

Coal ash leachate quality results for Wyoming coal ash presented in this report are taken from Kosson and others (2009) and summarized in Table 2 for three indicator elements/compounds of B, Mn and $SO_4$ which are used to assess ground-water contamination at the four plant sites. Typical leachate concentrations of B from Wyoming coal ash range from 15.6 to 200 mg/L (Table 2). Typical Mn leachate concentrations from the same coal ash range from 0.49 to 22 mg/L, and typical leachate concentrations for $SO_4$ range from 566.9 to 2200 mg/L. The data in Table 2 indicate that B, Mn, and $SO_4$ concentrations in coal ash leachate are typically higher than IEPA Class I and Class II ground-water protection standards.

Additionally, EPRI (2010), in its extensive (30 landfills and ash ponds) coal combustion ash leachate database, states that concentrations of B in coal ash leachate range from below detection limits to 109 mg/L, concentrations of Mn range from below detection limit to 3.17 mg/L, and concentrations of $SO_4$ range from 89 to 6070 mg/L. Therefore, the selection of the three indicator pollutants (B, Mn, and $SO_4$) is valid for assessing contamination at the Joliet #29, Powerton, Waukegan and Will County sites.

**Background Ground-Water Quality Characterization.**
In addition to the coal ash leachate data and IEPA/USEPA ground-water quality standards, there are specific Illinois ground-water quality data which are representative of background on a state-wide level for the three indicator pollutants. These background data represent ground water which has not been contaminated by the three indicator pollutants from coal ash leachate. The ash ponds at the four power plant sites overlay sand and gravel aquifers and/or shallow bedrock aquifers, which are the same aquifers from which the ambient (background) network wells are drawing water (IEPA, 2013). Comparison of the concentrations of B, Mn and $SO_4$, along with TDS from the background ground-water network (Table 3) to concentrations from the ground-water monitoring conducted at the power generating facilities by MWG, will show these background indicator pollutant concentrations for both the sand and gravel and shallow bedrock aquifers are an order of magnitude, or more, less than the same pollutants in contaminated ground water at the four power plant sites.

Table 3 also shows the median concentrations of B, Mn and $SO_4$ in MW-16, the most up-gradient well at Powerton. This monitoring well is considered to be a background well which is completed in the sand and gravel aquifer. As shown in Table 3, the indicator pollutants in MW-16 are similar to the IEPA (2013) background network wells for

sand and gravel aquifers. At the other three power plant sites (Joliet #29, Waukegan and Will County), there are no wells which can be considered as background for purposes of this report. For these three sites the state-wide background concentration data are utilized to assess the severity of ground-water contamination. Therefore, I conclude that the background concentrations for B, Mn and $SO_4$ in both sand and gravel and shallow bedrock aquifers for the four power plant sites of interest would range, respectively, from approximately 0.2 to 0.3 mg/L for B, 0.003 to 0.03 for Mn and 40 to 100 for $SO_4$.

**Direction of Ground-water Flow.** Measured ground-water elevations from monitoring wells at and near the ash ponds, measured ash pond water surface elevations, and nearby measured surface-water body elevations (canals, rivers, ponds and lakes) were reviewed to determine the direction of ground-water flow as well as the relative potential head differences between the ash pond water surfaces, the ground water beneath and near the ash ponds and nearby surface water bodies. The purpose of this review was to establish if the contaminants measured in the ground water at or near the ash ponds were sourced from the ash ponds or were entering the ground water from up gradient or possibly from adjacent surface water. This analysis was performed using measured data at or near each of the four MWG plant sites of interest.

This methodology was applied to each of the Joliet #29, Powerton, Waukegan and Will County coal-fired power plant ash ponds operated by MWG using historical and recent hydrologic data.

**JOLIET #29**

**Conceptual Site Model**

**Regional Setting.** The Joliet #29 site is located north of the Des Plaines River and south of the Illinois and Michigan Canal and U.S. Highway 6 south of the city of Joliet (Figure 1). The surrounding land use is almost entirely industrial with some parcels of undeveloped land. There is no indication that these land uses could be sources for the indicator pollutants unless coal ash was historically deposited at these locations.

**Coal-Ash Management.** Three coal-ash ponds are utilized to settle coal ash solids. Ponds 1 and 2 were lined with 60-mil thick HDPE plastic in 2008 and Pond 3 was lined with 60-mil HDPE in 2013. Prior to those dates the ash ponds were lined on the bottom and side slopes with 12 inches of geo-composite material (Poz-o-Pac) comprised of fly ash and cement. When all three Joliet #29 ash ponds were relined with HDPE, the plastic was placed on top of the existing Poz-o-Pac liner after its partial removal. Plastic was placed directly on the side slope Poz-o-Pac and attached to the ash pond concrete discharge structures (Bates Nos. 18132-18189). Partially removed Poz-o-Pac would likely be jagged and could have damaged the HDPE liner during or after construction. Also, any coal ash fragments left on top of the partially removed Poz-o-Pac could cause punctures in the new liner. Either of these possibilities would likely result in a continuing leak which would not be detected due to the protective layers placed on top of the liner during construction.

Typical ash pond operation at the Joliet #29 power plant is to pump the coal ash slurry across the Des Plaines River directly to the Lincoln Stone Quarry with intermittent discharge to the Joliet #29 Ash Ponds 1 and 2. Coal ash solids from the Ponds 1 and 2 are dredged every one to two years and the dredge spoil deposited into the Lincoln Stone Quarry. Pond 3 was dredged in 2013. Ash pond dredging using heavy equipment likely will damage the plastic liners given the thin (1 ft thick) protective sand layer and 6-in thick warning layer on top of the liners. Typically, at least two feet or more of protective layer is required on top HDPE if heavy equipment is utilized.

Water from the ash ponds is discharged to the Des Plaines River under NPDES Permit No. IL0064254. The HDPE-lined ash Ponds 1 and 2 have bottom elevations (top of the warning layer) of 516.0 ft MSL with the bottom of Poz-o-Pac liner approximately 2.5 ft lower (513.5 ft MSL). Pond 3 has a bottom elevation of 517.5 (top of the warning layer) and a Poz-o-Pac bottom elevation of approximately 515.0 ft MSL.

**Liner Damage.** When the Joliet Pond 1 and Pond 2 liners were installed in 2008, documentation from the MWG files (Bates Nos. 13734-13738) indicated that the HDPE was installed on top of 1.5 ft of the existing 2-ft Poz-o-Pac liner of which about 0.5 ft had been removed. It also is possible, based on the same documentation that some coal ash was also left on top of the Poz-o-Pac to act as a cushion for the HDPE liner. It is not clear exactly what was finally constructed because **no "as-built" drawings are available**, except that most of the original Poz-o-Pac was left in place. In my opinion, if either the Poz-o-Pac or coal ash or both formed the base of Ponds 1 and 2 and the HDPE liner was placed on top, then there is a risk that sharp-edged coal ash particles or sharp edges in the Poz-o-Pac could puncture the HDPE due to the weight of the dredging equipment when the ponds are cleaned.

In May 2008, Leak Location Services, Inc. (LLSI, 2008) performed a membrane leak location survey on the HDPE bottom liner installed in 2008 at Pond 2. One leak was found and the area excavated to reveal an 8-inch by 4-in tear. It is unknown if this leak was repaired. A similar leak location survey for the Pond 1 HDPE installed in 2008 could not be found in the MWG files. In September 2013, Leak Location Services (LLSI, 2013a) performed a membrane leak location survey on the HDPE bottom liner installed in 2013 at Pond 3.

There is a fairly high probability of liner installation defects (punctures, tears, cracks and bad seams) occurring during the construction of landfills and ponds and these installation defect frequencies are summarized by Schroeder and others (1994) for composite geomembrane liners. They estimate that 40 percent of the liner installation defects occur at a frequency of between 1 to 4 defects per acre. An additional 40 percent of liner installation defects occur at a frequency of between 4 to 10 defects per acre. The remaining 20 percent of liner installation defects occur at a frequency of 10 percent each for less than 1 defect per acre and 10 to 20 defects per acre. In summary, 90 percent of the liner installation defects occur at a frequency of greater than 1 defect per acre.

Schroeder and others (1994) recommend using a liner installation defect frequency of 1 defect per acre for intensively monitored projects. A defect frequency of 10 defects per acre or more is possible when quality assurance is limited to spot checks or when environmental difficulties are encountered during construction. Greater frequency of defects may also result from poor selection of materials, poor foundation preparation and inappropriate equipment as well as other design flaws and poor construction practices. For these reasons, I conclude that it is highly likely that when the Joliet #29 ponds, having a liner area of approximately 10 acres, were relined, there was more than one construction defect per acre which caused and continues to cause liner leakage from the ponds into the ground water even if leak detection testing showed no bottom liner leaks.

**Hydrogeology.** Based upon on-site soil borings, the geology beneath the Joliet #29 site consists of approximately 5 to 40 feet of sandy loam, silty gravel and clay underlain by Silurian Dolomite. Ground-water flow in the shallow, unconsolidated aquifer should be largely controlled by the Des Plaines River with ground water flowing towards the river during certain periods of the year. There also is a ground-water gradient component generally parallel to the Des Plaines River flowing from northeast to southwest, as well as a gradient from the River into the unconsolidated materials underlying the ash ponds during high river-flow periods as shown by the MWG quarterly monitoring reports. The ground-water gradient parallel to the River likely will bring contaminated ground water from a former coal ash disposal area northeast of the plant site into the ash pond monitoring wells.

**Available Data**

**Ground Water and Surface Water.** A ground-water monitoring network around the ash ponds at this facility (Figure 1) consists of eleven wells (MW-1 through MW-11). These wells have been monitored for water levels and water quality on a quarterly basis since December 2010, at the time of the hydrogeological assessment report (Patrick Engineering, 2011a), through present. Whereas ash pond and Des Plaines River water-level elevations were part of the original monitoring plan, the only available ash pond water-surface elevations were measured by

Patrick Engineering, Inc. (2011a) on December 6, 2010 and showed an elevation of 533.11 ft MSL in Pond 1 and an elevation of 530.13 ft MSL in Pond 3. The Pond 2 water-surface elevation could not be measured. These two pond water-surface elevations are higher than the underlying ground water indicating that there is a potential for contaminants in the ash ponds to discharge into the environment if the ponds are leaking.

Water-surface elevations in Des Plaines River are available from the USGS (2014a) at their gaging station 05537980 approximately 3.6 mi upstream from the Joliet #29 ash ponds. Water-surface elevations at this station are not representative of the Des Plaines River water-surface elevations at the site because it is upstream from the Brandon Lock and Dam which increases the water-surface elevations in the Des Plaines River at the USGS gage. However, discharge data at this gage was utilized as a proxy for Des Plaines River water-surface elevations at the Joliet #29 site. Use of that discharge data is appropriate because, since increasing River discharges result in increasing River water-surface elevations, and the distance from the USGS gaging station to the site downstream is short, the gaging station discharges are representative of those at the site and can be utilized to show increasing River water-surface elevations. Those Des Plaines River water-surface elevations correlate well with changes in ground-water elevations at the Joliet #29 site.

Soil boring logs up to depths of between 26.3 and 42 feet below ground surface are available at 11 locations corresponding to the ground-water monitoring well network. These soil borings show a highly variable stratigraphy at the site varying from sandy/gravel fill to black clay to limestone fragments to limestone bedrock (MW-6). Based on these driller's logs, it appears that limestone bedrock at the site is approximately 40 ft below ground surface. Monitoring wells have 10-foot long screened intervals beginning at depths between 16.25 and 32.0 feet below ground surface.

**Coal Ash Deposition outside the Ash Ponds.** There is evidence that coal ash has been deposited outside the ash ponds and is causing ground-water contamination. Six geoprobe borings done in 2005 (KPRG, 2005a) indicated bottom ash and/or slag in the top 1 to 2.5 ft in four of the borings. Coal ash deposits found outside the Joliet #29 ash ponds from these four soil borings (JS29-1 through -3 and JS29-6) are summarized in Table 4.

ENSR (1998b), while also identifying the area northeast of the existing ash ponds and between U.S. Route 6 (Channahon Road) and the Des Plaines River as a coal ash disposal area (Former Ash Disposal Area shown on Figure 2), did not drill soil borings nor ground-water monitoring wells in that area as part of their Phase II Environmental Site Assessment (ESA). They did, however, drill two monitoring wells (MW-1 and MW-2) in the vicinity of the ash ponds located as shown on Figure 1. ENSR also drilled three soil borings up to 37-ft deep in the vicinity of the ash ponds. Results of the ENSR (1998b) soil borings during their Phase II ESA indicated that there was coal ash in all three of those borings (B-1, B-3 and B-4) which could contribute contaminants to the ash pond monitoring wells. The extent of coal ash deposits outside the ash ponds at the Joliet #29 site for these borings also are summarized in Table 4.

The area northeast of the ash ponds was used for coal ash disposal by the Joliet #9 station (located on the south side of the Des Plaines River) prior to the construction of Joliet #29 in 1964 and 1965 (ENSR, 1998a). Coal ash was disposed in a landfill on the northeastern portion of the site approximately as shown on Figure 2. This former coal ash disposal site likely has influenced, and will continue to influence, ground-water contamination at the ash ponds because it is up-gradient (and up-river). Reports in MWG files indicate that this former coal ash disposal site has been eroded over the years by local runoff and the Des Plaines River, and nearly annual maintenance to minimize this erosion has been performed (KPRG, 2009a and b; 2010; 2012a and b, and 2013). The areal extent and depth of the coal ash in this disposal area is currently unknown (Table 4).

A second abandoned coal ash disposal landfill lies on the southwest portion of the site between the coal pile and the Caterpillar, Inc. site (ENSR, 1998a) but this southwestern coal ash disposal site probably does not influence

ground-water contamination at the ash ponds because it is well down-gradient (and down-river). It is unknown for certain if the areas where the current ash ponds are located at the Joliet #29 site were utilized for coal ash disposal in the past; however, based on soil borings discussed above, there is obvious evidence of coal ash present in the soils at the Joliet #29 site outside the ash ponds.

I conclude from the KPRG (2005a, 2005b, 2009a and b; 2010; 2012a and b, and 2013) and the ENSR (1998b) reports that there is coal ash in the upper portions of the unconsolidated materials outside the ash ponds. This coal ash is subject to continuous leaching of contaminants into the underlying soils and ground water by rainfall and snowmelt and these contaminants likely will be detected by the existing monitoring well network at the Joliet #29 site.

**Results and Evaluation of Environmental Contamination**

In my opinion, the ground water beneath the ash ponds at the Joliet #29 site is contaminated, and continues to be contaminated, with high concentrations of B, Mn and $SO_4$ as a result of leaky ash ponds and leaching of coal ash on or immediately beneath the land surface. I came to this conclusion for the following reasons, discussed in more detail herein. First, the ground-water quality data at Joliet #29 match coal ash leachate characteristics for B, Mn, and $SO_4$ and have concentrations greater than background for those constituents.

Second, MWG's documents and ground-water elevation data indicate that the coal ash pond liners have leaked and likely will to continue to leak. The evidence shows that (a) the HDPE liners in Ponds 1 and 2 were installed on top of coal ash and/or partially removed Poz-o-Pac which could cause punctures in the liner due to the weight of equipment used to dredge the coal ash from the pond; (b) the protective layers on top of the HDPE liner are too thin, with only 1 ft instead of at least 2 ft of protective materials; (c) liner installation defects are likely present which have caused, and likely will continue to cause, leaks in the liner; and (d) 2012 data show that ground-water elevation in one down-gradient monitoring well was higher than the ground water elevation in a monitoring well that is generally up-gradient of that monitoring well, which can only be explained by a liner leak.

Third, there are coal ash deposits outside of the ash ponds which, due to precipitation and ground-water flow through that coal ash toward the monitoring wells, are contributing contaminants to the ground water beneath the ash ponds at Joliet #29. Finally, during high river stages, the Des Plaines River causes ground water to flow from the River into the soils underlying the ash ponds, which re-saturates already-contaminated soils causing additional ground-water contamination.

**Water Surface Elevations.** Ground-water at the Joliet #29 site is strongly influenced by changes in Des Plaines River surface-water elevations as well as potentially leaking ash ponds. Figure 4 graphically shows the time series of ground-water elevations at the 11 monitoring wells located around the ash ponds. The time series shows some interesting characteristics. During the March and June 2011 quarterly monitoring, the ground-water elevations in the wells rose sharply. This most likely was due to a large increase in runoff and rising Des Plaines River water-surface elevations. Based on discharge data from the USGS gaging station 05537980, water discharges in the River during the period March through June 2011 were as high as 27,300 cubic feet per second (cfs) or more than 4 times the average River discharge (6,412 cfs) for the same period. There were two other very high discharges in May 2011 (20,100 and 20,800 cfs) which also resulted in high Des Plaines River stages at the Joliet #29 site. These high stages are reflected in ground-water mounding beneath the ash ponds during this period as seen in MWG Second Quarter 2011 monitoring report and Figure 3. Similar ground-water mounding also is seen in the MWG subsequent quarterly monitoring reports and is the result of both high Des Plaines River stages during the spring and early summer and also due to ash pond liner leaks in Pond 3 until it was relined in 2013. The consequences of this mounding would be to saturate already contaminated soils from previous ash pond leaks or from previous coal ash leaching events. The high Des Plaines River discharges certainly caused river bank erosion

at the former coal ash disposal area (Figure 2), which was addressed by MWG through erosion control remedial actions (KPRG, 2012a and b).

Ground-water elevation data presented in the 2012 Third Quarter monitoring event indicates that ash Pond 3 must have been leaking because the ground-water elevation in MW-9 was higher (505.66) than that in MW-8 (505.22) which is generally up-gradient from MW-9. Given that the general ground-water gradient is expected to be in the direction of flow of the Des Plaines River, we would expect the ground-water elevation in MW-8 to be slightly higher than that in MW-9. Therefore, I conclude that the ground-water elevations measured during the 2012 Third Quarter monitoring were not naturally occurring but likely the result of leaks from Pond 3.

Historically, ground-water elevations in MW-5 have been consistently lower than those in surrounding monitoring wells (MW-3, -4, -6 and -7) indicating that there most likely is an issue with the MW-5 completion, or ash Ponds 1 and 2, where MW-3, -4, -6 and -7 are located, also are leaking causing local ground-water table mounding. Whereas it is possible that both Ponds 1 and 2 have leaking liners, reflected in the higher ground-water elevations in MW-3, -4, -6, and -7, it is more likely that MW-5 has a faulty completion (well screen) which is causing the anomalously lower ground-water elevations.

Another anomaly in the ground-water elevations for the Joliet #29 ash ponds time series (Figure 4) is the low value in MW-4 during the May 2013 quarterly monitoring event. The reason for this is unknown, but the 2014 Fourth Quarter and Annual report by MWG speculates that "*This was either associated with dewatering for liner construction activities in the area which were being initiated or a recording error.*" It is not clear why dewatering for liner construction at Pond 3 was required as the ground-water elevations at the time were greater than 8 ft below the bottom of the Pond 3 Poz-o-Pac liner. A likely interpretation is that Pond 3 was leaking prior to being relined and that the ground-water elevation dropped after relining. An alternative interpretation is that measurement error was the cause of the anomalous ground-water elevation at MW-4 for the May 2013 monitoring event. A third interpretation is that Des Plaines River discharges prior to and during May 2013 increased dramatically to over 20,000 cfs, most likely resulting in the observed increased ground-water elevations during that time period.

A final observation regarding the ground-water elevation data shown on Figure 4 is the generally increasing trend in ground-water elevations at all monitoring wells after July 2013. Review of surface-water discharges at the USGS gaging station 05537980 for the period July 2013 through present indicates that discharges in the Des Plaines River reached over 18,000 cfs in mid-July 2014 after a general increase in River discharges after January 2014. In general, Des Plaines River discharges since November 2014 have decreased seasonally. Therefore, I would expect the ground-water elevations at the Joliet #29 site to decrease into the fourth quarter of 2014, which they have done as shown on Figure 4.

I conclude from interpretation of the ground-water elevations and presumed Des Plaines River water-surface elevations based on River discharge data that the River strongly influences the ground-water elevations and ground-water gradients at site, causing seasonal flow from the River into the unconsolidated materials beneath the ash ponds. However, not all of the ground-water mounding seen in the quarterly monitoring reports can be attributed to the Des Plaines River and I further conclude that the Joliet #29 ash ponds have leaked in the past and continue to leak.

**Ground-water Quality.** B, Mn, and $SO_4$ historically have been found in the ground water beneath the Joliet #29 site in concentrations higher than the IEPA Class I ground-water protection standards and typical background concentrations in Illinois (Table 3). These indicator pollutants are known contaminants from coal ash leaching. The fact that the ash ponds have leaked and likely continue to leak and that coal ash is abundantly present outside the ash ponds and in an up-gradient landfill at the site indicates that ground-water contamination has occurred and continues to occur at the Joliet #29 site. Figures 5, 6 and 7, respectively, show the quarterly time series of B,

Mn, and $SO_4$ concentrations in ground water for the period December 2010 through present for the 11 monitoring wells.

Figure 5 shows the time series of B concentrations in ground-water at the Joliet #29 site. Historically MW-11 has had B concentrations equal to or higher than the IEPA Class I ground-water standard of 2.0 mg/L during the monitoring period from December 2010 to present. Boron is known to be found in coal ash leachate (Table 2). It is noted that B concentrations in ground-water have recently increased dramatically in MW-5 and MW-11, with slightly increasing B concentration trends in all of the other 9 wells. Boron concentrations in ground water at all monitoring wells at the Joliet #29 site are higher than the background concentration of 0.12 mg/L for sand and gravel aquifers (Table 3). Therefore, I conclude that ground-water contamination by B at the Joliet #29 site was and is currently occurring as the result of ash pond liner leaks and/or leaching of coal ash deposits outside the ash ponds.

Mn concentrations in ground water as shown in the time series on Figure 6 have historically been higher than the IEPA Class I ground-water standard of 0.15 mg/L in MW-9. Manganese is known to be found in coal ash leachate (Table 2). It is noted that Mn concentrations in ground-water have recently decreased in MW-9 and in all of the other 10 wells. The other monitoring wells historically have had Mn concentrations much less than the IEPA Class I ground-water standard, but sometimes higher than the background ground-water concentration of 0.072 mg/L for sand and gravel aquifers. Therefore, I conclude that ground-water contamination by Mn at the Joliet #29 site was and is currently occurring as the result of ash pond liner leaks and/or leaching of coal ash deposits outside the ash ponds.

Figure 7 shows the time series of $SO_4$ concentrations in ground water at the Joliet #29 site with MW-9 having $SO_4$ concentrations consistently higher than the IEPA Class I ground-water standard of 400 mg/L. MW-8 has had one $SO_4$ concentration in ground water greater than the IEPA Class I standard during the Second Quarter of 2014. Sulfate is known to be found in coal ash leachate (Table 2). It is noted that $SO_4$ concentrations in ground-water have recently decreased in MW-5 and MW-8 and in all of the other 8 wells. It is noted that MW-9 is monitoring ground-water beneath ash Pond 3 which was relined in 2013. However, $SO_4$ concentrations in ground-water at MW-9 appear to be increasing since the Second Quarter of 2014, indicating that there most likely is a leak in the Pond 3 liner. An alternative explanation is that coal ash deposits outside the ash ponds continue to leach contaminants into the ground water at the Joliet #29 site.

The other monitoring wells historically have had $SO_4$ concentrations less than the IEPA Class I ground-water standard but typically higher than the background ground-water concentration of 54 mg/L for sand and gravel aquifers. Therefore, I conclude that ground-water contamination by $SO_4$ at the Joliet #29 site was and is currently occurring as the result of ash pond liner leaks and/or leaching of coal ash deposits outside the ash ponds. Ground water at the Joliet #29 site would require treatment in order to be used as drinking water, which is its potential use under the IEPA Class I ground-water protection standards.

The indicator pollutants (B, Mn and $SO_4$) do not behave the same way in a fluctuating ground water system. Firstly, B and $SO_4$ act as conservative constituents and do not strongly sorb or desorb onto the soil particles but tend to move with the ground water. This is not the case with Mn which can take on various valence forms (+2, +3, or +4) when ground-water levels go down and then re-dissolve when ground-water levels rise (Nádaská and others, 2012). This process also is true for leaching when the indicator pollutants come into contact with water during rainfall and snowmelt. Therefore, in the absence of liner leaks or leaching, B and $SO_4$ tend to be diluted by increased ground-water elevations and their concentrations go down during high ground-water elevations. Mn, on the other hand, most likely will increase in concentration in the ground water when the ground-water elevation rises and re-dissolves the Mn. Secondly, all of these constituents may increase in concentration in the ground-water if they are being leached from coal ash deposited on or beneath the ground surface or above the water table or if they are the result of liner leaks occurring within or above the water table.

**Why the Joliet #29 CCA will not Reduce Ground-water Contamination at the Joliet #29 Site**

The Joliet #29 CCA (IEPA, 2012a) sets forth various supposedly remedial actions by MWG to eliminate ground-water contamination at the site. The Joliet #29 site ground water is contaminated with constituents including Sb, As, B, Cl, Fe, Mn and $SO_4$. Additionally, ground-water at the site is affected by high TDS up-gradient and down-gradient from the ash ponds. The proposed CCA remedies will not, in my opinion, reduce the ground-water contamination at the Joliet #29 site because:

(1) Continued ground-water monitoring will not eliminate the ash pond liner leaks nor leaching of contaminants from past coal ash placement outside the existing ash ponds;
(2) There is no provision in the CCA for cessation of use and removal of coal ash from the three ash ponds;
(3) There is no provision in the CCA for clean-up and removal of fill/construction coal ash placed outside the ash ponds nor for coal ash disposed of on the land surface; and
(4) Relining the ash ponds will not reduce the potential for liner damage and subsequent liner leakage if dredging of coal ash is done utilizing the same dredging techniques as at other MWG sites.

Without removal of the coal ash source-terms at the Joliet #29 plant site, ground-water contamination will continue unabated into the future. Creation of an Environmental Land Use Control (ELUC) area and installation of additional ground-water monitoring wells will not prevent the existing coal ash sources from continuing to cause ground-water contamination.

**POWERTON**

**Conceptual Site Model**

**Regional Setting.** The Site is located in Section 9, Township 24 North, Range 5 West, in the City of Pekin, IL. The surrounding land use consists of the Illinois River to the north, industrial and residential properties to the east, agricultural land to the south, and Lake Powerton (Powerton Fish and Wildlife Area) to the west as shown on Figure 8. There is no indication that these land uses could be sources for B, Mn, and $SO_4$ at the site.

**Coal-Management.** The site contains five ash ponds: Ash Surge Basin, Secondary Ash Settling Basin, Metal Cleaning Basin, Ash Bypass Basin and East Yard Runoff Basin as shown on Figure 9. The Ash Surge Basin and Secondary Ash Settling Basin were relined with HDPE in 2013; whereas, the Metal Cleaning Basin and Ash Bypass Basin were relined with HDPE in 2010. The East Yard Runoff Basin is unlined. Prior to those relining dates, the other four ash ponds were lined on the bottom with a geo-composite material (Poz-o-Pac) comprised of fly ash and cement and had a Hypalon geo-membrane liner on the side slopes.

The Former Ash Basin is located northeast of the current ash ponds and has been partially filled but still contains abundant coal ash. The Former Ash Basin is unlined (Bates Nos. 13733-13799). According to Mark S. Kelly in his deposition on January 23, 2015 (Kelly, 2015, p. 52, p. 99-102), water and coal ash from the Ash Surge Basin have overflowed into the Former Ash Basin.

The Limestone Runoff Basin, also known as the slag overflow basin, is located immediately east of the Ash Surge Basin and has been utilized to store both coal ash and slag (ENSR, 1998c and Bates No. 21361). The bottom liner for this facility is Poz-o-Pac with Hypalon side slopes (Bates No. 21321). This basin is located west of MW-10 and north of MW-11 as shown on Figure 9.

Under NPDES Permit No. IL0002232, water from the ponds discharges to the East Channel (Figure 8), which discharges to the Illinois River. The ash ponds have varying bottom elevations as shown in Table 5. Pond water-surface elevations measured on November 3 and 4, 2010, March 4, 2012, and December 4, 2012 also are shown in Table 6. These pond water-surface elevations indicate that there is a potential for contaminants in the ash ponds to discharge into the environment if the ponds are leaking.

**Liner Damage.** Between the time that the five ash ponds were constructed (in the 1975-1978 range) and when four of the five were relined in 2010 and 2013, they appeared to have leaked contaminants into the ground water beneath the ponds (Patrick Engineering, 2011b). In 2006 the Ash Surge Basin, Secondary Ash Settling Basin, Bypass Basin, Metal Cleaning Basin and Limestone Runoff Basin liners were all judged to be in "poor" condition or were unlined and the hypalon side slopes of these basins were "often" repaired when they were dredged (Bates Nos. 68, 72, 76, 80, 88, 92, 96 and 100).

As noted above, the Metal Cleaning Basin was relined in 2010 with 60-mil thick HDPE plastic. In March 2011, Leak Location Services, Inc. (LLSI, 2011) performed a geomembrane leak location survey on the bottom of the Metal Cleaning Basin liner and found a 3-inch diameter puncture. LLSI could not determine if any additional leaks existed near the identified puncture. It is unknown if the 3-inch diameter puncture was repaired by MWG. Given that the HDPE liner was installed during the winter of 2010 there could be additional leaks in the Metal Cleaning Basin liner because of the adverse temperature conditions during liner installation. It appears that this basin does have liner leaks based on the ground-water quality data collected in nearby wells, especially MW-13, -14 and -15, since 2011.

In 2013 during relining of the Secondary Ash Basin, ground-water elevations were higher than the bottom of the basin and dewatering was required to install the new plastic liner (Bates No. 22014). This is confirmed by photographic evidence (Bates Nos.22015-22018). Ground-water elevations higher than the elevation of the plastic liner will lead to hydrostatic uplift as well as reduction of soil support of the liner and most likely lead to liner failure. Therefore, the Powerton ash ponds have a history of liner issues which most likely have caused and continue to cause leaks. Liner leaks, even if small, can cause detectable contamination in ground water at the site.

Coal ash solids from the basins are periodically dredged and the dredge spoil used for reclamation at the Burkhart Mine. Documents from MWG (Bates No. 21359) indicate that the ash ponds are dredged approximately every 5 to 6 years. Ash pond dredging using heavy equipment likely will damage the plastic liners unless extreme care is used during dredging operations. In fact, the Metal Cleaning Basin (Bates No. 92) was reported by MWG to be dredged yearly with repairs "often" needed on the hypalon side slopes. The Ash Surge Basin also had hypalon liner repairs often (Bates No. 92).

**Hydrogeology.** Based upon water well logs from the area, the geology beneath the site consists of approximately 100 to 125 feet of unconsolidated deposits (mainly alluvial sands and gravels with some minor clay), underlain by the Carbondale Formation which consists of alternating layers of limestone, shale, coal, and clay. Continuing monitoring and drilling of new monitoring wells has determined that the underlying unconsolidated materials consist of a shallower, localized saturated clay/silt unit underlain by a more areally extensive gravelly sand unit as shown schematically on Figure 10 (Patrick Engineering, 2011b). As such, these two units may be hydrogeologically distinct for purposes of water level elevations and water-quality constituents.

Ground water in the shallow unconsolidated clay/silt unit appears to flow from southeast to northwest; whereas ground water in the more extensive and deeper unconsolidated gravelly sand unit appears to flow from south to north. Ground-water flow in both shallow units, however, should be largely controlled by the Illinois River with ground water generally flowing north towards the river or along the flow direction of the river (northwest or west) during most periods of the year.

**Available Data**

**Ground Water and Surface Water.** A ground-water monitoring network around the ash ponds at this facility consists of sixteen wells (MW-1 through MW-16) as shown on Figure 9, with wells MW-6, MW-8, MW-12, MW-14 and MW-15 monitoring the shallower silt/clay unit and the remaining 11 wells MW-1 through MW-5, MW-7, MW-9 through MW-11, MW-13 and MW-16 screened in the deeper gravelly sand unit as shown on Figure 3. These wells have been monitored for water levels and water quality on a quarterly or, in some cases bi-monthly, since December 2010 at the time of the hydrogeological assessment report (Patrick Engineering, 2011b), or since the well installations, through the present time. Limited data collected by MWG for Illinois River, canal and pond water surface elevations also are available (Table 6).

Illinois River water levels near the Powerton plant site are important to local ground-water elevations and flow directions at the site. The U.S. Geological Survey (USGS, 2014b) has compiled a time series of Illinois River water-surface elevations at their station 05568500 at Kingston Mines, IL located approximately 5 miles down-river from the Powerton site. These river water-surface elevations were compared to the ground-water and pond-water surface elevations at the Powerton site.

Soil boring logs up to depths of between 28 and 45 feet below ground surface are available at 16 locations corresponding to the ground-water monitoring well network. Monitoring wells have 10-foot long screened intervals beginning at depths between 18 and 35 feet below ground surface.

**Coal Ash Deposition outside the Ash Ponds.** There is ample evidence that coal ash has been deposited outside the ash ponds and is causing ground-water contamination. Soil boring logs taken during construction of the monitoring wells show that there are coal cinders at MW-5 at the Former Ash Basin and that this coal ash extends from the ground surface to a depth of approximately 13 ft. MW-6 and MW-7, adjacent to the Secondary Ash Settling Basin, had coal ash in the surface soils extending from the ground surface to depths of 18 ft. Coal ash was observed in the soil boring at MW-8 adjacent to the Ash Surge Basin extending to a depth of 24.5 ft. At MW-9 south and east of the Ash Bypass Basin, coal ash was observed in the soil boring extending from the ground surface to a depth of 17 ft. In borings for monitoring wells MW-11 through MW-15, coal ash extended from the ground surface to a maximum depth of 19.5 ft. No coal ash was found in borings for MW-1 through MW-4, MW-10 nor MW-16, the up-gradient and background well at the Powerton site. A summary of the coal ash deposits outside the ash ponds for these monitoring wells is presented in Table 6.

An additional five borings done in 2005 (KPRG, 2005b) indicated bottom ash and/or slag in a boring on the north side of the Secondary Ash Settling Basin and in three borings west, east and south of the Ash Surge Basin. A boring south of the East Yard Runoff Basin also showed coal ash in soils below ground surface. All of these borings (PS-GT-5 through -9) had coal ash or slag identified at depths ranging from near the ground surface to 15 ft deep, as summarized in Table 6.

MWG had 23 soil borings (AP-3 through APB-10-08 in Table 6) drilled by Patrick Engineering, Inc. in 2008 (Bates Nos. 14225-14269) at the Former Ash Basin at Powerton, located as shown on Figure 9. Review of the logs for these soil borings indicated that coal ash cinders were present in all of the borings and to at least 10 ft below ground surface in 16 of these borings. One of the borings had coal ash cinders as deep as 31 ft below ground surface. Many of soil borings were augered beneath the ground-water table. This unlined Former Ash Basin is clearly a likely source of ground-water contamination from leaching of this coal ash due to precipitation and ground-water rising and falling over the year due to the influence of the Illinois River.

ENSR (1998d) prepared a Phase II ESA for MWG which indicated that of the 28 soil borings completed nearly all had coal ash, slag or coal in them. Outside the ash ponds at Powerton, 10 soil borings had coal ash/slag utilized

as fill material or structure foundation materials at depths up to 12 ft below ground surface. The areas of influence of six of these soil borings (B-10, B-11, B-12, B-13, B-14, and B-36 in Table 6) are all within the existing monitoring well network. I conclude from this information that coal ash/slag was utilized at Powerton for fill/construction materials and this coal ash/slag is a likely source of ground-water contamination from leaching due to precipitation and rising/falling ground-water levels. I conclude from these observations that in addition to the leaky ash ponds, there is a non-point source of coal ash at the Powerton site which likely is an additional cause of the ground-water contamination observed in the monitoring wells.

**Results and Evaluation of Environmental Contamination**

In my opinion, the ground water at and near the ash ponds at Powerton is contaminated with high concentrations of B, Mn and $SO_4$ as a result of current and former fly ash/slag storage at abandoned/unlined and lined ash ponds, using coal ash as a construction material at and near the ash ponds, and leaks in the ash pond liners. I came to this conclusion for the following reasons, discussed in more detail herein. First, the ground-water quality data at Powerton match coal ash leachate characteristics for B, Mn, and $SO_4$ and have concentrations greater than background for those constituents.

Second, MWG's documents and ground-water elevation data indicate that the coal ash pond liners have leaked and likely will continue to leak. The evidence shows that (a) in 2006, the liners of the four lined coal ash ponds at Powerton were judged to be in "poor" condition and the side slopes required frequent repairs when the ash ponds were dredged; (b) a puncture was found in March 2011 in the HDPE liner of the Metals Cleaning Basin, which had been replaced in 2010; (c) the ground-water elevation surrounding the coal ash ponds is higher than the ash pond bottoms, subjecting all the ash ponds at Powerton to hydrostatic uplift and reduction of soil support, both of which lead to liner failure; (d) poor dredging practices have been used, and continue to be used, at Powerton, creating a large risk of liner rips and tears; and (e) high concentrations of coal ash indicator pollutants in monitoring wells near the ponds strongly suggest that those ponds are leaking.

Third, ash pond water-surface elevations are nearly always higher than the surrounding ground water, meaning that contaminated ash pond water can flow from those ponds to the ground water. Fourth, numerous soil borings indicate that there are thick ash deposits outside of the ash ponds and in the former ash pond which, due to precipitation and ground-water flow through that ash toward the monitoring wells, are contributing contaminants to the ground water beneath the ash ponds at Powerton. Finally, seasonal changes in water levels in the Illinois River cause ground water to flow from the River into the ash-contaminated soils, re-saturating those contaminated soils and leading to increased leaching of contaminants and the "sloshing" back and forth of contaminated ground water at the site.

**Water Surface Elevations.** Ground water at the Powerton site is strongly influenced by changes in Illinois River surface-water elevations via the channels connecting it to the site, as well as potentially leaking ash ponds. Interpretation of historical ground-water and surface-water elevations for the upper silt/clay and the lower gravelly sand units, as shown graphically on Figures 11 and 12, coupled with the soil stratigraphy shown on Figure 10, indicates the following:

(1) The pond bottom elevation for the Secondary Ash Settling Basin is within the upper silt/clay unit but below the fill materials at the site;
(2) The other pond bottom elevations appear to be within the fill materials at the site based on the incomplete information provided by MWG;
(3) Ash pond water-surface elevations are nearly always at or above the ground-water and Illinois River water-surface elevations;
(4) If there are leaks in the pond liners, it would be possible for contaminants to move opposite to the general ground-water flow direction at the site;

(5) The responses of wells completed in the upper silt/clay unit to changes in both ash pond and Illinois River water-surface elevations are very small compared to similar responses of wells completed in the lower gravelly sand unit; and
(6) Illinois River water-surface elevations control the direction and velocity of ground-water in the vicinity of the ash ponds.

Therefore, the historical ground-water and surface-water elevations indicate that ground-water flow directions for short periods are away from the Illinois River and its associated intake and outlet channels at the Powerton site. Richard Frendt of Patrick Engineering, in an e-mail to Maria Race on January 7, 2011, said "*At Powerton, there are fairly clear gradients, but they are not all in the same direction well-to-well, and may even change seasonally over time …* (Bates No. 14096). Thus, the flow direction and movement of contaminants as well as potential ground-water mounding due to leaks in the ash pond liners are variable and change with time. However, it is likely that movement of contaminants from liner leaks and/or leaching of near-surface coal ash deposits is from north to south and south to north in the lower gravelly sand unit, and from west to east and east to west in the upper silt clay unit, as well as vertically.

This conclusion is exemplified by the MW-8 and MW-15 time series elevation lines on Figure 11 in the upper silt/clay unit and MW-1 and MW-10 elevation lines on Figure 12 in the lower gravelly sand unit whose ground-water elevation lines cross depending on the season of the year. Therefore, contaminant movements from ash pond leaks and/or leaching of in-place coal ash "slosh" back and forth in the ground-water at the site.

**Ground-water Quality.** B, Mn, and $SO_4$ are found in the site ground water in concentrations higher than the Illinois Class I water-quality standards and higher than background concentrations at MW-16. Because B, Mn, and $SO_4$ are known contaminants from coal ash leaching and coal ash is abundantly present at the site, it is likely that ground-water contamination has occurred and continues to occur.

Figures 13, 14 and 15 show, respectively, the quarterly time series of B, Mn, and $SO_4$ concentrations in ground water for the period December 2010 through present. Boron is present in concentrations higher than the IEPA Class I standard of 2.0 mg/L in ground-water samples taken from wells MW-2, -9, -10, -11 and -13 (lower gravelly sand unit well completions) and from wells MW-12 and -14 (completed in the upper silt/clay unit) as shown by the time series plotted on Figure 13. At MW-13, B concentrations have continued to remain above the IEPA standard even after re-lining of four of the ponds in 2010 and 2013. This indicates either that there is a leak in the new HDPE liners or that coal ash deposited historically outside the basins and utilized for construction is causing leachate which is migrating downward to the ground water. B concentrations in MW-9 ground-water samples appear to be declining since about March 2013. B concentrations, however, have spiked in MW-2, MW-12 and MW-10 since June 2013 indicating either liner leaks, surficial coal ash leaching, or situations where abrupt changes in ground-water flow direction or ground-water elevation changes resulted in additional coal ash leaching.

There has been a continuous increasing trend in B concentrations in MW-10 over the historical record since December 2010. MW-10 is in the lower gravelly sand unit and the increasing B concentrations correlate well with increasing Illinois River water-surface elevations which cause increased ground-water elevations and most likely increased leaching of historical coal ash deposits outside the ash basins.

Also, B concentrations in all of the monitoring wells are typically higher than the median background concentration of 0.17 mg/L at MW-16. I conclude that ground-water contamination by B at the Powerton site was and is currently occurring as the result of ash pond liner leaks and/or leaching of coal ash deposits outside the ash ponds.

Mn has been detected in concentrations higher than the IEPA Class I standard of 0.15 mg/L in ground-water samples taken from wells MW-5, -7, -10, -11 and -13 (lower gravelly sand unit) and from wells MW-6, -12, -14 and

-15 (upper silt/clay unit) as shown by the time series on Figure 14. Mn concentrations have remained generally high, most notably in MW-6, -7, -10, -11 and -13. The highest Mn concentrations appear to be in the lower gravelly sand unit (*e.g.,* MW-7 and MW-13) as a result of apparent ash pond liner leakage and, perhaps, also downward movement of Mn contamination from the overlying silt/clay unit and/or leaching of historical coal ash deposits outside the ash basins. The same trend in Mn concentrations as for B concentrations can be seen in MW-10 for the same reasons as stated above.

Mn concentrations in all of the monitoring wells, except the background well MW-16, are typically higher than the median background concentration of 0.0025 mg/L. I conclude that ground-water contamination by Mn at the Powerton site was and is currently occurring as the result of ash pond liner leaks and/or leaching of coal ash deposits outside the ash ponds.

$SO_4$ is present in concentrations higher than the IEPA Class I standard of 400 mg/L in ground-water samples taken from wells MW-13 (lower gravelly sand unit) and from wells MW-6, -8, -12, -14 and -15 (upper silt/clay unit) as shown on the Figure 15 time series. $SO_4$ concentrations correlate well with both B and Mn concentrations in ground water at the site. Because $SO_4$, like B and Mn, is known to be a product of leaching of coal ash, its presence is an indicator of past ash basin liner leaks, current liner leaks, or leaching of historical coal ash deposits outside the ash basins. Spikes in $SO_4$ concentrations, like those for B and Mn, are likely caused by one of the following: downward migration of leachate from the silt/clay unit into the gravelly sand unit, re-leaching of coal ash in the soils, or movement of contaminated ground water as a result of changing water-surface elevations in the Illinois River. Sulfate concentrations in all of the monitoring wells are typically higher than the median background concentration of 40 mg/L in MW-16.

After review of MWG documents related to the history of the Powerton ash ponds, ash pond operation and maintenance, and ground-water and surface-water elevation and water-quality data, I conclude that ground-water contamination at and near the ash ponds is the result of current and former fly ash/slag storage at abandoned/unlined and lined ash ponds, using coal ash as a construction material at and near the ash ponds, and leaks in the ash pond liners.

Spikes in B, Mn and $SO_4$ concentrations in ground water at the site are most likely the result of downward movement of leachate from liner leaks, from the silty/clay unit into the gravelly sand unit and of increased leaching of coal ash from changes in ground-water elevations that result from changes in Illinois River water-surface elevations. Ground-water concentration spikes of Mn also are caused by the reactive nature of Mn, as explained in the **"JOLIET #29 - Results and Evaluation of Environmental Contamination"**. Ground water at the Powerton site would require treatment in order to be used as drinking water which is its potential use under the IEPA Class I ground-water protection standards.

**Why the Powerton CCA will not Reduce Ground-water Contamination at the Powerton Site.**

The Powerton CCA (IEPA, 2012b) sets forth various supposedly remedial actions by MWG to eliminate ground-water contamination at the site. The Powerton site ground water is contaminated with constituents which include As, B, Cl, Fe, Mn, Hg $NO_3$, Se, $SO_4$ and Tl. Additionally, ground-water at the site is affected by pH and high TDS up-gradient and down-gradient from the ash ponds. The proposed CCA remedies will not, in my opinion, reduce the ground-water contamination the Powerton site because:

(1) Continued ground-water monitoring will not eliminate the ash pond liner leaks nor leaching of contaminants from past coal ash placement outside the existing ash ponds;
(2) There is no provision in the CCA for cessation of use and removal of coal ash from the ash ponds;
(3) There is no provision in the CCA for clean-up and removal of fill/construction coal ash placed outside the ash ponds nor of coal ash disposed of on the land surface; and

(4) Relining the ash ponds will not reduce the potential for liner damage and subsequent liner leakage as long as dredging of coal ash continues as in the past.

Without removal of the coal ash source-terms at the Powerton plant site, ground-water contamination will continue unabated into the future. Creation of an ELUC and installation of additional ground-water monitoring wells will not prevent the existing coal ash sources from continuing to cause ground-water contamination.

**WAUKEGAN**

**Conceptual Site Model**

**Regional Setting.** The Waukegan facility (the Site) is located in Section 15, Township 45 North, Range 12 East, in the City of Waukegan along the shore of Lake Michigan on the northeast side of Waukegan (Figure 16). The surrounding land use consists of undeveloped land to the north, apparently vacant industrial land and the Waukegan wastewater treatment plant to the south, vacant industrial land to the west, and Lake Michigan to the east.

As shown on Figure 16, there is industrial land to the west comprised of the former General Boiler property which manufactured radiators and, west of the former General Boiler property, the former Griess-Pfleger Tannery. As background on these properties, the Griess-Pfleger Tannery was built in 1917 and operated as a leather tanning facility from 1918 through early 1973. Shortly after the facility closed, a lacquer dust fire occurred which destroyed the interior of several of the main structures. The property was acquired by the predecessor of MWG in 1973. The General Boiler property also operated prior to 1920 and manufactured general boiler plating and, later, radiators. The exact date of closure of the radiator manufacturing plant is unknown but believed to be as late as the 1990s. The property was acquired by the predecessor of MWG in the late 1990s.

These two properties are alleged by MWG to be contributing contamination to ground water at the ash ponds. This allegation is unsubstantiated by the data in relation to the indicator pollutants (B, $SO_4$, and Mn) because B and $SO_4$ are typically not associated with either tannery or radiator manufacturing waste (Nemerow, 1963). Furthermore, Mn ground-water concentrations in wells at the former Griess-Pfleger Tannery and General Boiler sites, which are up-gradient, are lower than in the vicinity of the ash ponds. Thus it is unlikely that the higher concentrations of Mn in the vicinity of ash ponds are from the up-gradient sites. Finally, if ground-water contamination were sourced from the Tannery, I would expect the presence of chromium (Cr), a well-known tannery waste product, but it is not detectable in the ground water at the Waukegan site monitoring wells.

**Coal-Ash Management.** The Site contains two active ash ponds. The ponds were lined with high-density polyethylene (HDPE) in 2002, replacing the previous Hypalon liners. The East Pond was relined in 2003 and the West Pond was relined in 2005. The total area of the two ash ponds is approximately 25 acres. Coal ash solids from the ponds are dredged approximately annually from the ponds and the dredge spoil is deposited in a landfill.

Water from the ash ponds is decanted and discharged to Lake Michigan under NPDES Permit No. IL0002259. The ponds have a bottom elevation of approximately 572.5 ft MSL and top of dike elevations of approximately 601.5 ft MSL. Pond water level elevations measured on December 16, 2010 were 594.993 ft MSL for the West Pond and 585.443 ft MSL for the East Pond.

**Liner Damage.** Waukegan ash pond maintenance caused or exacerbated liner leaks at both the East and West Ponds. Ash pond dredging activities have damaged and likely will continue to damage the plastic liners unless extreme care is used during dredging operations. MWG documents indicate that this liner damage was caused by the use of heavy equipment during dredging (Bates No. 14271 *et seq.*).

The East Pond was relined in 2003 with 60-mil thick HDPE plastic and the West Pond was relined in 2005 with the same thickness HDPE. Prior to these relining events, the written record shows that the Waukegan ash ponds were lined in 2002 with Hypalon but apparently continued to leak, which resulted in the 2003 and 2005 relining of the ponds (VEC, 2014).

In August 2005, KPRG and Associates, Inc. (2005c) performed a liner inspection of the Waukegan East and West ash ponds. KPRG identified several liner issues which could cause the liners in the ponds to leak or become compromised in the future. These issues are summarized as follows:

(1) The 6-in thick limestone aggregate warning layer on top of the 12-in thick sand layer protecting the top of the HDPE liner could migrate downward to the HDPE and puncture it during heavy wheel loads, which likely will occur during coal ash dredging;
(2) Liner wrinkles, especially in the West Pond, indicate poor liner installation or potential incipient liner failure;
(3) Liner attachment to the vertical concrete sections of the ponds was inadequate and could cause liner system failure;
(4) There was visual evidence that the liner anchor trenches on top of the berms had settled, which could mean that the liner was being pulled out of the anchor trench due to liner settling under water/coal ash loading and also could account for the unusual wrinkles in the liner;
(5) There was liner bulging on the west side of the center berm of the West Pond which most likely indicates a liner subgrade failure;
(6) A liner tear associated with materials handling by construction equipment was noted on the south side of the East Pond; and
(7) A wedge weld pressure test seam cut in the southwest corner of the West Pond was not patched.

These liner deficiency issues would likely result in liner leaks. The issues listed are confirmed with photographs in the KPRG (2005c) letter report. Additionally, as discussed below, the bottom elevations of the ash ponds are below the ground-water phreatic surface (water table) and below the average water surface elevations of Lake Michigan all year long. Thus, hydrostatic uplift pressures on the liner likely have caused and likely will cause the welded seams to tear and cause leaks.

Hydrostatic uplift (buoyancy) of plastic liners causes the soils beneath the liner to lose strength and settle. According to Terzaghi and others (1996), total stress in soil is a sum of an effective stress (or intergranular stress as a result of particle-to-particle contact pressure) and a neutral stress (pore water pressure). At the instance of failure, total stress in the soil is equal to only the pore water pressure and the effective stress is equal to zero. In other words, when particle-to-particle contact disappears, so does the soil's strength. The loss of soil strength results in soil settlement or soil sliding on the ash pond side slopes and lack of support for the liner, which causes it to fail by separation of the liner seams or tears in the liner. High water tables also can simply "lift" the plastic liner or cause "bubbles" in the liner. Either loss of strength in soil supporting the liner or lifting of the plastic, or both, are considered failure of the liner

Based on example calculations of hydrostatic uplift (Ohio EPA, 2004), the potential for uplift of a soil (or plastic liner) layer exists whenever a piezometric level (head) extends to an elevation more than 1.3 times the thickness of the layer that is above the plane of potential failure. This is usually the contact plane between two layers with different permeabilities, in this case the low permeability plastic liner and the underlying soil. This condition would certainly occur whenever MWG cleaned the Waukegan ash ponds, as well as during operation of the ash ponds whenever the ash pond water levels were below the ground-water table outside the ponds.

Documents from MWG show that in 2007 (Bates Nos. 11573-11577) MWG contracted to repair the liner on the northeast corner of the East Pond and that in 2010 (Bates Nos. 11581-11583) MWG contracted to repair the liner

on the east side of the west leg of the West Pond. E-mails from MWG dated September 20 and October 11, 2013 (Bates Nos. 44622-44623) refers to liner patching in the northeast corner of the Waukegan East ash pond. E-mails from MWG dated October 30 and November 3, 2014 (Bates No. 44621) refer to some possible additional rips in the liner of the East Ash Pond and two rips in the West Ash Pond liner at Waukegan. Finally, in his February 20, 2015 deposition, Fred Veenbaas (2015) testified that there are currently two holes in the east pond liner (Veenbaas Dep. Tr. at 79:9 – 80:17) and two rips in the west ash pond liner (Veenbaas Dep. Tr. at 87:12 – 23).

In June 2014, MWG contracted with Valdez Engineering Company (VEC, 2014) to perform a visual inspection of the ash pond berms. Results of that visual inspection included the following:

(1) The ash pond berms were constructed with on-site materials and bottom ash;
(2) Wetland areas are located outside the berms on the east and south sides of the ash ponds; and
(3) There are dense bushes and trees growing on the berms especially on the east and south berms but also on the west berm.

Construction of pond berms utilizing coal ash means that the berms likely have been and will continue to be a source of ground-water contamination. The fact that there are wetlands on the south and east sides of the ash ponds indicates that the water table in this area is most likely at the land surface, which can easily cause instabilities at the toes of the steep (2H:1V) side slopes of the berms leading to less support of the plastic liners. Whereas erosion control using grass or man-made materials on steep side slopes is appropriate, allowing trees and bushes to grow on water retention earth structures, even if they are lined, is very poor engineering practice. Trees and other vegetation roots can penetrate deeply enough to "poke" through plastic liners if there is a small separation in a seam or a small hole. These issues also were confirmed in the VEC (2014) letter report and by site photographs taken at the time of the visual inspection.

I conclude from the above maintenance history that the HDPE liners installed in 2003 and 2005 in the East and West ponds, respectively, have most likely leaked since their initial installation and also most likely will continue to leak. Therefore, the Waukegan ash ponds have a history of liner issues which most likely have caused and continue to cause leaks, resulting in detectable ground-water contamination at the site.

**Hydrogeology.** Based upon water well logs from the area, the geology beneath the Site consists of approximately 20 feet of fill soils overlying approximately 100 feet of sand deposits, underlain by Silurian Dolomite. Monitoring well boring logs taken during installation of these wells show that the fill soils and unconsolidated natural soils in the vicinity of the ash ponds and to the west of the ash ponds are sand with some silt and clay, plus areas of coal ash, although there are no definitive clay layers which could be classified as aquitards (Patrick Engineering, 2011c). Lack of an aquitard(s) makes it unlikely that there could be upwelling of ground water from deeper within the sand deposits as alleged by MWG (Bates Nos. 15201-15204).

Ground-water flow in the unconsolidated sandy deposits generally flows towards Lake Michigan to the east or towards the generating station water intake to the northeast which is the same elevation as Lake Michigan. As discussed below, MWG has misinterpreted the local ground-water flow directions which are more complex, in my opinion.

__Available Data__

**Ground Water and Surface Water.** A ground-water monitoring network around the ash ponds at this facility consists of nine wells (MW-1 through MW-9), as shown on Figure 16. Wells MW-6 and MW-7 were not part of the original 5-well monitoring network upon which the IEPA violation notice was based. However, wells MW-6 and MW-7 were added to the monitoring network at the request of IEPA when the agency discovered that well MW-5 was clearly not an "up-gradient" monitoring well. Monitoring wells MW-8 and MW-9 were added to the network on

April 29, 2014. These wells have been monitored for water levels and water quality on a quarterly basis since October 2010, the time of the hydrogeological assessment report (Patrick Engineering, 2011c), or, for wells installed later, since their installation through present.

Additional monitoring in the same shallow sandy deposits west of the ash ponds has been ongoing in six additional wells (MW-10 through MW-15 shown on Figure 16) since 2002 for water levels and selected water-quality constituents when the former Griess-Pfleger Tannery and General Boiler properties were identified as potential source areas of ground-water contamination at the Waukegan ash ponds. Note that the locations MW-10 through MW-15, shown as red dots on Figure 16, are down-gradient or cross-gradient from both the former Griess-Pfleger Tannery and General Boiler properties. The period of record of water level measurements in these wells dates from approximately 2004 through present.

An additional 18 wells, seven within the former General Boiler property (MW-GB1 through MW-GB7 shown as yellow dots on Figure 16), and 11 within the former Griess-Pfleger Tannery property (MW-1 through MW-9 shown as green dots on Figure 16) have been periodically monitored for water levels and water quality. However, the amount of data available from these wells is limited for the purposes this study. Manganese concentrations in ground water samples obtained from these 18 additional wells on August 8, 2002 ranged from 0.08 to 0.86 mg/L with a mean value of 0.45 mg/L for both the General Boiler and Griess-Pfleger Tannery properties. Total dissolved solids concentrations for the same 18 wells on the same date ranged from 570 to 1600 mg/L with mean value of 1190 mg/L.

ENSR (1998d), in their Phase II ESA, present one-time ground-water levels which confirm my interpretations of ground-water contours and flow directions presented in this report. ENSR installed 5 new monitoring wells located hydraulically down-gradient from MW-11 and MW-12. These one-time water levels are discussed in relation to the existing monitoring wells in the **"Results and Evaluation of Environmental Contamination"** section below.

Soil boring logs up to depths of between 28.5 and 38 feet below ground surface are available at the locations corresponding to the MW-1 through MW-15 ground-water monitoring well network. All monitoring wells have 10-foot long screened intervals typically beginning at the water table at the time of drilling and monitor the unconsolidated materials in the interval between approximately 18.5 and 39 feet below ground surface.

Lake Michigan water levels are important to ground-water flow direction and flow velocities at the site. NOAA (2014) has compiled average Lake Michigan water surface elevations. These water surface elevations were compared to the ground water and pond water surface elevations at the Waukegan site.

**Coal Ash Deposition outside the Ash Ponds.** There is evidence that coal ash has been deposited outside the ash ponds and is causing ground-water contamination. Figure 16 also shows the location of a former coal ash and slag storage area west of the two current ash ponds which likely is contributing contaminants to the ground water. In a February 2012 e-mail to Maria Race, Richard Frendt of Patrick Engineering attached a document stating that "the elevated concentrations of compounds of interest in MW-5 appear to be the result of the well being installed in a former ash disposal area" (Bates Nos. 14157-14173, specifically Bates No, 14167).

In addition to the written documentation referenced above from VEC (2014) indicating that coal ash was utilized in the construction of the ash pond dikes, boring logs for the monitoring wells (Patrick, 2011c; IEPA, 2012c; and Bates Nos. 11932 and 45648-45649), an additional three geoprobe borings KPRG (2005a), as well as six soil borings by ENSR (1998d) were interpreted for coal ash deposited outside the Waukegan ash ponds. The results of these interpretations are summarized in Table 7, which shows that coal ash was found in 18 soil borings, including all of the active monitoring wells except MW-6, as well as all of the ENSR (B-1, B-14 through -17, and B-22) and KPRG soil borings (WS-GT-3 through -5). The maximum depth of coal ash deposits outside the ash

ponds at the Waukegan site is 22 ft below ground surface and the maximum thickness of coal ash outside the ash ponds is 21 ft. The areal distribution of the coal ash deposits outside the ash ponds is both up- and down-gradient from the ash ponds themselves. Therefore, I conclude from this information that coal ash/slag was utilized at Waukegan for fill/construction materials and deposited at various locations as temporary storage. This coal ash/slag is a likely source of ground-water contamination from leaching due to precipitation and rising/falling ground-water levels.

**Results and Evaluation of Environmental Contamination**

In my opinion, the ground water at and near the ash ponds at Waukegan is contaminated with high concentrations of B, Mn and $SO_4$ as a result of past and current leaks in the East and West ash pond liners at the site, past and ongoing leachate from the former fly ash/slag storage area west of the ash ponds, and leachate from coal ash used in construction of the ash pond berms and other coal ash deposits at Waukegan. I came to this conclusion for the following reasons, discussed in more detail herein.

First, the ground-water quality concentration data at Waukegan match coal ash leachate characteristics for B, Mn, and $SO_4$ and have concentrations greater than background for those constituents. Second, MWG's documents and ground-water elevation data indicate that the coal ash pond liners have leaked and likely will continue to leak. The evidence shows that (a) holes or tears were found in both the East and West pond liners at various times in 2005, 2007, 2010, 2013, 2014 and 2015; (b) in 2005, KPRG reported several concerns with the liners including wrinkles in the liners and a liner bulge in the West ash pond, all of which indicate that the liners either were already compromised or would likely be compromised in the future; (c) the ground-water elevation surrounding at the ash ponds are higher than the ash pond bottoms, subjecting all the ash ponds at Waukegan to hydrostatic uplift pressure and reduction of soil support, both of which lead to liner failure; (d) poor dredging practices have been used, and continue to be used at Waukegan, creating a large risk of liner rips and tears; and (e) MWG documents reveal that trees and bushes are growing on pond berms and the roots of those trees and bushes can push through holes in the liner and liner seams to exacerbate holes and tears in the liner.

Third, ash pond water surface elevations at Waukegan can be significantly higher than the surrounding ground water, meaning that contaminated ash pond water can flow from those ponds to the adjacent ground water. Fourth, MWG documents confirm that there are numerous deposits of coal ash outside of the ash ponds, including a former fly ash/slag area to the west of the ash ponds, berms partially constructed of coal ash, and other ash deposits around the Waukegan site. Those deposits of coal ash are contributing contaminants to the ground water in the monitoring wells by means of leaching of contaminants due to precipitation and ground-water flow through that ash toward the monitoring wells.

Fifth, seasonal changes in Lake Michigan water levels, associated changes in ground-water elevations, and changes in ash pond water surface elevations cause ground water to flow up- and cross-gradient at times through ash-contaminated soils, re-saturating those contaminated soils and leading to increased leaching of contaminants and the "sloshing" back and forth of contaminated ground water at the site. Finally, analysis of ground-water elevation data and the distribution of contaminants in ground water over time, as well as the absence of chromium, a well-known tannery waste product, in the ground water at the Waukegan site, make clear that ground-water contamination is sourced from coal ash rather than from the former Tannery site or the General Boiler site.

**Water Surface Elevations.** Ground-water at the Waukegan site is strongly influenced by changes in Lake Michigan surface-water elevations as well as likely leaking ash ponds. The abnormal ground-water elevation maps shown in the MWG quarterly monitoring reports do not fully represent the ground-water table up-gradient, down-gradient or cross-gradient from the Waukegan ash ponds. The contours shown in the MWG quarterly monitoring reports did not account for Lake Michigan or the generating station intake water-surface elevations which determine the ground-water gradient and flow direction from the up-gradient areas (Griess-Pfleger Tannery

and General Boiler properties) to beneath the ash ponds. As the Lake Michigan water-surface elevations go up and down, so does the ground-water in the monitoring wells, as can be easily seen on Figure 17 which shows the historical water-surface elevations for ground water, Lake Michigan and the ash ponds at the Waukegan site.

Interpretations of the elevations on Figure 17 show that the bottom elevations of the Waukegan ash ponds are 3.5 to 5 ft below the lowest Lake Michigan water-surface elevations and, historically, the ash ponds bottom elevations have been as much as 6.5 ft below Lake Michigan water-surface elevations. This would mean that the lower portions of the liner are founded in saturated soils and that there is a high likelihood of hydrostatic uplift pressures on the liner when the ash ponds are empty or have less than approximately 6 ft of water in them. Thus, the liner is likely being mechanically stressed which likely will cause welded seams to separate and cause leaks. It is poor engineering practice to complete liner construction so that any portion of the liner is below the water table.

Figure 17 also shows that during the hydrologic characterization of the Waukegan ash ponds in November and December 2010 (Patrick Engineering, 2011c), the ash pond water-surface elevations were higher than the ground-water table elevations. This indicates that any leaks would clearly cause contaminants to exit the ash ponds and enter the ground water. It also indicates that "up-gradient" is clearly undefined and that monitoring wells to the west of the ash ponds, such as MW-5 through 9 and MW-10 through 15 as shown on Figure 16, could be down-gradient wells with respect to the ash pond water-surface elevations and indicators of ground-water contamination from the ash ponds. No other ash pond water-surface elevations were provided by MWG even though those elevations were supposed to be part of the quarterly monitoring program approved by IEPA.

Finally, Figure 17 indicates four time periods during the historical water-surface elevation time series when all or nearly all of the monitoring wells were measured nearly simultaneously at the site. These four time periods were June 2011, June 2012, June 2013, and August 2014. Ground-water table contour maps were prepared for these four time periods and are shown, respectively, on the attached Figures 18, 19, 20 and 21.

Utilizing ground-water elevations from up to 15 wells, Lake Michigan and the generating station water intake, Figures 18, 19, 20, and 21 show my interpretation of the Waukegan site ground-water contours and ground-water flow directions, which are different than those presented by MWG in the quarterly reports submitted to IEPA between February 2011 and present. The most up-gradient of the 15 wells having water-level elevation data is MW-14, with a direction of ground-water flow to the north, east and south away from the ash ponds.

If there is a leak in the ash pond liner when the water-levels in the ash ponds are above the local water table, the potential gradient is away from the ponds into the ground water. This means that fluctuations in the ash pond water levels, the water table elevations, and Lake Michigan water-surface elevations likely will cause a back-and-forth movement of ground water in the vicinity of the Waukegan ash ponds. The water-surface elevation lines on Figure 17, which cross each other, show this back-and-forth movement of ground water. Thus, during certain times, the ground water flow is "up-gradient" or "cross-gradient" in localized areas such as from MW-5 towards the north, south or southwest.

The ground-water contours and flow directions shown on Figures 18, 19, 20 and 21 show that MW-14 is the most up-gradient well and that ground-water flow is radially away from MW-14 to the north, east and southeast. ENSR (1998d) also shows that the areas north of MW-11 and MW-12 are down-gradient. URS (2013) also notes *that "as wells MW-10, MW-11, and MW-14 are upgradient of well MW-13, and as wells MW-12 and MW-15 are cross-gradient, it is expected that contaminants of concern at the facility will be sufficiently monitored from the existing wells."* Thus, the ground-water contours shown on Figures 18, 19, 20 and 21 more accurately show ground-water flow directions than those presented in the MWG quarterly reports in my opinion.

Additional interpretations of the ground-water elevation contours shown on Figures 18, 19, 20 and 21 indicate that:

The ground-water flow directions based on my interpretations of ground-water contours indicate that the former Griess-Pfleger Tannery and General Boiler properties are unlikely to be contributing indicator pollutants to ground water in the vicinity of the Waukegan ash ponds. Additionally, the available water-quality data discussed below present a consistent picture of the ground-water contamination seen by the monitoring wells in light of the ground-water flow directions shown on Figures 18, 19, 20 and 21. The June 2011 (Figure 18), June 2012 (Figure 19), June 2013 (Figure 20) and August 2014 (Figure 21) simultaneous ground-water elevation measurements show a ground-water ridge passing through the Waukegan ash ponds. Ground-water flow directions are generally north, south and east from this ground-water ridge and these flow directions result in the following conclusions:

(1) The "ridge" in the ground-water contours at the ash ponds may indicate a liner leak in the west ash pond,
(2) Ground-water flow direction is away from the ash ponds to the north, south, east and, if a liner leak is occurring, toward the west,
(3) The above patterns of ground-water flow are consistent based on the available simultaneous ground-water elevation measurements, and
(4) Additional monitoring wells north and south of the Waukegan ash ponds are necessary to fully assess these ground-water flow directions.

Ground-water quality data at the Waukegan site show that the concentrations of indicator pollutants are higher in the vicinity of the former ash/slag storage area west of the ash ponds. To the east of the ash ponds, the monitoring wells most likely are influenced by liner leaks from the east ash pond and from coal ash utilized for dike construction.

I conclude from this information that it is difficult and perhaps impossible for ground-water contaminants from the northern half of the Griess-Pfleger Tannery site to impact the ground-water concentrations in monitoring wells MW-1 through 9. Based on the ground-water flow directions, I conclude that the indicator pollutants (B, Mn and $SO_4$) observed in monitoring wells MW-1 through -9 and MW-15 are most likely sourced either from ongoing or past ash pond liner leaks and/or coal ash deposits outside the ash ponds.

I further conclude that the fact that Waukegan ash pond liners are located below the ground water table results in the following outcomes:

(1) Soils supporting the liner are saturated and lose strength to support the plastic liner,
(2) Liner failure due to the ground water moving up and down in response to changes in Lake Michigan water-surface elevations,
(3) Liner failure due to hydrostatic uplift,
(4) Transport of contaminants in the ground water is facilitated,
(5) The movement of contaminants up-gradient and cross-gradient.

**Ground-water Quality.** Long-term ground-water quality data are available at monitoring wells MW-10 through MW-15 for Mn and total dissolved solids (TDS) but not for B or $SO_4$. Therefore, the interpretation of consistency between ground-water flow direction and ground-water contamination from the Waukegan ash ponds is based on Mn and TDS concentrations, with B and $SO_4$ concentrations indicating that the Mn and TDS contamination are from coal ash deposition outside the ash ponds as well as liner leaks from the ash ponds and not from up-gradient (i.e. the former Griess-Pfleger Tannery and General Boiler properties). Because there is a former fly ash/slag storage area (Figure 16) west of the existing ash ponds and because all of the monitoring well soil borings, except MW-6, show coal ash deposits up- and down-gradient from the ash ponds, it is likely that B, Mn and $SO_4$ in the ground water is sourced from these coal ash deposits. However, ground-water concentrations of B and $SO_4$ in MW-1 through MW-4 indicate that the Waukegan ash ponds also may be contributing contamination to the ground

water via liner leaks as these concentrations are up to 10-times higher than background concentrations in typical sand and gravel materials in Illinois (Table 3).

As explained in the **"JOLIET #29 - <u>Results and Evaluation of Environmental Contamination</u>"**, B, Mn and $SO_4$ concentrations in ground water at Waukegan do not behave the same way in a fluctuating ground water system. This is because of rising/falling ground-water surface elevations and the reactive nature of Mn. I prepared the time series plots of Mn concentrations in the ground water west of the ash ponds from data measured since 1996 (Figure 22). These measurements were terminated in 2007, except for one measurement in July 2012 and MWG measurements the second and third quarters of 2014, because Mn no longer showed either an increasing or decreasing statistical trend, according to MWG (URS, 2013). TDS concentration measurements in the ground water west of the ash ponds has continued into the present (Figure 23). TDS concentrations in ground-water show a decreasing trend for the Griess-Pfleger tannery wells (MW-10 through MW-15); whereas, TDS concentrations are increasing in Waukegan ash pond monitoring wells (MW-1 through MW-9). These TDS concentration time series are indicators of less migration of the indicator pollutants of interest (B, Mn and $SO_4$) from the former Griess-Pfleger and General Boiler properties than has been assumed by MWG and their consultants, with these same indicator pollutants now coming from leaking Waukegan ash ponds, leaching of coal ash deposits outside the ponds, and coal ash utilized for construction at the ash ponds.

Concentrations of Mn (Figure 22) have generally continued to stay the same or to slightly decline in monitoring wells north and west of the former General Boiler property (MW-10, -11, -12, -13 and -14; whereas, in monitoring wells generally down-gradient from the former fly ash/slag storage area shown on Figure 16, the concentrations of Mn have either remained high or increased (MW-5, -6, -7 and 15). This indicates that the former ash/slag storage area likely is a major contributor of contaminants to the ground water at the Waukegan site, but may also reflect contamination contributions due to leaching of coal ash in the pond berms, liner leaks at the ash ponds, or leaching of coal ash deposited elsewhere, as indicated by above-standard ground-water concentrations of B and $SO_4$ in monitoring wells MW-1 through MW-4. Long-term ground-water TDS concentrations shown on Figure 23 have similar characteristics as Mn, but with an increasing concentration trend since December 2010 in monitoring wells MW-1 through 4 east (down-gradient) of the ash ponds.

The most significant ground-water contamination issues are associated with B and $SO_4$ as shown graphically on Figures 24 and 25, respectively. These two contaminants are known to be associated with coal ash and their concentrations have remained high over the four-year monitoring period since December 2010. It is highly unlikely that B could be sourced from the use of Borax at the former Griess-Pfleger tannery property, as claimed by MWG, given the high concentrations measured in all of the current ash pond monitoring wells (MW-1 through MW-9), and because there was no evidence of B in ground-water within the Griess-Pfleger tannery site wells (MW-1 through MW-9) shown as green dots on Figure 16.

Concentrations of B in ground water in all of the monitoring wells at the Waukegan site are higher than the background concentration of 0.12 mg/L in sand and gravel aquifers. Concentrations of Mn in monitoring wells MW-1 through MW-4 are still less than the background concentration of 0.072 mg/L in sand and gravel aquifers. The low ground-water concentrations of Mn may be caused by the reactive nature of Mn as explained in the **"JOLIET #29 - <u>Results and Evaluation of Environmental Contamination</u>"**. This does not mean the low Mn concentrations indicate the absence of coal ash contamination. Concentrations of $SO_4$ in ground water in all of the monitoring wells at the Waukegan site (Figure 25) are higher than the background concentration of 54 mg/L in sand and gravel aquifers. Therefore, I conclude that ground water at the Waukegan site is contaminated due to coal ash. Ground water at the Waukegan site would require treatment in order to be used as drinking water, which is its potential use under the IEPA Class I ground-water protection standards.

I further conclude that the most likely source(s) of the B and $SO_4$, as well as Mn, appear to be:

(1) Past and ongoing leachate from the former fly ash/slag storage area west of the ash ponds;
(2) Leachate from coal ash used in construction of the ash pond berms and other miscellaneous construction using coal ash; and
(3) Past and current leaks in the East and West ash pond liners at the Waukegan site.

**Why the Waukegan CCA will not Reduce Ground-water Contamination at the Waukegan Site**

The Waukegan CCA (IEPA, 2012c) sets forth various purported remedial actions by MWG to eliminate ground-water contamination at the site. The Waukegan site ground water is contaminated with constituents which include Sb, As, B, Cl, Fe, Mn and $SO_4$. Additionally, ground water at the site is affected by elevated pH and high TDS up-gradient and down-gradient from the ash ponds. The proposed CCA remedies will not, in my opinion, reduce the ground-water contamination at the Waukegan site because:

(1) The coal ash in the ponds, as well as the toes of the ash pond dikes, are at or below the ground-water table (wetland areas east and south of the ponds) at the site;
(2) Maintenance records of the pond liners indicate that the liners continue to fail due to the high ground-water table and poor coal ash removal practices causing liner leaks into the environment;
(3) There is no provision in the CCA for cessation of use and removal of coal ash in the two ash ponds;
(4) There is no provision in the CCA for clean-up and removal of coal ash placed outside the ash ponds for construction or coal ash disposed of on the land surface; and
(5) Relining the ash ponds will not reduce the potential for liner damage and subsequent liner leakage as long as dredging of coal ash continues as in the past.

Without removal of the coal ash source-terms at the Waukegan plant site, ground-water contamination will continue unabated into the future. Creation of an ELUC and installation of additional ground-water monitoring wells will not prevent the existing coal ash sources from continuing to cause ground-water contamination.

**WILL COUNTY**

**Conceptual Site Model**

The Will County facility is located in Section 2, Township 36 North, Range 10 East, in the City of Romeoville (Figure 26). The surrounding land use consists of undeveloped land to the north, the Chicago Sanitary and Ship (CSS) Canal to the east, a quarry to the south, and the Des Plaines River to the west. There is no indication that these land uses could be sources for B, Mn and $SO_4$ in ground water at the site.

**Coal-Ash Management.** The Site includes two active ash ponds (Ponds 2-S and 3-S) and two inactive and out-of-service ash ponds (Pond 1-N and Pond 1-S) located as shown on Figure 26. Ponds 2-S and 3-S were lined with 60-mil HDPE in 2009 and 2013, respectively; with Pond 2-S having a side slope liner of concrete-filled geocells placed over the HDPE plastic to protect it during coal ash dredging. The four ash ponds were previously lined on the bottoms with 36 inches of geo-composite material (Poz-o-Pac). The total area of the four ash ponds is approximately 8 acres. Coal ash solids from the Ponds 2-S and 3-S are dredged approximately annually and the dredge spoil is deposited in a landfill.

Water from the active ash ponds is discharged to the CSS Canal under NPDES Permit No. IL0002208. The ash ponds all have a nominal bottom elevation of 582.5 ft MSL. This elevation is the top of the liner (warning layer) with the bottom of the liner (Poz-o-Pac) approximately 3 ft lower (579.5 ft MSL). When Ponds 2-S and 3-S were relined, the HDPE plastic was placed on top of a portion of the existing Poz-o-Pac after removal of some of the geo-composite material to allow adequate coal ash storage.

**Liner Damage.** Written documentation available from MWG on Will County ash pond reconstruction, retirement and maintenance in 2012 and 2013 indicates that the ash ponds leaked until at least 2013 and likely continue to leak due to poor liner construction and maintenance (Bates Nos. 28849-28851; 48612-49617). During 2013, Ponds 1-N and 1-S were retired. The pond bottoms were sloped to drain to their existing pipe discharge points with ultimate discharge to the CSS Canal. It is not clear what materials were utilized on top of the existing Poz-o-Pac bottom liners to provide the sloping surface, but photographs taken during construction appear to show that coal ash remained in those ponds as fill material. In her December 2, 2014 deposition Rebecca Maddox, Environmental Specialist for MWG at the Will County site, confirmed that no ash was removed from Ponds 1-N and 1-S. (Maddox Deposition p. 50).

Pond 3-S was relined with 60-mil HDPE plastic on the bottom and side slopes during 2009. However, during a routine inspection of the pond after coal ash dredging in June 2012 (Bates Nos. 14177-14269), it was discovered that the HDPE liner and underlying geofabric in a section of the pond side slope near the pond bottom had been torn apart allowing leachate to discharge to the underlying ground water. The exact time of this liner tear (documented with photographs) was unknown to MWG but caused a very serious leak which had existed for "many months" prior to its discovery (Bates No. 14177). According to the December 2, 2014 deposition (p. 93) of Rebecca Maddox (Environmental Specialist for MWG at the Will County power plant site), a contractor subsequently repaired this liner tear.

During 2013 when Pond 2-S was relined with 60-mil HDPE plastic, MWG recognized that coal ash dredging was likely to tear the HDPE liner, so a geocell system was installed at the contact of the side slopes and pond bottom, extending 5-ft along the pond bottom, up the pond side slope, and anchored to the top of the pond berms. These geocells were filled with concrete to provide protection for the HDPE liner during coal ash dredging. No other ash pond at Will County, or at any of the other three sites, has this type of liner protection. Protection of the side slope HDPE liner does not protect the bottom liner, and vehicle traffic on the sand cushion and warning layers overlying the HDPE bottom liner could cause, and likely has caused, liner damage and leaks from the weight of the dredging equipment pushing the crushed limestone warning layer material through the underlying plastic.

In August 2013, Leak Location Services, Inc. (LLSI, 2013b) performed a geomembrane leak location survey on the HDPE bottom liner of Pond 2-S and found no leaks. However, LLSI could not perform leak detection tests on the side slope HDPE liner because of the presence of the geocells and could not determine if any additional liner leaks existed as a result of the geocell installation.

MWG e-mails (Bates Nos. 28862-28863) indicate that the original Poz-o-Pac liner material on the pond bottoms, which was only partly removed during relining of Ponds 2-S and 3-S, had water passing upward through cracks in the Poz-o-Pac due to the water table at the site being above elevation 582.5 ft MSL. This observation shows an intimate hydraulic connection between the Will County ash ponds and the site ground water. I conclude that all of the Poz-o-Pac liners in the four Will County ash ponds most likely leaked and that upward hydrostatic uplift pressures are compromising the HDPE liners installed in Ponds 2-S and 3-S if ground water levels are higher than the pond liners (approximately elevation 582.5 ft MSL), which frequently occurs based on the data presented in the "**Results and Evaluation of Environmental Contamination"** section below.

**Hydrogeology.** Based upon water well and monitoring well boring logs from the area, the geology beneath the Site consists of approximately 7 to 12 feet of unconsolidated deposits or fill underlain by Silurian Dolomite. The four ash ponds were constructed directly on top of the Dolomite based on information in MWG files and the monitoring well boring logs (Patrick, 2011d).

Ground-water flow in the shallow aquifer should be largely controlled by the Des Plaines River and the CSS Canal with ground water likely flowing towards either the river or canal during most periods of the year. Ground-water

flow in the deeper aquifers is controlled by the regional hydraulic gradient which is to the southeast (Patrick, 2011d). In his e-mail to Maria Race, Richard Frendt of Patrick Engineering (Bates No. 14096) stated that "*...the term "upgradient" isn't always clear. At Will County, for example, there is strong hydraulic evidence to suggest that everything is downgradient that the ponds may be draining in multiple directions towards either the river or the canal*".

**Available Data**

**Ground Water and Surface Water.** A ground-water monitoring network around the ash ponds at this facility (Figure 26) consists of ten wells (MW-1 through MW-10). These wells have been monitored for water levels and water quality on a quarterly basis since December 2010 at the time of the hydrogeological assessment report (Patrick Engineering, 2011d) through present. Patrick reported that ash pond water levels in the four ponds were 3 to 6 ft higher than monitoring well ground-water levels measured in December 2010. Whereas ash pond water levels were part of the original monitoring plan, there appears to be no reliable ash pond water-surface elevation data available since that date. Water-surface elevations for the CSS Canal and Des Plaines River are available from the USGS (2014c and e) as close as 0.3 mi upstream from the Will County ash ponds. Additional CSS Canal and Des Plaines River water-surface elevation data available from the USGS (2014d and f) also were utilized for the interpretations in this report.

Des Plaines River and CSS Canal water-surface elevations near the Will County plant site are important to local ground-water elevations and flow directions at the site. The Des Plaines River flows from north to south on the west side of the ash ponds and the CSS Canal flows from north to south on the east side of the Will County plant site. The U.S. Geological Survey (USGS, 2014c) has compiled daily time series of Des Plaines River water-surface elevations at their gaging station 05534000 at Romeoville, IL, located approximately 0.3 miles up-river from the Will County site. I compared these river water-surface elevations to the ground-water and ash pond bottom elevations at the Will County site. Because the Romeoville gaging station was discontinued by the USGS in 2012, I utilized the next gaging station upstream (Lemont Station 05533600 – USGS, 2014d) to extend the Romeoville Des Plaines River water surface elevations between 2012 and present utilizing non-linear regression analyses.

The USGS (2014e) also operates a gaging station on the CSS Canal at Romeoville (05536995) approximately 0.3 miles up-canal from the Will County site. They also operate a gaging station on the Canal (05536998) at the Lockport Control Works (USGS, 2014f). I compared these CSS Canal water-surface elevation data to ground-water table elevations, Des Plaines River water-surface elevations, and the Will County ash pond bottom elevations. As shown on Figure 28, the water-surface elevations in the CCS Canal are typically 5 ft lower than the water-surface elevations in the Des Plaines River. Therefore, I conclude that water-surface elevations in the CCS Canal have minimum influence on ground-water elevations near the ash ponds.

**Coal Ash Deposition outside the Ash Ponds.** MWG documents show that coal ash has been deposited outside the ash ponds at the Will County site and is causing ground-water contamination. Soil boring and rock core logs up to depths of between 18 and 22 feet below ground surface are available at 10 locations corresponding to the ground-water monitoring well network. These borings show coal ash outside the pond areas extending from ground surface to depths of 12 ft at MW-1 through MW-4 and at MW-6. Table 8 shows a summary of coal ash deposition outside the ash ponds from the monitoring well network. The limestone bedrock was cored from the bottom of the soil borings (depths between 7 and 12 feet below ground surface) to between 17.5 and 22 ft below ground surface. The monitoring wells have 10-foot long screened intervals beginning at depths between 7 and 12 feet below ground surface which means that the monitoring wells are completed in the Dolomite portions of the stratigraphic section at the site.

An additional five geoprobe borings done in 2005 (KPRG, 2005a) indicated bottom ash and/or slag in all five of those borings. Those borings were located as follows: (1) boring (WC-GT-1), approximately 840 ft north of Pond 1-N and west of the coal stockpile; (2) boring (WC-GT-2), located between Ponds 1-N and 1-S; (3) boring (WC-

GT-3), east of Pond 1-S; (4) boring (WC-GT-4), west of the boundary between Pond 1-S and 2-S; and (5), boring (WC-GT-5), approximately 950 ft southeast of Pond 3-S. . All of these borings had coal ash or slag identified at depths ranging from ground surface to 10 ft deep. The results of borings WC-GT-2, -3 and -4 are summarized in Table 8.

ENSR (1998e) drilled and sampled 18 shallow (less than 3 ft deep) soil borings and installed 5 monitoring wells at the Will County site as part of their Phase II ESA. Of the 18 soil borings, 10 had coal or coal ash up to 3 ft below ground surface as summarized in Table 8. Only three of the soil borings (B-5, B-6 and B-7) are relevant to the existing monitoring wells because the remainder of those soil borings are outside the area of influence of the monitoring wells. I conclude from this information that coal ash was utilized for fill and/or construction materials throughout the Will County plant site. I further conclude that this coal ash outside the ash ponds is a contributor to ground-water contamination from leaching due to precipitation and rising/falling ground-water levels.

**Results and Evaluation of Environmental Contamination**

In my opinion, the ground water at and near the ash ponds at Will County is contaminated with high concentrations of B, Mn, and $SO_4$ as a result of past and current leaks in the liners of the four ash ponds and past and ongoing leachate from ash utilized for fill and/or construction materials outside of the ponds. I came to this conclusion for the following reasons, discussed in more detail herein. First, the ground-water quality data at Will County match coal ash leachate characteristics for B, Mn, and $SO_4$ and have concentrations greater than background for those constituents.

Second, MWG's documents and ground-water elevation data indicate that the ash pond liners have leaked and likely continue to leak. The evidence shows that (a) the original Poz-o-Pac liners under all four ponds are in poor condition, allowing a hydraulic connection between the Will County ash ponds and the site ground water; (b) ash ponds 1-N and 1-S, which still contain large quantities of coal ash, are only lined with these poor-quality Poz-o-Pac liners; (c) the ground-water elevation surrounding the coal ash ponds is frequently higher than the ash pond bottoms creating a hydraulic connection between the contents of Ponds 1-N and 1-S and the ground water, and subjecting the HDPE liners in Ponds 2-S and 3-S to hydrostatic uplift pressure, which can lead to liner failure; (c) in 2012, the HDPE and geomembrane liners in Pond 3-S were torn, allowing leachate to discharge to underlying ground water; (d) vehicle traffic on the sand cushion and warning layers overlying the HDPE bottom liners in Ponds 2-S and 3-S could cause, and likely has caused, liner damage and leaks from the weight of the dredging equipment pushing the crushed limestone warning layer material through the underlying plastic; and (e) the presence of geocell on the side slopes of Pond 2-S prevents the detection of leaks in the underlying HDPE liner.

Third, since monitoring began at the site in December 2010, there has been ground-water table mounding beneath the ash ponds, as shown on ground-water table contour maps in the MWG quarterly monitoring reports, and all ground-water monitoring wells at the site should be considered down-gradient. Fourth, MWG documents confirm that there are deposits of coal ash outside of the ash ponds. These deposits are contributing contaminants to the ground water in the monitoring wells by means of leaching of contaminants due to precipitation and ground-water flow through that ash toward the monitoring wells.

**Water Surface Elevations.** Ground-water at the Will County site is strongly influenced by changes in Des Plaines River and CSS Canal surface-water elevations as well as likely leaking ash ponds. Interpretation of historical surface-water elevations and ground-water elevations in the Dolomite limestone bedrock beneath the ash ponds, as shown on Figures 27 and 28 respectively, coupled with the stratigraphy at the site, indicate that:

**Ground-Water Mounding**

(1) There has been and appears to continue to be ground-water mounding beneath the ash ponds, presumably from leaks in the ash pond liners and/or rising and falling Des Plaines River water-surface elevations;

(2) The ground-water table at the Site has been consistently above the bottoms of the ash ponds liners (approximately elevation 579.5 ft MSL) in MW-10, -4, -6 and -8 which are down-gradient wells most of the time relative to both the ground-water mounding and the Des Plaines River; and
(3) Water levels in MW-9 are highly variable indicating potentially large local ground-water gradient reversals due to liner leaks or possibly due to anisotropy and non-homogeneity in the Dolomite bedrock where the monitoring wells are completed.

**Other Facts**

(4) Ground-water levels in the monitoring wells are correlated to water-level changes in the Des Plaines River, but appear to be unrelated to water-level changes in the CSS Canal;
(5) The ash pond liners are periodically below the water-surface elevations of the Des Plaines River, but are always above the water-surface elevations of the CSS canal;
(6) Changes in ground-water levels in MW-1 through MW-6 on the east side of the ash ponds are much less variable than in MW-7 through MW-10 on the west (Des Plaines River) side of the ash ponds; and
(7) At all times there is a ground-water gradient along the west side of the ash ponds from MW-7 toward MW-10 and along the east side of the ash ponds from MW-1 toward MW-6 which is parallel to the flow direction of the Des Plaines River and the CSS Canal.

Ground-water levels in 5 monitoring wells in the ENSR (1998e) Phase II ESA clearly showed that there is a ground-water divide between the Des Plaines River and the CSS Canal. This divide runs more or less north-south through the center of the site half way between the River and the Canal. I conclude from this that ground-water from the site discharges to both the Des Plaines River and the CSS canal.

I also conclude from the above facts and the graphical presentation of ground-water and surface-water elevations shown on Figures 27 and 28 that the Will County ash ponds have historically leaked, are in intimate connection with the underlying ground water, have their liners episodically inundated by Des Plaines River and are causing contamination of the local ground-water from coal ash leachate and most likely contaminating the Des Plaines River and the CSS Canal. The ground-water quality data discussed below confirms that there is contamination due to leachate from the Will County ash ponds.

I further conclude that the fact that the Will County ash pond liners are located below the ground water table results in the following outcomes:

(1) Soils supporting the liner are saturated and lose strength to support the plastic liner;
(2) Liner failure due to the ground water moving up and down in response to changes in Des Plaines river water-surface elevations;
(3) Liner failure due to hydrostatic uplift;
(4) Transport of contaminants in the ground water is facilitated; and
(5) The movement of contaminants up-gradient and cross-gradient.

**Ground-water Quality.** B, Mn, and $SO_4$ are found in the ground water beneath the Will County site in concentrations higher than the IEPA Class I ground-water protection standards and accepted background concentrations for bedrock in Illinois (Table 3). These constituents are known contaminants from coal ash leaching. The fact that the ash ponds have leaked and likely continue to leak and that coal ash is abundantly present, both indicate that ground-water contamination has occurred and continues to occur at the Will County site. Figures 29, 30 and 31, respectively, show the quarterly time series of B, Mn, and $SO_4$ concentrations in ground water for the period December 2010 through present for the 10 monitoring wells.

Figure 29 shows the time series of B concentrations in ground-water at the Will County site. Every monitoring well has had B concentrations higher than the IEPA Class I ground-water standard of 2.0 mg/L during the monitoring

period from December 2010 to present. Because B is known to occur in coal ash leachate (Table 2), I conclude that ground-water contamination at the Will County site was and is currently occurring as the result of ash pond liner leaks and/or leaching of coal ash deposits outside the ponds. B concentrations in ground-water have recently increased in MW-2, -3, -4 and -9, and B concentrations in 8 of the 10 monitoring wells are still higher than the IEPA Class I ground-water standard. Concentrations of B at all of the monitoring wells at the Will County site are higher than the background B concentration of 0.28 mg/L for shallow bedrock.

Mn concentrations in ground water as shown in the time series on Figure 30, behave similarly to B concentrations at the Will County site, with all but 3 of the 10 monitoring wells having Mn concentrations higher than the IEPA Class I ground-water standard of 0.15 mg/L a majority of the time during the monitoring period. As with B, Mn is known to be a contaminant found in coal ash leachate (Table 2) and the high concentrations in ground water at the Will County site indicate ash pond liner leakage and/or leaching of coal ash deposits located outside the ash ponds. With the exception of MW-9, all of the monitoring well Mn concentrations at the Will County site are higher than the background Mn concentration of 0.0029 mg/L for shallow bedrock.

Figure 31 shows the time series of $SO_4$ concentrations in ground water at the Will County site with all but one of the monitoring wells having $SO_4$ concentrations higher than the IEPA Class I ground-water standard of 400 mg/L. Except at MW-4 and MW-5, the $SO_4$ concentrations in the monitoring wells have remained steady but persistently higher than the IEPA Class I ground-water standard. This indicates that the ash pond liners continue to leak and/or coal ash deposits located outside the ash ponds are leaching. Concentrations of $SO_4$ in all of the monitoring wells at the Will County site are higher than the background $SO_4$ concentration of 106 mg/L for shallow bedrock.

After my review of MWG documents related to the history of the Will County ash ponds, ash pond operation and maintenance, and ground-water and surface-water elevation and water-quality data, I conclude that ground-water contamination at and near the ash ponds is the result of current and former coal ash/slag storage in the ash ponds, using coal ash as a construction material at and near the ash ponds, and leaks in the ash pond liners. Spikes in B, Mn and $SO_4$ concentrations in ground water at the site are the result of leachate from liner leaks, leachate from coal ash deposited in the past outside the ash ponds and/or from changes in ground-water elevations as a result of changes primarily in Des Plaines River water-surface elevations. Ground water at the Will County site would require treatment in order to be used as drinking water which is its potential use under the IEPA Class I ground-water protection standards.

**<u>Why the Will County CCA will not Reduce Ground-water Contamination at the Will County Site</u>**

The Will County CCA (IEPA, 2012d) sets forth various purported remedial actions by MWG to eliminate ground-water contamination at the site. The Will County site ground water is contaminated with constituents which include Sb, B, Cl, Fe, Mn and $SO_4$. Additionally, ground water at the site is affected by elevated pH and high TDS up-gradient and down-gradient from the ash ponds. The proposed CCA remedies will not, in my opinion, reduce the ground-water contamination at the Will County site because:

(1) The ash and the pond bottom liners are at or below the ground-water table at the site;
(2) Maintenance records of the pond liners indicate that the liners continue to fail due to the high ground-water table and poor coal ash removal practices causing liner leaks into the environment;
(3) There is no provision in the CCA for cessation of use and removal of ash in the four ash ponds;
(4) There is no provision in the CCA for clean-up and removal of ash placed outside the ash ponds for construction or disposal of ash on the land surface;
(4) Continued ground-water monitoring will not remove the potential sources of ground-water contamination; and
(5) Relining the ash ponds will not reduce the potential for liner damage and subsequent liner leakage as long as dredging of ash continues as in the past.

Without removal of the ash source terms at the Will County plant site, ground-water contamination will continue unabated into the future. Creation of an ELUC and installation of additional ground-water monitoring wells will not prevent the existing ash sources from continuing to cause ground-water contamination.

**SUMMARY OF CONCLUSIONS REGARDING ENVIRONMENTAL CONTAMINATION BY ASH PONDS AT MWG'S JOLIET #29, POWERTON, WAUKEGAN AND WILL COUNTY COAL-FIRED POWER PLANTS**

**General**

- Boron (B), manganese (Mn), and sulfate ($SO_4$) are indicators of coal ash leachate;
- At all of the power plant sites, the concentrations of B, Mn, and $SO_4$ measured in ground water match the leachate characteristics of coal ash;
- At all of the power plant sites, coal ash has been deposited in ash ponds whose liners have leaked and continue to leak due to poor liner construction techniques, poor coal ash removal/maintenance practices and/or high water tables which cause failure of the soils supporting the liners or cause hydrostatic uplift, all of which can cause liner punctures and failure of the liner seams;
- At all of the power plant sites, coal ash was utilized for fill/construction materials or stored at many locations outside the ash ponds, and this coal ash is being leached by precipitation and the leachate is percolating into the ground water beneath the sites;
- Ground-water elevations at all of the power plant sites are strongly influenced by changes in adjacent surface-water elevations causing leaching of indicator pollutants through continued wetting and drying of coal ash used for fill/construction purposes;
- Ground water at all of the power plant sites would require treatment in order to be used as drinking water which is its potential use under the IEPA Class I ground-water protection standards;
- The proposed Compliance Commitment Agreement remedies for each of the four sites will not reduce existing or future ground-water contamination from coal ash deposits and leaky liners; and
- Relining the ash ponds will not reduce the potential for liner damage and subsequent liner leakage as long as dredging of coal ash continues as in the past.

**Joliet #29**

- Concentrations of B in ground water (up to 2.6 mg/L) at the Joliet #29 plant site have been higher than the IEPA Class I ground-water standard of 2 mg/L and also much higher than background B concentrations (0.12 mg/L) in IEPA sand and gravel network wells;
- Concentrations of Mn in ground water (up to 1.6 mg/L) at the Joliet #29 plant site are higher than the IEPA Class I ground-water standard of 0.15 mg/L and also much higher than background Mn concentrations (0.072 mg/L) in IEPA sand and gravel network wells;
- Concentrations of $SO_4$ in ground water (up to 1600 mg/L) at the Joliet #29 plant site are higher than the IEPA Class I ground-water standard of 400 mg/L and also much higher than background $SO_4$ concentrations (54 mg/L) in IEPA sand and gravel network wells;
- The ground-water contamination at the Joliet #29 site is the result of past/current ash pond liner leaks and/or leaching of coal ash deposits outside the ash ponds; and
- Coal ash from the Joliet #9 plant was deposited in a large area up-gradient from the current Joliet #29 plant and this coal ash is being leached by precipitation and being eroded into the Des Plaines River during high river discharge events.

**Powerton**

- Concentrations of B in ground water (up to 4.3 mg/L) at the Powerton plant site are higher than the IEPA Class I ground-water standard of 2 mg/L and also much higher than background B concentrations (0.20 mg/L) in the site background well MW-16;
- Concentrations of Mn in ground water (up to 13 mg/L) at the Powerton plant site are higher than the IEPA Class I ground-water standard of 0.15 mg/L and also much higher than background Mn concentrations (0.003 mg/L) in the site background well MW-16;
- Concentrations of $SO_4$ in ground water (up to 1400 mg/L) at the Powerton plant site are higher than the IEPA Class I ground-water standard of 400 mg/L and also much higher than background $SO_4$ concentrations (43 mg/L) in the site background well MW-16;
- The ground-water contamination at the Powerton site is the result of current and former fly ash/slag storage at abandoned/unlined and lined ash ponds, using coal ash as a construction material at and near the ash ponds and leaks in the ash pond liners;
- Ash pond water surface elevations are periodically below ground-water table elevations which likely has resulted, and will likely result in the future, in hydrostatic uplift and liner failure; and
- Ground-water elevations rise and fall in response to Illinois River water-surface elevations periodically inundating the pond bottom liners.

**Waukegan**

- Concentrations of B in ground water (up to 49 mg/L) at the Waukegan plant site are higher than the IEPA Class I ground-water standard of 2 mg/L and also much higher than background B concentrations (0.12 mg/L) in IEPA sand and gravel network wells;
- Concentrations of Mn in ground water (up to 0.99 mg/L) at the Waukegan plant site are higher than the IEPA Class I ground-water standard of 0.15 mg/L and also much higher than background Mn concentrations (0.072 mg/L) in IEPA sand and gravel network wells;
- Concentrations of $SO_4$ in ground water (up to 1200 mg/L) at the Waukegan plant site are higher than the IEPA Class I ground-water standard of 400 mg/L and also much higher than background $SO_4$ concentrations (54 mg/L) in IEPA sand and gravel network wells;
- The ground-water contamination at the Waukegan site is due to past and ongoing leachate from the former fly ash/slag storage area west of the ash ponds, leachate from coal ash used in construction of the ash pond berms and other miscellaneous fill/construction using coal ash, and past and current leaks in the East and West ash pond liners at the Waukegan site;
- The ash pond bottom liners are always below the surface-water elevations in Lake Michigan and also the ground-water table which results in hydrostatic uplift pressures which likely has caused, and will likely cause in the future, liner leaks; and
- Ground-water contamination by the indicator pollutants at the site is due to liner leaks and coal ash deposits outside the ash ponds and not due to contaminated ground-water from up-gradient.

**Will County**

- Concentrations of B in ground water (up to 6.2 mg/L) at the Will County plant site are higher than the IEPA Class I ground-water standard of 2 mg/L and also much higher than background B concentrations in IEPA sand and gravel (0.12 mg/L) and bedrock (0.28 mg/l) network wells;
- Concentrations of Mn in ground water (up to 1.0) at the Will County plant site are higher than the IEPA Class I ground-water standard of 0.15 mg/L and also much higher than background Mn concentrations in IEPA sand and gravel (0.072 mg/L) and bedrock (0.029 mg/L) network wells;
- Concentrations of $SO_4$ in ground water (up to 4800 mg/L) at the Will County plant site are higher than the IEPA Class I ground-water standard of 400 mg/L and also much higher than background $SO_4$ concentrations in IEPA sand and gravel (54 mg/L) and bedrock (106 mg/L) network wells;

- The ground-water contamination at the Will County site at and near the ash ponds is the result of current and former coal ash/slag storage in both unlined and lined ash ponds, using coal ash as a construction material, and leaks in the ash pond liners; and
- Ground-water and Des Plaines River surface-water elevations are always above the bottom of the liners which likely has caused, and likely will cause in the future, hydrostatic uplift and liner failure.

Yours truly,

JAMES R. KUNKEL, Ph.D., P.E.

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Kelly, M.S. 2015. The discovery deposition of MARK S. KELLY, taken under oath on the 23rd day of January 2015, at 10 South LaSalle Street, Suite 3600, Chicago, Illinois, pursuant to the Rules of the Supreme Court of Illinois and the Code of Civil Procedure, before Brad Benjamin, a certified shorthand reporter in and for the State of Illinois, pursuant to notice. PCB No-2013-15 (Enforcement-Water).

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**ATTACHMENTS**

Table 1

Ground-water Screening Levels for Four Coal-Fired Power Plants, Illinois, Midwest Generation (Case No. PCB 2013-015)

| Constituent | CAS | Units | Illinois State Water Quality: Class I Groundwater MCLs (a) | Illinois State Water Quality: Class II Groundwater MCLs (b) | Federal Water Quality: USEPA MCLs (c) | Federal Water Quality: USEPA SMCLs (c) |
|---|---|---|---|---|---|---|
| **Inorganics** | | | | | | |
| Aluminum | 7429-90-5 | mg/L | NA | NA | NA | 0.05 |
| Antimony | 7440-36-9 | mg/L | 0.006 | 0.024 | 0.006 | NA |
| Arsenic | 7440-38-2 | mg/L | 0.01 | 0.20 | 0.01 | NA |
| Barium | 7440-39-3 | mg/L | 2 | 2 | 2 | NA |
| Beryllium | 7440-41-7 | mg/L | 0.004 | 0.500 | 0.004 | NA |
| Boron | 7440-42-8 | mg/L | 2 | 2 | NA | NA |
| Cadmium | 7440-43-9 | mg/L | 0.005 | 0.050 | 0.005 | NA |
| Chloride | 16887-00-6 | mg/L | 200 | 200 | NA | 250 |
| Chromium | 16065-83-1 | mg/L | 0.1 | 1 | 0.1 (d) | NA |
| Cobalt | 7440-48-4 | mg/L | 1 | 1 | NA | NA |
| Copper | 7440-50-8 | mg/L | 0.65 | 0.7 | 1.3 (e) | 1 |
| Cyanide (as free CN) | 57-12-5 | mg/L | 0.2 | 0.6 | 0.2 | NA |
| Fluoride | 16984-48-8 | mg/L | 4 | 4 | 4 | 2 |
| Iron | 7439-89-6 | mg/L | 5 | 5 | NA | 0.3 |
| Lead | 7439-92-1 | mg/L | 0.0075 | 0.100 | 0.015 (e) | NA |
| Manganese | 7439-96-5 | mg/L | 0.15 | 10 | NA | 0.05 |
| Mercury | 7487-94-7 | mg/L | 0.002 | 0.010 | 0.002 | NA |
| Molybdenum | 7439-98-7 | mg/L | NA | NA | NA | NA |
| Nickel | 7440-02-0 | mg/L | 0.1 | 2.0 | NA | NA |
| Nitrate-Nitrite (as N) | 14797-55-8 | mg/L | 10 | 100 | 10 | NA |
| Perchlorate | 14797-73-0 | mg/L | 0.0049 | 0.0049 | 0.0040 (g) | NA |
| pH | 13967-14-1 | units | 6.5 - 9.0 | 6.5 - 9.0 | NA | 6.5 - 8.5 |
| Radium-226 | 7440-14-4 | pCi/L | 20 | NA | 5 (f) | NA |
| Radium-228 | 7440-61-1 | pCi/L | 20 | NA | 5 (f) | NA |
| Selenium | 7782-49-2 | mg/L | 0.05 | 0.05 | 0.05 | NA |
| Silver | 7440-22-4 | mg/L | 0.05 | NA | NA | 0.1 |
| Sulfate | 7757-82-6 | mg/L | 400 | 400 | NA | 250 |
| Thallium | 7440-28-0 | mg/L | 0.0020 | 0.020 | 0.0020 | NA |
| Total Dissolved Solids (TDS) | 67-16-3 | mg/L | 1,200 | 1,200 | NA | 500 |
| Tin | 7440-31-5 | mg/L | NA | NA | NA | NA |
| Vanadium | 7440-62-2 | mg/L | 0.049 | 0.1 | NA | NA |
| Zinc | 7440-66-6 | mg/L | 5 | 10 | NA | 5 |

Notes:
CAS - Chemical Abstracts Service.
MCL - Maximum Contaminant Level.
NA - Not Available.
SMCL - Secondary Maximum Contaminant Level. No MCL available.
USEPA - United States Environmental Protection Agency.
mg/L - Milligrams per liter.
pCi/L - picoCuries per liter.
(a) - Illinois Administrative Code, Title 35, Subtitle F, Chapter 1, Part 620, Section 620.410.
(b) - Illinois Administrative Code, Title 35, Subtitle F, Chapter 1, Part 620, Section 620.420.
(c) - USEPA 2012 Edition of the Drinking Water Standards and Health Advisories. Spring 2012.
http://water.epa.gov/drink/contaminants/index.cfm
(d) - The drinking water standard or MCL for chromium is based on total chromium.
(e) - The Action Level presented is recommended in he USEPA Drinking Water Standards.
(f) - The value shown is for combined Ra-226 and Ra-228 which is the USEPA MCL.
(g) - Threshold concentration.
https://www.federalregister.gov/articles/2011/02/11/2011-2603/drinking-water-regulatory-determination-on-perchlorate

**Table 2**

**Landfill Leachate Concentrations for Wyoming Coal Ash**
**(Case No. PCB 2013-015)**

| | Wyoming Coal Ash[1] | | |
|---|---|---|---|
| Date | B (mg/L) | Mn (mg/L) | $SO_4$ (mg/L) |
| 12/1/97 | 50.5 | (2) | 1250 |
| 12/18/95 | 44 | | 1730 |
| 12/2/98 | 150 | | 1900 |
| 12/20/94 | 35 | | 690 |
| 12/6/93 | 18.75 | | 575 |
| 3/18/99 | 140 | | 2000 |
| 3/2/98 | 51 | | 1230 |
| 3/21/96 | 48.6 | | 1100 |
| 3/25/97 | 53 | | 1380 |
| 3/7/95 | 34 | | 710 |
| 3/8/94 | 24.5 | | 666 |
| 6/12/95 | 120 | | 1500 |
| 6/12/97 | 145 | 5.1 | 1270 |
| 6/2/98 | 200 | 0.49 | 2200 |
| 6/6/96 | 62.8 | 12.675 | 1300 |
| 6/6/96 | 67 | | 1300 |
| 6/6/96 | 156 | | 2042 |
| 6/7/94 | 94.4 | 5.681 | 1416 |
| 6/9/93 | 99.7 | 2.955 | 1470 |
| 8/18/95 | 41 | | 930 |
| 9/1/98 | 220 | | 2100 |
| 9/15/93 | 29.8 | | 759 |
| 9/19/94 | 66.3 | | 1074 |
| 9/3/97 | 51 | | 1420 |
| 12/1/97 | 60.4 | 10 | 1300 |
| 12/18/95 | 43 | 13 | 1440 |
| 12/18/95 | 46 | 13 | 1640 |
| 12/2/98 | 83 | 6.4 | 1400 |
| 12/20/94 | 35 | 10 | 690 |
| 12/6/93 | 15.6 | 7.698 | 566.8999 |
| 3/18/99 | 98 | 4.8 | 1600 |
| 3/2/98 | 51 | 9.2 | 1220 |
| 3/21/96 | 42.6 | 14 | 1160 |
| 3/25/97 | 56 | 9.5 | 1260 |
| 3/25/97 | 56 | 10 | |
| 3/7/95 | 36 | 14 | 710 |
| 8/8/94 | 18.5 | 8.07 | 657 |
| 6/12/95 | 55 | | |
| 6/12/97 | 140 | 22 | 1040 |
| 6/2/98 | 72 | 5.6 | 1200 |
| 6/2/98 | 83 | 6.9 | 1200 |
| 6/6/96 | 54.1 | 11.41 | 1046 |
| 6/7/94 | 27 | 9.025 | 701 |
| 6/9/93 | 17.2 | 8.135 | 594 |
| 9/15/93 | 27.4 | 7.52 | 746 |
| 9/18/95 | 40 | 10 | 1000 |
| 9/19/94 | 42.7 | 8.087 | 956 |
| 9/3/96 | 61.1 | 12.15 | 1130 |
| 9/3/97 | 71 | 9.1 | 1270 |
| Max | 220 | 22 | 2200 |
| Min | 15.6 | 0.49 | 566.8999 |
| Mean | 68.04 | 9.19 | 1202.96 |
| Std. Dev. | 46.85 | 4.08 | 426.33 |
| N | 49 | 29 | 47 |

(1) USEPA Leach Database (Kosson and others, 2009).
(2) Blank means no data were presented.

## Table 3

**Median Concentrations of Indicator Pollutants in IEPA Background Network Wells in Sand and Gravel and Shallow Bedrock Aquifers (Case No. PCB 2013-015)**

| Sand and Gravel Indicator Pollutant[1] | Background Concentraton (mg/L)[1] | Powerton MW-16 (mg/L)[2] |
|---|---|---|
| B | 0.12 | 0.20 |
| Mn | 0.072 | 0.003 |
| $SO_4$ | 54 | 43 |
| TDS | 703 | -- |

| Bedrock Indicator Pollutant[1] | Background Concentraton (mg/L)[1] | |
|---|---|---|
| B | 0.28 | -- |
| Mn | 0.029 | -- |
| $SO_4$ | 106 | -- |
| TDS | 530 | -- |

(1) Background Ground-Water Quality (IEPA, 2013).
(2) MWG Quarterly Reports (2012 - 2014).

**Table 4**

**Summary of Joliet #29 Ash Deposits Located Outside the Ash Ponds Based on Monitoring Well and Soil Boring Logs (Case No. PCB 2013-015)**

| Boring or Monitoring Well ID[(1)] | Depths of Ash[(2)] (ft. bgs) | Thickness of Ash[(3)] (ft) | Source[(4)] |
|---|---|---|---|
| MW-1 | N/A[(5)] | -- | Patrick (2011a) |
| MW-2 | N/A | -- | Patrick (2011a) |
| MW-3 | N/A | -- | Patrick (2011a) |
| MW-4 | N/A | -- | Patrick (2011a) |
| MW-5 | N/A | -- | Patrick (2011a) |
| MW-6 | N/A | -- | Patrick (2011a) |
| MW-7 | N/A | -- | Patrick (2011a) |
| MW-8 | N/A | -- | Patrick (2011a) |
| MW-9 | N/A | -- | Patrick (2011a) |
| MW-10 | N/A | -- | Patrick (2011a) |
| MW-11 | N/A | -- | Patrick (2011a) |
| ENSR MW-1 | Unknown | Unknown | ENSR (1998b) |
| B-1 | N/A | -- | ENSR (1998b) |
| B-3 | Unknown | Unknown | ENSR (1998b) |
| B-4 | Unknown | Unknown | ENSR (1998b) |
| JS29-GT-1 | 0 - 1 | 1 | KPRG (2005a) |
| JS29-GT-2 | 0 - 1 | 1 | KPRG (2005a) |
| JS29-GT-3 | 0 - 1 | 1 | KPRG (2005a) |
| JS29-GT-4 | N/A | -- | KPRG (2005a) |
| JS29-GT-5 | N/A | -- | KPRG (2005a) |
| JS29-GT-6 | 0 - 2.5 | 2.5 | KPRG (2005a) |
| Former Ash Disposal Area (Northeast of Plant Site and Ash Ponds) | Unknown | Unknown | KPRG (2009a, b), KPRG (2010), KPRG (2012a, b), KPRG (2013), ENSR (1998b) |
| | Mean | 1.4 | |
| | Std. Dev. | 0.75 | |
| | Max. | 2.5 | |
| | Min. | 1 | |
| | N | 4 | |

(1) MW designates a monitoring well. All other designations are borings.
(2) Depth below ground surface from boring logs.
(3) Difference in maximum and minimum depth bgs.
(4) Reference or Bates Numbers.
(5) N/A = no ash in boring log.

## Table 5

**Summary of Powerton Ash Basin Characteristics**
**(Case No. PCB 2013-015)**

| Basin Name[1] | Year Lined[2] | Bottom Elev.[3] (ft MSL) | Typical W/S Elev.[4] (ft MSL) | Patrick W/S Elevs (ft MSL) | 11/3-4/10 | 4/4/2012 | 12/4/2012 |
|---|---|---|---|---|---|---|---|
| Ash Surge Basin | 2013 | 452 | 481.8 | AP-1 | 458.475 | 450.9 | 465.37 |
| | | | | AP-2 | 451.949 | 463.48 | 451.32 |
| Metal Cleaning Basin | 2010 | 456 | 462-465 | AP-3 | 464.319 | 463.77 | 456.85 |
| | | | | AP-4 | 454.348 | | 451.91 |
| Seconday Ash Settling Basin | 2013 | 440 | 453 | AP-5 | 447.348 | | 447.69 |
| | | | | AP-6 | 447.34 | | 447.67 |
| Ash Bypass Basin | 2010 | 459 | Not Avail. | Lake Ch. | 433.507 | | 432.49 |
| | | | | East Ch. | 434.694 | | 434.19 |
| East Yard Runoff Basin | Unlined | Unknown | Not Avail. | West Ch. | 431.472 | | 430.78 |
| | | | | North Pd. | 439.015 | | |
| Limestone Runoff Basin | 1978 | Unknown | Not Avail. | South Pd. | 439.57 | | 436.2 |
| | | | | Cooling Pd. | | 440.65 | |
| Former Ash Basin | Unlined | Unknown | Not Avail. | Illinois R. | 430.76 | 434.26 | 430.37 |
| | | | | | | 434.28 USGS | |

(1) As shown on Figure 9.
(2) All liners are 60-mil HDPE. Previous to 2010 liners were Poz-o-Pac bottom with Hypalon sideslopes.
(3) Approximate. Obtained from MWG files (various Bates Nos).
(4) Approximate operating W/S elev from MWG files (various Bates Nos).

**Table 6**

**Summary of Powerton Ash Deposits Located Outside the Ash Ponds Based on Monitoring Well and Soil Boring Logs (Case No. PCB 2013-015)**

| Boring or Monitoring Well ID(1) | Depths of Ash(2) (ft. bgs) | Thickness of Ash(3) (ft) | Source(4) |
|---|---|---|---|
| MW-1 | N/A(5) | -- | Patrick (2011b) |
| MW-2 | N/A | -- | Patrick (2011b) |
| MW-3 | N/A | -- | Patrick (2011b) |
| MW-4 | N/A | -- | Patrick (2011b) |
| MW-5 | 0 - 12.5 | 12.5 | Patrick (2011b) |
| MW-6 | 0 - 18 | 18 | Patrick (2011b) |
| MW-7 | 0 - 13.5 | 13.5 | Patrick (2011b) |
| MW-8 | 0 - 24.5 | 24.5 | Patrick (2011b) |
| MW-9 | 0 - 17 | 17 | Patrick (2011b) |
| MW-10 | N/A | -- | Patrick (2011b) |
| MW-11 | 0 - 16 | 16 | Bates Nos. 40059-40062 |
| MW-12 | 0 - 18.5 | 18.5 | Bates Nos. 40059-40062 |
| MW-13 | 0 - 15 | 15 | Patrick (2011e) |
| MW-14 | 0 - 18.5 | 18.5 | Patrick (2011e) |
| MW-15 | 0 - 20 | 20 | Patrick (2011e) |
| MW-16 | N/A | -- | REF? |
| B-1 | N/A | -- | ENSR (1998d) |
| B-4 | N/A | -- | ENSR (1998d) |
| B-5 | N/A | -- | ENSR (1998d) |
| B-6 | N/A | -- | ENSR (1998d) |
| B-9 | 0 - 8 | 8 | ENSR (1998d) |
| B-10 | 0 - 6 | 6 | ENSR (1998d) |
| B-11 | 0 - 7 | 7 | ENSR (1998d) |
| B-12 (ENSR MW-2) | 0 - 6 | 6 | ENSR (1998d) |
| B-13 | 0 - 8 | 8 | ENSR (1998d) |
| B-14 | 4 - 16 | 12 | ENSR (1998d) |
| B-19 | 0 - 12 | 12 | ENSR (1998d) |
| B-21 | 0 - 3.5 | 3.5 | ENSR (1998d) |
| B-22 | 0 - 4 | 4 | ENSR (1998d) |
| B-23 | 0 - 12 | 12 | ENSR (1998d) |
| B-35 | N/A | -- | ENSR (1998d) |
| B-36 | N/A | -- | ENSR (1998d) |
| PS-GT-5 | 2 - 4 | 2 | KPRG (2005a) |
| PS-GT-6 | 1 - 6 | 5 | KPRG (2005a) |
| PS-GT-7 | 2 - 13 | 11 | KPRG (2005a) |
| PS-GT-8 | 2.5 - 15 | 12.5 | KPRG (2005a) |
| PS-GT-9 | 3 - 14 | 11 | KPRG (2005a) |
| AP-3 | 0 - 2 | 2 | Bates Nos. 14225-14269 |
| AP-4 | 0 - 19 | 19 | Patrick (2008) |
| AP-5 | 0 - 9.7 | 9.7 | Patrick (2008) |

**Table 6**

**Summary of Powerton Ash Deposits Located Outside the Ash Ponds Based on Monitoring Well and Soil Boring Logs (Case No. PCB 2013-015)**

| Boring or Monitoring Well ID[(1)] | Depths of Ash[(2)] (ft. bgs) | Thickness of Ash[(3)] (ft) | Source[(4)] |
|---|---|---|---|
| AP-6 | 0 - 10 | 10 | Patrick (2008) |
| AP-8 | 0 - 5.3 | 5.3 | Patrick (2008) |
| AP-9 | 0.5 - 10 | 9.5 | Patrick (2008) |
| AP-10 | 0.5 - 10 | 9.5 | Patrick (2008) |
| AP-11 | N/A | -- | Patrick (2008) |
| AP-12 | 0 - 3 | 3 | Patrick (2008) |
| AP-13 | 0 - 8 | 8 | Patrick (2008) |
| AP-14 | 0 - 7.5 | 7.5 | Patrick (2008) |
| AP-15 | 0 - 5 | 5 | Patrick (2008) |
| AP-16 | 0 - 9.5 | 9.5 | Patrick (2008) |
| APB-1-08 | 1 - 31 | 30 | Patrick (2008) |
| APB-2-08 | 1 - 23 | 22 | Patrick (2008) |
| APB-3-08 | N/A | -- | Patrick (2008) |
| APB-4-08 | N/A | -- | Patrick (2008) |
| APB-5-08 | N/A | -- | Patrick (2008) |
| APB-6-08 | N/A | -- | Patrick (2008) |
| APB-7-08 | N/A | -- | Patrick (2008) |
| APB-8-08 | N/A | -- | Patrick (2008) |
| APB-9-08 | 1 - 4.5 | 3.5 | Patrick (2008) |
| APB-10-08 | N/A | -- | Patrick (2008) |
| | Mean | 11.2 | |
| | Std. Dev. | 6.54 | |
| | Max. | 30 | |
| | Min. | 2 | |
| | N | 40 | |

(1) MW designates a monitoring well. All other designations are borings.
(2) Depth below ground surface from boring logs.
(3) Difference in maximum and minimum depth bgs.
(4) Reference or Bates Numbers.
(5) N/A means no ash identified in boring log.

**Table 7**

**Summary of Waukegan Ash Deposits Located Outside the Ash Ponds Based on Monitoring Well and Soil Boring Logs (Case No. PCB 2013-015)**

| Boring or Monitoring Well ID[(1)] | Depths of Ash[(2)] (ft. bgs) | Thickness of Ash[(3)] (ft) | Source[(4)] |
|---|---|---|---|
| MW-1 | 0 - 20 | 20 | Patrick (2010c) |
| MW-2 | 0 - 11 | 11 | Patrick (2010c) |
| MW-3 | 0 - 18.5 | 18.5 | Patrick (2010c) |
| MW-4 | 0 - 18.5 | 18.5 | Patrick (2010c) |
| MW-5 | 0.5 - 17 | 16.5 | Patrick (2010c) |
| MW-6 | N/A[(5)] | -- | IEPA (2012c) |
| MW-7 | 1 - 9.5 | 8.5 | IEPA (2012c) |
| MW-8 | 3 - 4.5 | 1.5 | Bates No. 45648 |
| MW-9 | 6 - 9.5 | 3.5 | Bates No. 45649 |
| MW-10 | ? | ? | ? |
| MW-11 | ? | ? | ? |
| MW-12 | ? | ? | ? |
| MW-13 | ? | ? | ? |
| MW-14 | ? | ? | ? |
| MW-15 | 0 - 5 | 5 | Bates No. 11932 |
| B-1 | 0 - 4 | 4 | ENSR (1998d) |
| B-14 | 0 - 4 | 4 | ENSR (1998d) |
| B-15 | 0 - 4 | 4 | ENSR (1998d) |
| B-16 | 0 - 2 | 2 | ENSR (1998d) |
| B-17 | 0 - 4 | 4 | ENSR (1998d) |
| B-22 | 0 - 1.5 | 1.5 | ENSR (1998d) |
| WS-GT-3 | 1.5 - 4 | 2.5 | KPRG (2005a) |
| WS-GT-4 | 1 - 19.5 | 18.5 | KPRG (2005a) |
| WS-GT-5 | 1 - 22 | 21 | KPRG (2005a) |
| | Mean | 9.1 | |
| | Std. Dev. | 7.46 | |
| | Max. | 21 | |
| | Min. | 1.5 | |
| | N | 18 | |

(1) MW designates a monitoring well. All other designations are borings.
(2) Depth below ground surface from boring logs.
(3) Difference in maximum and minimum depth bgs.
(4) Reference or Bates Numbers.
(5) N/A means no ash indicated in boring log.

**Table 8**

**Summary of Will County Ash Deposits Located Outside the Ash Ponds Based on Monitoring Well and Soil Boring Logs (Case No. PCB 2013-015)**

| Boring or Monitoring Well ID[(1)] | Depths of Ash[(2)] (ft. bgs) | Thickness of Ash[(3)] (ft) | Source[(4)] |
|---|---|---|---|
| MW-1 | 0 - 5 | 5 | Patrick (2011d) |
| MW-2 | 0 - 12 | 12 | Patrick (2011d) |
| MW-3 | 0 - 7.5 | 7.5 | Patrick (2011d) |
| MW-4 | 0 - 6 | 6 | Patrick (2011d) |
| MW-5 | N/A[(5)] | -- | Patrick (2011d) |
| MW-6 | 0 - 8 | 8 | Patrick (2011d) |
| MW-7 | N/A | -- | Patrick (2011d) |
| MW-8 | N/A | -- | Patrick (2011d) |
| MW-9 | N/A | -- | Patrick (2011d) |
| MW-10 | N/A | -- | Patrick (2011d) |
| B-5 | 0 - 1.3 | 1.3 | ENSR (1998e) |
| B-6 | N/A | -- | ENSR (1998e) |
| B-7 | 0 - 1 | 1 | ENSR (1998e) |
| WC-GT-2 | 0 - 2.5 | 2.5 | KPRG (2005a) |
| WC-GT-3 | 0 - 9.5 | 9.5 | KPRG (2005a) |
| WC-GT-4 | 0 - 2 | 2 | KPRG (2005a) |
| | Mean | 5.5 | |
| | Std. Dev. | 3.77 | |
| | Max. | 12 | |
| | Min. | 1 | |
| | N | 10 | |

(1) MW designates a monitoring well. All other designations are borings.
(2) Depth below ground surface from boring logs.
(3) Difference in maximum and minimum depth bgs.
(4) Reference or Bates Numbers.
(5) N/A means no ash indicated in boring log.


**Figure 1 Joliet Area and Monitoring Well Location Map (PCB 2013-015)**


**Figure 2 Former Ash Disposal Area**
**(Approximately Located) (PCB 2013-015)**

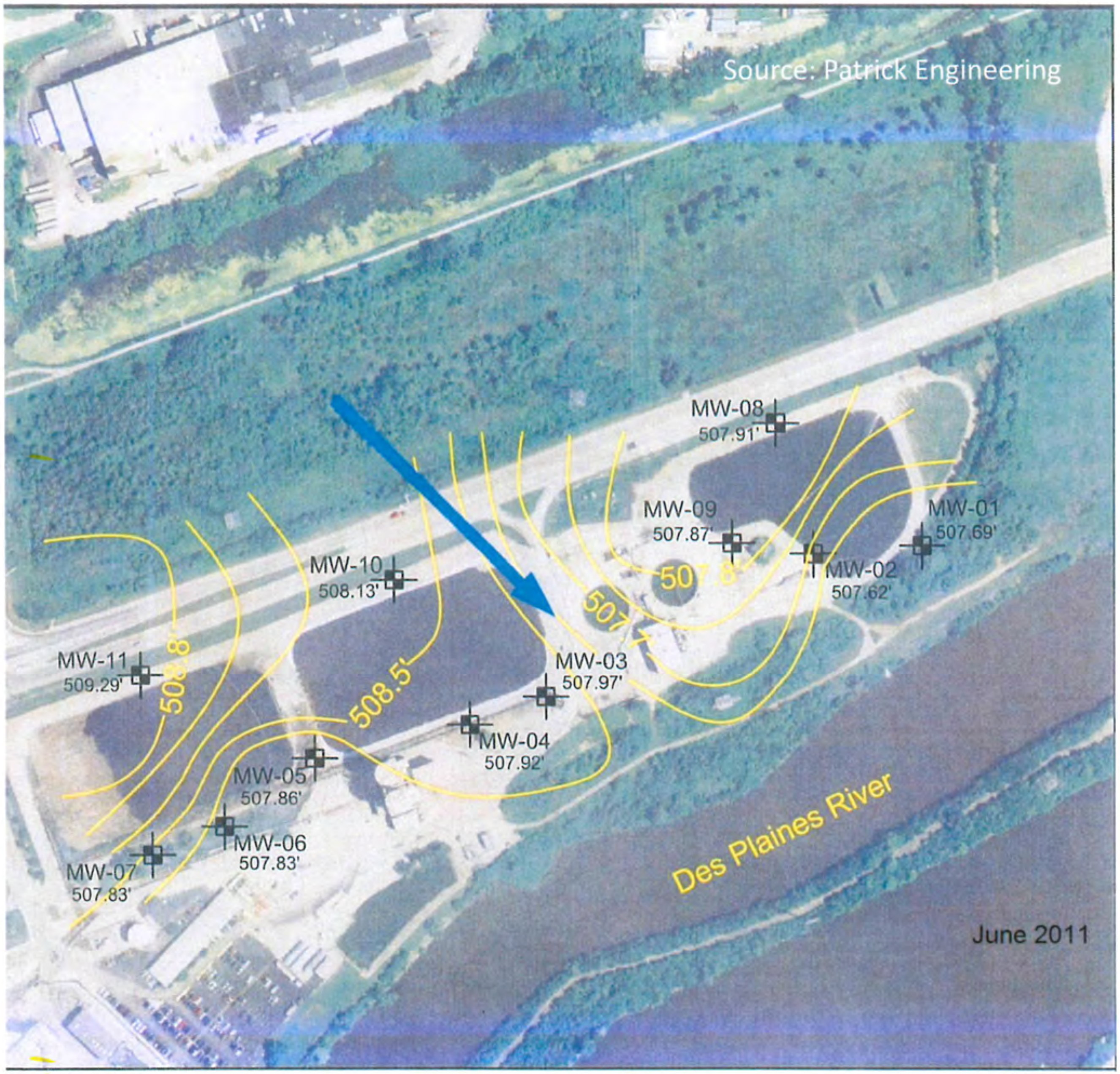


**Figure 3 June 2011 Second Quarter Ground-water Contours Showing Mounding Beneath the Joliet Ash Ponds (PCB 2013-015)**

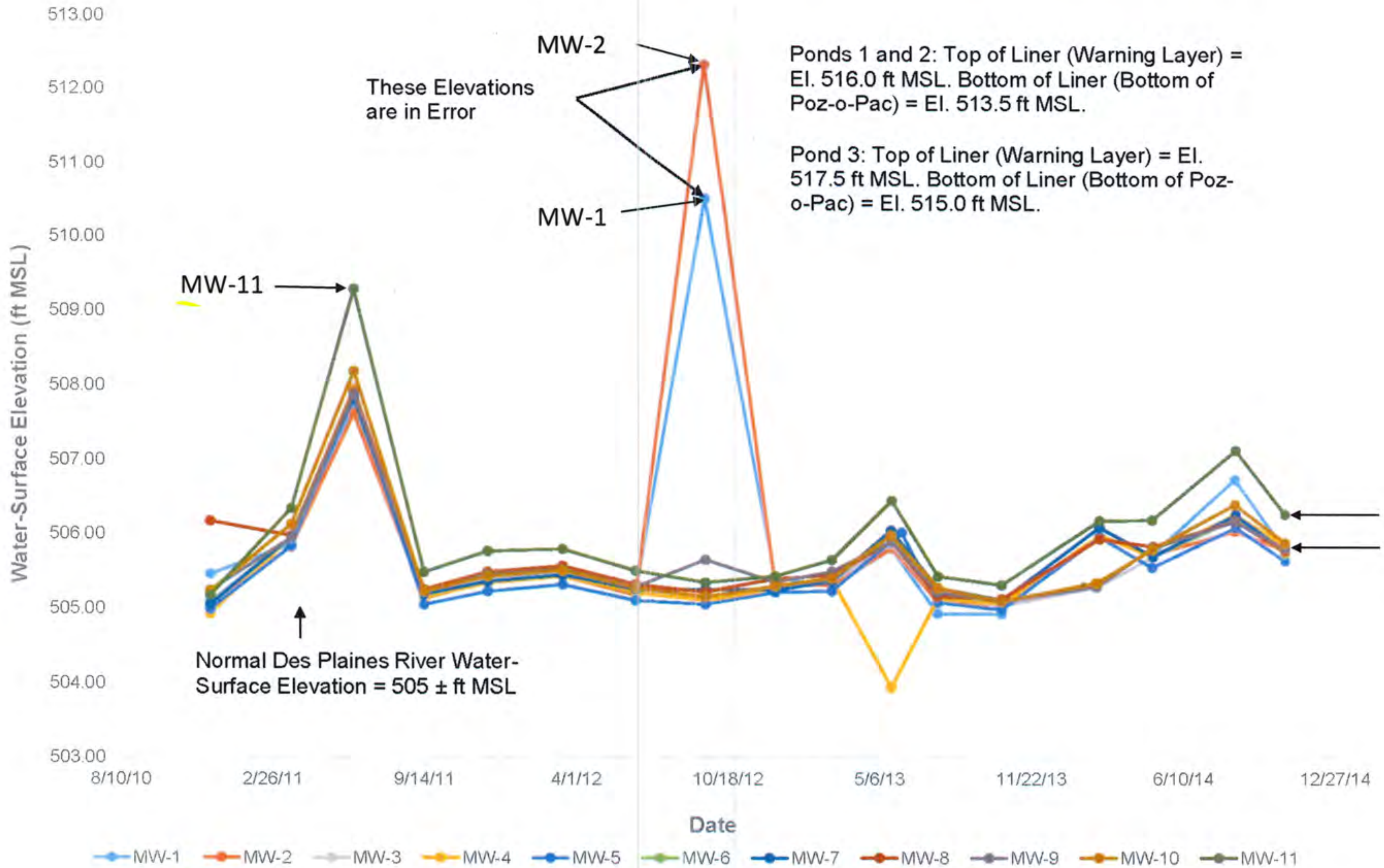


**Figure 4 Joliet #29 Site Historical Ground-water Elevations (PCB 2013-015)**

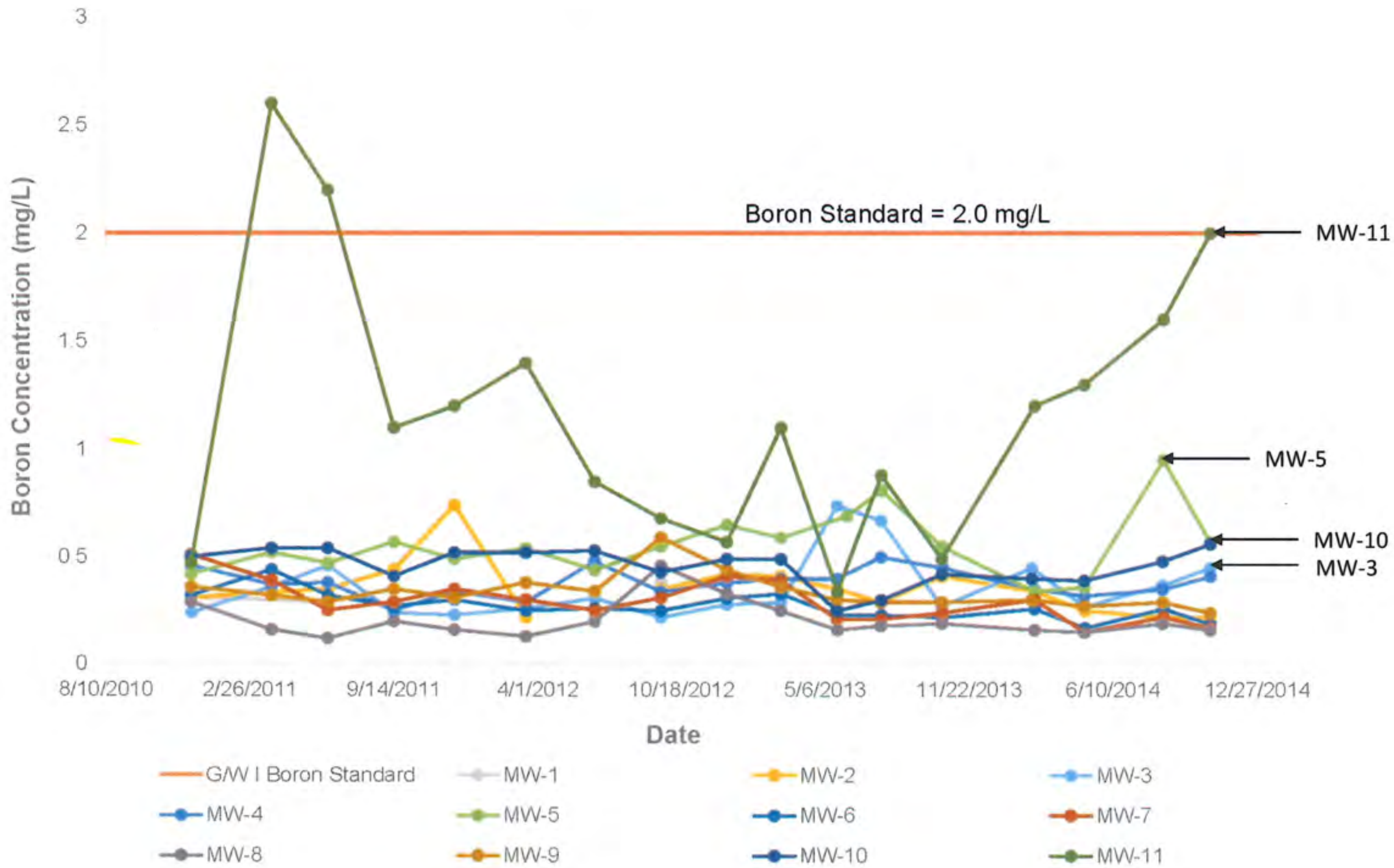


**Figure 5 Boron Concentrations in Ground Water**
**Joliet #29 Site (PCB 2013-015)**

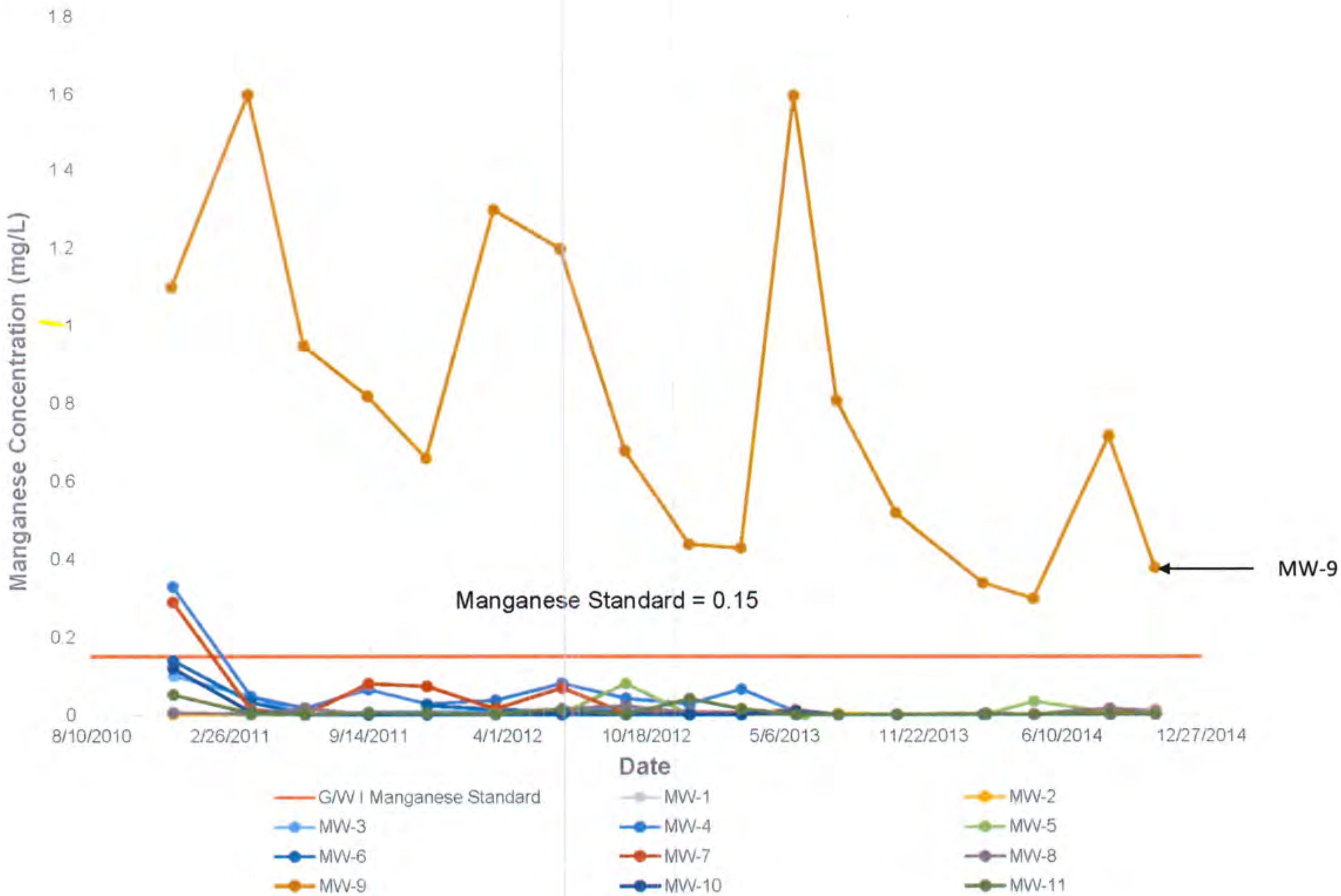


**Figure 6 Manganese Concentrations in Ground Water**
**Joliet #29 Site (PCB 2013-015)**

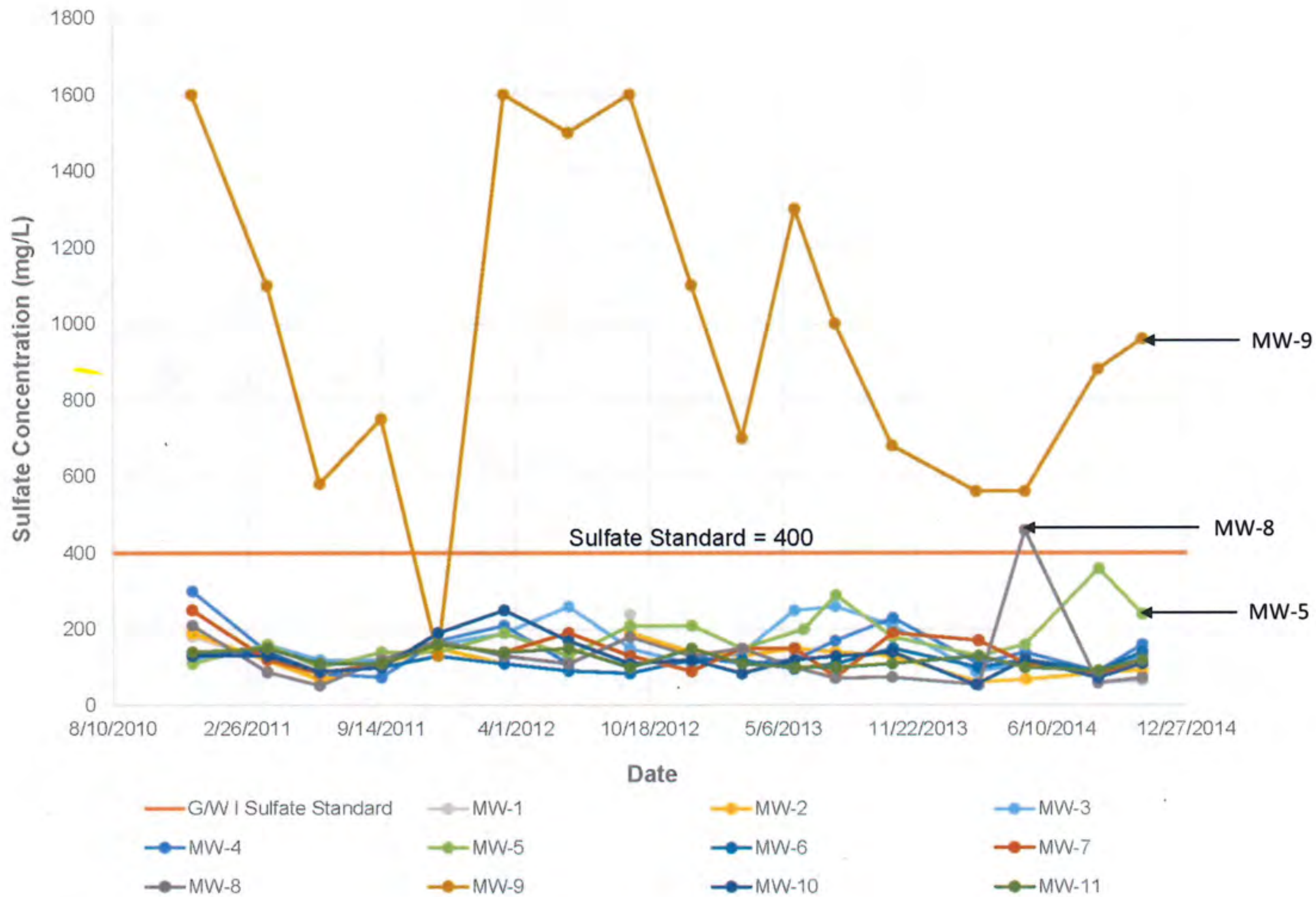


**Figure 7 Sulfate Concentrations in Ground Water**
**Joliet #29 Site (PCB 2013-015)**


**Figure 8 Powerton Area Location Map (PCB 2013-015)**

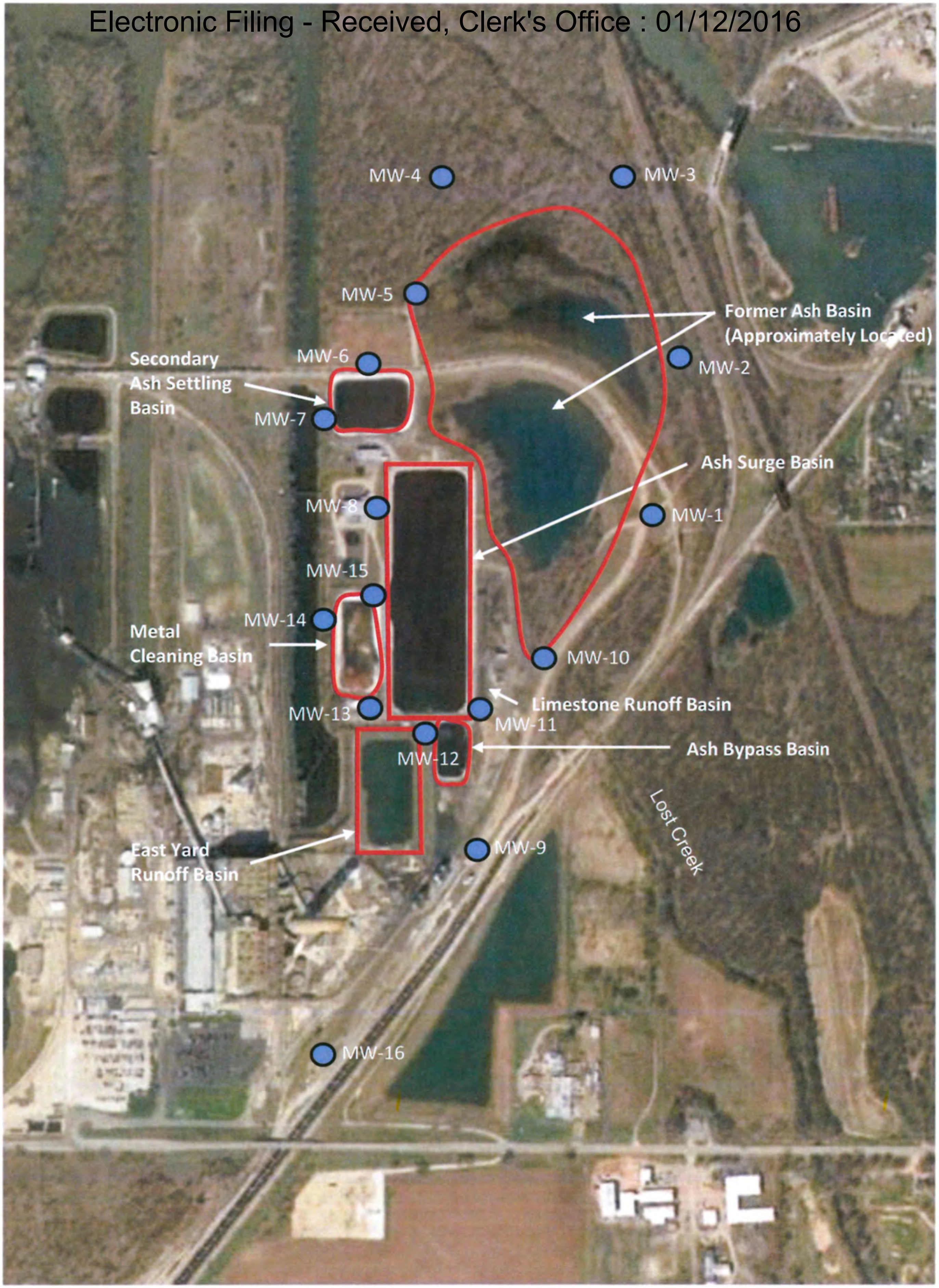


**Figure 9 Powerton Areas and Monitoring Well Locations (PCB 2013-015)**

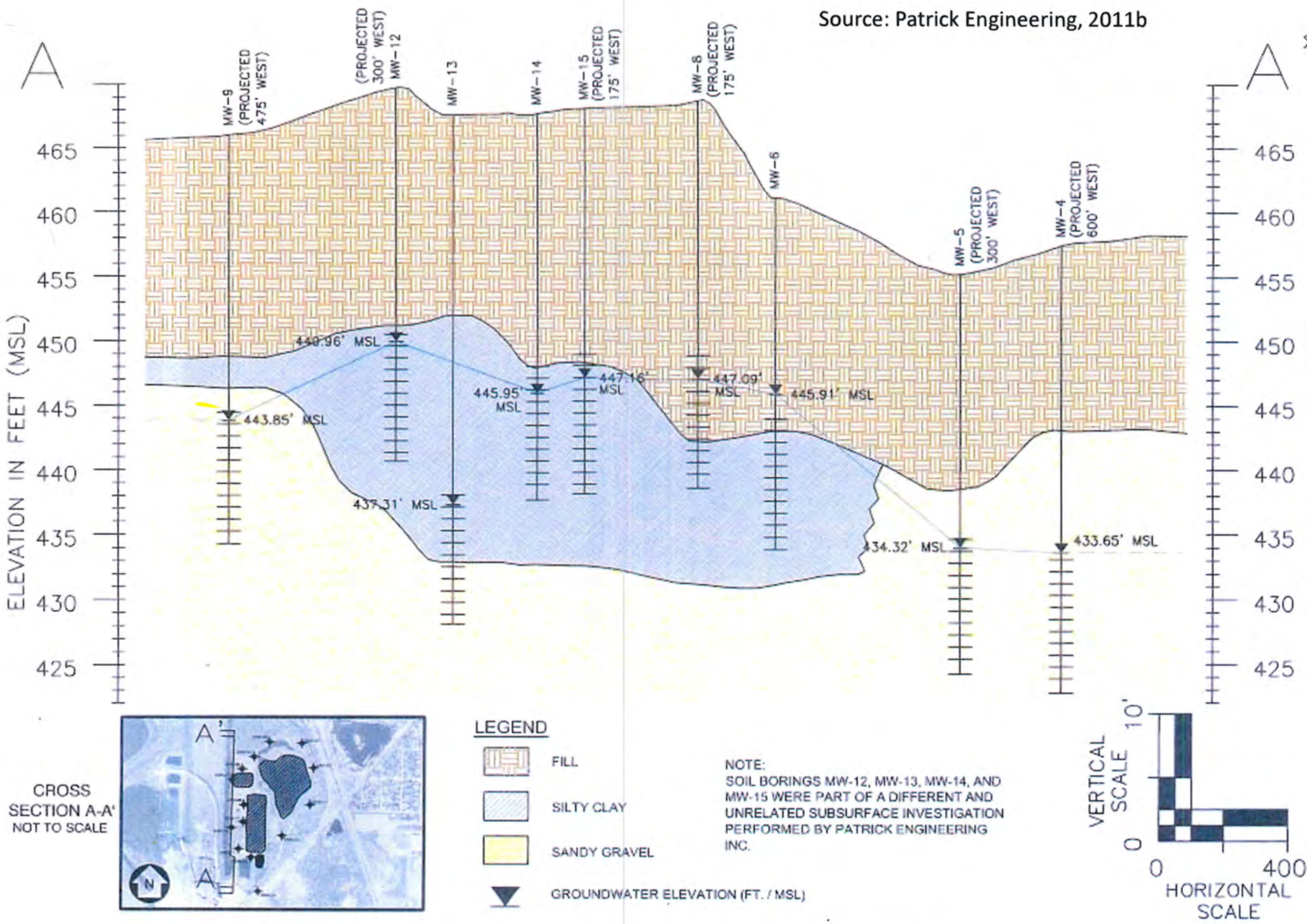


**Figure 10 Powerton Soil Stratigraphy (PCB 2013-015)**

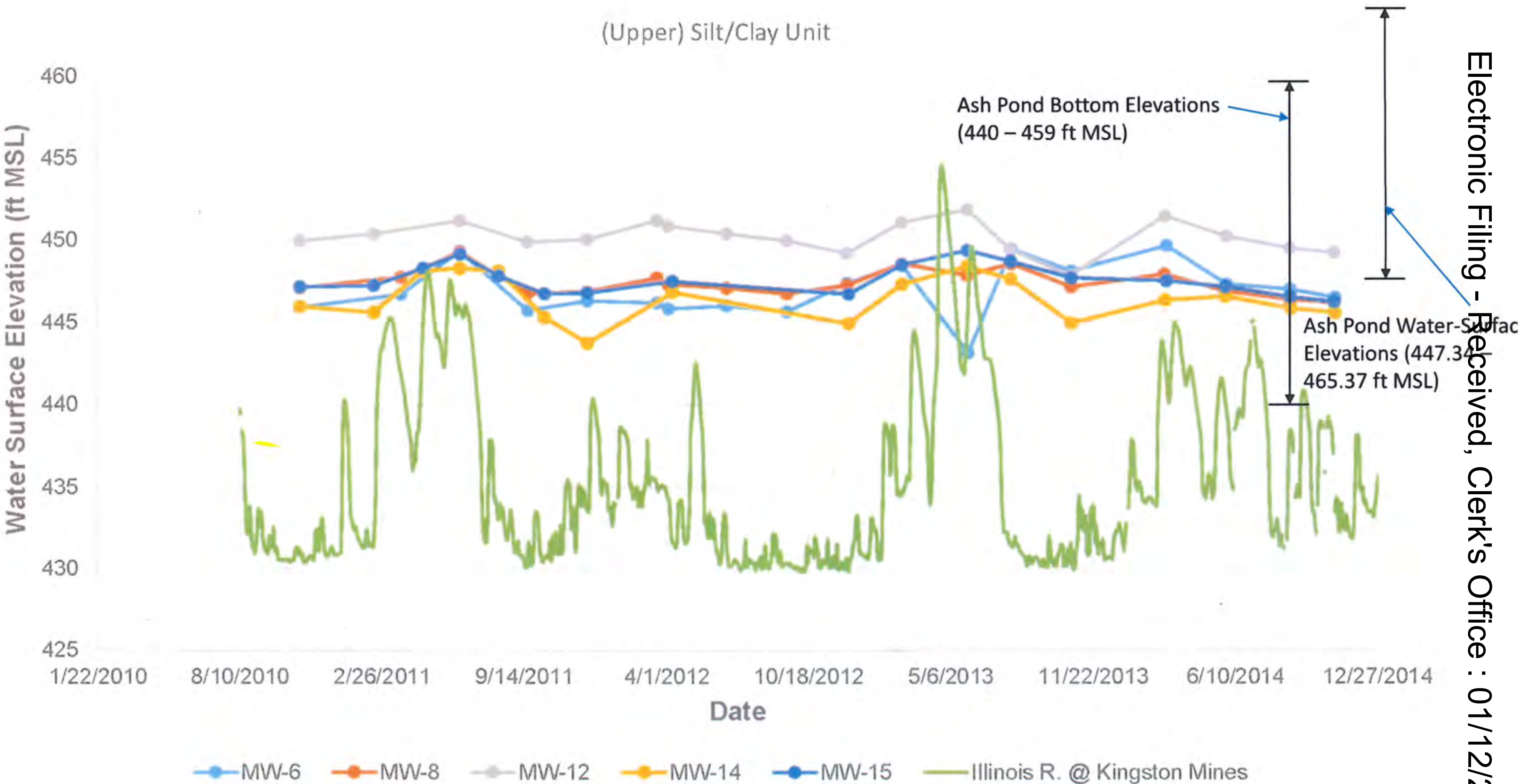


**Figure 11 Powerton Site Historical Ground-water, Illinois River and Ash Pond Water-surface Elevations – Clay/Silt Unit (PCB 2013-015)**

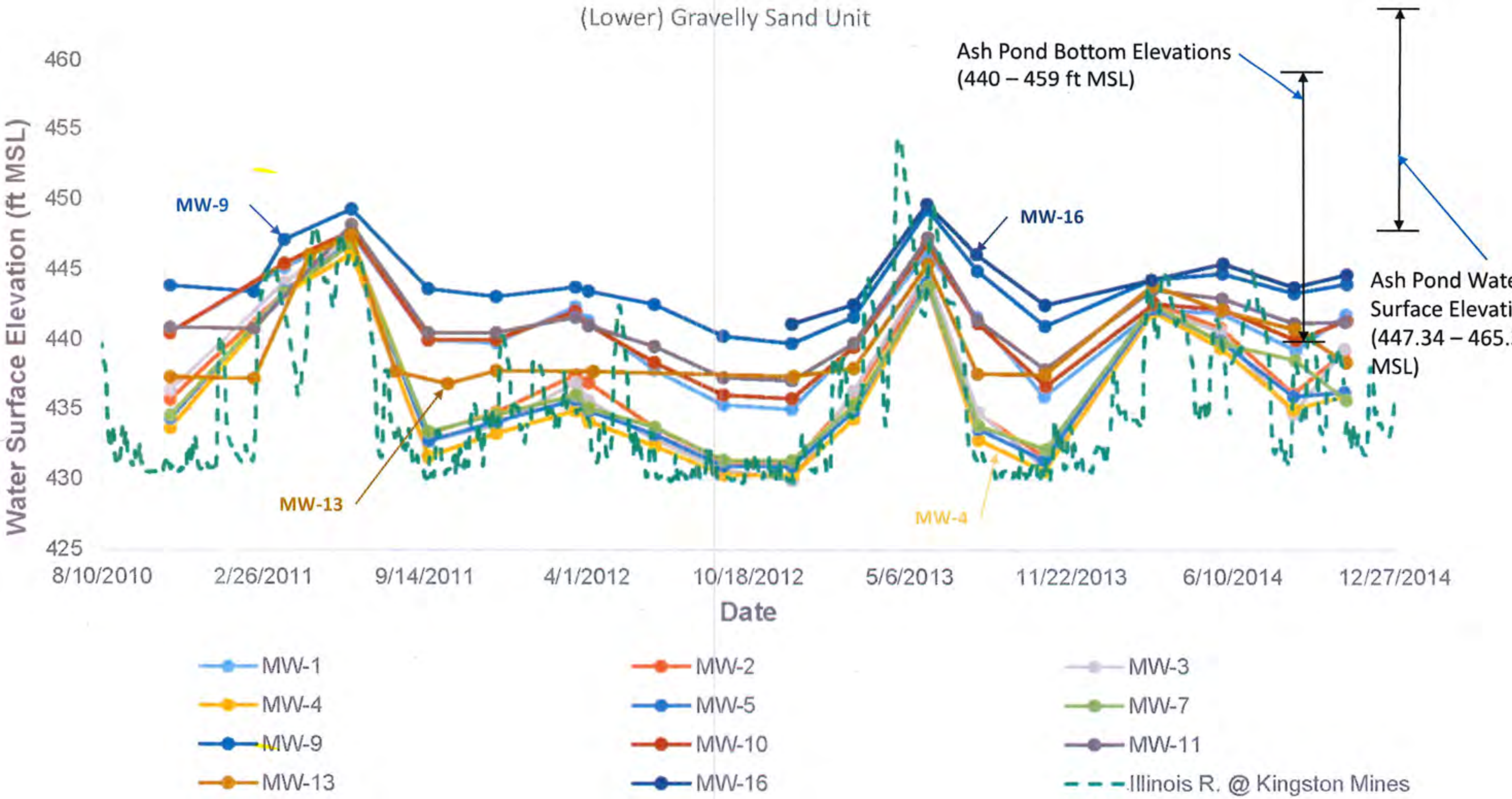


**Figure 12 Powerton Site Historical Ground-water, Illinois River and Ash Pond Water-surface Elevations -- Gravelly Sand Unit (PCB 2013-015)**

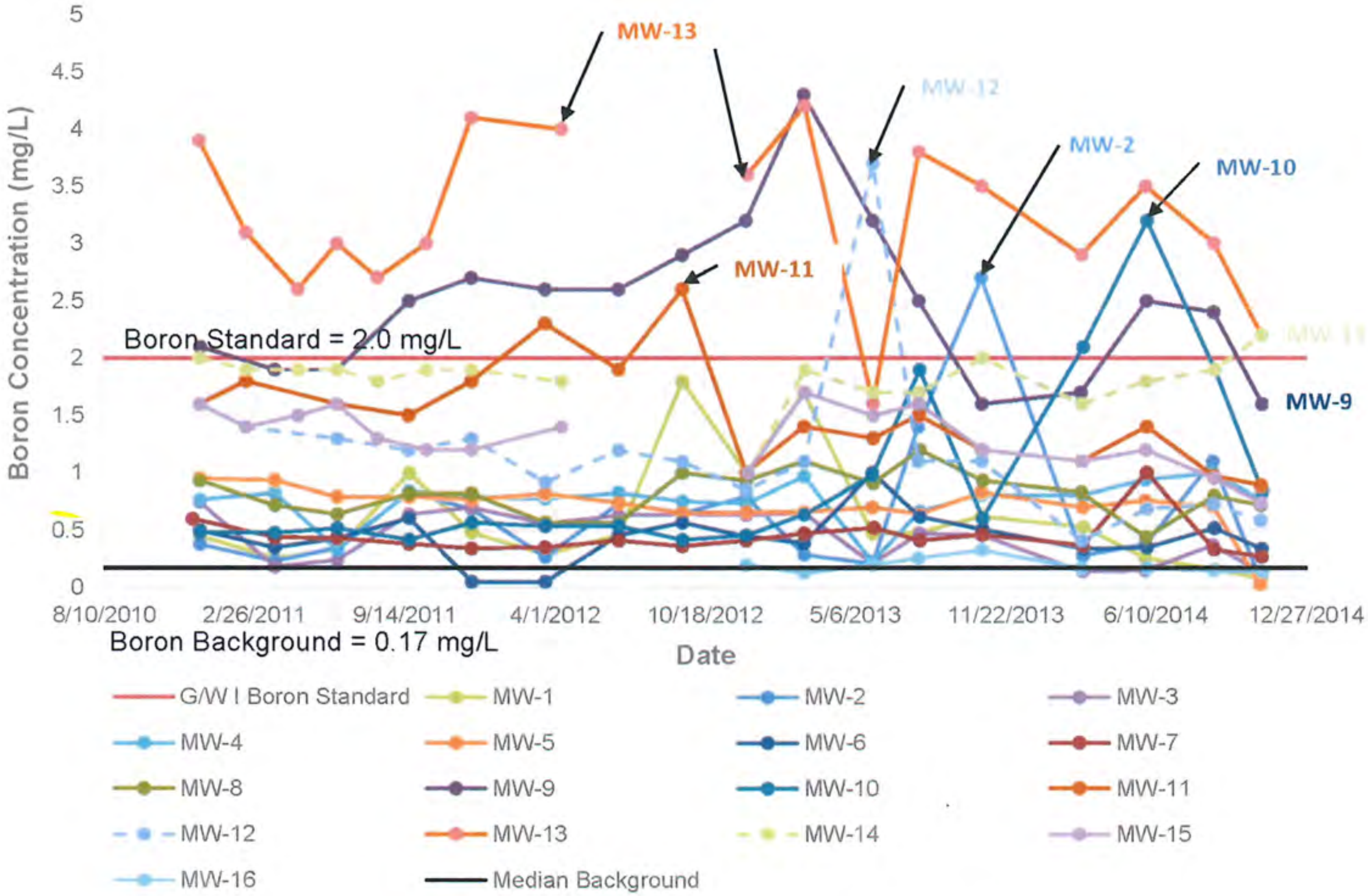


**Figure 13 Boron Concentrations in Ground Water**
**Powerton Site (PCB 2013-015)**

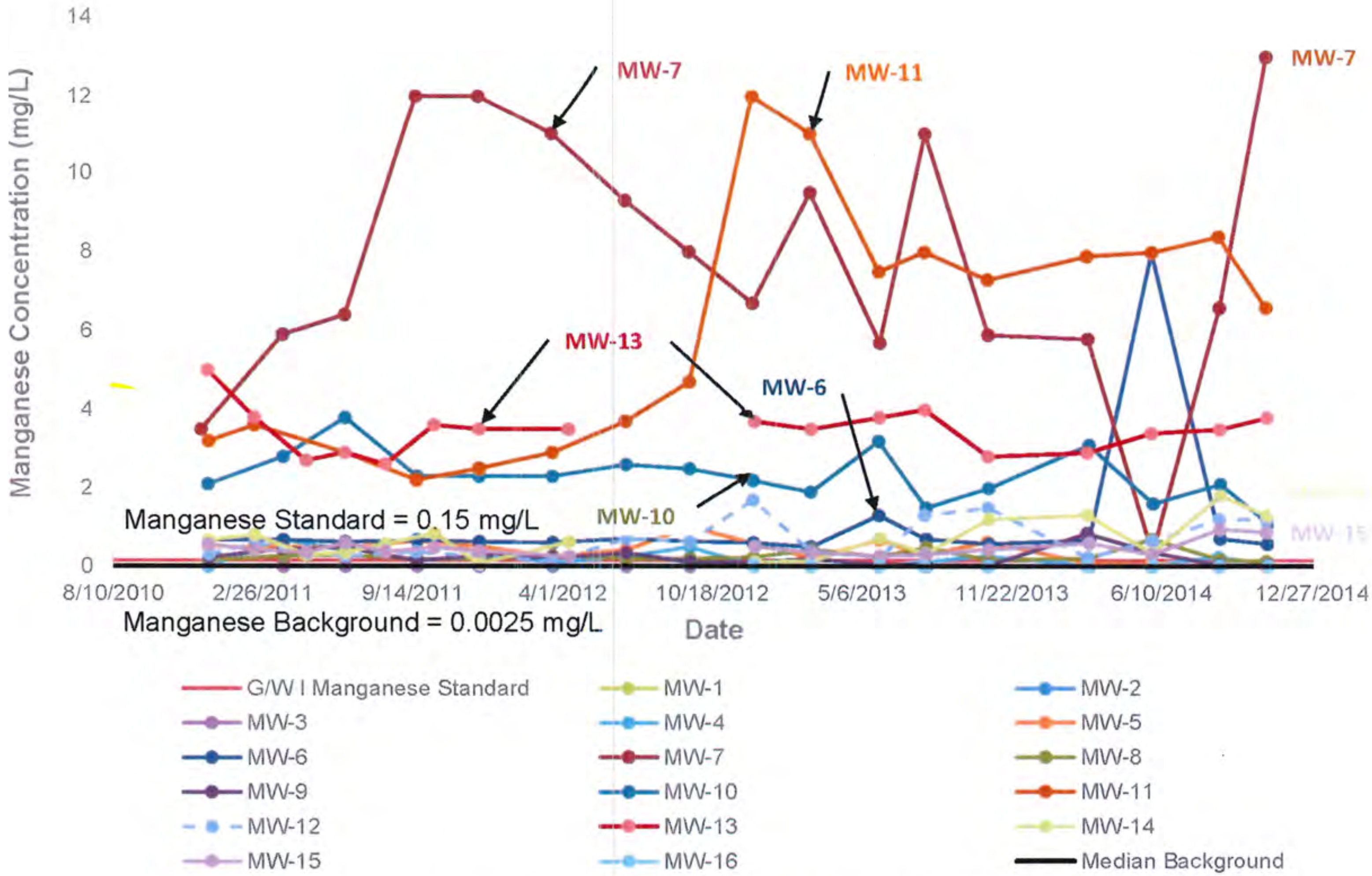


**Figure 14 Manganese Concentrations in Ground Water**
**Powerton Site (PCB 2013-015)**

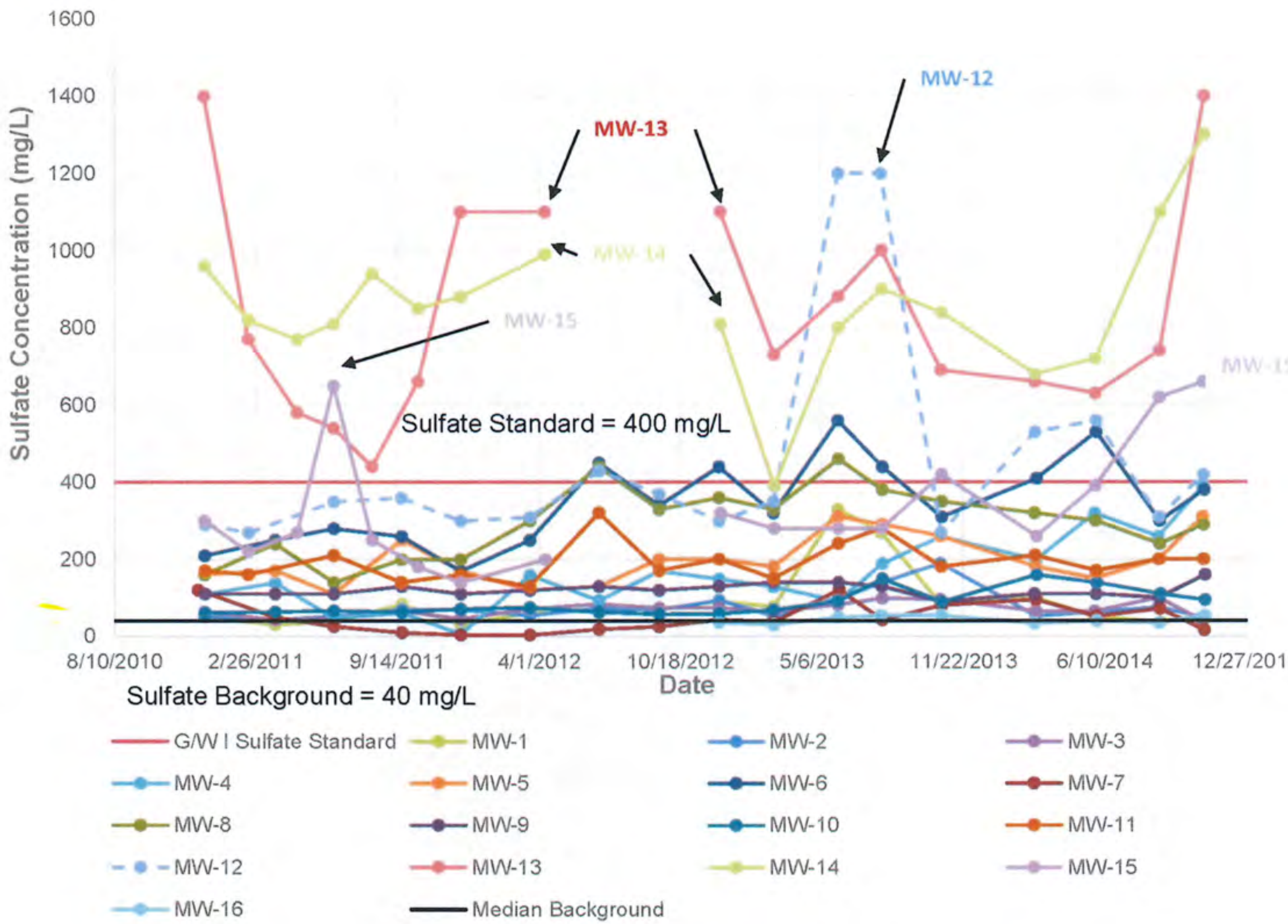


**Figure 15 Sulfate Concentrations in Ground Water**
**Powerton Site (PCB 2013-015)**

**DRAFT**

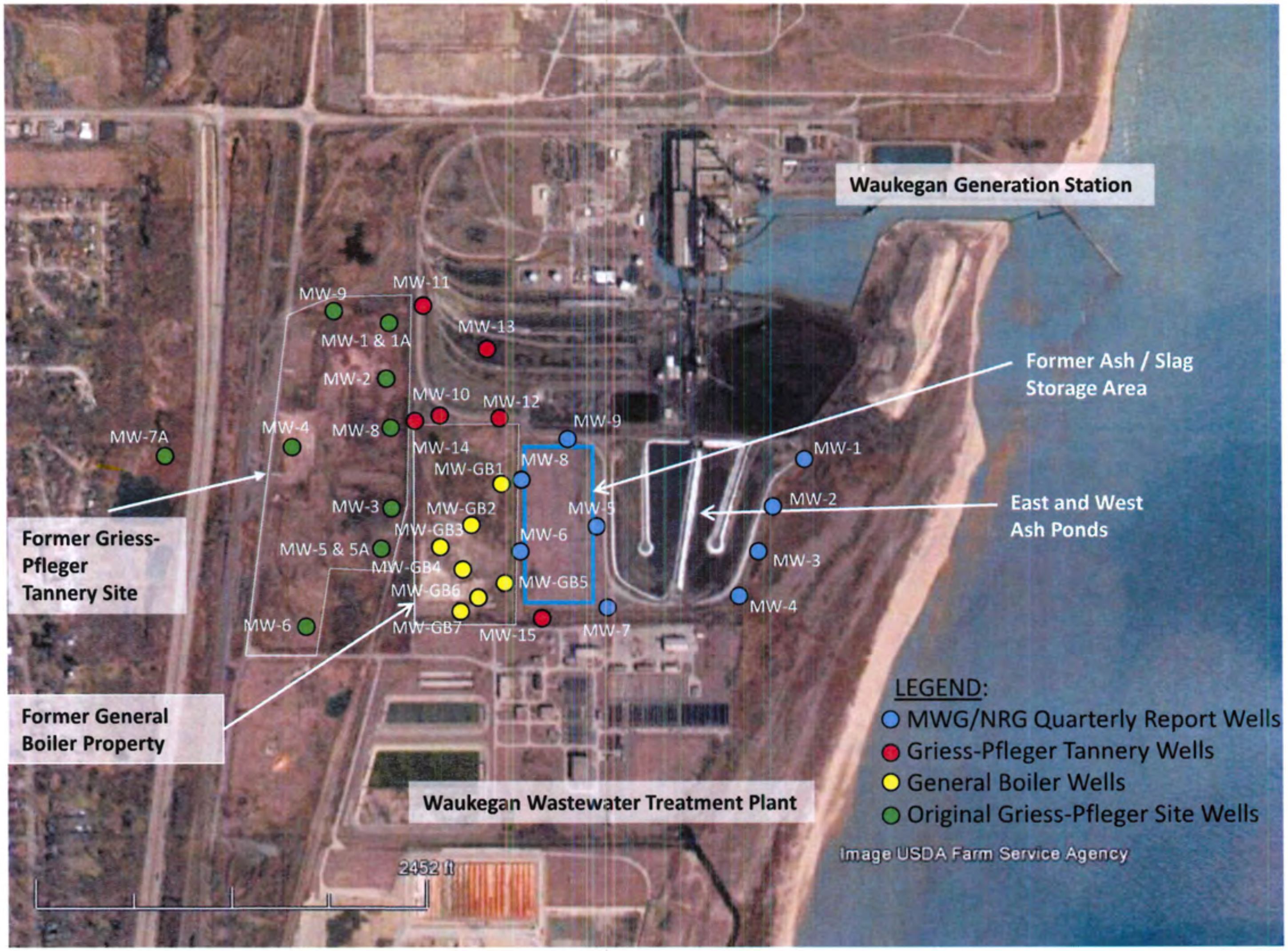


**Figure 16 Waukegan Areas and Monitoring Well Locations (PCB 2013-015)**

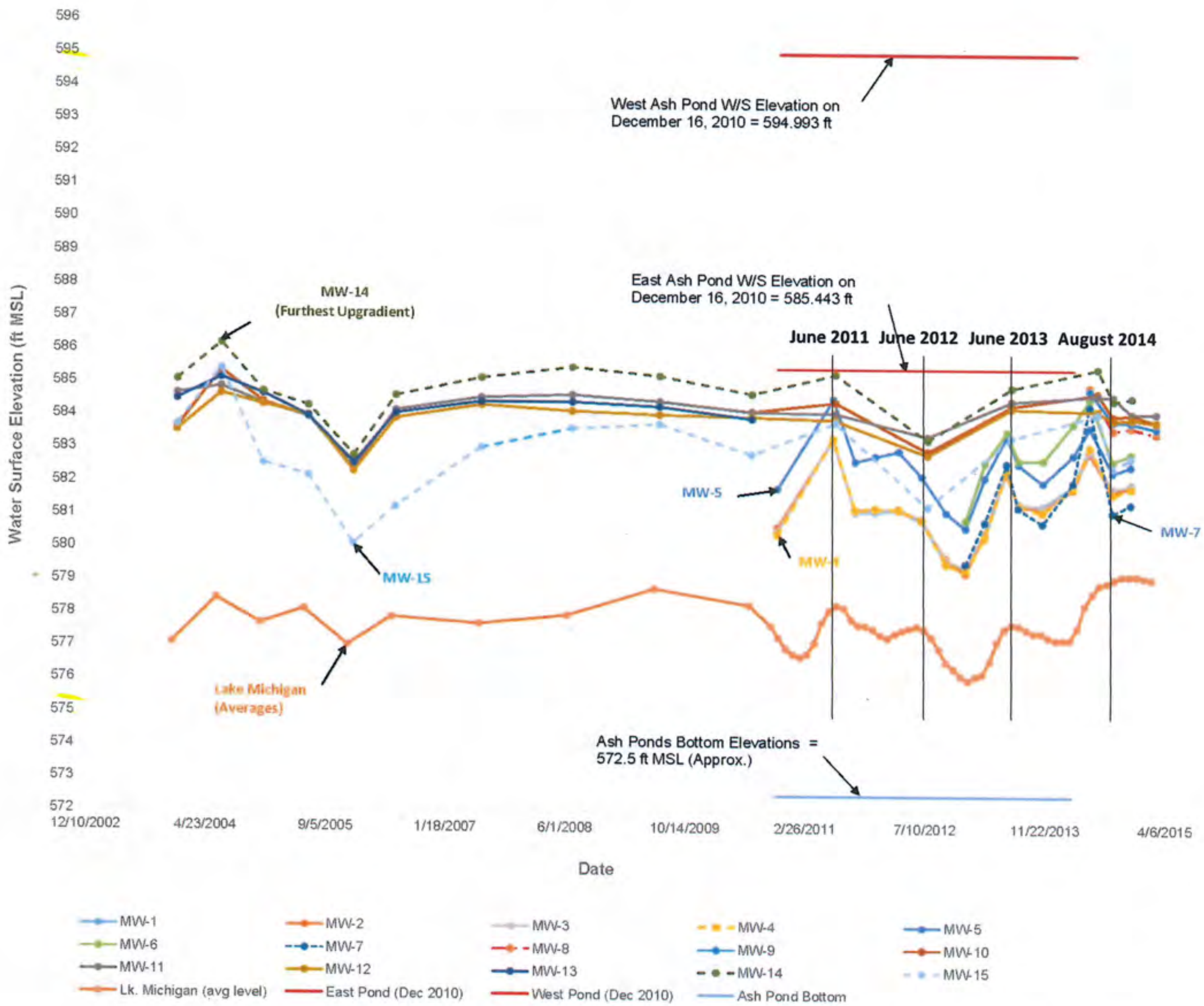


**Figure 17 Waukegan Site Historical Ground-water, Lake Michigan and Ash Pond Water-surface Elevations (PCB 2013-015)**

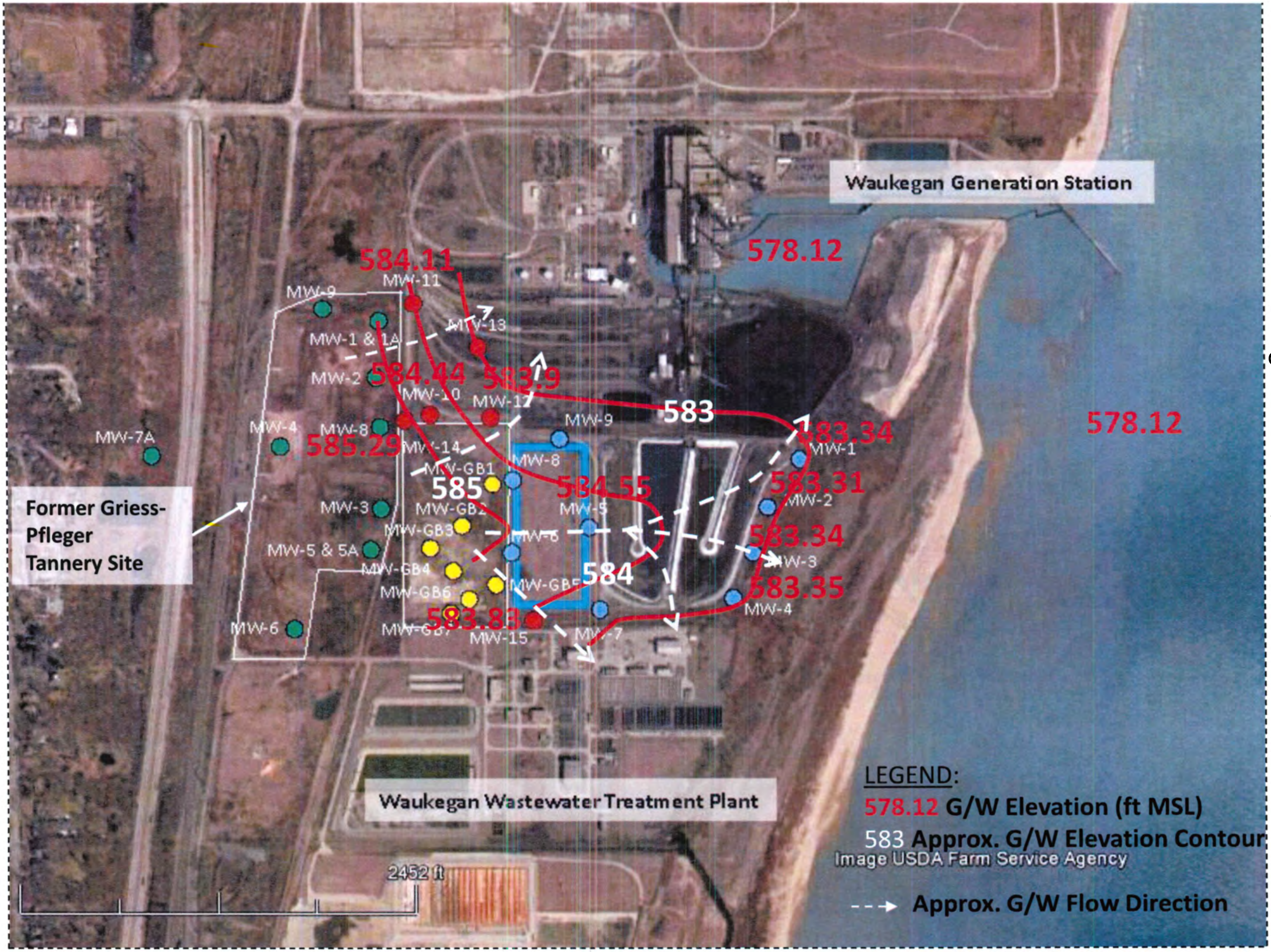


**Figure 18 Approximate Ground-water Contours**
**June 2011 (PCB 2013-015)**


**Figure 19 Approximate Ground-water Contours June 2012 (PCB 2013-015)**


**Figure 20 Approximate Ground-water Contours June 2013 (PCB 2013-015)**


**Figure 21 Approximate Ground-water Contours August 2014 (PCB 2013-015)**

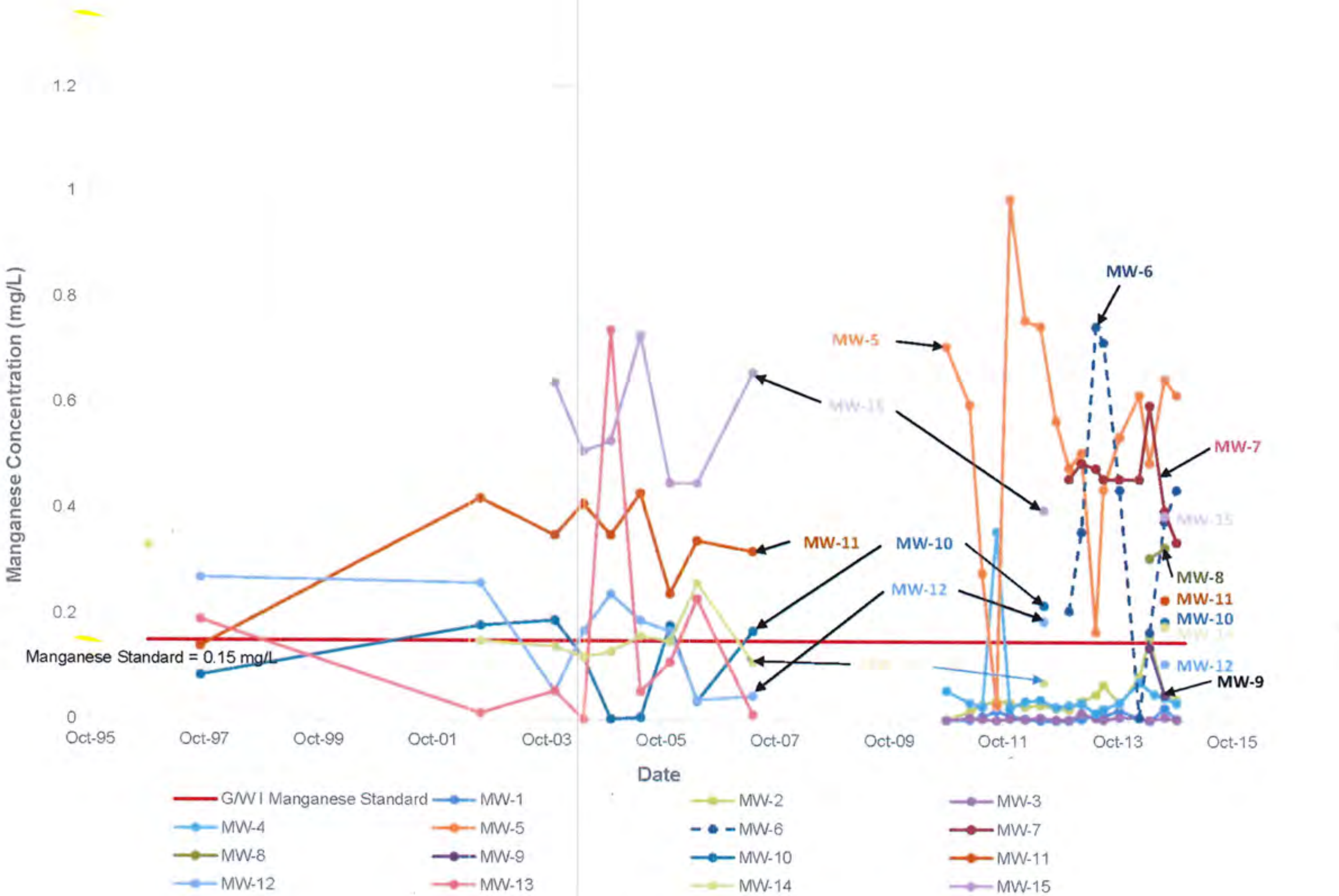


**Figure 22 Manganese Concentrations in Ground Water Waukegan Site (PCB 2013-015)**

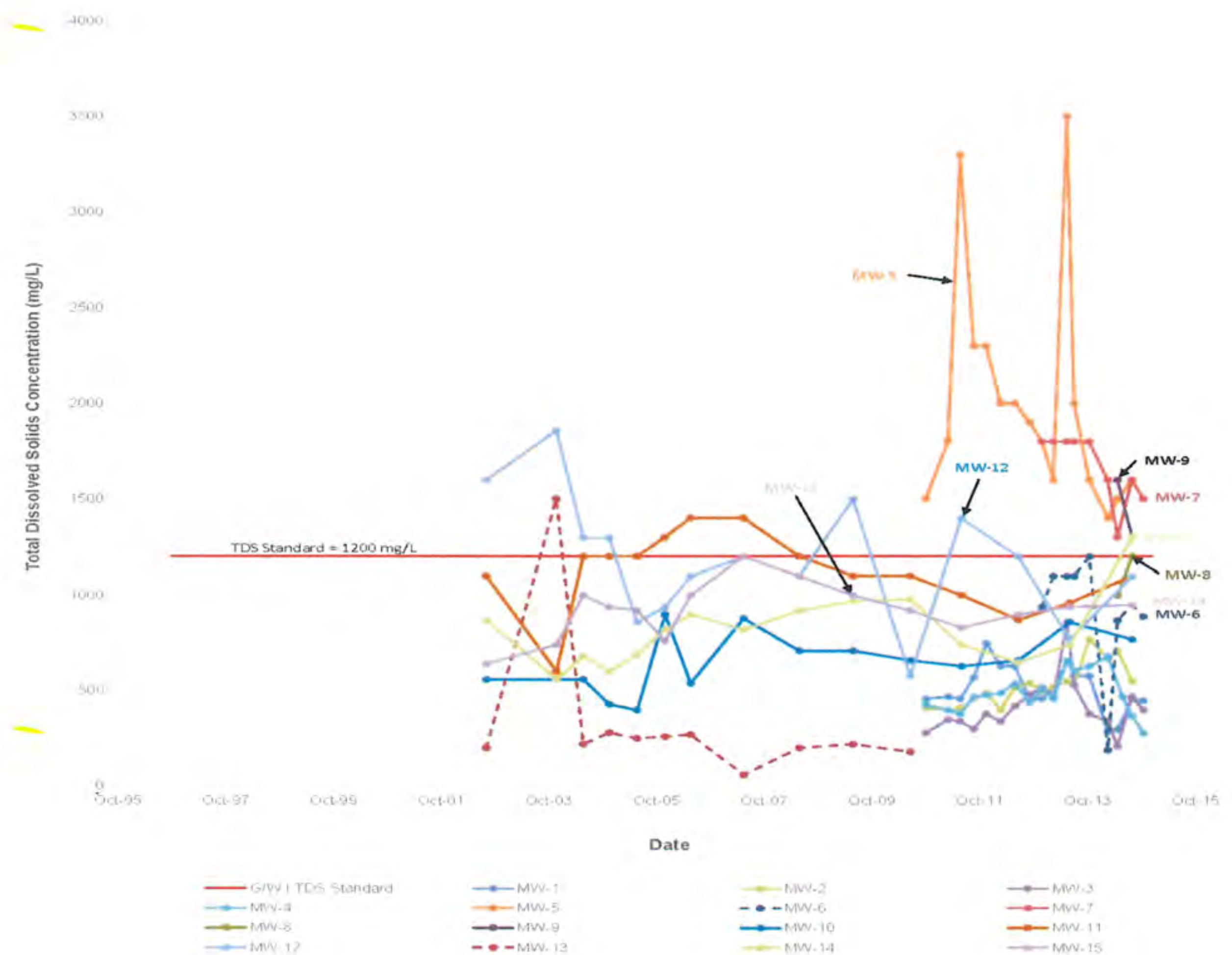


**Figure 23 TDS Concentrations in Ground Water**
**Waukegan Site (PCB 2013-015)**

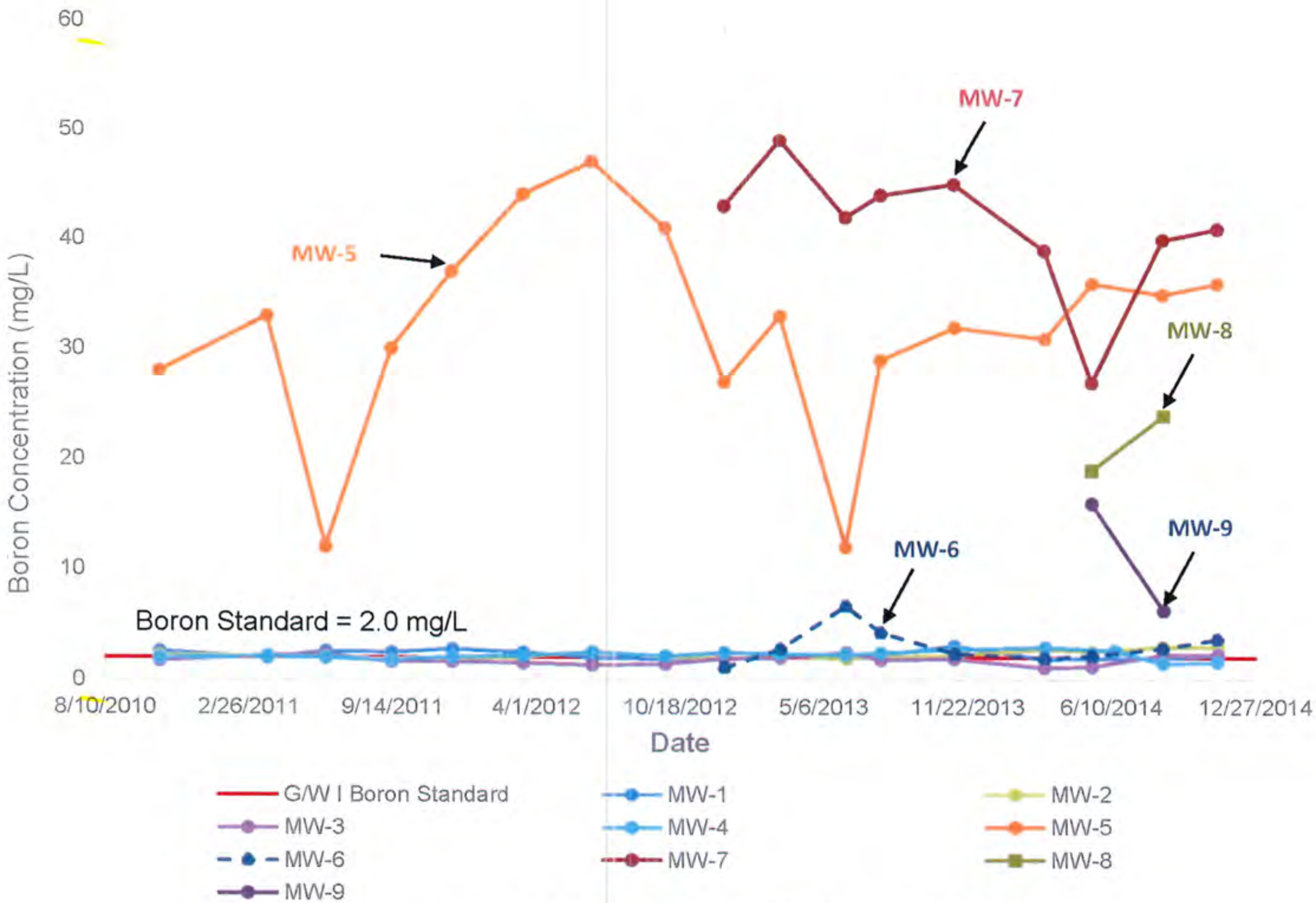


**Figure 24 Boron Concentrations in Ground Water Waukegan Site (PCB 2013-015)**

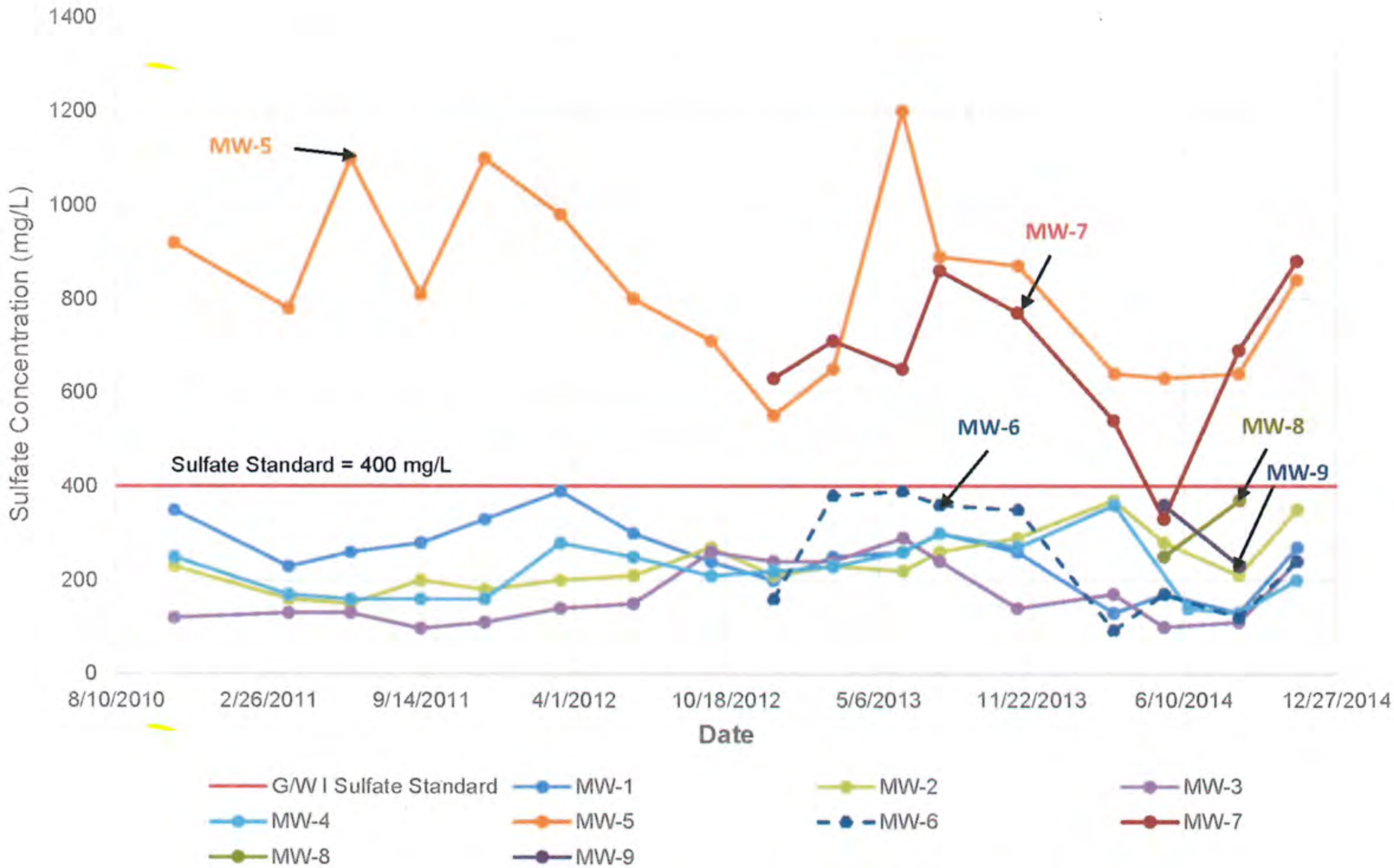


**Figure 25 Sulfate Concentrations in Ground Water**
**Waukegan Site (PCB 2013-015)**


**Figure 26 Will County Areas and Monitoring Well Locations (PCB 2013-015)**

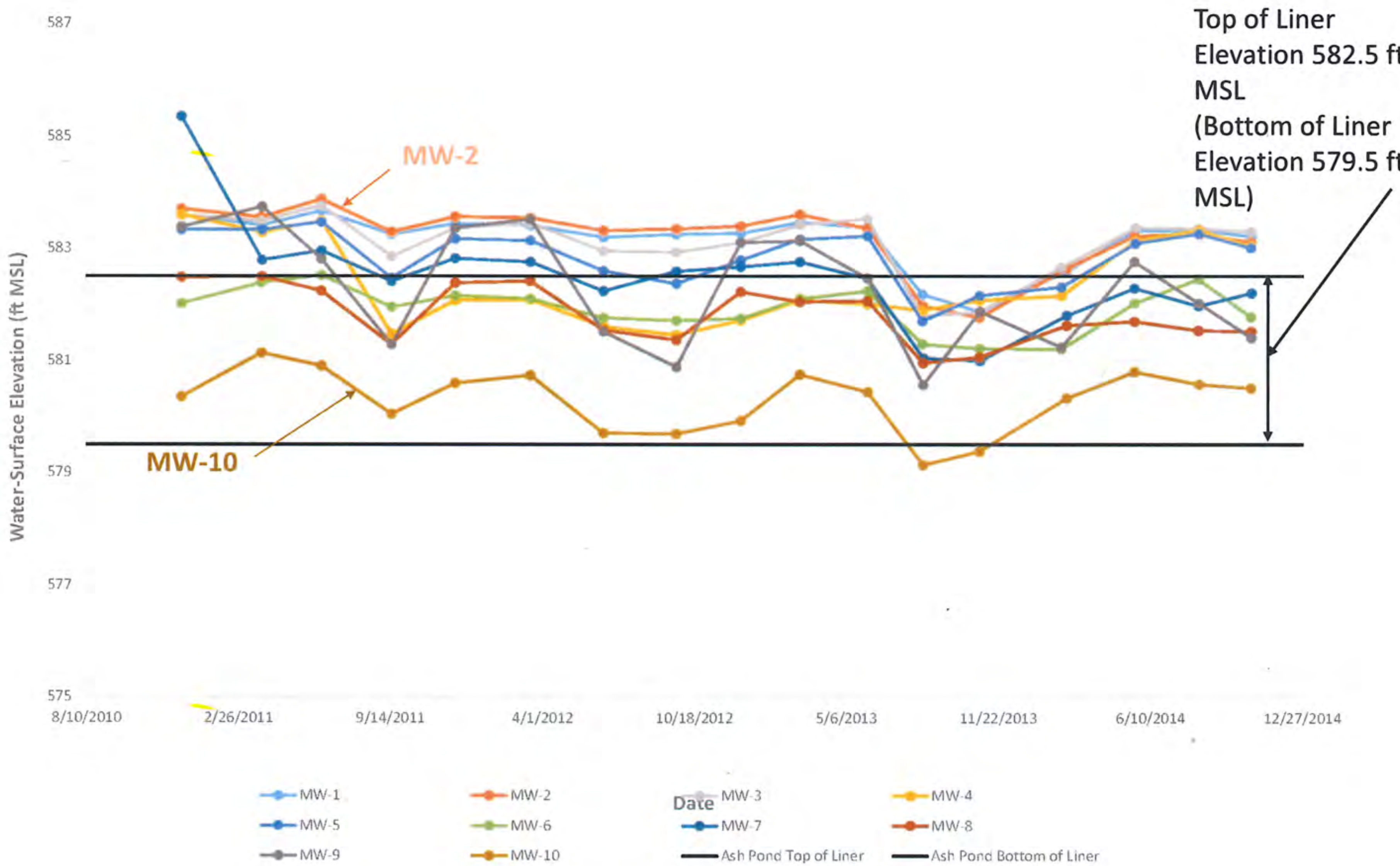


**Figure 27 Will County Site Historical Ground-water Elevations (PCB 2013-015)**

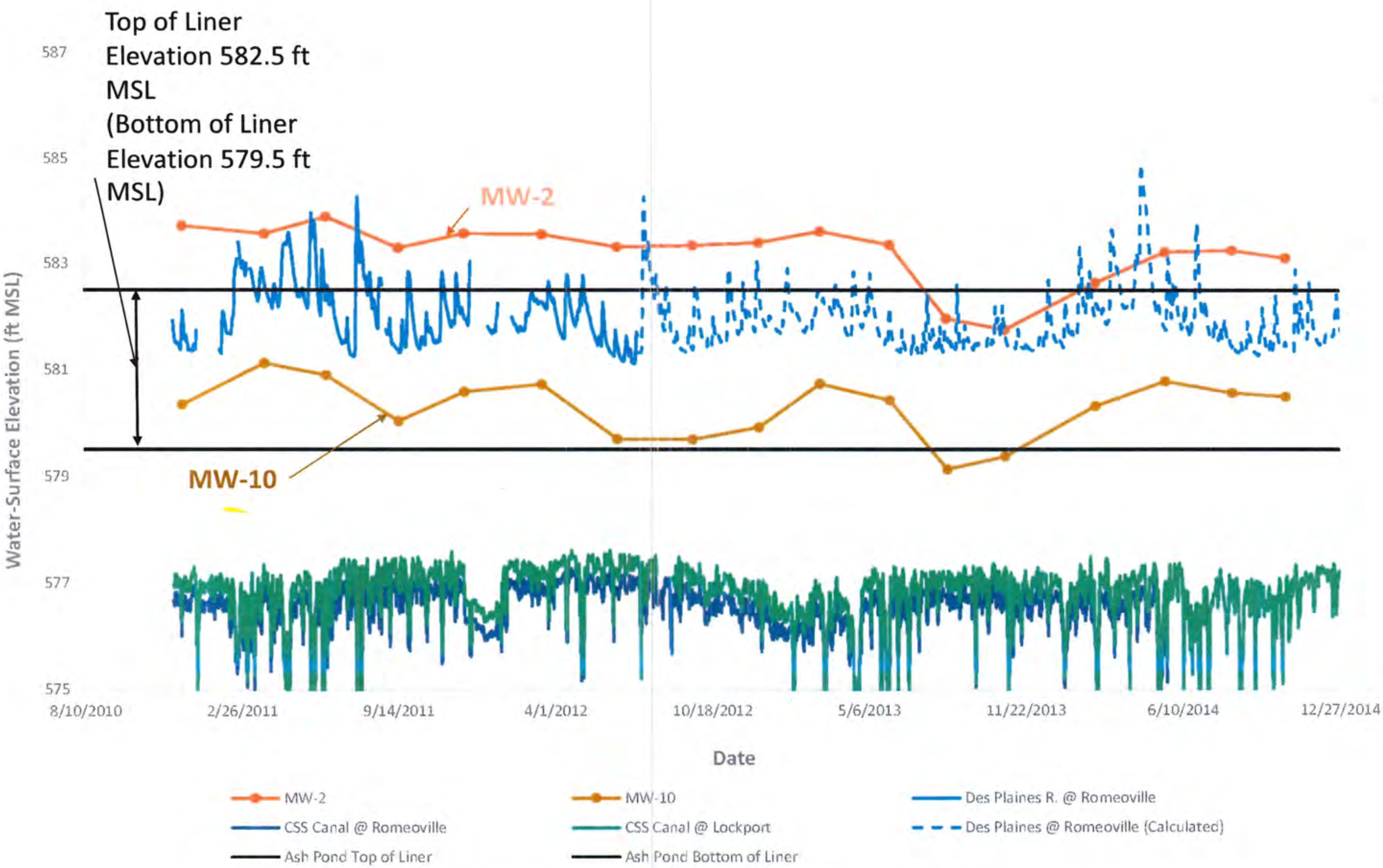


**Figure 28 Will County Site Historical Des Plaines River and CSS Canal Water-surface Elevations (PCB 2013-015)**

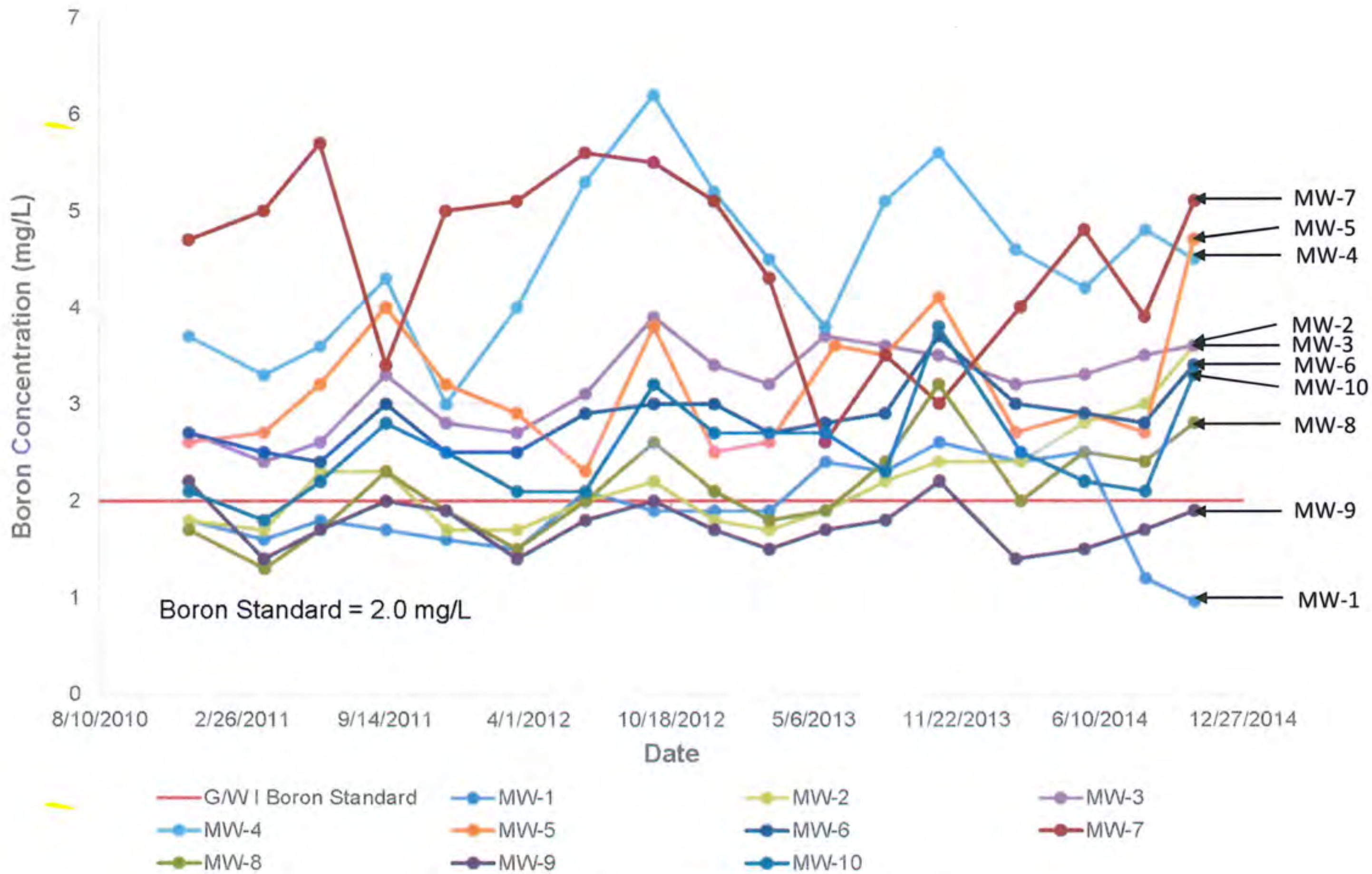


**Figure 29 Boron Concentrations in Ground Water**
**Will County Site (PCB 2013-015)**

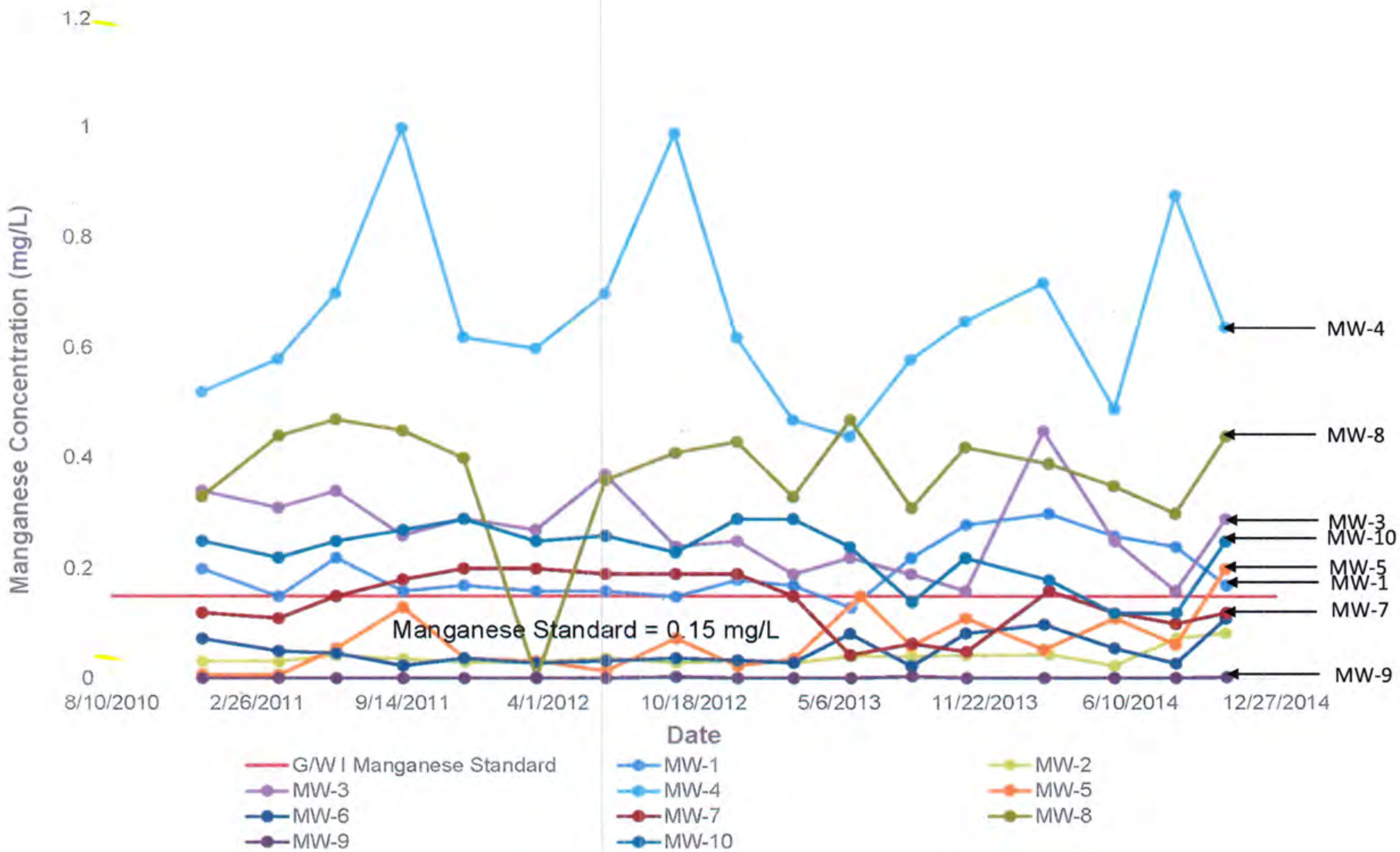


**Figure 30 Manganese Concentrations in Ground Water Will County Site (PCB 2013-015)**

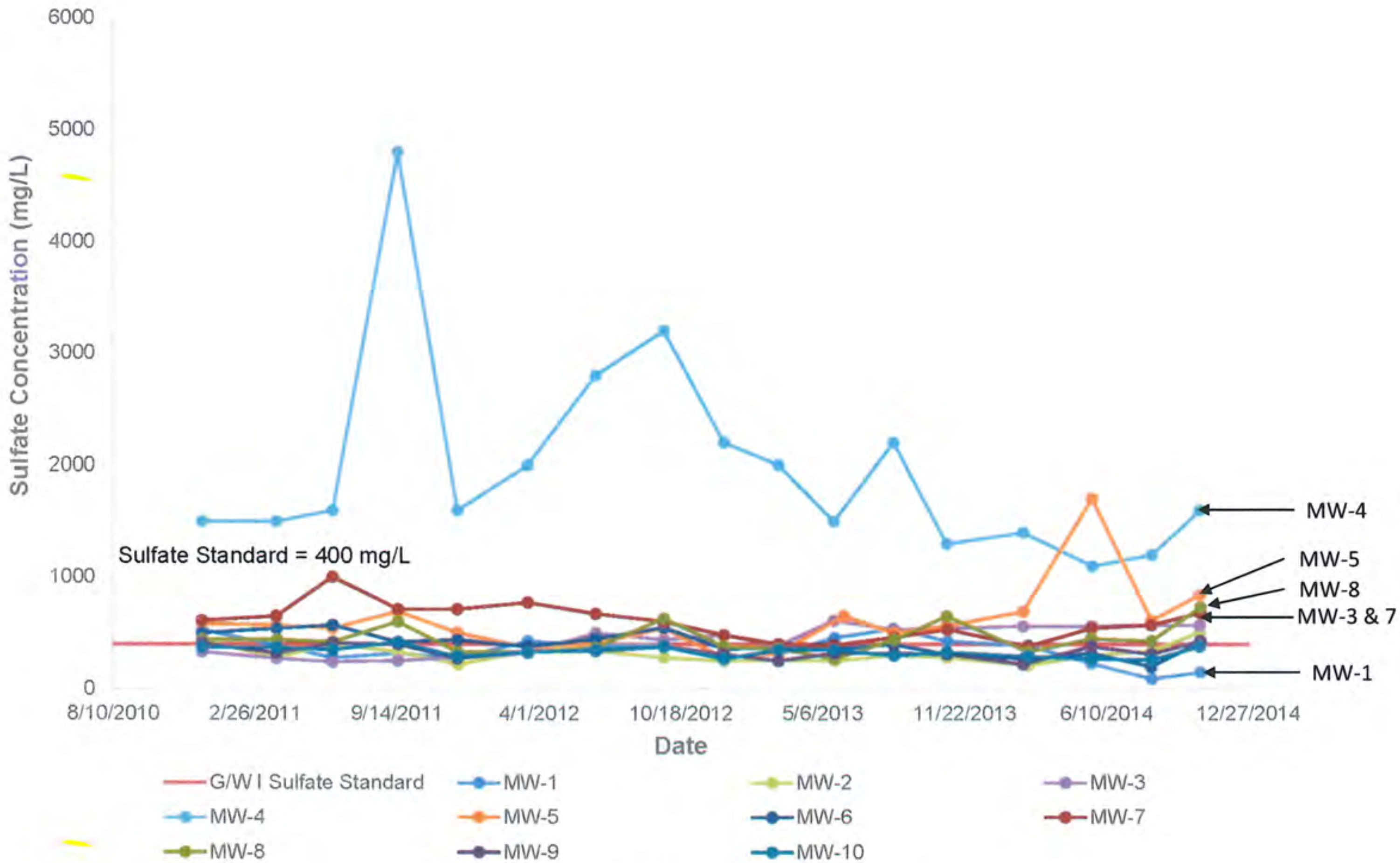


**Figure 31 Sulfate Concentrations in Ground Water**
**Will County Site (PCB 2013-015)**

***SIERRA CLUB, ET AL. V. MIDWEST GENERATION, LLC* PCB 13-15**

**RESPONSE TO MOTION TO STRIKE**

# EXHIBIT B

# EXPERT REPORT OF JOHN SEYMOUR, P.E.

# Expert Report of John Seymour, P.E.

I have prepared this Expert Report on behalf of Midwest Generation, LLC (MWG) to present my opinions and to address the two expert reports issued by M. James R. Kunkel in the Matter of:

SIERRA CLUB, ENVIRONMENTAL LAW AND POLICY CENTER, PRAIRIE RIVERS NETWORK, and CITIZENS AGAINST RUINING THE ENVIRONMENT
Complainants,
v
MIDWEST GENERATION, LLC,
Respondent
PCB 2013-0015

## Section 1: INTRODUCTION

### 1.1. Background

Since 1999, MWG has operated four electric generating stations at issue in this matter: the Joliet #29 Generating Station ("Joliet #29") located in Joliet, Will County, Illinois; the Powerton Generating Station ("Powerton") located in Pekin, Tazewell County, Illinois; the Waukegan Generating Station ("Waukegan") located in Waukegan, Lake County, Illinois; and the Will County Generating Station ("Will County") located in Romeoville, Will County, Illinois. Prior to 1999, the stations were operated by other entities and pre-1999 documents identify historic areas where ash was placed.[1]

Each of the generating stations includes active ash ponds as an integral part of the generating stations' wastewater treatment systems (MWG Facility NPDES Permits).[2] All of the ash ponds are permitted pursuant to MWG's NPDES permits (IL0064254, IL0002232, IL0002259, and IL0002208) and operate pursuant to the limits, terms, and conditions of the permits. All of the active ash ponds at the MWG facilities are fully lined with 60 mil-thick high density polyethylene (HDPE) liners.

In 2010, MWG voluntarily agreed to Illinois EPA's request to perform hydrogeological assessments around the ash ponds at its generating stations.[3] On June 11, 2012, based on the results of the hydrogeological assessments, Illinois EPA issued Violation Notices (VN) to MWG alleging violations of

[1] MWG13-15_8502-8536, MWG13-15_11966-12040, MWG13-15_29502-29532, MWG13-15_25139-25167

[2] MWG's Answer and Defenses to Second Complaint, Answers to Complaint ¶¶1, 3, 5, 7

[3] MWG13-15_364; MWG13-15_384; MWG13-15_407; MWG13-15_421

groundwater quality standards purportedly caused by the ash ponds.[4] The VNs listed exceedances of the groundwater quality standards for specific constituents at each station, such as chloride, antimony, and boron.[5]

MWG responded to the VNs, disputing that the ponds were the cause of groundwater exceedances.[6] MWG explained that the ash ponds are not disposal sites because the ash is routinely removed and that the alleged groundwater exceedances were inconsistent and did not show a connection to the ash ponds. Illinois EPA and MWG agreed on a Compliance Commitment Agreement (CCA) for each MWG station to resolve the VNs.[7]

As the CCAs were finalized,[8] Complainants filed a Complaint against MWG alleging open dumping violations, violations of Section 12 of the Illinois Environmental Protection Act, and violations of the Pollution Control Board groundwater regulations (35 Ill. Adm. Code 620.115, 620.301(a), and 620.405). Complainants later amended their Complaint to include historic filled areas on the sites. In support of their Complaint, Complainants presented two reports by James R. Kunkel.[9]

## 1.2. Contents of Opinion

I have reviewed the Kunkel reports and provide my assessment and opinions, below. In addition, I reviewed operational information, monitoring data, construction data and other documents for each of the stations to develop my opinions. Each of my opinions is supported by a reasonable degree of scientific certainty. The following outlines my approach to support my opinion:

- Section 2: Overview of Opinions
- Section 3: Credentials of John Seymour, P.E.
- Section 4: Summary of Current Conditions and Conceptual Site Models (CSM)
- Section 5: Opinion 1—MWG's Actions are Appropriate for the Sites and are Protective of Human Health and the Environment
- Section 6: Opinion 2—The Remedial Approach Provided in the Kunkel Remedy Report is Not Warranted

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[4] MWG13-15_328-358
[5] MWG13-15_328-358
[6] MWG13-15_364-437
[7] MWG13-15_553-572, 553-575
[8] MWG13-15_795-806
[9] Kunkel, 2015a and 2015b

## Section 2: Overview of Opinions

**Opinion 1: MWG's Actions are Appropriate for the Sites and are Protective of Human Health and the Environment.**

It is my opinion that MWG's actions at each plant site are appropriate for the measured groundwater impacts and are protective of human health and the environment. This opinion is based on the following:

- An approach that eliminates the exposure pathways to address the potential groundwater impacts is appropriate.
- Establishment of administrative controls such as Groundwater Management Zones (GMZ) and/or Environmental Land Use Controls (ELUC) are effective remedial approaches to reduce the exposure of potential groundwater impacts, are remediation industry-accepted approaches, and are approved State of Illinois methods.
    - GMZs are specified for sites undergoing corrective actions under Title 35, IAC Sections 620 (Bureau of Water) and 740 (Bureau of Land).
    - A minimum of 10 sites in Illinois currently have GMZs established by the IEPA Bureau of Water. IEPA Bureau of Water has not reported any groundwater violations for sites with GMZs.
    - The IEPA Bureau of Land has implemented on the order of 100 ELUCs.[10]
    - ELUCs and GMZs allow control of groundwater use along the exposure pathways by eliminating the ingestion pathway and dermal contact pathway while corrective action is underway.
        - The groundwater ingestion pathway is eliminated by restricting the installation of potable water wells in the area of the GMZs and ELUCs.
        - The dermal contact pathway is eliminated by restricting the access of the industrial properties to only trained workers.
- All of the active ponds were relined to eliminate a potential exposure pathway.
    - The relining of the CCR Ponds with 60-mil thick HDPE is an industry-accepted remediation approach to reduce the potential for groundwater impacts.

[10] The IEPA Bureau of Land also has approved GMZs for many sites.

  - The relining of the CCR Ponds was completed and inspected by an independent third party under construction quality assurance protocols and documented to be completed in accordance with the design documents or subsequently inspected by a qualified third party.
- The lined ponds are properly operated and maintained, which is the industry-accepted standard approach to preclude groundwater impacts. The operation and maintenance is being completed under consistent protocols.
- Groundwater monitoring is an accepted method to assess a remedial approach.
- I reviewed recent groundwater monitoring data and literature on liners to identify if liner defects were likely and if leaks of leachate through alleged liner defects could be impacting groundwater at the subject sites. It is my opinion that groundwater concentrations are not the result of leaks of leachate from the ash currently stored in lined ponds, as outlined below.
  - The leachate from bottom ash currently stored in ash ponds contains constituents at levels that do not exceed IEPA Class I groundwater standards based on neutral leaching analyses of site-specific samples, indicating that the bottom ash in the ponds is not a source of impact to groundwater.
  - The characteristics of ash leachate were identified based on site-specific impounded ash data or on published leachate data from ponds of subbituminous CCR sourced from the Powder River Basin (PRB) in Wyoming that is the source of coal ash from the Plants.
  - The profiles of the constituents in the groundwater do not match the profiles of leachate constituent indicators in the ponds at all four plant sites. This is based on a comparison of the occurrence of groundwater constituents detected in 2014 compared to minimum and maximum sets of indicators of leachate from ash stored in ponds.
- Groundwater conditions do not pose risks to surface water based on Illinois Water Quality Standards and Illinois Water Quality Criteria that are issued by the State of Illinois to be protective of human health and the environment. An assessment of human and ecological receptors in surface water indicates that there is no risk to the surface water environment at each site based on regulatory risk standards and standards of practice for risk assessments. The potential surface water risks were evaluated using a screening level

approach that compared concentrations in groundwater to Illinois Water Quality Standards (WQS) or Water Quality Criteria (WQC).

- Historical ash in fill materials outside of the ponds is not a source and is not a risk to human health and the environment.
  - Ash generated by coal combustion may be classified as CCB when there is beneficial use determined by IEPA as established in 415 Illinois Compiled Statutes 5/3.135. It is analogous to compare the current condition of CCB to the current IEPA criteria. In my opinion, the presence of CCB outside of the pond areas is acceptable for engineering considerations when compared to Illinois requirements.
  - Data obtained from recent samples of ash used as fill from multiple sites show that leachate from the ash meets IEPA Class I standards based on leaching from a soil-like environment.

**Opinion 2: The Remedial Approach Provided in the Kunkel Remedy Report is Not Warranted.**

It is my opinion that the remedial approach in the Kunkel Remedy Report, which is removal of all CCRs and the ash ponds, is not warranted. In addition to Opinion 1, removal is unwarranted because:

1. based on the concentrations of COIs that have been observed in groundwater around the ponds, MWG's remedial approach is protective of human health and the environment;
2. the concentrations of bottom ash indicator constituents from leachate do not match the groundwater chemistry. This shows that the constituents in groundwater are not from the ponds, the ponds are functioning in accordance with the design, and the ponds do not need to be removed;
3. there is no evidence that historical coal ash outside of the ash ponds is a current source of groundwater impact that needs to be removed; and
4. Kunkel did not follow the Illinois procedures for investigations and remedial activities.

Further, there are many inaccuracies in the Kunkel Expert Report on Ground-Water Contamination that, in general, incorrectly imply that groundwater is more threatened than supported by the data.

The following is provided to demonstrate this opinion:

- The ash ponds do not need to be removed because they are for wastewater treatment purposes and are not landfills for permanent ash disposal.
- The ash ponds are not a source of groundwater impacts because they are lined with 60-mil high density polyethylene (HDPE), which was the accepted standard of the ash pond lining industry, and there is no evidence that the liners are leaking. The liner construction quality is consistent with the ash pond lining quality management standards for long-term use.
  - The liner subgrade was inspected for sharp surfaces prior to installation of the HDPE liner and a protective geotextile was installed below the HDPE liner to avoid the potential for puncture.
  - Available literature on liners concludes that tears usually occur upon placement of overlying cushion and warning materials. MWG avoided this issue by inspecting the HDPE liner for leaks typically after installation of a protective sand cushion layer using the state of the practice electronic leak detection survey technologies.
  - Warning and cushion layers are installed above the HDPE liners to protect them from accidental contact and damage during future dredging operations.
  - The quality of construction was documented by an independent engineering firm that attested that the construction met the project drawings and specifications and manufacturer's recommendations, or subsequently inspected by a qualified third party.
- Operation and maintenance (O&M) of the ash ponds will avoid future leaks because O&M are conducted in accordance with consistent operating procedures that include:
  - Periodic dredging of settled bottom ash is carefully performed using excavators. If the excavator bucket were to encounter the stone warning layer, which is located over the protective layer, which in turn is located over the HDPE liner, it would be obvious to the operator who is instructed to stop excavating. If the HDPE liner was encountered, white HDPE material would be visually observed in the bucket by the excavator operator who would stop work.
  - Previous tears observed in the ash pond liners have been above the impounded water surface with one exception. Tears above impounded water would not be expected to result in leaks. Only one tear was discovered in a pond liner that was below the level of impounded ash and water at the Will County Ash Pond 3S; this

tear occurred when no water was in Ash Pond 3S and was repaired prior to refilling water to the level of the tear in the ash pond. All observed tears were repaired.

- Kunkel incorrectly concludes that all of the former ash ponds leaked and the current ash ponds are leaking. He asserts that the groundwater elevations are above the bottom of the ponds or pond water surface and in turn causing bottom heave. He is incorrect on several bases. First, an uplift pressure argument is relative to the top of the bottom liner. Second, an uplift argument is an issue for soil liners, not geomembrane liners that are at all of the ponds. Third, groundwater levels are not often above the top of the bottom liners and when they are above the bottom liner there are other opposing forces or controls to eliminate uplift.
- Kunkel incorrectly asserts that hydrostatic uplift is causing liner failure for multiple ash ponds. Kunkel does not account for the fact that the hydrostatic uplift pressures at the two ponds where the groundwater levels are above the bottoms of the ponds are resisted by the weight of the sand and protective layers and the weight of overlying pond water.
- Kunkel is incorrect by alleging that there is groundwater mounding at Joliet #29. Kunkel alleges that mounding is occurring by selecting the single highest water level value at MW-9. Yet, the years of data shows the average water level in MW-9 is lower than MW-8, rebutting any notion of a groundwater mound.
- Kunkel is incorrect by alleging that there is groundwater mounding at Waukegan. Kunkel alleges that mounding is occurring based on high groundwater elevations below the pond. My analysis of groundwater contours indicates that the contours reflect the surrounding surface topography.
- Kunkel incorrectly portrays background concentrations by using state-wide data for groundwater at the Joliet #29, Waukegan, and Will County sites. It is my opinion that this approach is inappropriate and also fails to account for those sites where upgradient groundwater is impacted prior to migrating on-site.

**Opinion 3: In Addition to Being an Unwarranted Remedy, Kunkel's Remedy Cost Opinion Underestimates the Costs to Implement the Unwarranted Cleanup.**

Even if the unwarranted remedy recommended by Kunkel were to be implemented, the Kunkel Remedy Report significantly underestimates the cost of his proposed cleanup.

- Kunkel's proposed remedy fails to incorporate the costs of disposal at a permitted landfill. I estimated the disposal costs associated with Kunkel's proposed remedy to be on the order of $178,000,000 in total for all four sites. This increases the total estimated cost of the unwarranted remedy by 68 percent.
- Kunkel's proposed remedy, consisting of removal of ash-impacted soil and backfilling, results in significant disruptions of the electricity generation facilities. As examples:
    - Kunkel's estimates include areas below equipment such as switchyards, coal handling and transfer equipment, and cooling water conveyance and treatment equipment. Given Kunkel's estimates of the areas and thicknesses of coal ash in these areas, equipment would be down on the order of years at each plant, during which time the plants will experience significant outages and extensive costs to dismantle and reassemble equipment and underground utilities, roadways, etc. and would cause lost service to public and industrial users.
    - The cost to remove and replace the equipment is not included in the cost estimate.
- Kunkel's proposed remedy results in significant impacts to the surrounding communities, including dust, noise, and traffic. Of particular concern is the increased risk of vehicle crashes involving large trucks.
    - Based on Kunkel's estimates of volume of ash-impacted soils, off-site disposal is anticipated to create on the order of 17,000,000 miles of large truck traffic for the four sites.
    - The large amount of truck traffic would be a significant nuisance to the neighboring communities from:
        - The increased road dust and increased road traffic; and
        - The human health risk of large truck crashes (1.42 fatalities per 100,000,000 miles). Based on the above mileage estimate, the human health risk of Kunkel's proposed remedy is on the order of ¼ fatalities and 4.6 injuries based on large traffic crashes alone.

  - Therefore, the risk of removal of all coal ash and trucking to an offsite facility is not supported by the risk of leaving the existing materials in place, which is essentially no risk to human health and the environment.
- Kunkel's proposed remedy also fails to consider the impact of vehicle carbon dioxide emissions on climate change. I estimate the carbon dioxide emissions from the large truck traffic and excavation equipment to be on the order of 30,000 tons.

# Section 3: Credentials of John Seymour, P.E.

## 3.1. Introduction

I am a geotechnical engineer with nearly three decades of experience in the U.S., Canada, Spain, Guatemala and Korea in the areas of site remediation, high-rise building deep foundations, and construction management. I have focused on waste management and remediation (Superfund (CERCLA) and RCRA) projects for 25 years, with significant involvement in 17 sites providing professional services in the areas of project management, project coordination (client representative), site characterization, feasibility studies, bench/pilot studies, civil/geotechnical design, construction quality assurance (CQA), and operation and maintenance.

I have completed field studies including geologic and hydrogeologic studies, aquifer testing, seismic surveys, landfill settlement tests, and the characterization of volatile organic compounds (TCE and by-products), semi-volatile organic compounds, PCBs, metals, and saline groundwater intrusion. In addition, I have geotechnical engineering experience with the design and construction of deep foundations, including drilled piers, tie backs, foundation grouting and soil improvement programs, and diaphragm (slurry) walls.

My full curriculum vita is attached as Appendix A.

## 3.2. My relevant experience

I have provided coal combustion residuals (CCRs) engineering services, regarding management of fly ash, bottom ash and flue gas desulfurization (FGD) waste for ponds and landfills. These services have included geotechnical and environmental evaluations of waste disposal expansions, operations and closure, disposal permit application preparation, for eight U.S coal power generation clients. Overall I have provided relevant consulting engineering services for 7 CCRs ponds and 14 CCR landfills and provided records review, evaluation and engineering scope of work development for 4 additional CCR ponds. I have translated some of this experience into 11 technical papers and completed 2 research guidance documents on CCR ponds (co-investigator), and provided 10 technical presentations at conferences including at conferences focusing on CCR management. The specific types of services I have provided are: investigation of the subsurface soils and bedrock (geology) at CCR disposal sites; CCR waste characterizations in various settings; characterization of site hydrogeology through use of monitoring wells and piezometers and conducting aquifer hydraulic testing; engineering feasibility studies of potential configurations of new ash disposal facilities and expansion of existing ash disposal facilities, including economic evaluations; design engineering management for geotechnical, stormwater, wastewater treatment, and remediation projects; characterization of the nature and extent of contamination and associated risks; construction quality assurance/quality control (QA/QC) plans and implementation; and project management and construction management.

### 3.3. Materials Reviewed

In order to develop my opinions in this matter, with the assistance of my staff, I reviewed site histories, analyzed facts, reviewed monitoring data, conducted assessments and calculations of risks, and assessed potential impacts. The documents I relied upon are cited within this report.

# Section 4: Summary of Current Conditions and Conceptual Site Models

## 4.1. Joliet #29

### 4.1.1. Site Description, Site History, and Neighboring Properties

The Joliet #29 site is located along the Des Plaines River in Section 19, Township 35 North, Range 10 East, in the City of Joliet, Will County, Illinois.[11] The Joliet #29 site encompasses approximately 271 acres.[12] The current land use is for coal-fired steam electric power generation.[13] The facility has two generating units each consisting of two boilers and twin turbines that were installed in 1965 to 1966.[14] The Joliet #29 site is in an industrial area; the former Caterpillar, Inc. manufacturing facility is adjacent to the west and there are additional industrial facilities to the north and east.

### 4.1.2. Description of CCR Management

Fly ash generated by coal combustion is collected using electrostatic precipitators and then transported off-site for beneficial reuse.[15] Bottom ash from the boilers is mainly conveyed automatically by an enclosed pipe system across the Des Plaines River to a permitted landfill.[16] Prior to October 12, 2015, a small fraction of the bottom ash slurry (approximately 5 to 10 percent) was pumped to Ash Pond 1 or Ash Pond 2 for settling when the conveyor system is offline.[17] Subsequently, Ash Pond 1 has been taken out of service and all ash has been removed.[18] Ash Pond 3 is used as a finishing pond for the effluent and is considered to receive a *de minimus* amount of ash.[19] Bottom ash is collected from ash ponds and is transported off-site for disposal in a permitted landfill. Treated water is either recycled or discharged to the Des Plaines River under a National Pollutant Discharge Elimination System (NPDES) Permit.[20]

The following summarizes the approximate dimensions and capacities of Joliet #29 ash ponds[21]:

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[11] Patrick, 2010a
[12] MWG13-15_25147
[13] In addition, an industrial wastewater treatment plant formerly existed at the site.
[14] MWG13-15_25147
[15] MWG13-15_25154
[16] MWG13-15_25152; Deposition of Jim DiCola, p. 49
[17] Deposition of Jim DiCola, p. 49.
[18] Teleconference with Pete O'Day
[19] Teleconference with Harrison Estepp; MWG13-15_49742-MWG13-15_49753
[20] MWG13-15_18155; MWG13-15_44279
[21] MWG13-15_30-32

- Ash Pond 1: 168 feet by 419 feet with a depth of 19 feet; capacity is approximately 2,000,000 cubic feet ($ft^3$)
- Ash Pond 2: 168 feet by 419 feet with a depth of 19 feet; capacity is approximately 2,000,000 $ft^3$
- Ash Pond 3: Non-rectangular shape with length 340 feet and widths varying between 80 feet and 220 feet; capacity is approximately 1,100,000 $ft^3$

Construction history and information is provided in Section 5.3.2.1.

#### 4.1.3. Geological Setting

The regional geology beneath the Joliet #29 site consists of approximately 5 to 30 feet of sandy loam, underlain by Silurian Dolomite to approximately 176 feet below ground surface, and Maquoketa shale from approximately 176 to 241 feet below ground surface based on water well logs. The Maquoketa shale is an aquitard that separates the shallow groundwater in the unconsolidated units and the Silurian dolomite from the underlying aquifers.[22]

MWG submitted the results of a potable water well investigation to the Illinois EPA by letter dated July 15, 2009 that identified 17 potable/industrial use wells located within a 2,500-foot radius of the Joliet #29 ash ponds.[23] Only two of the wells (Numbers 19 and 4) are located downgradient from the ash ponds. Both of these industrial use wells are owned by MWG, are drilled at 1,525 feet below ground surface, and are screened below the Maquoketa shale, the primary aquitard separating shallower aquifers from the screened interval of the MWG wells.[24] These wells have consistently been in compliance with the potable water regulations.[25]

Groundwater flow in the shallow, unconsolidated aquifer is mainly controlled by the Des Plaines River with groundwater flowing towards the river during most periods of the year.[26] Groundwater flow in the deeper aquifers is controlled by the regional hydraulic gradient in these aquifers, which is to the northeast.[27]

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[22] Patrick, 2011a
[23] Patrick, 2011a
[24] Patrick, 2011a; MWG13-15_293-305
[25] MWG13-15_293-305
[26] Patrick, 2011a
[27] Patrick, 2011a

#### 4.1.4. Site-Specific Lithology

I reviewed boring logs and summarize the following lithology generally observed at Joliet #29: fill of varying soil materials was observed near the surface at most locations; at certain borings, ash or cinders were observed in fill materials. Within the vadose zone, unsaturated soils included fine to coarse sand and gravel, limestone fragments, clay, silty clay, and sandy silt. In the shallow aquifer, saturated soils included fine to coarse sand and gravel, limestone fragments, and silty clay. Limestone bedrock was recorded at one boring (B-MW-6) at a depth of 38.5 feet bgs.[28]

#### 4.1.5. Site-Specific Groundwater Elevations

Groundwater elevations at the 11 monitoring wells at the Joliet #29 site (see Figure 4-1) during the period of record varied between 503.94 feet above MSL (at monitoring well MW-4 in May 2013) to 512.33 feet above MSL (at monitoring well MW-2 in September 2012) as summarized in Table 4-1. The highest groundwater elevation is typically found at monitoring well MW-11 during the period of record. The lowest groundwater elevation is typically found at either monitoring well MW-1 or MW-5.[29] Based on my review of the groundwater elevations, groundwater generally flows south to the Des Plaines River.

#### 4.1.6. Site-Specific Groundwater Conditions

I reviewed groundwater concentrations at monitoring wells at the Joliet #29 site, and it is my opinion that there is no groundwater plume. Constituents of interest (COI) that were observed at concentrations exceeding IEPA Class I groundwater standards are listed in Table 4-2. The data shows that there is no spatial trend in COI concentrations in the direction of the groundwater flow. Furthermore, the observed COI concentrations intermittently exceed IEPA Class I groundwater standards. Without evidence that there is spatial or temporal consistency in groundwater impacts, it is my opinion that there is no plume at the Joliet #29 site. Without the existence of a plume, there is no support that there is a source area remaining at the site that could be remediated to reduce groundwater concentrations.

Groundwater conditions at Joliet #29 are impacted by upgradient off-site sources; for example, chloride was found upgradient away from the Joliet ash pond area. See Section 6.5.7.

[28] Patrick, 2011a
[29] MWG13-15_48653-55

## 4.2. Powerton

### 4.2.1. Site Description, Site History, and Neighboring Properties

The Powerton site is located along the Illinois River in Section 9, Township 24 North, Range 5 West in the City of Pekin, Tazewell County, Illinois.[30] The Powerton site encompasses approximately 1,710 acres, which includes 1,440 acres of Powerton Lake.[31] The current land use is for coal-fired steam electric power generation. The facility has two active electric generating units (Units 5 and 6) that were installed in 1971 to 1973.[32]

Neighboring properties include a cabinetry manufacturer and railroad to the east and wooded and agricultural areas to the north, west, and south.[33]

### 4.2.2. Description of CCR Management

Fly ash generated by coal combustion is collected using electrostatic precipitators and then transported off-site for mine reclamation.[34] Bottom ash from the boilers is mixed with water to form a slurry that is pumped to dewatering bins where the water is decanted and sent to the Ash Surge Basin for settling.[35] Bottom ash is collected from ash ponds and is sold and transported off-site by a third-party.[36] Treated wastewater is either recycled or discharged under an NPDES permit.

The following summarizes the approximate dimensions and capacities of Powerton ash ponds[37]:

- Ash Surge Basin: 960 feet by 250 feet with a depth of 14 feet; capacity is approximately 4,100,000 $ft^3$
- Secondary Ash Settling Basin: approximately 320 feet by 220 feet with an estimated depth of 10 feet; capacity is approximately 590,000 $ft^3$
- Ash Bypass Basin: approximately 256.5 feet by 135 feet; capacity is approximately 264,900 $ft^3$

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[30] Patrick, 2011b
[31] MWG13-15_8509
[32] MWG13-15_8516
[33] MWG13-15_8517
[34] MWG13-15_49655
[35] MWG13-15_7401
[36] Deposition of Mark Kelly, p. 41
[37] MWG13-15_20-23; MWG13-15_10983

- Metal Cleaning Basin: 350 feet by 120 feet with a depth of 12 feet; capacity is approximately 720,000 $ft^3$

Construction history and information is provided in Section 5.3.2.2.

### 4.2.3. Geological Setting

The regional geology beneath the Powerton site consists of approximately 100 to 125 feet of unconsolidated deposits (mainly alluvial sands and gravels with some minor clay), underlain by the Carbondale Formation, which consists of alternating layers of limestone, shale, coal, and underclay. Groundwater flow in the shallow, unconsolidated aquifer is largely controlled by the Illinois River with groundwater flowing towards the river during most periods of the year.[38]

MWG submitted the results of a potable water well investigation to the Illinois EPA by letter dated July 15, 2009 that identified six wells located within a 2,500-foot radius of the Powerton ash ponds. None of these wells are located downgradient from the ash ponds. Two of these wells supply Powerton with water, which have consistently been in compliance with the potable water regulations.[39]

### 4.2.4. Site-Specific Lithology

I reviewed boring logs and summarize the following lithology generally observed at Powerton: fill materials consisting of fine to coarse sand, gravel, silty clay, and topsoil were observed near the surface; in certain borings, coal cinders were also observed in fill materials. Within the vadose zone, unsaturated soils included the fill materials previously described, fine to coarse sand and gravel, clayey silt, silty clay, silt, and clay. In the shallow aquifer, saturated soils included fine to coarse sand and gravel, trace silt, and clay.[40]

### 4.2.5. Site-Specific Groundwater Elevations

Groundwater elevations at the 16 monitoring wells at Powerton (see Figure 4-2) during the period of record have varied between 429.94 feet above MSL (at monitoring well MW-3 in December 2012) to 451.84 feet above MSL (at monitoring well MW-12 in May 2013) as summarized in Table 4-3. The highest groundwater elevations are typically found at either monitoring well MW-6 or MW-12 in a shallow, localized saturated clay/silt unit during the period of record. The lowest groundwater elevations are typically found at either monitoring well MW-3 or MW-4 in a more

[38] Patrick, 2011b
[39] Patrick, 2011b; MWG13-15_293-305
[40] Patrick, 2011b

extensive sand unit underlying the clay/silt unit.[41] Based on my review of the groundwater elevations, there are two groundwater units at the site that are hydraulically connected: 1) groundwater in the sand unit generally flows north to the Illinois River, and 2) groundwater in the clay/silt unit flows west toward Powerton Lake.

#### 4.2.6. Site-Specific Groundwater Conditions

I reviewed groundwater concentrations at monitoring wells at the Powerton site, and it is my opinion that there is no groundwater plume. COI that were observed at concentrations exceeding IEPA Class I groundwater standards are listed in **Table 4-4**. The data show that there is no spatial trend in COI concentrations in the direction of the groundwater flow in either the sand unit or the clay/silt unit. Furthermore, the observed COI concentrations intermittently exceed IEPA Class I groundwater standards. Without evidence that there is spatial or temporal consistency in groundwater impacts, it is my opinion that there is no plume at the Powerton site. Without the existence of a plume, there is no support that there is a source area remaining at the site that could be remediated to reduce groundwater concentrations.

Groundwater conditions at Powerton are impacted by upgradient off-site sources; for example, nitrate is found upgradient, which is not related to COIs found on the Powerton site. See Section 6.5.7.

### 4.3. Waukegan

#### 4.3.1. Site Description, Site History, and Neighboring Properties

The Waukegan site is located in Section 15, Township 45 North, Range 12 East in the City of Waukegan, Lake County, Illinois. The Waukegan site encompasses approximately 194 acres. The current land use is for coal-fired steam electric power generation. The facility has two active electric generating units (Units 7 and 8) constructed in 1958, and 1962, respectively.[42]

Neighboring properties include the Johns Mansville Company, which is an active Superfund site, to the north, the former site of the General Boiler Company, and the former site of the

[41] MWG13-15_48722-25
[42] MWG13-15_12003-12018

Greiss-Pfleger Leather Tanning Facility to the west, and the North Shore Water Reclamation District publicly owned treatment works to the south.[43]

The Greiss-Pfleger Leather Tanning Facility operated on land hydraulically upgradient of the Waukegan Generation Station. In 2003, at the neighboring property owner's request, MWG established an Environmental Land Use Control (ELUC) on the western side of its property as an institutional control to prevent against exposure to historically contaminated soil and groundwater that has migrated onto MWG's Waukegan site as the result of past industrial activities on the former Greiss-Pfleger Tannery Site.[44] The Greiss-Pfleger Tannery utilized the chromium tanning process, which consisted of nine steps and involved numerous chemicals including sodium sulfate, diethylamine, sulfhydrate, cyanide salts, sulfuric acid, and borax.[45] Analytical results of the groundwater at/from the tannery indicate that certain inorganic constituents, including arsenic, boron, chromium, lead, and mercury, have migrated onto the Waukegan property.[46] Presently there is a switchyard and substation at the former Greiss-Pfleger Tannery site.

### 4.3.2. Description of CCR Management

Fly ash generated by coal combustion is collected using electrostatic precipitators and then transported off-site for beneficial reuse.[47] Bottom ash from the boilers is mixed with water to form a slurry that is pumped to ash ponds to be treated by settling.[48] Bottom ash is collected from ash ponds and is transported off-site for beneficial reuse.[49] Treated water is either recycled or discharged to a wastewater treatment plant.[50]

The following summarizes the approximate dimensions and capacities of Waukegan ash ponds[51]:

- West Ash Pond: Non-rectangular with length of 972.5 feet and width up to 437.5 feet with a depth of 22.5 feet; capacity is approximately 7,700,000 $ft^3$

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[43] MWG13-15_12003-12018, MWG13-15_48644
[44] MWG13-15_12713–12738
[45] MWG13-15_47089
[46] MWG13-15_217-222, MWG13-15_46600, MWG13-15_45512 and MWG13-15_50086-50092
[47] MWG13-15_12017
[48] MWG13-15_12017
[49] MWG13-15_49679-49700
[50] MWG13-15_7392
[51] MWG13-15_13-15

- East Ash Pond: Non-rectangular with length of 972.5 feet and width up to 437.5 feet with a depth of 22.5 feet; capacity is approximately 6,500,000 $ft^3$

Construction history and information is provided in Section 5.3.2.3.

#### 4.3.3. Geological Setting

The regional geology beneath the Waukegan consists of approximately 100 feet of sand deposits, underlain by Silurian Dolomite to approximately 360 feet below ground surface, underlain by the Maquoketa shale. The Maquoketa shale is an aquitard that separates the shallow groundwater in the unconsolidated units and the Silurian dolomite from the underlying aquifers. Groundwater in the shallow, unconsolidated aquifer flows towards Lake Michigan, located primarily to the east. Groundwater flow in the deeper aquifers is controlled by the regional hydraulic gradient in these aquifers, which is to the northeast.[52]

MWG submitted the results of a potable water well investigation to the Illinois EPA by letter dated July 15, 2009 that identified eight potable/industrial use wells located within a 2,500-foot radius of the Waukegan ash ponds. There are no potable use wells downgradient of the ash ponds.[53]

#### 4.3.4. Site-Specific Lithology

I reviewed boring logs and summarize the following lithology generally observed at Waukegan. Fill materials consisting of silty clay, clayey silt, gravely clay, silt, sand, fine to coarse gravel, crushed rock, crushed limestone, and cobbles were observed near the surface; in certain borings, coal cinders and ash was observed in fill materials. Within the vadose zone, unsaturated soils included the fill materials previously noted, and fine to coarse sand. In the shallow aquifer, saturated soils included fine to coarse sand and gravel.[54]

#### 4.3.5. Site-Specific Groundwater Elevations

Groundwater elevations at the seven monitoring wells at Waukegan (see Figure 4-3) varied between 579.27 feet above MSL (at monitoring well MW-2 in December 2012) to 584.56 feet above MSL (at monitoring well MW-6 in May 2014) as summarized in Table 4-5. The highest groundwater elevation is typically found at either monitoring well MW-5 or MW-6 during the period of record. The lowest groundwater elevation during each quarterly monitoring event varied between the

[52] Patrick, 2011c
[53] Patrick, 2011c; MWG13-15_293-305
[54] Patrick, 2011c

following monitoring wells: MW-1, MW-2, MW-4, or MW-7.[55] Additional upgradient monitoring wells have been installed and monitored at the Waukegan Site in response to the migration of inorganic constituents from the former Greiss-Pfleger Tannery site. Based on my review of the groundwater elevations, groundwater generally flows east to Lake Michigan. Site-wide groundwater contours for the Waukegan site are provided on Figure 4-4. See Section 6.5.7.

### 4.3.6. Site-Specific Groundwater Conditions

I reviewed groundwater concentrations at monitoring wells at the Waukegan site, and it is my opinion that there is no groundwater plume. COI that were observed at concentrations exceeding IEPA Class I groundwater standards are listed in Table 4-6. Furthermore, the observed COI concentrations intermittently exceed IEPA Class I groundwater standards.

Groundwater conditions at Waukegan are impacted by upgradient and off-site sources; for example, boron was detected exceeding IEPA Class I groundwater standards in upgradient wells from the former Greiss-Pfleger Tannery site. See Section 6.5.7.

## 4.4. Will County

### 4.4.1. Site Description, Site History, and Neighboring Properties

The Will County site is located between the Chicago Sanitary and Ship Canal and the Des Plaines River in Section 2, Township 36 North, Range 10 East, in the City of Romeoville, Will County, Illinois. The Will County site encompasses approximately 215 acres and is used for coal-fired steam electric power generation.[56] The facility has one active electric generating unit (Unit 4) constructed in 1963. Neighboring properties include a former drum restoration operation to the northwest,[57] the Citgo Lemont Refinery to the northeast, Hanson Materials (f/k/a Material Service Corp.) to the south, and a ComEd switchyard to the west.[58]

### 4.4.2. Description of CCR Management

Fly ash generated by coal combustion is collected using electrostatic precipitators and then transported off-site for beneficial reuse.[59] Bottom ash from the boilers is mixed with water to form

[55] MWG13-15_48908-09
[56] MWG13-15_29509
[57] MWG13-15_13242- 13421
[58] MWG13-15_29509
[59] MWG13-15_29516

a slurry that is pumped to Ash Ponds 2S or 3S for settling.[60] Bottom ash is collected from ash ponds and is transported off-site for beneficial reuse. The slurry water is recycled back into the Station for treatment. In 2010, Midwest Generation ceased using Ash Ponds 1N and 1S, and no additional ash or ash slurry is deposited in those ponds; furthermore, the water levels of Ash Ponds 1N and 1S are not allowed to exceed one foot above the base.

The following summarizes the approximate dimensions and capacities of Will County ash ponds:[61]

- Ash Pond 2S: 350 feet by 178 feet with a depth of 7 feet; capacity is 510,000 $ft^3$; and
- Ash Pond 3S: 322 feet by 234 feet with a depth of 7 feet; capacity is 530,000 $ft^3$.

Construction history and information is provided in Section 5.3.2.4.

### 4.4.3. Geological Setting

The regional geology beneath the Will County site consists of approximately 1 to 5 feet of unconsolidated deposits or fill, underlain by Silurian Dolomite to approximately 140 feet below ground surface; the Silurian Dolomite is underlain by the Maquoketa shale. The Maquoketa shale is an aquitard that separates the shallow groundwater in the unconsolidated units and the Silurian dolomite from the underlying aquifers. Groundwater flow in the shallow aquifer is largely controlled by the Des Plaines River and the Chicago Sanitary and Ship Canal with groundwater flowing towards either of the surface water channels during most periods of the year. Groundwater flow in the deeper aquifers is controlled by the regional hydraulic gradient in these aquifers, which is to the southeast.[62]

MWG submitted the results of a potable water well investigation to the Illinois EPA by letter dated July 15, 2009 that identified nine potable wells within a 2,500-foot radius of the Will County Station ash ponds, seven of which are upgradient of the Station. Two of these wells are located between the Des Plaines River and the Chicago Sanitary and Ship Canal. Both of these wells are drilled more than 1,500 feet below ground surface and are screened below the Maquoketa shale, the primary aquitard separating shallower aquifers from the screened interval of the wells.[63]

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[60] MWG13-15_29516
[61] Schwartz, 2005
[62] Patrick, 2011d
[63] Patrick, 2011d; MWG13-15_293-305

#### 4.4.4. Site-Specific Lithology

I reviewed boring logs and summarize the following lithology generally observed at Will County. Fill materials consisting of fine to coarse sand, gravel, silt, and silty sand were observed near the surface; in certain borings, coal cinders and ash were also observed in fill materials. Within the vadose zone, unsaturated soils included the fill materials previously noted, coarse sand, fine to coarse gravel, clayey gravel, clay, silty clay, and silt. In the shallow aquifer, saturated soils included fine to coarse gravel, coal cinders, coal dust, weathered limestone, sand, silt, silty clay, and clay. Weathered limestone bedrock was encountered between 7 and 12 feet bgs.[64]

#### 4.4.5. Site-Specific Groundwater Elevations

Groundwater elevations at the 10 monitoring wells at Will County (see Figure 4-5) have varied between 579.13 feet above MSL (at monitoring well MW-10 in August 2013) to 583.87 feet above MSL (at monitoring well MW-2 in June 2011) as summarized in Table 4-7. The highest groundwater elevation during each quarterly monitoring event varied between the following monitoring wells: MW-1, MW-2, MW-3, MW-5, and MW-9. The lowest groundwater elevation during each quarterly monitoring event for the period of record was found at monitoring well MW-10.[65]

Based on a review of the groundwater elevations, groundwater generally flows west to the Des Plaines River on the western portion of the site and is understood to flow east to the Chicago Sanitary and Ship Canal on the eastern portion of the site.

#### 4.4.6. Site-Specific Groundwater Conditions

I reviewed groundwater concentrations at monitoring wells at the Will County site, and it is my opinion that there is no groundwater plume. COI that were observed at concentrations exceeding IEPA Class I groundwater standards are listed in Table 4-8. The data show there is no spatial trend in COI concentrations in the direction of the groundwater flow. Furthermore, the observed COI concentrations intermittently exceed IEPA Class I groundwater standards. Without evidence that there is spatial or temporal consistency in groundwater impacts, it is my opinion that there is no plume at the Will County site. Without the existence of a plume, there is no support that there is a source area remaining at the site that could be remediated to reduce groundwater concentrations.

[64] Patrick, 2011d
[65] MWG13-15_48850-2

Shallow groundwater conditions at the Will County site are impacted by surface water elevation fluctuations of the Des Plaines River and the Chicago Sanitary and Ship Canal. See Section 6.5.7.

## Section 5: Opinion 1—MWG's Actions are Appropriate for the Sites and are Protective of Human Health and the Environment

It is my opinion that MWG's actions for the sites are appropriate for the measured groundwater impacts and are protective of human health and the environment.

### 5.1. An Elimination of Exposure Pathways is Appropriate

A standard approach that accounts for receptors to address the potential groundwater impacts at the sites is appropriate. An approach that eliminates the exposure pathways has been implemented by completion of a site characterization, comparison of groundwater analytes with State of Illinois water quality standards, and evaluation of the potential exposure routes. This resulted in a decision to reline the ash ponds and implement administrative controls of groundwater use to preclude the exposure to groundwater. Groundwater monitoring is conducted to assess changes in groundwater quality.

The following sections elaborate on the key points associated with the exposure pathways approach:

Section 5.2: Establishment of Administrative Controls is an Effective Remedial Approach

Section 5.3: Active Ponds are Lined to Eliminate a Potential Exposure Pathway

Section 5.4: Groundwater Monitoring is Appropriate to Demonstrate that Groundwater Exposure Pathways are Mitigated

Section 5.5: Recent Groundwater Concentrations are Not the Result of Ash Stored in Lined Ponds

Section 5.6: Groundwater Conditions Do Not Pose Risks to Surface Water Receptors Based on a Risk Screening Assessment

Section 5.7: Historical Ash in Fill Materials Outside of the Ponds is Not Adversely Impacting Groundwater

Section 5.8: Bottom Ash in Inactive Ponds is Not a Source of Groundwater Concentrations

## 5.2. Establishment of Administrative Controls is an Effective Remedial Approach

### 5.2.1. Summary of Implementation of Administrative Controls at the Four Sites

A remedial approach has been implemented that includes administrative controls to eliminate the groundwater exposure pathway for ingestion and dermal contact for specific areas. MWG has completed establishing GMZs and/or ELUCs at the four sites as summarized below.

- At Joliet #29, a GMZ has been established over the portion of the site containing the ash ponds extending from the north to the limit of a road and south to the intake canal. Additionally, there is an ELUC on the western side of the property, which MWG installed at the request of Caterpillar to address soil and groundwater contamination originating on Caterpillar property.[66]
- At Powerton, a GMZ has been established over the portion of the site containing the ash ponds extending to the east and south to the limits of a railroad, west to a canal and north to the Illinois River. Furthermore, an ELUC has been implemented to cover the area of the Powerton property that is contained by the GMZ.
- At Waukegan, the Former Tannery Site ELUC was established in a portion of the property, and an additional ELUC has been implemented to cover the remaining Waukegan property to the east that includes the ash ponds.
- At Will County, a GMZ has been established over the portion of the site containing the ash ponds extending west to the Des Plaines River and east to the Chicago Sanitary and Ship Canal. Furthermore, an ELUC has been implemented to cover the area of the Will County Station property that is contained within the GMZ, except for that portion of the GMZ area which is owned by the former property owner.

### 5.2.2. Demonstration that Administrative Controls are Effective

ELUCs and GMZs are used to eliminate groundwater exposure pathways by eliminating groundwater ingestion pathway and dermal contact pathways while corrective actions are underway. The groundwater ingestion pathway is eliminated by restricting the installation of potable water wells near the ash ponds. The dermal contact pathway is eliminated by restricting the access of the industrial properties to qualified workers.

[66] Carlson, 2010

Administrative controls, including GMZs and ELUCs, are remediation-industry accepted approaches. IEPA has the authority for establishing GMZs as specified in Title 35, Illinois Administrative Code (IAC) Sections 620 and 740.

IEPA has the authority for establishing ELUCs as specified in Title 35, IAC Section 742. The significance of the GMZ with respect to groundwater quality standards is described in 35 IAC Section 620.450 Alternative Groundwater Quality Standards: "Prior to completion of a corrective action described in Section 620.250(a), the standards as specified in Sections 620.410, 620.420, 620.430, and 620.440 are not applicable to such released chemical constituent, provided that the initiated action proceeds in a timely and appropriate manner." In other words, the concentrations of COIs constituents of interest can be higher than the groundwater quality standards within the GMZ.

Within Illinois, a minimum of 10 sites currently have GMZs established by the IEPA Bureau of Water.[67] IEPA Bureau of Water has not reported any groundwater violations for sites with GMZs.[68] Within Illinois, a minimum of 100 sites currently have ELUCs established by the IEPA Bureau of Land.[69]

Thus, it is my opinion that establishment of a GMZ or an ELUC is an effective method to reduce the potential risk for groundwater impacts, are remediation-industry-accepted approaches, and are approved by State of Illinois environmental protection procedures.

## 5.3. Active Ponds are Lined to Eliminate a Potential Exposure Pathway

A remedial approach has been implemented to address the ponds as a potential source of groundwater impacts that includes the installation of HDPE liners, decommissioning some ash ponds and properly operating and maintaining active ponds.

### 5.3.1. Summary of Pond Relining and Pond Decommissioning Actions

Midwest Generation has completed remedial actions that include liner installation or pond decommissioning at the four sites as summarized below. It is my opinion that MWG's actions are a reasonable and appropriate remedial approach for addressing groundwater conditions.

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[67] Telecommunication with IEPA Groundwater Protection Program Hydrogeology Unit Manager
[68] Telecommunication with IEPA Groundwater Protection Program Hydrogeology Unit Manager
[69] Telecommunication with IEPA Site Remediation Program staff member

- At Joliet #29, construction permits were obtained to reline Ash Ponds 1, 2, and 3 with 60-mil thick, high density polyethylene ("HDPE") liners, and the work has been completed. Ash Pond 1 was taken out of service on October 12, 2015.
- At Powerton, construction permits were obtained to reline the Ash Surge Basin, the Secondary Ash Settling Basin, Metal Cleaning Basin, and Bypass Basin, with 60-mil thick, HDPE liners, and the work has been completed.
- The Powerton East Yard Run-off Basin is not part of the ash sluicing flow system and is not used for ash storage.[70]
- At Waukegan, the East Ash Pond and West Ash Pond were relined with HDPE liners in 2003 and 2004, respectively.
- At Will County, Ash Ponds 1 North (1N) and 1 South (1S) were removed from service in 2010.[71] All process water has been diverted from ponds 1N and 1S to existing Ash Ponds 2 South (2S) and 3 South (3S). A dewatering system was implemented in 2013 that is designed to not allow water to exceed a depth of one foot above the bottom of Ponds 1N and 1S.[72]
- Construction permits were obtained to reline Will County Station Ash Ponds 2S and 3S with 60 mil thick, HDPE liners, and the work has been completed.

### 5.3.2. Pond Liners are Effective at Precluding Groundwater Impacts

I reviewed the design specifications and construction documentation for current pond liners used for active ash ponds at the sites, as summarized in Sections 5.3.2.1 through 5.3.2.4. The current pond liners are consistent with remediation-industry-accepted approaches, which are further described in Section 5.3.2.5. I reviewed the construction quality assurance and quality control (QA/QC) documentation in Section 5.3.2.6. Properly operating and maintaining lined ponds are the industry-accepted approach to preclude groundwater impacts; based on my review of site-specific records in Section 5.3.2.7, operation and maintenance is being conducted under appropriate and consistent protocols. It is my opinion that the current pond liners are effective to preclude quantifiable groundwater impacts, as described further below.

[70] Mark Kelly Deposition pp 113-4
[71] Fredrick Veenbaas Deposition p. 33-34
[72] MWG13-15_29339; MWG13-15_560-563

#### *5.3.2.1. Joliet #29 Active Ash Pond Liners*

The following summarizes information regarding ash pond history and construction elements:

- Ash Pond 1 (see Figure 5-1 for a typical construction cross-section)[73]
    - Originally constructed in 1978 with the following layers (from top to bottom):[74]
        - Bituminous seal coat
        - Poz-o-Pac[75]—12 inches thick
        - Compacted granular material—12 inches thick
    - Relined in 2007 under IEPA Water Pollution Control Permit (WPCP) No. 2007-EB-4091 with following layers (from top to bottom):[76]
        - New crushed limestone warning layer—6 inches thick
        - New sand cushion layer—12 inches thick
        - New geotextile cushion—12 ounces per square yard
        - New HDPE liner—60 mil thick
        - New geotextile cushion—16 ounces per square yard
        - Existing Poz-o-Pac—12 inches thick
- Ash Pond 2 (see Figure 5-2 for a typical construction cross-section)
    - Originally constructed in 1978 with the following layers (from top to bottom)[77]
        - Bituminous seal coat
        - Poz-o-Pac—12 inches thick
        - Compacted granular material—12 inches thick
    - Relined in 2008 under IEPA WPCP No. 2007-EB-4091 with following layers (from top to bottom):[78]
        - New crushed limestone warning layer—6 inches thick
        - New sand cushion layer—12 inches thick
        - New geotextile—12 ounces per square yard
        - New HDPE liner—60 mil thick
        - New geotextile cushion—16 ounces per square yard

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[73] "Typical" is a term of engineering practice that identifies the construction features that are most commonly observed; in this case, throughout the pond.
[74] Schwartz, 2005
[75] The density of Poz-o-Pac is 136.9 pounds per cubic foot. (MWG13-15_30-32)
[76] MWG13-15_18053; MWG13-15_18133-18189; MWG13-15_49362-49507
[77] Schwartz, 2005
[78] MWG13-15_18053; MWG13-15_18133-18189; MWG13-15_49362-49507

        - Existing Poz-o-Pac—12 inches thick
- Ash Pond 3 (see Figure 5-3 for a typical construction cross-section)
    - Originally constructed in 1978 with the following layers (from top to bottom):[79]
        - Bituminous seal coat
        - Poz-o-Pac—12 inches thick
        - Compacted granular material—12 inches thick
    - Relined in 2013 under IEPA WPCP No. 2013-EB-1191 with following layers (from top to bottom):[80]
        - New crushed limestone warning layer—12 inches thick
        - New sand cushion layer—24 inches thick
        - New geotextile cushion—16 ounces per square yard
        - New HDPE liner—60 mil thick
        - New geotextile cushion—16 ounces per square yard
        - Existing Poz-o-Pac—12 inches thick
- Generally, bottom ash is conveyed across the Des Plaines River to a permitted landfill on the south side of the Des Plaines River.[81] Prior to October 12, 2015, a small fraction of the bottom ash (approximately 5 to 10 percent) was pumped into Ash Pond 1 or 2 for settling when the conveyor system requires maintenance.[82] Ash Ponds 1 and 2 were dredged every one to two years, and the ash is disposed off-site.[83] Ash Pond 1 was taken out of service as of October 12, 2015; Ash Pond 2 is still in service.[84] Ash Pond 3 is used as a finishing pond for the effluent and is considered to receive a *de minimus* amount of ash.[85] (See Section 4.1.2.)
- Joliet #29 is planned to be converted to natural gas fuel combustion. Ash Pond 1 has been emptied of ash as of October 12, 2015 and is no longer in service.[86] Ash Pond 2 will remain

[79] Schwartz, 2005
[80] MWG13-15_44275-44278; MWG13-15_33867-33997
[81] Deposition of Jim DiCola, p. 49
[82] Deposition of Jim DiCola, p. 49
[83] Jim DiCola Deposition, pp. 103-106
[84] Teleconference with Pete O'Day
[85] MWG13-15_49742-49753
[86] Teleconference with Harrison Estepp; Teleconference with Pete O'Day

in service until the station is converted to natural gas fuel combustion in Spring 2016.[87] Thereafter, it is anticipated that Ash Pond 2 will be decommissioned.[88]

#### *5.3.2.2. Powerton Active Ash Pond Liners*

The following summarizes information regarding ash pond history and construction elements:

- Ash Surge Basin (see Figure 5-4 for a typical construction cross-section)
  - Originally constructed in 1978 with the following layers (from top to bottom)[89]
    - Bituminous seal coat
    - Poz-o-Pac—12 inches thick on the bottom
    - Compacted granular material—thickness not specified
    - Additionally, a Hypalon® liner was installed on the sides[90]
  - Relined in 2013 under IEPA WPCP No. 2013-EB-1213 with following layers (from top to bottom):[91]
    - New crushed limestone warning layer—6 inches thick
    - New sand cushion layer—12 inches thick
    - New geotextile—16 ounces per square yard
    - New HDPE liner—60 mil thick
    - New geotextile cushion—16 ounces per square yard
    - Existing Poz-o-Pac—12 inches thick
  - The Ash Surge Basin is the primary ash basin for Powerton. Ash is removed from the basin every six to eight years.[92]
- Secondary Ash Settling Basin (see Figure 5-5 for a typical construction cross-section)
  - Prior to the 2013 relining, the Secondary Ash Settling Basin had a Hypalon® liner.[93]
  - Relined in 2013 under IEPA WPCP No. 2013-EB-1065 with following layers (from top to bottom):[94]

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[87] Teleconference with Harrison Estepp
[88] Teleconference with Harrison Estepp
[89] Schwartz, 2005
[90] Mark Kelly Deposition, p. 40
[91] MWG13-15_9583-9643; MWG13-15_10812-10815; MWG13-15_33998-34157
[92] Mark Kelly Deposition, p. 41
[93] Mark Kelly Deposition, p. 26-27
[94] MWG13-15_34158-34267

        - New crushed limestone warning layer—6 inches thick
        - New sand cushion layer—12 inches thick
        - New HDPE liner—60 mil thick
        - New geotextile—16 ounces per square yard
        - New sand layer—12 inches thick
        - Underdrain system that removed groundwater during construction and can be used during pond cleanout.
    - The Secondary Ash Settling Basin is considered a low volume ash pond because historically it received approximately 3 feet of ash in approximately 30 years.[95]
- Metal Cleaning Basin (see Figure 5-6 for a typical construction cross-section)
    - Originally constructed in 1978 with the following layers (from top to bottom):[96]
        - Bituminous seal coat
        - Poz-o-Pac—12 inches thick
        - Hypalon® liner along the sloped sides[97]
        - Compacted granular material—12 inches thick
    - Relined in 2010 under IEPA WPCP No. 2009-EB-2748 with following layers (from top to bottom):[98]
        - New crushed limestone warning layer—6 inches thick
        - New sand cushion layer—12 inches thick
        - New geotextile—12 ounces per square yard
        - New HDPE liner—60 mil thick
        - New geotextile—16 ounces per square yard
        - Existing Poz-o-Pac—12 inches thick
    - The Metal Cleaning Basin is not a part of the ash sluice system. It is used during outages for collection of fly ash from high-pressure blasting on the external part of tubes, and as a temporary lay-down area during cleanouts at Powerton. The ash is removed annually.[99]
- Bypass Basin (see Figure 5-7 for a typical construction cross-section)

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95 Teleconference with Mark Kelly
96 Schwartz, 2005
97 Mark Kelly Deposition, p. 53
98 MWG13-15_49099-49256; MWG13-15_10209-10212
99 Mark Kelly Deposition pp. 54-6

- Prior to the 2010 relining, the Bypass Basin was lined on the sides with Hypalon® and lined on the bottom with Poz-o-Pac.[100]
- Relined in 2010 under IEPA WPCP No. 2010-EB-0664 with following layers (from top to bottom):[101]
  - New crushed limestone warning layer—6 inches thick
  - New sand cushion layer—12 inches thick
  - New geotextile—12 ounces per square yard
  - New HDPE liner—60 mil thick
  - New geotextile—16 ounces per square yard
  - Prepared subgrade—thickness not specified
- The Bypass Basin only receives ash when Powerton is emptying the Ash Surge Basin.[102] The Bypass Basin is emptied every six to eight years. [103]

##### *5.3.2.3. Waukegan Active Ash Pond Liners*

The following summarizes information regarding ash pond history and construction elements:

- West Ash Pond (see Figure 5-9 for a typical construction cross-section)
  - Originally constructed in 1977 with a Hypalon® liner.[104]
  - Relined in 2004 with following layers (from top to bottom):[105]
    - New crushed limestone warning layer—6 inches thick
    - New sand cushion layer—12 inches thick
    - New HDPE liner—60 mil thick
    - Prepared subgrade—thickness not specified
- East Ash Pond (see Figure 5-8 for a typical construction cross-section)
  - Originally constructed in 1977 with a Hypalon® liner.[106]
  - Relined in 2003 with following layers (from top to bottom):[107]

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[100] Mark Kelly Deposition p. 58; MWG13-15_9783
[101] MWG13-15_49099-49256; MWG13-15_30421-30424
[102] Mark Kelly Deposition p. 57
[103] Mark Kelly Deposition. pp. 59 & 61
[104] Schwartz, 2005; Christopher Lux Deposition p. 14
[105] MWG13-15_12827-12845; MWG13-15_411
[106] Schwartz, 2005; Christopher Lux Deposition p. 18
[107] MWG13-15_12827-12; MWG13-15_411

- New crushed limestone warning layer—6 inches thick
- New sand cushion layer—12 inches thick
- New HDPE liner—60 mil thick
- Prepared subgrade—thickness not specified

#### *5.3.2.4. Will County Active Ash Pond Liners*

The following summarizes information regarding ash pond history and construction elements:

- Ash Pond 2S (see Figure 5-10 for a typical construction cross-section)
    - Originally constructed in 1977 with the following layers (from top to bottom):[108]
        - Bituminous seal coat
        - Poz-o-Pac—36 inches thick
    - Relined in 2013 under IEPA WPCP 2008-EB-1166 with following layers (from top to bottom):[109]
        - New crushed limestone warning layer—6 inches thick
        - New sand cushion layer—12 inches thick
        - New geotextile—12 ounces per square yard
        - New HDPE liner—60 mil thick
        - New geotextile cushion—16 ounces per square yard
        - Existing Poz-o-Pac—30 inches thick
        - Additionally, the sides of the basin have a concrete geocell to further protect the liner.
- Ash Pond 3S (see Figure 5-11 for a typical construction cross-section)
    - Originally constructed in 1977 with the following layers (from top to bottom):[110]
        - Bituminous seal coat
        - Poz-o-Pac—36 inches thick
    - Relined in 2009 under IEPA WPCP 2008-EB-1166 with following layers (from top to bottom):[111]
        - New crushed limestone warning layer—6 inches thick

[108] Schwartz, 2005
[109] MWG13-15_34268-34433; MWG13-15_48604-48605
[110] Schwartz, 2005
[111] MWG13-15_33867-33997; MWG13-15_48604-48605

  - New sand cushion layer—12 inches thick
  - New geotextile—12 ounces per square yard
  - New HDPE liner—60 mil thick
  - New geotextile cushion—16 ounces per square yard
  - Existing Poz-o-Pac—30 inches thick
- Ash Pond 2S and 3S alternate receiving bottom ash (only one pond is in ash service at a time).[112]

#### *5.3.2.5. The Pond Liners are Consistent with Remediation-Industry-Accepted Approaches*

I reviewed the pond construction information and compared it to remediation-industry guidance documents for liners. It is my opinion that the current pond liners are consistent with remediation-industry-accepted approaches.

USEPA's Guide for Industrial Waste Management (2012) provides technical considerations for employing liner systems where needed to protect groundwater from contamination and includes the selection of geomembranes, such as HDPE liners, to ensure that the liner system will function as designed. Liners have been studied extensively for purposes of designing landfills and ponds and evaluating leaching rates through the liners. Use of numerical models is common practice for estimating the rates of infiltration through soils, waste and liners, and a 60-mil thick HDPE is appropriate for the design of ash ponds (USEPA, 2012).

Overlying fill layers are typically a material that drains like sand, such that placement of materials over the liner avoids puncturing or tearing (USEPA, 2012). Cushion geotextiles are also often used to protect geomembranes against puncture (NAS, 2007). Thus, for purposes of potentially coarser subgrade materials where a composite liner is not constructed, my opinion is that a subgrade cushion, as used by MWG, is an appropriate method to protect against subgrade punctures.

Basin maintenance activities are anticipated to have potential loads and stresses associated with heavy construction equipment above the HDPE liners. Evaluation of the overburden stress on a geomembrane can be calculated using the methods and equations of Narejo and Corcoran

[112] Rebecca Maddox Deposition p. 18

(1996). NRT calculated the overburden stresses on behalf of MWG and found that the resulting stress on HDPE with 18 inches of soil cover would be within the range of conservative design standards.[113]

#### *5.3.2.6. Construction Quality Assurance and Quality Control*

Construction quality assurance (CQA) for HDPE geomembrane liners follows two classes of protocols: (1) material testing, installation quality control, and finished product destructive testing; and (2) non-destructive electrical leak location surveys after liners have been installed and covered with a protective material (Darilek and Laine, 2001). Electrical leak location surveys at the completion of liner installation discover more leaks than testing-based protocols because they are conducted after all potential construction damage has occurred but also prior to placement of overlying materials such as protective materials or waste layers. When the electrical leak location survey is conducted after liner installation, the density of leaks discovered in 2.0 millimeter (approximately 79 mil) HDPE was 0.2 leaks per hectare (approximately 0.08 leaks per acre, or 1 leak per 12 acres) based on 170,190 square meters (approximately 42 acres) of liners that had CQA with electrical leak location surveys (Forget et al., 2005). The electrical leak location surveys identify leaks prior to the completion of all liner construction project, so identified leaks are repaired prior to completion of the liner construction project. In summary, when HDPE liners are installed with CQA, the numbers of liner defects or tears are significantly reduced from values cited by Kunkel. Furthermore, there was no correlation between the number of leaks and geomembrane thickness for liner systems (Forget, et al., 2005).

I reviewed the CQA documentation or a third party inspection report for the installation of HDPE liners for the following ash ponds:

- Joliet #29 Ash Ponds No. 1[114], No. 2[115], and No. 3[116]
- Powerton Ash Surge Basin[117], Secondary Ash Settling Basin[118], Metal Cleaning Basin[119], and Bypass Basin[120]
- Waukegan East and West Ash Ponds[121]

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[113] MWG13-15_49296-49298
[114] MWG13-15_49362-49507
[115] MWG13-15_49362-49507
[116] MWG13-15_33867-33997
[117] MWG13-15_33998-34157
[118] MWG13-15_34158-34267
[119] MWG13-15_49099-49256
[120] MWG13-15_49099-49256
[121] MWG13-15_12827-12845

- Will County Ash Ponds 2S[122] ; additionally, I reviewed the specifications and construction notes for the Will County Ash Pond 3S relining project.[123]

The CQA for the above liner installations demonstrate a high level of quality because of the following reasons:

- The pond linings were designed by Natural Resource Technology, Inc., and inspected by Natural Resource Technology, Inc. for Joliet #29, Powerton, and Will County Stations, and inspected by KPRG for Waukegan.
- All relining construction was completed under a construction quality assurance protocol that included inspections by an independent third party.
- The liner installer inspected the subgrade and certified that it was acceptable for installation of the HDPE liner as discussed below.
- The inspections included traditional leak detection tests of welds and seams as the liner was installed.
- After completion of seaming and covering the liner with a sand cushion layer, the liner had an additional electronic leak detection survey of the surface conducted by a third party (Leak Location Services, Inc.).[124]
- Any defects that were discovered were repaired before ponds were placed in service.
- Each relining construction project was certified by the installer (CAAW Systems, LLC) as complying with the project drawings and specifications and manufacturer recommendations.
- At the Waukegan East and West Ash Ponds, an independent review of the liner quality assurance documentation was performed and found no evidence that leaks would be present below the surface water line of the pond. [125]

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[122] MWG13-15_34268-34427

[123] MWG13-15_29165-29259; MWG13-15_34517-34550; MWG13-15_29023-29081; MWG13-15_29102-29104

[124] At the Powerton Secondary Settling Basin, an electronic leak detection survey was conducted prior to the placement of the sand cushion layer. At the Waukegan East and West Ash Ponds, an independent review of the liner quality assurance documentation was performed and found no evidence that leaks would be present below the surface water line of the pond.

[125] MWG13-15_12827-12845

#### *5.3.2.7. Operation and Maintenance is Being Conducted under Appropriate and Consistent Protocols*

I reviewed operation and maintenance activities for MWG's ash ponds and noted the following that demonstrate that these activities are being conducted under appropriate and consistent protocols.

- The operation of the ponds primarily includes maintaining water level controls in the ponds, daily inspections, groundwater monitoring, discharge monitoring, and removal of bottom ash. Weekly inspections of the ash ponds are now recorded by personnel.[126]
- Protocols are in place to conduct the daily operations that include utilization of experienced plant and corporate operations, engineering, and environmental management personnel. Depositions of Mr. Lux[127], Mr. Kelly[128], Ms. Maddox[129], Mr. DiCola,[130] and Mr. Veenbaas[131] indicated that, in summary, daily inspections of the ponds are completed and if any unusual conditions are observed, the shift supervisor is notified and the repairs are implemented.
- Protocols are in place with the ash cleanout contractors.
  - LaFarge North America, Inc. removes the ash from the Will County and Waukegan ash ponds. Pursuant to the contract, LaFarge must perform all services in a competent manner, in compliance with all standards for the services, and comply with all rules, policies, and procedures.[132] Moreover, in the recently executed contract, LaFarge employees and subcontractors must comply with all policies, procedures, and directives, to remove ash using methods to avoid damage to the liner and to make timely repairs when damage is observed. Thus, before every removal, LaFarge meets with its employees and subcontractors to discuss the best practices to remove the ash, identify all of the markers for the bottoms and edges of the basins, and describe the color of the warning layer. Moreover, equipment is used to remove ash primarily on and near the bottom where the liner is protected by the crushed stone and sand cushion layers and not on the side slopes where the geomembrane liner is exposed. Operators are instructed to stop excavating should

[126] MWG13-15_49756-49760; MWG13-15_50095-50148
[127] Christopher Lux Deposition, p. 41
[128] Mark Kelly Deposition, p. 87
[129] Rebecca Maddox Deposition, pp. 73, 145
[130] James DiCola Deposition, p. 114
[131] Frederick Veenbaas Deposition, p. 81
[132] MWG13-15_13032; MWG13-15_49679-49700

a hard layer be encountered that would indicate the protective layer. Additionally, LaFarge managers are onsite continuously during the removal to supervise work to avoid any damage to the liner systems. The protocol for managing incidents includes reporting to LaFarge supervisors followed by reporting to a supervisor at the station and to the station administration.[133]

- The Powerton personnel remove the ash from its ponds with its equipment and deposits the ash into trucks owned and operated by Capital Sales.[134] Prior to ash removal, the Powerton shift supervisor has a pre-work meeting to discuss the proper process of removing ash. In the meeting, the personnel supervisor reminds the personnel of the locations of the warning posts, the warning layer below the ash, and a description of the liner. Additionally, the personnel supervisor reminds each operator not to tear or damage the liner during removal. The protocol for managing incidents includes reporting to the personnel supervisor and to the Powerton Chemical Specialist who is responsible for conducting liner repairs.[135]
- The Joliet #29 contracts with an ash removal contractor on an as-needed basis using a competitive bidding process. The Joliet #29 ash removal project manager holds a kick-off meeting prior to starting work to discuss protocols for proper removal of ash. The meeting includes a description of the ponds, identification of the warning posts, the warning layer, and a description of the liner. The Station project manager inspects work throughout the ash removal process to confirm the work is acceptable. The protocol for managing incidents includes reporting to the Station project manager who would stop work that could cause damage to the liner. Ash would be removed from the vicinity of the damaged location. The Station project manager is responsible for conducting liner repairs.[136]

A demonstration of the effectiveness of the operations protocols is the fact that tears or damages to the HDPE liners have been detected based on inspections and promptly repaired as soon as weather conditions allowed. I reviewed tears or damages that have occurred as of September 2015, and observed that all tears were above the water line of the pond or occurred when the water had been

[133] Teleconference with Mitch Nowicki
[134] Deposition of Mark Kelly, p. 61
[135] Teleconference with Mark Kelly; MWG13-15_48636-48639
[136] Teleconference with Harrison Estepp

drained from the pond.[137] Tears above the water line occurred more frequently because of exposure to mechanical equipment at the facilities. Tears below the water line were not observed are not likely given the documented longevity of HDPE liners and because the areas are protected from exposure to equipment. There is no evidence that the liners are deficient or that infrequent liner tears are a source of groundwater impacts.

## 5.4. Groundwater Monitoring is Appropriate to Demonstrate that Groundwater Exposure Pathways are Mitigated

Groundwater monitoring is appropriate to demonstrate that groundwater exposure pathways are mitigated and to assess the remedial approach. MWG has specified groundwater monitoring programs for each facility. Groundwater monitoring consulting professionals at KPRG are regularly tracking groundwater conditions, and the results are reported to the IEPA. The results during the period of record show that the groundwater exposure pathways are consistently mitigated, and there is no evidence that further remedial action is required.

## 5.5. Recent Groundwater Concentrations are Not the Result of Ash Stored in Lined Ponds

I reviewed recent groundwater monitoring data to identify if theoretical leaks of leachate through possible liner defects (as posited by Mr. Kunkel) could be impacting groundwater at the subject sites. It is my opinion that the groundwater concentrations are not the result of leakage from the HDPE-lined ponds.

### 5.5.1. Typical Characteristics of Leachate for the Ash Stored in Ponds at the Sites

I reviewed the characteristics of leachate that are typical for the ash currently stored in ponds at the sites and selected appropriate constituent indicators. The characteristics of ash leachate are based on site-specific impounded ash data (Section 5.5.1.1) or on published leachate data from ponds of subbituminous CCR sourced from the Powder River Basin (PRB) in Wyoming that is the source of coal for the Plants (Section 5.5.1.2). I reviewed the data, and constituent indicators for leachate from ash currently stored in ponds include at a minimum: barium, boron, and sulfate, and at a maximum: antimony, arsenic, barium, boron, cadmium, chromium, cobalt, copper, manganese, nickel, selenium, silver, sulfate, and zinc (Section 5.5.1.3).

[137] MWG13-15_48563, KPRG 2005c, MWG13-15_11574, 11581, Veenbaas Deposition, p. 78-79,87-90, MWG13-15_14177, Maddox Deposition, p. 94-95, MWG13-15_48636-48639

#### *5.5.1.1. Site-Specific Data and Discussion of Leachate Characteristics for Ash Stored in Site Ponds*

Four samples of bottom ash from ponds at Powerton, Waukegan, and Will County were collected between 2004 and 2010 and characterized for leaching under neutral pH conditions (see Table 5-1). ASTM D3987-85 provides a standard test method for the leaching of materials to obtain an aqueous solution under specified testing conditions, including neutral pH of 7 (ASTM, 1985). Analytical neutral leachable procedure (NLET) results for these four bottom ash ponds show metals, sulfate, and total dissolved solids. The following analytes have been detected in bottom ash neutral leaching samples from the ponds:

- barium at concentrations up to 0.27 mg/L, which are less than the IEPA Class I groundwater standard of 2.0 mg/L;
- boron at concentrations up to 2.0 mg/L, which are equal to or less than the IEPA Class I groundwater standard of 2.0 mg/L;
- sulfate at a concentration of 49 mg/L, which is less than the IEPA Class I groundwater standard of 400 mg/L; and
- total dissolved solids at a concentration of 200 mg/L, which is less than the IEPA Class I groundwater standard of 1,200 mg/L.

The analytical results for bottom ash neutral leaching samples from the ponds can be extended to all the site ponds because all bottom ash at all of the four MWG generating stations is from the combustion of coal sourced from the PRB in Wyoming. The analytical results for bottom ash neutral leaching samples show that the leachate in ponds does not have the potential to cause groundwater impacts above IEPA Class I groundwater standards.

#### *5.5.1.2. Published Leachate Data from CCR Ponds for Subbituminous Coal*

I identified a report that published leachate data from CCR ponds for subbituminous coal, which is characteristic of coal sourced from the PRB in Wyoming that is the source of coal for the Plants.[138] Analyses for leachate samples from existing CCR facilities were characterized in an Electric Power Research Institute (EPRI) report (EPRI, 2006). The EPRI leachate results for leachate from other facility ponds containing CCR from subbituminous/lignite coal sources are summarized in Table 5-2.

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[138] MWG13-15_12847

#### *5.5.1.3. Constituent Indicators for Leachate from Ash Stored in Ponds*

Because there are differences between the set of constituents that leach based on site-specific data and published leachate data, I developed two sets of constituent indicators for leachate from ash currently stored in ponds. The first set is the minimum set of constituent indicators that would be expected under neutral conditions. This minimum set of constituent indicators is defined as the constituents that were observed in NLET analyses of bottom ash stored in site ponds. The second set is the maximum set of constituent indicators that may be expected based on other facility leachate data published by EPRI (2006). This maximum set of constituent indicators is defined as all constituents observed in analyses of leachate samples from other facility ponds containing CCR from subbituminous/lignite coal sources (see Table 5-2).

I reviewed the summary of leachate data in Table 5-3, and constituent indicators for leachate from ash currently stored in ponds include at a minimum: barium, boron, and sulfate, and at a maximum: antimony, arsenic, barium, boron, cadmium, chromium, cobalt, copper, lead, manganese, mercury, nickel, selenium, sulfate, and zinc.

### 5.5.2. Recent Groundwater Concentrations do Not Match Constituent Indicators for Leachate from Ash Stored in Ponds

I compared the occurrence of constituents during groundwater monitoring events in the most recent year, 2014, to the minimum and maximum sets of constituent indicators of leachate from ash currently stored in ponds. Conceptually, if all the constituents detected in groundwater samples from a monitoring well match the constituents detected in leachate from ash currently stored in ponds, and if constituents *not* detected in groundwater samples match the constituents *not* detected in leachate from ash currently stored in ponds, then it would be probable that leachate from ash currently stored in ponds is impacting groundwater. To evaluate whether or not groundwater concentrations match leachate constituent indicators, I calculated the percentage of constituents detected at each groundwater monitoring well that match constituent indicators of leachate from ash currently stored in the ponds ("matching percentages"). I restricted my analysis to the most recent full year of groundwater monitoring, 2014, to account for seasonal variations in constituent concentrations and to reflect groundwater concentrations after MWG's pond relining and pond decommissioning had been completed.

In summary, if the constituents match then it is likely that the leachate from the ash is impacting the groundwater. If the constituents *do not* match then it is likely that the leachate *is not* impacting the groundwater.

My results are tabulated in Tables 5-4 and 5-5 and are summarized as follows:

- At Joliet #29, the percentage of constituents at groundwater monitoring wells that match constituent indicators of leachate from ash currently stored in the ponds ranges from
  - 11 percent to 37 percent based on the minimum set of indicators, and
  - 37 percent to 53 percent based on the maximum set of indicators.
- At Powerton, the percentage of constituents at groundwater monitoring wells that match constituent indicators of leachate from ash currently stored in the ponds ranges from
  - 5 percent to 37 percent based on the minimum set of indicators, and
  - 32 percent to 58 percent based on the maximum set of indicators.
- At Waukegan, the percentage of constituents at groundwater monitoring wells that match constituent indicators of leachate from ash currently stored in the ponds ranges from
  - 16 percent to 26 percent based on the minimum set of indicators, and
  - 42 percent to 58 percent based on the maximum set of indicators.
- At Will County, the percentage of constituents at groundwater monitoring wells that match constituent indicators of leachate from ash currently stored in the ponds ranges from
  - 21 percent to 37 percent based on the minimum set of indicators, and
  - 37 percent to 53 percent based on the maximum set of indicators.

The low matching percentages demonstrate that there are substantial and widespread mismatches between the characteristics of recent groundwater analyzed near the ash ponds and the characteristics of leachate from ash currently stored in the ash basins. Thus, it is my opinion that the recent groundwater impacts are not a result of the ash currently stored in ponds at the sites, but instead are more likely than not a result of historical uses at the sites and the surrounding industrial companies and conditions.[139]

[139] IEPA, 2015 and MWG13-15_29975-29776.

## 5.6. Groundwater Conditions Do Not Pose Risks to Surface Water Receptors Based on a Risk Screening Assessment

### 5.6.1. Overview

I worked with my staff to develop an appropriate methodology to assess the exposure to surface waters from groundwater impacts at the sites. We assessed the potential for human health and ecological risks from an assumed exposure to constituents of interest (COIs) in groundwater associated with each of the four sites that may migrate to surface water. These evaluations are conservative as they assume a complete exposure pathway exists between groundwater COIs and receptors in the adjacent surface water bodies, and do not fully analyze attenuation or dilution mechanisms. The screening assessment also considers background and upgradient source COIs that are not from the ponds, thereby overestimating the risk from the pond operations. It is my opinion that groundwater conditions do not pose risks to surface water receptors based on the risk characterization included in Appendix B and described below.

### 5.6.2. Definition of Risk

"No unacceptable risks" means that the site-specific groundwater concentrations are less than Illinois Water Quality Standards (WQS) or Water Quality Criteria (WQC), which are considered to be protective of human health and the environment in surface water.[140] These WQS/WQC incorporate toxicological (i.e., cause-and-effect) data as well policy-based assumptions, including the state-determined acceptable risk level.

This evaluation includes a refinement step that considers the exceedance location (relative to other wells and receiving water bodies), magnitude, and frequency. If these lines of evidence support that "no unacceptable risks" are likely at the point-of-exposure (i.e., the lake or river), then it is concluded that there is an unlikely potential for risk.

### 5.6.3. Results of Risk Evaluation

The following summarizes the results of the evaluation. A complete evaluation is in Appendix B attached to this opinion.

Joliet #29: antimony, boron, manganese, and TDS do not pose unacceptable risks because concentrations are lower than WQS/WQC. Concentrations of chloride, sulfate, and iron

[140] WQS are defined in 35 IAC 302, Subpart B (Joliet #29, Powerton, and Will County) and E (Waukegan). WQC are derived by the IEPA under authority of 35 IAC 302, Subpart B.

exceeded WQS/WQC on occasion; however, further evaluation of site-specific conditions indicated an unlikely potential for risk from these COIs.

Powerton: boron, chloride, nitrate, selenium, sulfate, and TDS do not pose unacceptable risks because concentrations are lower than WQS/WQC. Concentrations of arsenic, iron, lead, manganese, thallium, and pH exceeded WQS/WQC on occasion; however, further evaluation of site-specific conditions indicated an unlikely potential for risk from these COIs.

Waukegan: the results of the risk evaluation are complicated by groundwater impacts at the Waukegan site, including groundwater impacts resulting from the migration of inorganic constituents from upgradient and offsite sources. Antimony and manganese do not pose unacceptable risks because concentrations are lower than WQS/WQC. Concentrations of arsenic, chloride, and pH exceeded WQS/WQC on occasion; however, further evaluation of site-specific conditions indicated an unlikely potential for risk from these COIs. Concentrations of boron, iron, sulfate, and TDS exceeded WQS/WQC in wells to the west and southwest of the ponds (MW-05 through MW-09). Importantly, there are no unacceptable risks for boron, iron, sulfate, and TDS in wells MW-01 through MW-04, which represent the most downgradient wells at the site (see Figure 4-4). MW-01 through MW-04 appear to be downgradient of MW-05, MW-06, MW-08, and MW-09, indicating attenuation is occurring. Although no wells are directly downgradient of MW-07, there is no data to indicate that similar attenuation is not occurring in this area.

Will County: antimony, boron, chloride, manganese, and TDS do not pose unacceptable risks because concentrations are lower than WQS/WQC. Concentrations of sulfate and pH exceeded WQS/WQC on occasion; however, further evaluation of site-specific conditions indicated an unlikely potential for risk from these COIs.

## 5.7. Historical Ash in Fill Materials Outside of the Ponds is Not Adversely Impacting Groundwater

Ash generated by coal combustion may be classified as coal combustion by-product (CCB) and used for purposes of fill material when there is beneficial use determined by IEPA (see Section 5.7.1). Current data obtained from recent ash samples and groundwater collected from multiple sites show that leachate from the historical ash in fill materials meets IEPA Class I groundwater standards based on leaching from a soil- like environment (see Section 5.7.2). It is my opinion that the current conditions of the existing weathered ash are not contributing to groundwater exceedances at the four sites based on leaching analyses of actual ash fill at the sites.

### 5.7.1. Coal Ash may be Classified as Coal Combustion Byproducts to Allow Beneficial Use

Structural fill and import fill ("fill") at the sites was placed historically, as long as 38 years ago. Ash generated by coal combustion may be classified as CCB when there is beneficial use determined by IEPA as established in 415 Illinois Compiled Statutes 5/3.135. Although the current IEPA criteria were not applicable when the CCB was placed, it is analogous to compare the current condition of CCB to the current IEPA criteria. Additionally, the design and construction of coal ash structural fills is a standard practice, and procedures for using coal combustion products, including fly ash, bottom ash, and boiler slag, to achieve desired geotechnical properties are described in ASTM E2277-14 (2014). In my opinion, the presence of CCB outside of the pond areas is considered an acceptable use when compared to Illinois requirements and the standard ASTM practice.

### 5.7.2. Investigations of Potential Leaching Characteristics of Historical Ash in Fill Materials at Sites

Data obtained from recent samples of ash used as fill from multiple sites show that leachate from the ash in its current condition meets IEPA Class I standards based on leaching from a soil-like environment (NLET method). These data were obtained during a 2004 investigation at Powerton, a 2005 investigation at Joliet #29, and a 2015 investigation at Will County, as discussed further below. Based on these data, it is reasonable to conclude that historical ash areas at all four MWG sites are not a source of groundwater impacts. Significantly, there is no evidence to conclude, as Kunkel does, that the ash areas are a source.

#### *5.7.2.1. Joliet #29 Investigation*

On behalf of Midwest Generation, in June 2005 KPRG performed an investigation of historical ash in fill materials at the Joliet #29 site. This investigation included the collection of historical ash samples from 15 soil borings at the Joliet #29 site. Historical ash samples were analyzed using a neutral leachable procedure (NLET) for metals. KPRG's report found the following conclusions:[141]

- "The ash deposits are consistent and homogenous consisting of interlayered fly ash and bottom ash/slag from the coal combustion process."

[141] KPRG, 2005a

- "The NLET metals data from sample location GP-14A displayed elevated levels of lead and copper at concentrations at least two times higher than the Class I groundwater standard." This area was later further delineated and excavated (see below).
- "The NLET metals data from the remaining 16 sample locations indicate with a high degree of statistical certainty that the criteria established in 415 ILCS 5/3.135 (formerly 415 ILCS 5/3.94) a-5(B) are met and that the material may be considered CCB relative to this criterion...."[142]

A supplemental investigation was performed in the vicinity of GP-14A in November 2005. Eight additional historical ash samples were collected from soil borings and analyzed using NLET for metals. The June 2005 and November 2005 samples were used to delineate the extent of excavation in the vicinity of GP-14A. Approximately 1,062.88 tons of fill material containing historical ash was excavated and disposed off-site at a landfill during the week of November 21, 2005. The excavation was backfilled using surficial materials near the excavation area. Following the excavation, the historic ash in the area met the CCB criteria under 415 ILCS 5/3.135.[143]

Thus, it is my opinion that leachate from historical ash in fill materials at Joliet #29 is not adversely impacting the groundwater.

#### *5.7.2.2. Powerton Investigation*

On behalf of MWG, Andrews Environmental Engineering, Inc. (AEEI) performed an investigation in May 2004 of historical ash in fill materials at Powerton[144]. A total of eight historical ash samples were collected from test pits in the Limestone Runoff Basin. Samples were analyzed for NLET metals using ASTM D3987-85. Selenium was detected in two NLET samples and chromium was detected in one NLET sample at concentrations greater than the IEPA Class I groundwater standards. All other metals in the NLET results from the eight ash samples were less than the IEPA Class I groundwater standards.

I reviewed selenium and chromium concentrations in groundwater at Powerton, and only selenium was detected at one location (MW-14) above IEPA Class I groundwater standards during the period of record.[145] Groundwater concentrations measured during the most recent full year of

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[142] Of the remaining 16 sample locations, 14 sample locations were located at Joliet #29.
[143] KPRG, 2005c
[144] AEEI, 2004
[145] MWG13-15_48711-48843

quarterly groundwater monitoring in 2014 were all below IEPA Class I groundwater standards, indicating no impacts of selenium or chromium. Thus, it is my opinion based on this analysis, that leachate from historical ash in fill materials at Powerton is not adversely impacting the groundwater.

#### *5.7.2.3. Will County Investigation*

On behalf of MWG, KPRG performed an investigation in June and August 2015 of historical ash in fill materials at Will County.[146] This investigation included the collection of 20 historical ash samples from 20 soil borings at the Will County site. Historical ash samples were analyzed using a neutral leachable procedure (NLET) for metals. KPRG's report documented the following conclusions:

- "The ash deposits are consistent and homogenous consisting bottom ash/slag from the coal combustion process."
- "There were no outlier samples, and all samples collected were used in the calculations."
- "The NLET metals data from the 20 sample locations indicate with a high degree of statistical certainty that the criteria established in 415 ILCS 5/3.135 (formerly 415 ILCS 5/3.94) a-5(B) are met and that the material may be considered CCB relative to this criterion for engineering/beneficial reuse."
- "The data set is sufficiently large to support the statistical evaluations based on the variance and specific regulatory threshold relationships."

Thus, it is my opinion that leachate from historical ash in fill materials at Will County is not adversely impacting the groundwater.

### 5.8. Bottom Ash in Inactive Ponds is Not a Source of Groundwater Concentrations

Data obtained from recent samples of bottom ash accumulated in ash ponds from multiple sites show that leachate from the bottom ash meets IEPA Class I standards based on leaching from the pond environment (NLET) (see Section 5.5.1.1). Based on these data, it is reasonable to conclude that bottom ash accumulated in inactive ash ponds are not a source of groundwater concentrations.[147]

[146] KPRG, 2015

[147] The Will County inactive ash ponds 1N and 1S have been modified to prevent more than one foot of standing water. This pond modification will reduce the volume of potential leachate at the Will County inactive ash ponds.

## Section 6: Opinion 2—The Remedial Approach Provided in the Kunkel Remedy Report is Not Warranted

It is my opinion that the remedial approach in the Kunkel Remedy Report, which is removal of all CCRs and the ash ponds, is not warranted because:

1. the concentrations of COIs that have been observed in groundwater around the ponds are low, such that MWG's remedial approach to protect human health and the environment is in accordance with Illinois standards (Section 6.1);
2. the bottom ash indicator constituents from leachate do not match the groundwater chemistry, indicating that the constituents in groundwater are not from the ponds, the ponds are functioning in accordance with the design, and the ponds do not need to be removed (Section 6.2), and
3. there is no evidence that coal ash currently outside of the ash ponds is a source of groundwater impacts (Section 6.3).

Further, Kunkel did not follow the Illinois procedures his opinions concerning remedial activities. After the completion of a site investigation, groundwater and soil remediation objectives would need to be developed that consider exposure routes and would be protective of human health and the environment. The selection of remedial technologies needs to consider the feasibility of implementation, whether the technologies will perform satisfactorily and reliably, and whether remediation objectives will be achieved within a reasonable period of time (Section 6.4).

I also found many inaccuracies in the Kunkel Report on Ground-Water Contamination that, in general, portray conditions that imply that groundwater is more threatened than is actually supported by the data.

The following is provided in support of Opinion 2:

- Ash ponds are for wastewater treatment purposes and are not landfills for permanent ash disposal (Section 6.5.1).
- Ash ponds are lined with 60-mil HDPE, which is the accepted standard of the ash pond lining industry. Further, the liner construction quality is consistent with the ash pond lining quality management standards for long-term use based on available construction documentation. (Section 6.5.2)

- O&M of the ash ponds are conducted in accordance with consistent operating protocols. (Section 6.5.3)
- Kunkel incorrectly concludes that all of the former ash ponds leaked and the current ash ponds are leaking. He asserts that the groundwater elevations are above the bottom of the ponds or pond water surface and in turn causing bottom heave. His analysis is incorrect on several bases. First, an uplift pressure argument is relative to the top of the bottom liner. Second, an uplift argument is an issue for soil liners, not geomembrane liners that are at all of the ponds. Third, groundwater levels are rarely above the top of the bottom liners and when they are above the bottom liner there are other opposing forces or controls to eliminate uplift. (Section 6.5.4)
- In addition to errors in Kunkel's groundwater elevation analysis, Kunkel fails to consider the weight of the Poz-o-Pac liner (where present), sand cushion, and limestone warning layers. An appropriate hydrostatic uplift calculation should include at a minimum the weight of sand cushion layers and limestone warning layers that provide downward forces that counteract the upward hydrostatic uplift force. The presence of bottom ash and pond water provide further downward forces that counteract the upward hydrostatic uplift force. (Section 6.5.5)
- Groundwater mounding that the Kunkel Groundwater Contamination Report concluded was an indication of an ongoing leak has not been observed at Joliet #29 monitoring well MW-9. Kunkel alleges that mounding is occurring at Joliet 29 because the groundwater elevation in downgradient MW-9 is higher than upgradient MW-8. However, the majority of the data show that the average water level in MW-9 is lower than MW-8. (Section 6.5.6)
- Kunkel incorrectly portrays background concentrations by using state-wide data for groundwater at the Joliet #29, Waukegan, and Will County sites. It is my opinion that this approach is inappropriate and fails to account for those sites where upgradient groundwater is impacted prior to migrating on-site. (Section 6.5.7)

## 6.1. MWG's Remedial Approach to Protect Human Health and the Environment is in Accordance with Illinois Standards

Kunkel states that his professional analyses and opinions have an "emphasis on remedy options which, if implemented, would stop or minimize the continuing ground-water contamination from MWG's ash ponds and/or other coal ash disposal areas at the four power plant sites."[148] Kunkel alleges that "[t]he remedy for continued long-term ground-water contamination at the four power plant sites is removal of the leaking ash ponds as well as all or a portion of the coal ash which has been deposited outside the ash ponds. The conclusions in my previous report ([Kunkel Groundwater Contamination Report]) form the bases for this remedy report."[149]

I conclude that further source remediation is not warranted. Observed COI concentrations in groundwater around the ponds are low, such that MWG's remedial approach to protect human health and the environment is in accordance with Illinois standards.

- Bottom ash indicator constituents from leachate do not match the groundwater chemistry (see Section 5.5).
- There is no evidence that historical ash in fill materials outside of the ash ponds is a source of groundwater impacts based on leaching analyses of the existing weathered ash in fill materials and observed groundwater concentrations (see Section 5.7.2).
- Administrative controls eliminate the completion of the groundwater ingestion pathway and dermal exposure pathway (see Section 5.2).
- Groundwater conditions do not pose unacceptable risks to surface water receptors (see Section 5.6).

## 6.2. Bottom Ash Indicator Constituents from Leachate Do Not Match the Groundwater Chemistry

Kunkel alleges that boron, sulfate, and manganese are valid indicators of groundwater contamination because "EPRI and IEPA deem them to be of concern at all four of the power plant sites and they are typically present in high concentrations in coal ash leachate…." However, the sources cited by Kunkel (EPRI, 2012; Kosson, 2009; and IEPA, 2010) are not specific to the four MWG sites. As demonstrated in Section 5.5.1.3, constituent indicators for leachate from ash currently stored in ponds include at a minimum: barium, boron, and sulfate, and at a maximum: antimony, arsenic, barium, boron, cadmium, chromium, cobalt, copper, manganese, nickel, selenium, silver, sulfate, and zinc. In order to compare the constituents in the ponds with the groundwater conditions, a more complete selection of constituent indicators should be used.

[148] Kunkel Remediation Report, Page 2
[149] Kunkel Remediation Report, Page 2

Kunkel includes removal of the ash ponds as part of his remedy and alleges that "[p]oor liner construction is an initial cause of liner defects which results in leaking ponds and release of contaminated fluids into the underlying ground water."[150] This allegation would imply that recent groundwater concentrations would be substantially impacted by the leachate from bottom ash currently stored in ash ponds. If this were true, constituents that are indicator chemicals for the ash currently stored in ash ponds would match the constituents actually observed in groundwater near the ponds. However, bottom ash indicator constituents from leachate do not match the groundwater chemistry (see Section 5.5). Thus, constituents in groundwater are not from the ponds and the ponds are functioning in accordance with the design.

I conclude that the ponds do not need to be removed.

### 6.3. There is No Evidence That Historical Coal Ash Outside of the Ash Ponds is a Source of Groundwater Impacts

Kunkel's proposed remedy includes removal of coal ash historically deposited outside the ash ponds, which includes coal ash "utilized in the construction of roadways, pond dikes and also for general land leveling at all four power plants."[151] He further states, without supporting data, that "[t]his coal ash is subject to leaching by rainfall and snowmelt, rising and falling ground-water levels, and this leachate is transported downward causing contamination of the ground water."[152] However, Kunkel's remediation approach is inconsistent with construction practices in Illinois and ASTM standards. The appropriate approach in Illinois for the evaluation of ash used beneficially as fill is to conduct leaching evaluations on actual fill at the sites (see Section 5.7.1). There is no evidence that historical ash in fill materials outside of the ash ponds is a source of groundwater impacts based on leaching analyses of the existing weathered ash in fill materials and observed groundwater concentrations (see Section 5.7.2). I conclude that there is no evidence supporting Kunkel's allegation that leachate from ash used as fill is causing groundwater contamination.

[150] Kunkel Remediation Report, Page 2
[151] Kunkel Remediation Report, Page 2
[152] Kunkel Remediation Report, Page 2

### 6.4. Kunkel did Not Follow the Illinois Procedures for Investigative and Remedial Activities

Kunkel alleges that "adequately addressing the contamination at the four sites requires the complete removal of the existing ash ponds and selected areas of coal ash deposited outside the ash ponds as the remedy. Coal ash from the ash ponds, coal ash used in construction activities at each site and the coal ash deposited on the ground surface outside the existing ash ponds must be placed in an appropriate landfill for the four MWG power plant sites."[153] However, Kunkel did not follow the Illinois procedures for the investigative and remedial activities. After the completion of a site investigation, groundwater and soil remediation objectives would need to be developed that consider exposure pathways and would be protective of human health and the environment. The selection of remedial technologies needs to consider the feasibility of implementation, whether the technologies will perform satisfactorily and reliably, and whether remediation objectives will be achieved within a reasonable period of time. Kunkel did not demonstrate that any of these steps were followed when he alleged that his proposed remedy is required.

- Removal of all ash from the sites is not feasible when all costs and site disruptions are considered (Section 7), and
- Ponds and historical ash are not sources of groundwater impacts (see Sections 5.3 and 5.5); thus removal of all ash will not achieve groundwater remediation objectives.

It is my opinion that Kunkel's remedy is inappropriate based on the Illinois procedures for investigative and remedial activities.

### 6.5. Responses to Specific Inaccuracies in Kunkel's report on Groundwater Contamination

I noted various inaccuracies in Kunkel's report on Ground-Water Contamination that imply that groundwater is more threatened than supported by the data. The following presents my responses to specific inaccuracies.

[153] Kunkel Remediation Report, Page 3

### 6.5.1. Ash Ponds are for Wastewater Treatment Purposes and are not Landfills for Permanent Ash Disposal

Kunkel alleges that there "has been and continues to be ground-water contamination from MWG's ash ponds and/or other coal ash disposal areas at the four power plant sites."[154] However, the ash ponds are not coal ash disposal areas as implied by Kunkel. The ash ponds are integral components of the wastewater treatment process for the generating facilities.[155] Furthermore, ash is routinely excavated and beneficially used off-site as evidenced in billing records from waste removal contractors, such as Lafarge.[156] It is my opinion that the vast majority of the potential for leachate from ash generated by the generating stations is appropriately managed by wastewater treatment using lined ash ponds and off-site disposal or beneficial reuse of the separated ash.

### 6.5.2. Ash Ponds are not Leaking and Construction Quality is Consistent with the Ash Pond Lining Quality Management Standards for Long-Term Use

Kunkel broadly alleges that at all four generating stations have "ash ponds whose liners have leaked and continue to leak due to poor liner construction techniques...."[157] However, Kunkel fails to provide evidence of the leaking for any of the ash ponds at any of the sites. Instead, Kunkel relies on an inapplicable study of other sites to assume leaks are occurring at the MWG ponds.[158] It is my opinion that the MWG ash ponds are not leaking because they are lined with 60-mil HDPE, which is the accepted standard of the ash pond industry. Further, the liner construction quality is consistent with the ash pond lining quality management standards for long-term use based on my review of construction quality assurance documentation. Specifically:

- The liner subgrades were inspected for sharp surfaces prior to installation of the HDPE liner and protective geotextile was installed below the HDPE liners to avoid the potential for puncture (see Section 5.3.2.5 and 5.3.2.6).
- The HDPE liners were inspected for leaks after installation of a protective sand cushion layer using the state of the practice electronic leak detection survey technologies (see Section 5.3.2.5 and 5.3.2.6).

[154] Kunkel Ground-Water Contamination Report, page 2.

[155] MWG13-15_16907-63; MWG13-15_18115-31; MWG13-15_24935-54; MWG13-15_10926-10947

[156] MWG13-15_36-65

[157] Kunkel Ground-Water Contamination Report, page 2.

[158] Kunkel cites Schroeder (1994), which does not consider the frequency of leaks when certain construction quality assurance protocols are followed. See Section 5.3.2.6 for applicable studies.

- Warning and cushion layers are installed above the HDPE liners to protect them from accidental contact and damage during future dredging operations (see Sections 5.3.2.1 through 5.3.2.5).
- The quality of construction was documented by an independent engineering firm that attested that the construction met the project drawings and specifications and manufacturer's recommendations (see Section 5.3.2.6).

Thus, I conclude that it is inaccurate to portray ash ponds as "continuing to leak" when there is no evidence that the current HDPE liners are leaking. Additionally, in my opinion, the CQA documentation indicates the HDPE liner construction is of high quality.

### 6.5.3. O&M of the Ash Ponds are Not Expected to Cause Leaks and O&M are Conducted in Accordance with Consistent Operating Procedures

Kunkel alleges that at all of the generating stations, ash pond have liners that "have leaked and continued to leak due to ... poor coal ash removal/maintenance practices...."[159] Furthermore, Kunkel alleges that "[r]elining the ash ponds will not reduce the potential for liner damage and subsequent liner leakage as long as dredging of coal ash continues as in the past."[160] However, I conclude that ash removal and maintenance practices are good, and O&M of the ash ponds are not expected to cause leaks based on my review of O&M documentation and practices. Specifically:

- Periodic dredging of settled bottom ash is carefully performed using excavators. If the excavator bucket were to encounter the stone warning layer, which is located over the protective layer, which in turn is located over the HDPE liner, it would be obvious to the operator who is expected to stop excavating. If the HDPE liner were encountered, white HDPE material would be visually observed in the bucket by the excavator operator who would stop work. Based on my review of the O&M documentation, damage of the HDPE liner below the water level during dredging has not been observed at any ash pond (see Section 5.3.2.7).
- Kunkel specifically alleges that "[a]sh pond dredging using heavy equipment likely will damage the plastic liners given the thin (1 ft thick) protective sand layer and 6-in thick warning layer on top of the liners. Typically, at least two feet or more of protective layer is

[159] Kunkel Ground-Water Contamination Report, page 2
[160] Kunkel Ground-Water Contamination Report, page 2

required on top HDPE if heavy equipment is utilized." However, Kunkel did not provide any load bearing analysis that the protective and warning layers would be insufficient for heavy equipment traffic loads. It is my opinion that the protective and warning layers are sufficient based on my review of the overburden stress analysis conducted by NRT for 18 inches of soil cover over the liner (see Section 5.3.2.5).

- Most tears observed in the ash pond liners have been above the impounded water surface (see Section 5.3.2.7). All tears were promptly repaired as allowed by favorable weather conditions. Tears above impounded water would not be expected to result in leaks. The only tear that was potentially below the water line occurred when no water was in the ash pond and was repaired prior to refilling water to the level of the tear in the ash pond.

### 6.5.4. Groundwater Elevations above the Bottoms of Ash Ponds are Temporary or Seasonal Conditions

Kunkel alleges that at Powerton, "...ash pond water surface elevations are periodically below ground-water table elevations..."[161]; at Waukegan, "...ash pond bottom liners are always below the surface-water elevations in Lake Michigan and also the ground-water table..."[162]; and at Will County, "Ground-water and Des Plaines River surface-water elevations are always above the bottom of the liners..."[163] These statements are misleading and inaccurate. First, an uplift pressure argument is relative to the top of the bottom liner. Second, an uplift argument is a potential issue for soil liners, not geomembrane liners that are at all of the ponds. Third, groundwater levels are not often above the top of the bottom liners and when they are above the bottom liner there are other opposing forces or controls to eliminate uplift.

Uplift pressure under a geomembrane liner is not an indication of failure. In the event that uplift pressures were to occur, the geomembrane would lift vertically out of position and would have to be inspected and repaired prior to service. This would only occur absent weight and pressure from pond materials (section 6.5.5), and has never been reported at any of the ponds.

To demonstrate the inaccuracy of Kunkel's uplift proposition, I evaluated the groundwater elevation and pond bottom data. The data show the following:

[161] Kunkel Ground-Water Contamination Report, page 3
[162] Kunkel Ground-Water Contamination Report, page 3
[163] Kunkel Ground-Water Contamination Report, page 4

- Joliet #29 Ash Ponds 1, 2, and 3—groundwater elevations in nearby monitoring wells have always been below the ash pond bottom elevations during the period of record.
- Powerton Ash Surge Basin: The groundwater elevations during the entire period of record at nearby monitoring wells MW-8, MW-11, MW-12, and MW-15 have been below the bottom liner elevation of 452.0 feet above MSL (see Figure 5-2).
- Powerton Secondary Ash Settling Basin: The groundwater elevations during the entire period of record at nearby monitoring well MW-6 have been below the bottom liner elevation of 440.0 feet above MSL (see Figure 5-3). The groundwater elevations at nearby monitoring well MW-7 have been above the bottom of the pond during only 2 of 16 quarterly groundwater monitoring events. However, the groundwater in this area can be controlled by the underdrain system that can relieve uplift pressures when the pond is dewatered and groundwater elevations are high.
- Powerton Metal Cleaning Basin: Groundwater elevations during the entire period of record at nearby monitoring wells MW-13, MW-14, and MW-15 have been below the bottom liner elevation is 457.5 feet above MSL (see Figure 5-4).
- Powerton Ash Bypass Basin: The groundwater elevations during the entire period of record at nearby monitoring wells MW-9 and MW-12 have been below the bottom liner elevation of 459.0 feet above MSL (see Figure 5-5)..
- Waukegan West and East Ash Ponds: Design documentation[164] has demonstrated that the bottom of the ponds is at approximately elevation 585.5 feet above MSL (see Figure 5-6). Groundwater elevations during the entire period of record at nearby downgradient monitoring wells MW-1 through MW- 4 and in upgradient monitoring well MW-5 were a minimum of 579.3 up to a maximum of 584.5 ft MSL which are all below the bottom of the ponds.
- Will County Ash Ponds 2 South and 3 South: The bottom liner elevation is 580.5 feet above MSL (see Figure 5-7). Groundwater elevations have been above the bottom of the pond during the period of record at nearby monitoring wells MW-5, MW-6, and MW-9, and monitoring well MW-10 during 6 of 16 quarterly groundwater monitoring events.

Therefore, groundwater levels are above the bottom liner at only three of the eight ponds which Kunkel claims have uplift pressures. However, for all ponds, the uplift pressures are offset

[164] MWG13-15_49285

by the weight of water in the ponds when they are full. For two ponds, uplift pressures are offset by the weight of overlying cushion and protective layers (See Section 6.5.5), and one pond has a groundwater underdrain to offset uplift pressures.

### 6.5.5. An Appropriate Analysis of Hydrostatic Uplift Involves Consideration of Counteracting Downward Forces

Kunkel alleges that at Powerton, "[a]sh pond water surface elevations are periodically below ground-water table elevations which likely has resulted, and will likely result in the future, in hydrostatic uplift and liner failure...."[165] Similarly, Kunkel alleges that at Waukegan, "ash pond bottom liners are always below ... the ground-water table which results in hydrostatic uplift pressures which likely has caused, and will likely cause in the future, liner leaks..."[166] Additionally, Kunkel alleges at Will County, "[g]round-water ... elevations are always above the bottom of the liners which likely has caused, and likely will cause in the future, hydrostatic uplift and liner failure." However, Kunkel does not support his allegations with any site-specific calculations or analysis.

In addition to errors in Kunkel's analysis (see Section 6.5.4), Kunkel fails to consider the weight of the Poz-O-Pac, sand cushion, and limestone warning layers. An appropriate hydrostatic uplift calculation should include at a minimum the weight of Poz-O-Pac, sand cushion layers, and limestone warning layers that provide downward forces that counteract the upward hydrostatic uplift force. The presence of bottom ash and wastewater provide further downward forces that counteract the upward hydrostatic uplift force. I calculated the following net resultant hydrostatic uplift forces present when only the pond liner system is present and nearby groundwater elevations are at a maximum. These calculations are for the three ash ponds where groundwater elevations are temporarily or seasonally higher than the bottom elevations and are summarized as follows:

- Powerton Secondary Ash Settling Basin: There is a net resultant uplift force when the pond is empty. This was demonstrated during pond relining when the Illinois River was at an unusually high level causing groundwater levels to rise, and in turn causing inflow into the excavations. The inflow was controlled by a drainage system. During cleanout, the drainage system is available to eliminate hydrostatic uplift. While the ponds are full, however, there

[165] Kunkel Ground-Water Contamination Report, page 3
[166] Kunkel Ground-Water Contamination Report, page 3

is no hydrostatic uplift because of the downward force of water which is 180 to 700 pounds per square foot (psf)[167], depending on the groundwater level.

- Will County Ash Pond 2S: Uplift force is entirely counteracted by the weight of the Poz-O-Pac, sand cushion, and limestone warning layers, with a net resultant downward force of 195 psf.
- Will County Ash Pond 3S: Uplift force is entirely counteracted by the weight of the Poz-O-Pac, sand cushion, and limestone warning layers, with a net resultant downward force of 195 psf.

### 6.5.6. Kunkel's Conclusion of Groundwater Mounding at Joliet #29 Monitoring Misrepresents Actual Groundwater Elevations

Kunkel alleges that at Joliet #29 "ash Pond 3 must have been leaking because the ground-water elevation in MW-9 was higher (505.66) than that in MW-8 (505.22) which is generally up-gradient from MW-9." However, I reviewed groundwater elevations measured at Joliet #29 monitoring wells MW-8 and MW-9 during the period of record between 2010 and 2014. Groundwater elevations at MW-8 were higher than groundwater elevations at MW-9 during 11 of 16 quarterly groundwater monitoring events (69 percent). Furthermore, the average groundwater elevation at MW-8, 505.67 feet above MSL, was higher than the average groundwater elevation at MW-9, 505.65 feet above MSL, during the period of record. Kunkel selected the largest value for the difference in groundwater elevations between MW-9 and MW-8 to prove a conclusion, yet the overall data do not support the conclusion.

The groundwater elevations across the approximately 18 acres of the site covered by the monitoring well network vary by 0.5 ft on average (see Table 4-1). The measurement accuracy of a typical groundwater level monitor is approximately 0.05 ft. It is my opinion that the accuracy of the readings combined with the narrow differences and variations of groundwater elevations indicate that any mounding would be too subtle to detect.

Therefore, it is my conclusion that the data do not show any mounding.

[167] Calculated based on normal pool elevation of 453 ft, average groundwater elevation of 441.5 ft and maximum groundwater elevation of 450 ft.

### 6.5.7. Kunkel's Conclusion of a Liner Leak at Waukegan is Actually an Expression of Surface Topography

Kunkel prepared groundwater contour maps and concluded that "The "ridge" in the ground-water contours at the ash ponds may indicate a liner leak in the west ash pond,...". I prepared a groundwater contour map (Figure 4-4) of data from May and June 2014 using the information from the Waukegan monitoring wells and ELUC wells. I conclude that the area where a "ridge" was shown in Kunkel's maps is more muted and simply a reflection of the ground surface topography which dips to the north, east and south from the area of the ash ponds. This groundwater "mirroring" of ground surface topography would be expected in an aquifer that is primarily granular (more permeable) material that responds relatively quickly to infiltration and lateral migration. The groundwater mirroring is consistent with the additional information that the ponds are not leaking.[168] (See 5.5.2).

### 6.5.8. Background Constituent Concentrations Should be Based on Contemporary Data from Upgradient Wells

Kunkel alleges that he compared measured groundwater quality concentrations to "site background water quality."[169] However, Kunkel instead relies on "specific Illinois ground-water quality data which are representative of background on a state-wide level" for Joliet #29, Waukegan, and Will County. It is my opinion that this approach is inappropriate and misrepresentative for sites where upgradient groundwater is impacted prior to migrating on-site (see Sections 4.2.1 and 4.3.1). In particular, Kunkel claims that "indicator pollutants in [Powerton] MW-16 are similar to the IEPA (2013) background network wells for sand and gravel aquifers." However, Kunkel limits his assessment to boron, manganese, and sulfate as the "indicator pollutants" and does not consider other constituents that also comprise background concentrations. It is my opinion that it is inaccurate to portray background concentrations at a state-wide level as representative of background at the sites where there are upgradient monitoring data.

An appropriate approach would be to evaluate background concentrations based on site specific data such as monitoring wells installed at the upgradient site boundaries in locations without the presence of ash materials in fill.

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[168] IEPA, 2015 and MWG13-15_29775-29776
[169] Kunkel Ground-Water Contamination Report, page 7.

- Joliet #29—monitoring wells MW-8, MW-10, and MW-11 are near the upgradient site boundary, and the boring logs show that these three wells are not installed in ash fill. Groundwater quality at these three locations are not consistent:
    - MW-8 has historical exceedances of chloride and sulfate above IEPA Class I groundwater standards.[170]
    - MW-10 has historical exceedances of chloride above the IEPA Class I groundwater goal.[171]
    - MW-11 has historical exceedances of boron and chloride above IEPA Class I groundwater standards.[172]

  Thus, background groundwater concentrations at Joliet #29 reflect sources other than the ponds and historical ash fill based on site-specific data because monitoring wells near the upgradient site boundary exceed IEPA Class I groundwater standards prior to migrating below the ponds.

- Powerton—monitoring wells MW-1, MW-9, and MW-16 are near the upgradient site boundary, and the boring logs show that MW-1 and MW-16 are not installed within ash fill. The groundwater concentrations at MW-1 and MW-16 have historical exceedances for nitrate above the IEPA Class I goal and pH has historical exceedances that are both above and below the acceptable IEPA Class I range of goals.[173] MW-16 groundwater also detected barium, boron, chloride, and sulfate. MW-1 groundwater also detected barium, boron, chloride, fluoride, manganese, nitrate, and sulfate. MW-9 groundwater also detected barium, boron, chloride, fluoride, manganese, selenium, and sulfate. Thus, background concentrations at Powerton reflect sources other than the ponds and historical fill areas based on site-specific data because monitoring wells near the upgradient site boundary detect or exceed IEPA Class I groundwater standards prior to migrating below the ponds.
- Waukegan—monitoring wells MW-6 and MW-8 are near the upgradient site boundary, and the boring logs show that MW-6 is not installed within ash fill. An estimate of site-wide groundwater contours for the Waukegan site are provided on Figure 4-4. Groundwater concentrations at MW-6 have several historical exceedances for boron and manganese

[170] MWG13-15_48647-48710
[171] MWG13-15_48647-48710
[172] MWG13-15_48647-48710
[173] MWG13-15_48711-48843

above IEPA Class I groundwater standards. [174] Additionally, wells installed for the neighboring and upgradient ELUC, including ELUC MW-10, ELUC MW-11, ELUC MW-12, ELUC MW-14, and ELUC MW-15, show elevated levels for boron and manganese above IEPA Class I groundwater standards.[175] Thus, background concentrations at Waukegan reflect sources other than the ponds and historical fill areas based on site-specific data because monitoring wells near the upgradient site boundary exceed IEPA Class I groundwater standards prior to migrating below the ponds.

- Will County—shallow groundwater conditions at the Will County site are impacted by the Des Plaines River and the Chicago Sanitary and Ship Canal. Groundwater hydraulic gradients are confounded by surface water influences with some groundwater migrating toward the Des Plaines River and some groundwater understood to be migrating toward the Chicago Sanitary and Ship Canal. Thus, background concentrations at Will County cannot be established based on site-specific data. Additionally, due to the unique groundwater conditions at the Will County site, it is not appropriate to use background groundwater quality based on a state-wide level for the Will County site.

[174] MWG13-15_48902-48958
[175] MWG13-15_50086-50092

# Section 7: Opinion 3—Kunkel Underestimates the Costs to Implement the Unwarranted Cleanup

It is my opinion that the Kunkel Remedy Report significantly underestimates the cost of Kunkel's proposed cleanup to remove all ash ponds and all CCRs in fill at the plants.

- Kunkel's proposed remedy fails to incorporate the costs of disposal at a permitted landfill (see Section 7.1).
- Kunkel's proposed remedy does not account for significant and costly disruption at the generating plants (see Section 7.2).
- Kunkel's proposed remedy results in significant impacts to the surrounding communities, including dust, noise, and traffic (see Section 7.3). Of particular concern is the increased risk of vehicle crashes involving large trucks.
- Kunkel's proposed remedy fails to consider the impact of vehicle carbon dioxide emissions. I estimate the emissions from the large truck traffic to be on the order of 203,840,000 kilograms of carbon dioxide (see Section 7.4).

## 7.1. Costs of Soil Disposal at a Permitted Landfill

Kunkel's cost estimate for his proposed remedy includes the costs associated with excavation, hauling, and backfill. However, Kunkel fails to include the cost of soil disposal at a permitted landfill, which is essential to his proposed remedy. In my experience, the disposal cost for impacted soil has a unit price of approximately $20 per ton. Assuming a disposal cost of $20 per ton, and using the unit tonnage estimates provided by Kunkel, I estimated the disposal costs associated with Kunkel's proposed remedy as follows:

- Joliet #29—$14,000,000 (708,657 tons)
- Powerton—$93,000,000 (4,645,190 tons)
- Waukegan—$53,000,000 (2,661,395 tons)
- Will County—$18,000,000 (910,525 tons)
- Total Disposal Costs: $178,000,000

Thus, the disposal costs for his proposed remedy increases his estimated cost for excavation, hauling, and backfilling (approximately $260,000,000 total of all four sites site-wide) by 68 percent.

## 7.2. Kunkel's Proposed Remedy Results in Significant and Costly Disruptions of the Electricity Generation Plants

Kunkel includes estimates of the areas and volumes of ash-impacted soils that he asserts should be removed from the four sites (see Kunkel's Table 6 and Figures 1 through 4 in the Remedy Report). The data are summarized as follows:

- Joliet #29—Top 1.4 feet of soil over 251 acres (566,925 cubic yards of ash-impacted soil)
- Powerton—Top 6.6 feet of soil over 349 acres (3,716,152 cubic yards of ash-impacted soil)
- Waukegan—Top 5.3 feet of soil over 249 acres (2,129,116 cubic yards of ash-impacted soil)
- Will County—Top 2.1 feet of soil over 215 acres (728,420 cubic yards of ash-impacted soil)

As shown on figures within Kunkel' report, the cost estimates include areas below equipment such as switchyards and coal handling and transfer equipment. Removing soil from these areas of the sites would cause substantial operational disruptions, including extended temporary shutdowns, of the generating stations. Before any excavation could occur, MWG would need to decommission and remove or bypass all of the overlying equipment. Power generating stations are fixed structures, and it is not simple to remove and replace equipment.

Following disassembly of equipment, excavation of the soil would require additional time. I identified the allegedly impacted areas with critical generating equipment, and I estimated the acreages so that I could in turn estimate the duration of excavation activities in those areas. The estimates of the durations of excavation activities are as follows:

- Joliet #29 (see Figure 7-1):
  - Electrical switchyard—approximately 3.2 acres
  - Coal handling and transfer equipment—approximately 2.8 acres
  - Depth of soil excavation proposed by Kunkel—1.4 feet
  - I estimate once the equipment are decommissioned or removed or bypassed, that each of these areas could be excavated within one week based on a typical soil excavation production rate of 5,000 cubic yards per day for large projects.

- Powerton (see Figure 7-2):
    - Electrical switchyard—approximately 11.2 acres
    - Coal handling and transfer equipment—approximately 2.2 acres
    - Depth of soil excavation proposed by Kunkel—6.6 feet
    - I estimate that once the equipment are decommissioned or removed or bypassed, the electrical switchyard area and coal handling and transfer equipment area could be excavated within four weeks and one week, respectively, based on a typical soil excavation production rate of 5,000 cubic yards per day for large projects.
- Waukegan (see Figure 7-3):
    - Electrical switchyard—approximately 6.8 acres
    - Coal handling and transfer equipment—approximately 3.9 acres
    - Depth of soil excavation proposed by Kunkel—5.3 feet
    - I estimate that once the equipment are decommissioned or removed or bypassed, the electrical switchyard area and coal handling and transfer equipment area could be excavated within two weeks and one week, respectively, based on a typical soil excavation production rate of 5,000 cubic yards per day for large projects.
- Will County (see Figure 7-4):
    - Electrical switchyard—approximately 9.6 acres
    - Coal handling and transfer equipment—approximately 13.3 acres
    - Depth of soil excavation proposed by Kunkel—5.3 feet
    - I estimate that once the equipment are decommissioned or removed or bypassed, the electrical switchyard area and coal handling and transfer equipment area could be excavated within three weeks and four weeks, respectively, based on a typical soil excavation production rate of 5,000 cubic yards per day for large projects.

Following excavation, the equipment would also need to be reassembled and tested. In some cases, disassembled equipment may not be of sufficient quality to reassemble. For these parts, disassembled parts would need to be demolished and disposed or recycled off-site, and the parts would need to be replaced.

Importantly, Kunkel fails to account for the additional and significant costs to disassemble, reassemble, and test the switchyards and coal handling and transfer equipment. Those costs include the additional personnel and contractors to safely disassemble and reassemble the equipment and additional material costs to safely store the equipment during excavation.

Moreover, the generating units cannot be operated without being supplied coal, and the electrical switchyard is necessary for distributing power. The generating stations would be offline for an extended period of time and would in turn incur significant costs associated with the loss of revenue from the offline generation units. These equipment cannot be practicably bypassed to continue to operate the generating units; furthermore, there is not sufficient space at the sites to disassemble electrical switchyard equipment and the coal handling and transfer equipment simultaneously. Fully disassembling, reassembling, and testing the electrical switchyard equipment and the coal handling and transfer equipment would be on the order of two to five years for each site.[176]

Kunkel's estimation entirely fails to consider the outage costs and loss of revenue during the extended period required to conduct his proposed remediation. During this time, many people, such as plant workers and coal producers, will be out of employment suffering a loss of income that has a trickle-down effect on the local communities.

### 7.3. Additional Impacts to the Surrounding Communities

In addition to the substantial disruptions to operations of the generating units, the surrounding community would be adversely impacted by the increased risk of vehicle crashes involving large trucks, increased travel times, reduced air quality from diesel exhaust, increased noise, and increased dust.

Protection of the community from adverse effects during implementation of the alternative is a factor that bears upon assessing the reasonableness of Kunkel's proposed remedy. Of particular relevance for these subject sites and the remedy proposed by Kunkel is the increased risk of vehicle accidents involving large trucks.

The U.S. Department of Transportation, National Highway Traffic Safety Administration (NHTSA) reports traffic data for large trucks that are involved in crashes resulting in fatalities or injuries. Based on traffic data for 2013, which is the most recent year of data reported by NHTSA, large trucks accounted for 4 percent of all registered vehicles but accounted for 9 percent of all vehicles involved in fatal crashes (NHTSA, 2015). In 2013, 3,964 people were killed and 95,000 people were injured in

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[176] Teleconference with Mark Kelly and Rachel Maddox; teleconference with Fred Veenbaas; teleconference with Pete O'Day

crashes involving large trucks; 71 percent of these fatalities were occupants of other vehicles involved in the crash (NHTSA, 2015). The Insurance Institute for Highway Safety (IIHS) identified the main problem of large truck fatalities as the vulnerability of people traveling in smaller vehicles (IIHS, 2015).

In 2013, 0.73 percent (36.86 fatalities and 690 injuries per 100,000) of registered trucks were involved in a crash resulting in fatalities or injuries (NHTSA, 2015). The involvement rate in 2013 based on the mileage traveled by large trucks was 1.42 fatalities and 27 injuries per 100,000,000 miles (NHTSA, 2015).

I estimated the transportation requirements for hauling ash-impacted soil and import fill based on typical remediation practices for transportation and disposal.

- Trucks for hauling soil and fill have 20-cubic yard capacities;
- One truckload of clean import fill is needed for each truckload of ash-impacted soil disposal;
- Trucks used for disposing ash-impacted soil should not be used for importing clean fill, so trucks return empty after disposing or importing fill;[177]
- Assuming a disposal site for ash-impacted soil is 15 miles away from each site, the round-trip distance is 30 miles per trip;
- Assuming the source of clean import fill to replace the removed soil is 10 miles away from each site, the round-trip distance is 20 miles per trip; and
- For each cubic yard of ash-impacted soil to be excavated, the resulting transportation requirements for the project work is on the order of 2.5 miles per cubic yard ([30 miles per round-trip of ash-impacted soil disposal + [20 miles per round-trip of fill imported] / [20 cubic yards per round trip].

Based on the number of weeks for soil hauling activities developed for the hypothetical scenario, this results in the following total mileage:

- Joliet #29—More than 1,400,000 miles of large truck travel
- Powerton—More than 9,300,000 miles of large truck travel
- Waukegan—More than 5,300,000 miles of large truck travel
- Will County—More than 1,800,000 miles of large truck travel

[177] If trucks were lined with disposal plastic liners or were decontaminated at disposal facilities, trucks could transport soil for disposal and import fill in a single round trip. If these additional costs to the project were incurred to eliminate one leg of the truck route, the mileage may be reduced by approximately 30 percent.

Using Kunkel's proposed remedial approach results in more than 17,000,000 miles of large truck travel for the four sites in total. Using the 2013 mileage-based probability of a fatality involving a large truck based (1.42 fatalities and 27 injuries per 100,000,000 miles), a risk of 0.25 traffic fatalities and 4.6 injuries would be expected for the large truck traffic generated by Kunkel's proposed remedial approach under the hypothetical scenario.

Therefore, I conclude the risk of removal of all coal ash and trucking to an offsite facility is not supported by the risk of leaving the existing materials in place, which is essentially no risk to human health and the environment.

## 7.4. Estimate of Carbon Dioxide Emissions Associated with Kunkel's Proposed Remedy

Large trucks and heavy construction equipment generate emissions of carbon dioxide from the combustion of fossil fuels (typically diesel for large trucks and heavy construction equipment). Kunkel's assessment of his proposed remedy fails to include this significant impact of vehicle carbon dioxide emissions. The mass of carbon dioxide emitted from large trucks can be easily estimated using emissions factors and the total miles of large trucks as demonstrated below.

USEPA recently developed emissions factors based on Table 2-15 from the *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2012*, and based on vehicle-miles data for highway vehicles from Table VM-1 of the Federal Highway Administration Highway Statistics 2012 (USEPA, 2014). The transportation emissions factor for medium- and heavy-duty trucks is 1.456 kilograms per vehicle-mile. Based on the estimated large truck mileage in Section 7.2 (17,000,000 miles), the resulting carbon dioxide emissions are approximately 24,800,000 kilograms (equivalent to approximately 27,000 tons).

USEPA estimated the rate of carbon dioxide emissions from a large excavator at 440 pounds per hour. Kunkel estimated the total volume of excavated soil site-wide for the four sites as 7,140,613 cubic yards. Assuming a typical soil excavation production rate of 500 cubic yards per hour for large projects, the total hours of excavation is approximately 14,000 hours of operation for an excavator. This resulting carbon dioxide emissions are approximately 6,160,000 pounds (equivalent to approximately 3,080 tons).

The total carbon dioxide emissions for Kunkel's proposed remedy is approximately 30,000 tons, which is conservative because it does not include emissions from other heavy construction equipment used at the sites, disposal facilities, and import fill sources.

## Section 8: Reservation

Due to the delay in the production of documents relied upon by Dr. Kunkel, I am reserving the ability to supplement my opinions in response to any documents or bases for Dr. Kunkel's reports that are presented by the Complainants. In addition, my opinions may be supplemented based on future changes in the construction or operation of the generating stations and in response to any future changes in groundwater conditions observed at the sites.

## Section 9: Signature

This report contains 165 pages, including figures, tables, and appendices.

John Seymour, P.E.

2 November 2015
DATE

## Section 10: Acronyms

| Acronym | Definition |
|---|---|
| AEEI | Andrews Environmental Engineering, Inc. |
| CCA | Compliance Commitment Agreement |
| CCB | Coal combustion by-product |
| CCR | Coal combustion residual |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended |
| COI | Constituent of Interest |
| CQA | Construction quality assurance |
| CSM | Conceptual Site Model |
| ELUC | Environmental Land Use Control |
| EPA | Environmental Protection Agency |
| EPRI | Electric Power Research Institute |
| FGD | Flue gas desulfurization |
| GMZ | Groundwater Management Zone |
| HDPE | High density polyethylene |
| IAC | Illinois Administrative Code |
| IEPA | Illinois Environmental Protection Agency |
| IIHS | Insurance Institute for Highway Safety |
| ILCS | Illinois Compiled Statutes |
| MSL | Mean Sea Level |
| MWG | Midwest Generation, LLC |
| NHTSA | National Highway Traffic Safety Administration |
| NLET | Neutral Leaching Extraction Test |
| NPDES | National Pollutant Discharge Elimination System |
| PRB | Powder River Basin |
| RCRA | Resource Conservation and Recovery Act of 1976, as amended |
| TCE | Trichloroethylene |
| TDS | Total dissolved solids |
| USEPA | United States Environmental Protection Agency |
| VN | Violation Notice |
| WPCP | Water Pollution Control Permit |
| WQC | Illinois Water Quality Criteria |
| WQS | Illinois Water Quality Standard |

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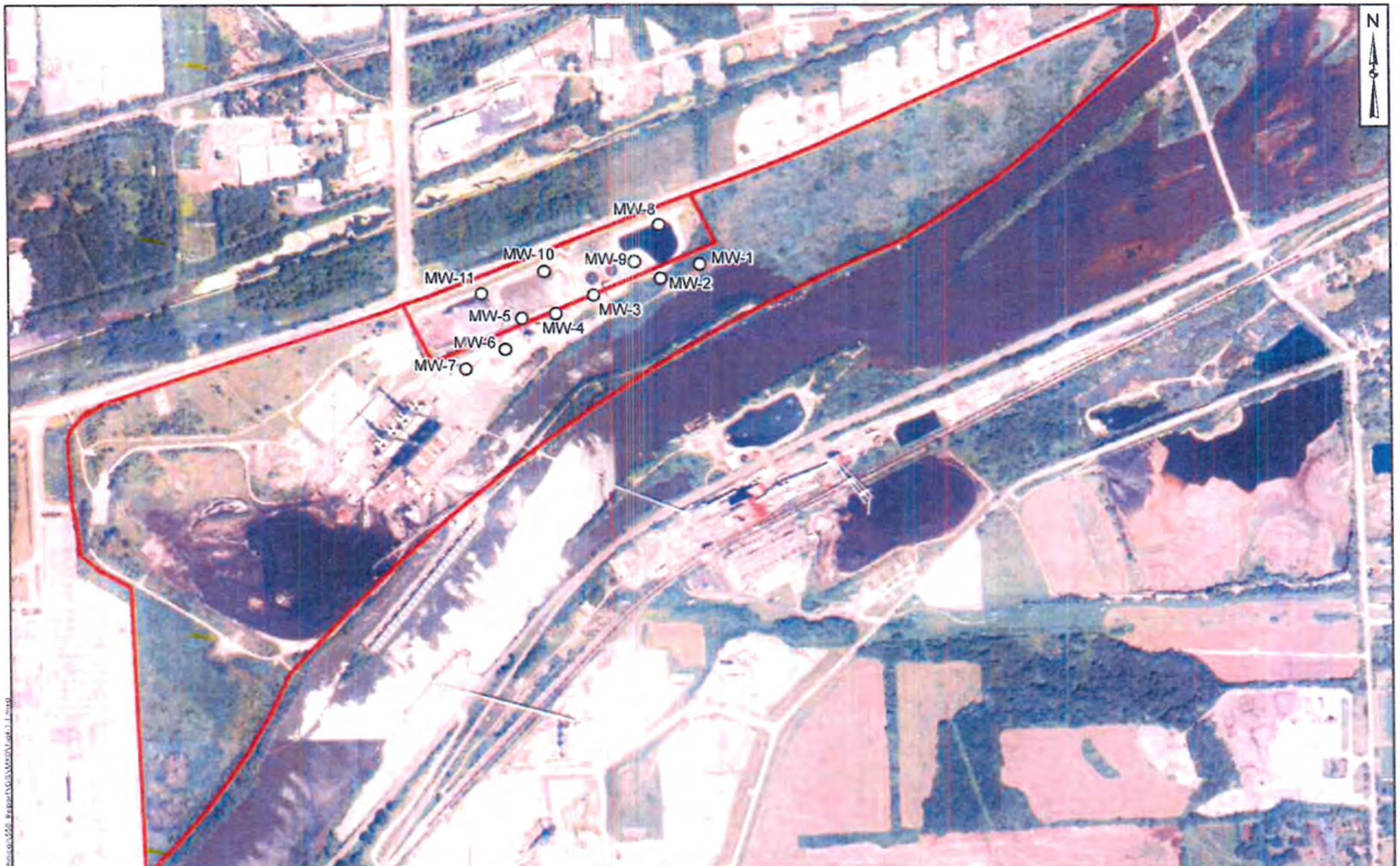
# J.SEYMOUR EXPERT REPORT

## FIGURES




**Legend**

○ Monitoring Well

Note: Locations are approximate and based on MWG, 2015a.

1,000 500 0 1,000 Feet

| | | |
|---|---|---|
| **Joliet #29 Station Monitoring Wells** Joliet, Illinois | Geosyntec consultants | Figure 4-1 |
| October 2015 | Chicago | |


**Legend**

Approx. Site Area and Ponds

O Monitoring Well

Note: Locations are approximate and based on MWG, 2015b.

1,000 500 0 1,000 Feet

**Powerton Station Monitoring Wells**

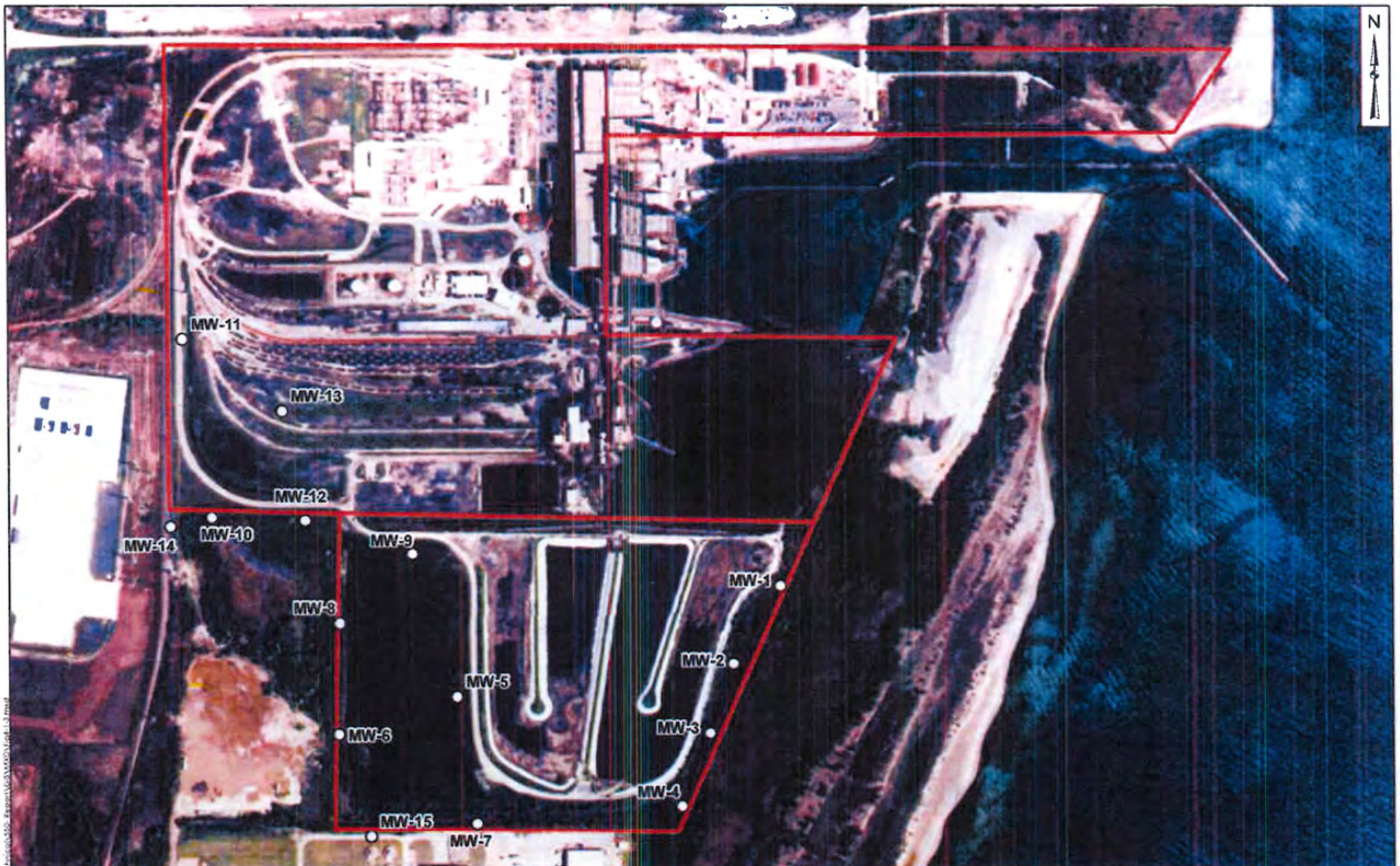
**Pekin, Illinois**

October 2015

Geosyntec consultants

Chicago

Figure 4-2




**Legend**

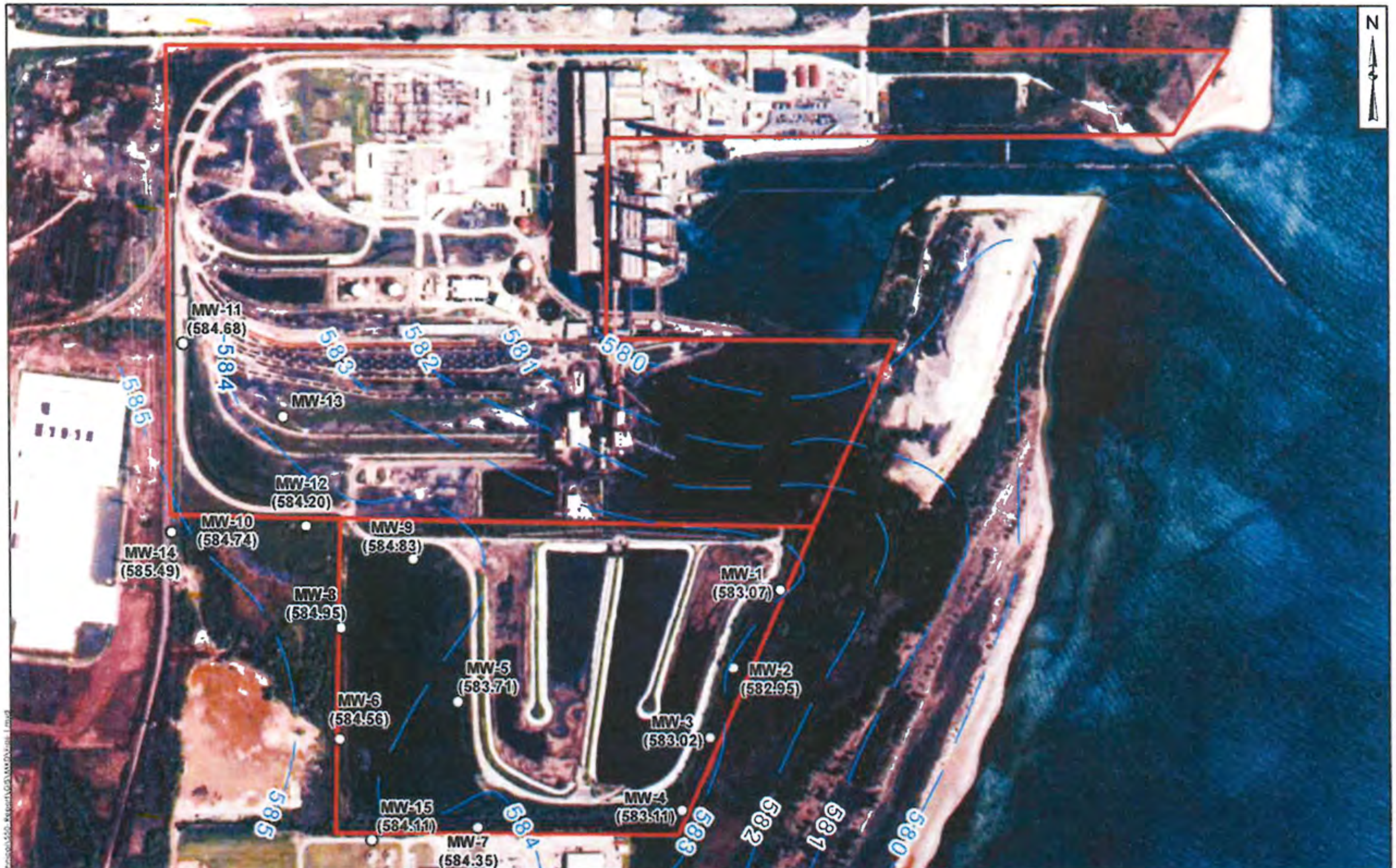
O Monitoring Wells

— Approx. Site Area and Ponds

Notes: Locations are approximate and based on MWG, 2015c and MWG13-15_44135.

800 400 0 800 Feet

| | | |
|---|---|---|
| **Waukegan Station Monitoring Wells**<br>**Waukegan, Illinois** | Geosyntec consultants | Figure<br>**4-3** |
| October 2015 | Chicago | |




**Legend**

o Monitoring Well (May or June 2014 Groundwater Elevation in Feet Mean Sea Level)

Approx. Site Area and Ponds

Approximate Groundwater Elevation Contours for May and June 2014 (feet Mean Sea Level)

Notes: Locations are approximate and based on MWG, 2015c and MWG13-15_44135.

Groundwater elevation contours are based on June 2014 and May 2014 groundwater elevations reported in MWG, 2015c and MWG13-15_44128.

800 400 0 800 Feet

**Waukegan Station Groundwater Elevation Contours**

**Waukegan, Illinois**

October 2015

Geosyntec consultants

Chicago

Figure

**4-4**


**Legend**

O Monitoring Wells

Approx. Site and Ponds

Note: Locations are approximate and based on MWG, 2015d.

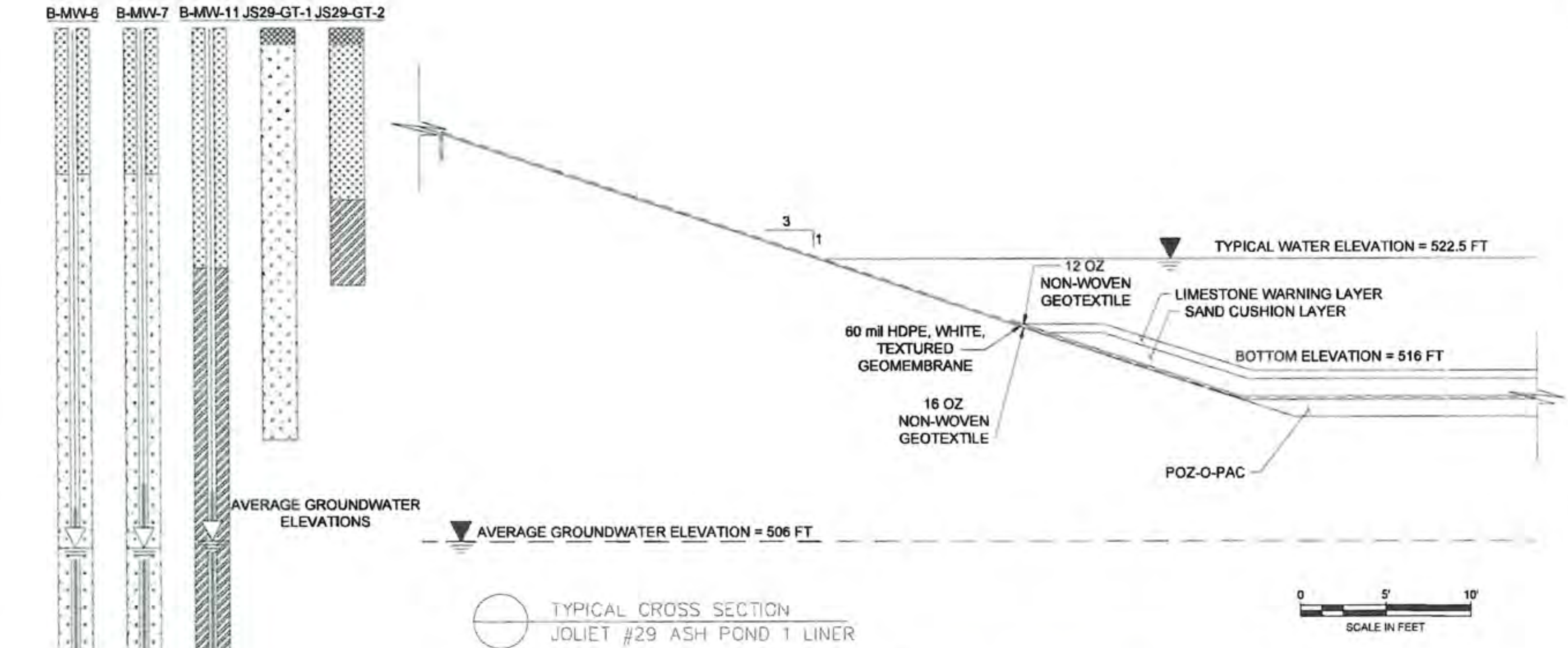
**Will County Station**
**Monitoring Wells**

**Romeoville, Illinois**

Geosyntec consultants

Chicago | October 2015

Figure 4-5




NEARBY LITHOLOGY
JOLIET #29 ASH POND 1

LEGEND:

PRIMARY MATERIALS

- FILL W/ ASH
- FILL
- SAND & GRAVEL
- SAND & SILT
- SILT & CLAY
- LIMESTONE BEDROCK

NOTES:

1) SITE LITHOLOGY TAKEN FROM LOGS OF BORINGS BY KPRG IN 2005 AND PATRICK ENGINEERING IN 2010.

2) GROUNDWATER ELEVATIONS BASED ON OBSERVED GROUNDWATER ELEVATIONS AT MONITORING WELLS MW-6, MW-7, AND MW-11 DURING THE PERIOD OF RECORD (SECOND QUARTER 2011 THROUGH FIRST QUARTER 2015).

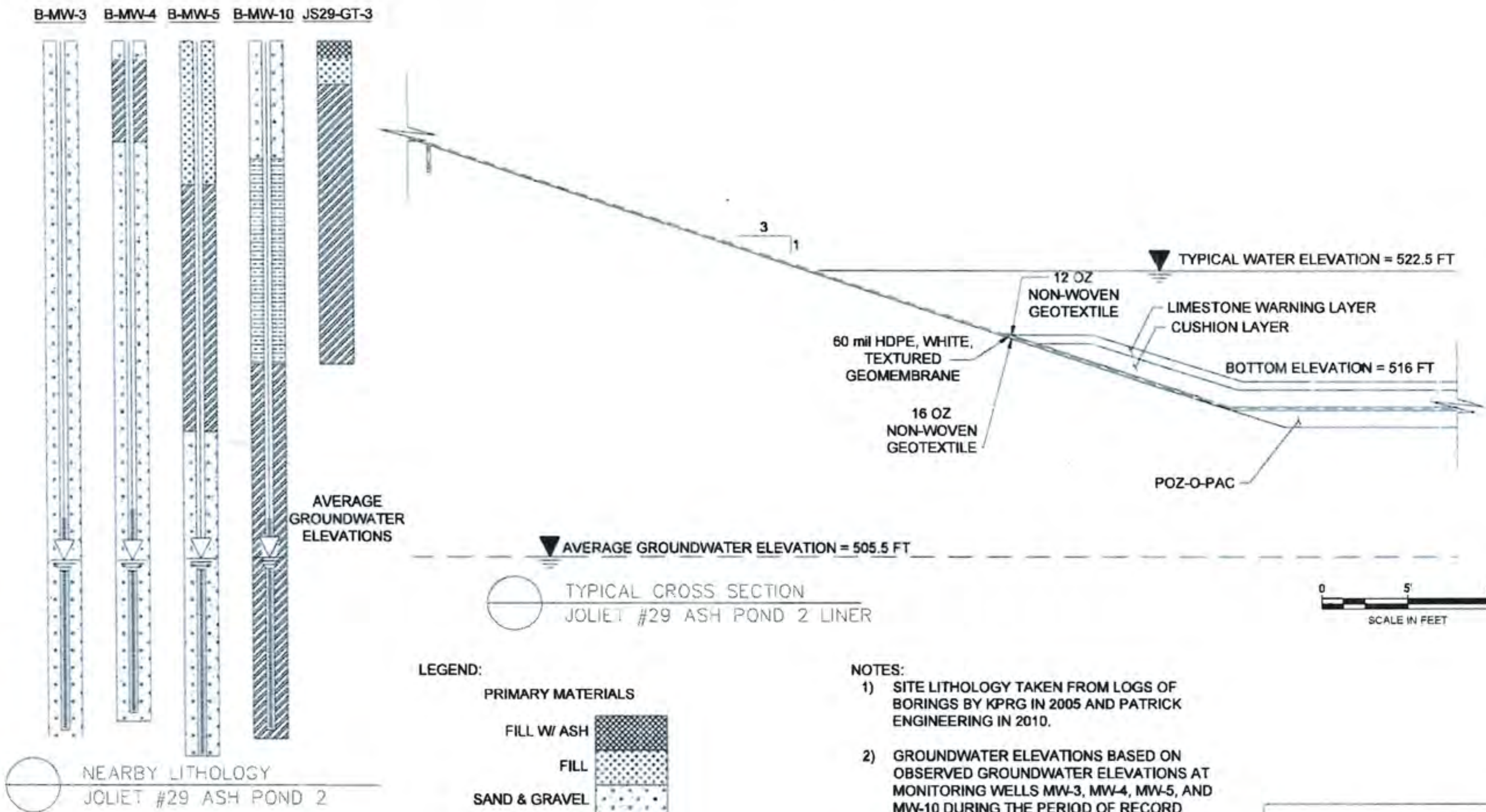
3) THE MAXIMUM GROUNDWATER ELEVATION WAS 509.3 FT MSL AT MONITORING WELL MW-11 DURING SECOND QUARTER 2011.

JOLIET #29
TYPICAL CROSS-SECTION OF ASH POND 1 LINER AND NEARBY LITHOLOGY

Geosyntec consultants

FIGURE 5-1

PROJECT NO: CHE8303 | OCTOBER 2015




LEGEND:

PRIMARY MATERIALS

- FILL W/ ASH
- FILL
- SAND & GRAVEL
- SAND & SILT
- SILT & CLAY
- LIMESTONE BEDROCK

NOTES:

1) SITE LITHOLOGY TAKEN FROM LOGS OF BORINGS BY KPRG IN 2005 AND PATRICK ENGINEERING IN 2010.

2) GROUNDWATER ELEVATIONS BASED ON OBSERVED GROUNDWATER ELEVATIONS AT MONITORING WELLS MW-3, MW-4, MW-5, AND MW-10 DURING THE PERIOD OF RECORD (SECOND QUARTER 2011 THROUGH FIRST QUARTER 2015).

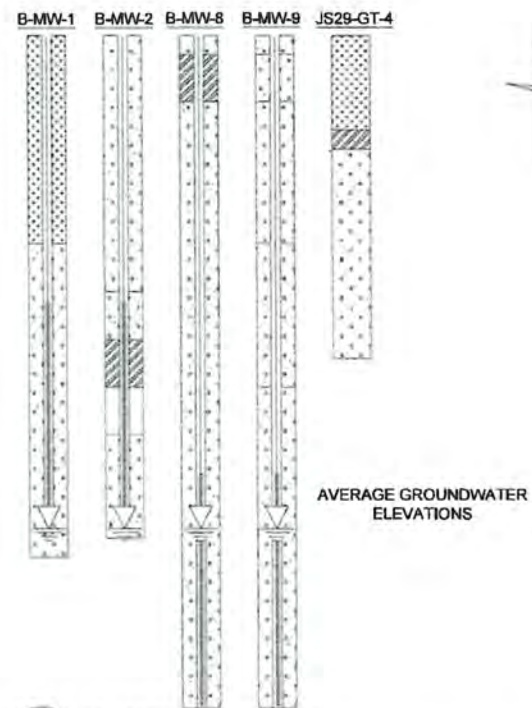
3) THE MAXIMUM GROUNDWATER ELEVATION WAS 508.2 FT MSL AT MONITORING WELL MW-10 DURING SECOND QUARTER 2011.

JOLIET #29
TYPICAL CROSS-SECTION ASH POND 2 LINER AND NEARBY LITHOLOGY

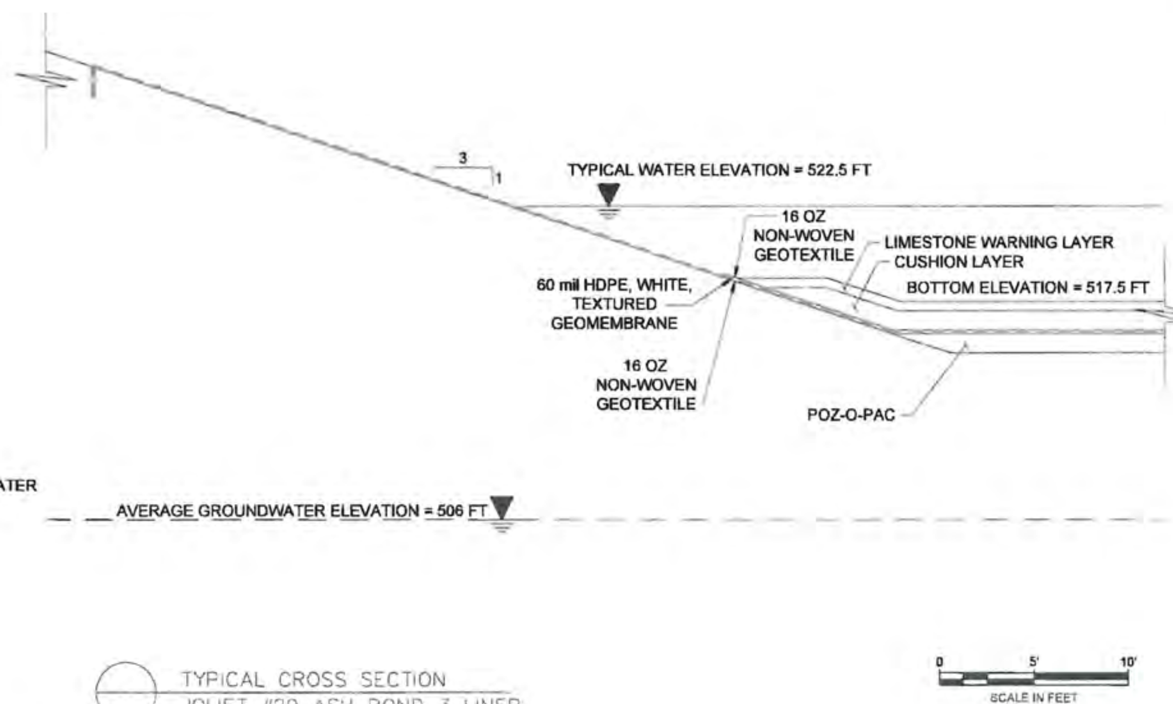
Geosyntec consultants

FIGURE 5-2

PROJECT NO: CHE8303 | OCTOBER 2015




NEARBY LITHOLOGY
JOLIET #29 ASH POND 3




TYPICAL CROSS SECTION
JOLIET #29 ASH POND 3 LINER

**LEGEND:**

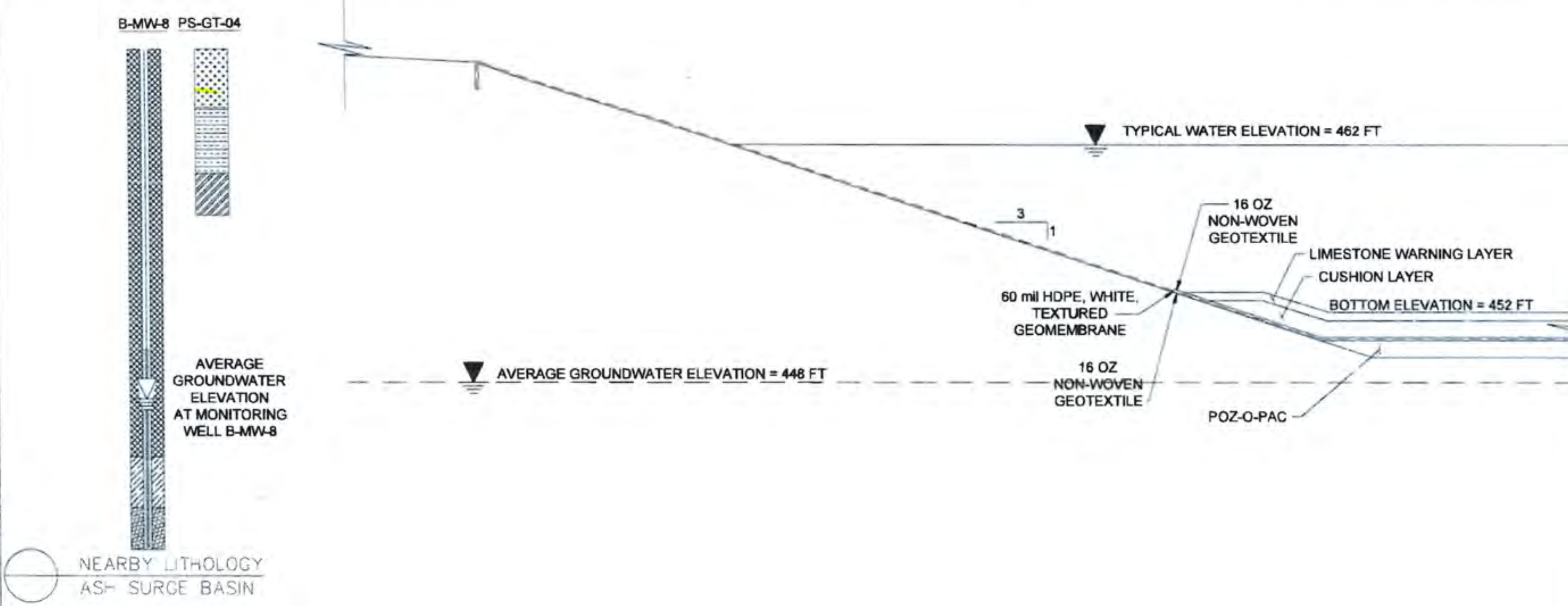
**PRIMARY MATERIALS**


**NOTES:**

1) SITE LITHOLOGY TAKEN FROM LOGS OF BORINGS BY KPRG IN 2005 AND PATRICK ENGINEERING IN 2010.
2) GROUNDWATER ELEVATIONS BASED ON OBSERVED GROUNDWATER ELEVATIONS AT MONITORING WELLS MW-1, MW-2, MW-8, AND MW-9 DURING THE PERIOD OF RECORD (SECOND QUARTER 2011 THROUGH FIRST QUARTER 2015).
3) THE MAXIMUM GROUNDWATER ELEVATION WAS 512.3 FT MSL AT MONITORING WELL MW-2 DURING THIRD QUARTER 2012.

| JOLIET #29<br>TYPICAL CROSS-SECTION OF ASH POND 3 LINER AND NEARBY LITHOLOGY | | |
|---|---|---|
| Geosyntec consultants | | FIGURE 5-3 |
| PROJECT NO: CHE8303 | OCTOBER 2015 | |

G:\CHP3\CHE8303-MIDWESTGEN-CONFIDENTIAL\500 - TECHNICAL\550- REPORT\CAD\JOLIET ASH POND 3




NEARBY LITHOLOGY
ASH SURGE BASIN

TYPICAL CROSS SECTION
POWERTON ASH SURGE BASIN LINER

LEGEND:

PRIMARY MATERIALS

- FILL W/ ASH
- FILL
- SAND & GRAVEL
- SAND & SILT
- SILT & CLAY
- ORGANIC CLAY
- ORGANIC SILT
- LIMESTONE BEDROCK

NOTES:

1) SITE LITHOLOGY TAKEN FROM LOGS OF BORINGS BY KPRG IN 2005 AND PATRICK ENGINEERING IN 2010.

2) GROUNDWATER ELEVATIONS BASED ON OBSERVED GROUNDWATER ELEVATIONS AT MONITORING WELLS MW-8, MW-15, MW-12, AND MW-11 DURING THE PERIOD OF RECORD (SECOND QUARTER 2011 THROUGH FIRST QUARTER 2015).

3) THE MAXIMUM GROUNDWATER ELEVATION WAS 452 FT MSL AT MONITORING WELL MW-12 DURING SECOND QUARTER 2013.

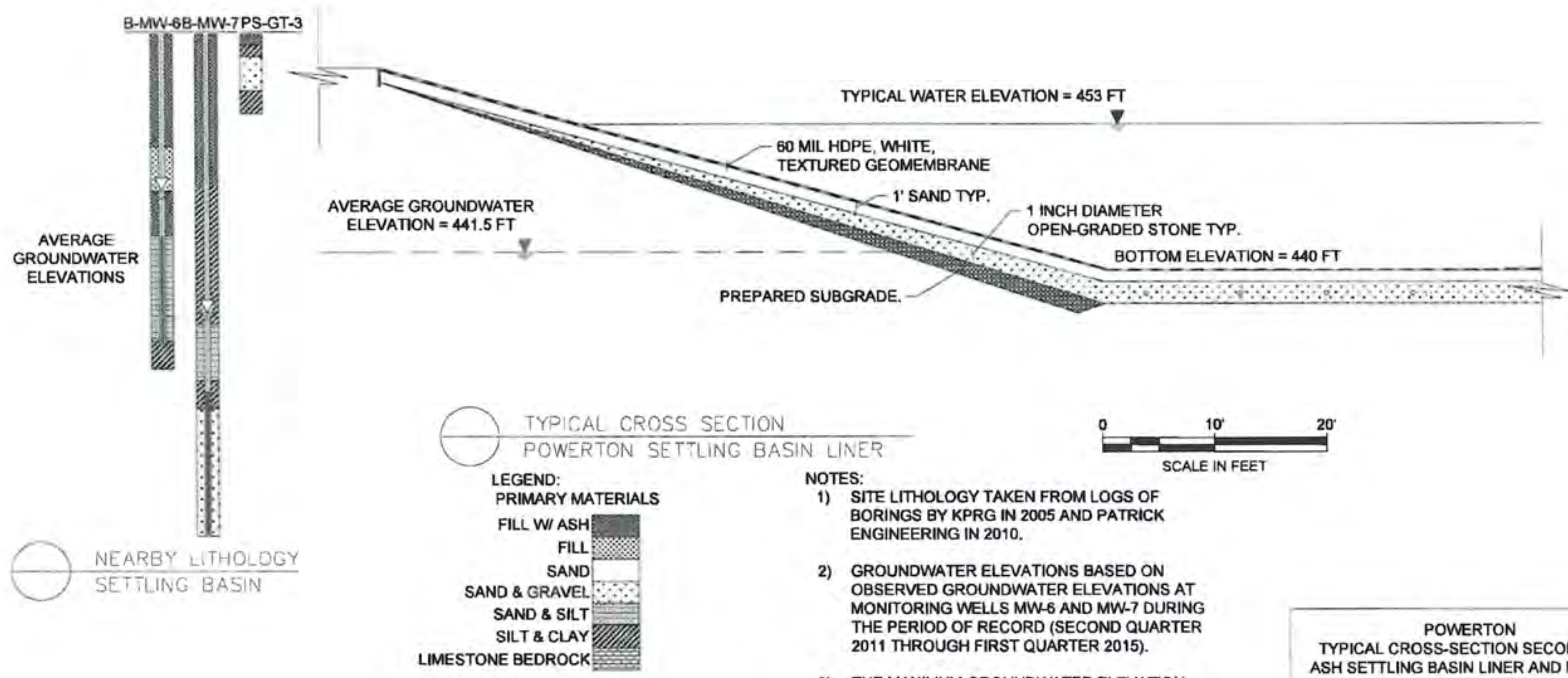
0 5' 10'
SCALE IN FEET

POWERTON
TYPICAL CROSS-SECTION OF ASH SURGE BASIN LINER AND NEARBY LITHOLOGY

Geosyntec consultants

FIGURE 5-4

PROJECT NO. CHE8303 | OCTOBER 2015




NOTES:

1) SITE LITHOLOGY TAKEN FROM LOGS OF BORINGS BY KPRG IN 2005 AND PATRICK ENGINEERING IN 2010.
2) GROUNDWATER ELEVATIONS BASED ON OBSERVED GROUNDWATER ELEVATIONS AT MONITORING WELLS MW-6 AND MW-7 DURING THE PERIOD OF RECORD (SECOND QUARTER 2011 THROUGH FIRST QUARTER 2015).
3) THE MAXIMUM GROUNDWATER ELEVATION WAS 450 FT MSL AT MONITORING WELL MW-6 DURING FIRST QUARTER 2014.

POWERTON
TYPICAL CROSS-SECTION SECONDARY ASH SETTLING BASIN LINER AND NEARBY LITHOLOGY

Geosyntec consultants

FIGURE 5-5

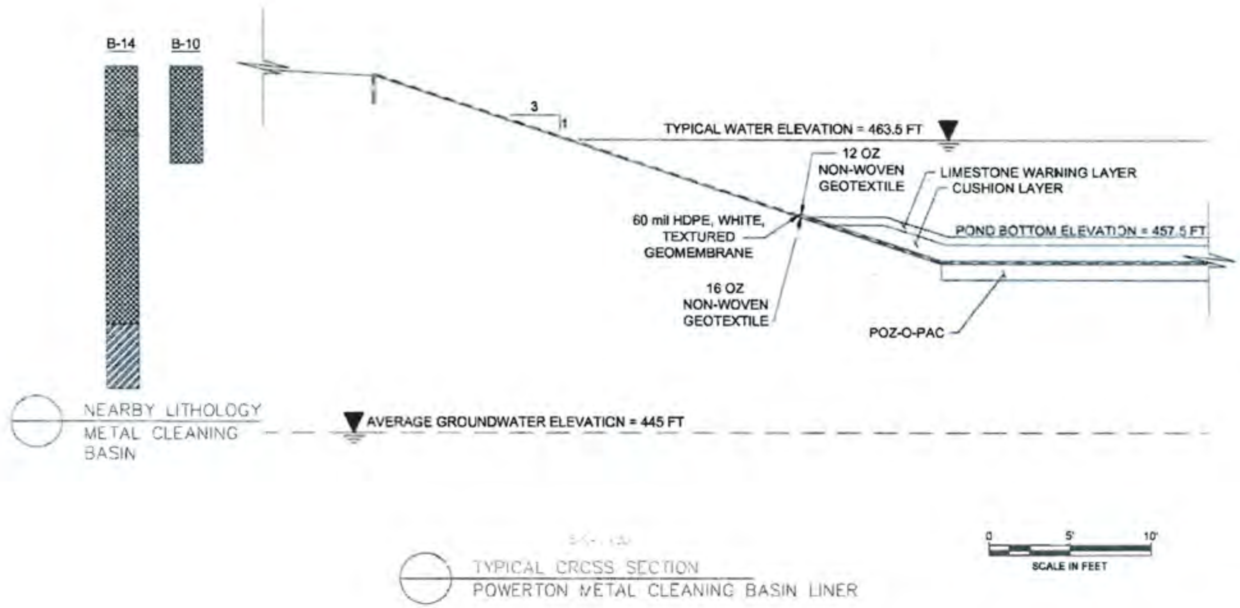
PROJECT NO: CHE8303 | OCTOBER 2015

NOTES:

1) SITE LITHOLOGY TAKEN FROM LOGS OF BORINGS BY ENSR IN 1993

2) GROUNDWATER ELEVATIONS BASED ON OBSERVED GROUNDWATER ELEVATIONS AT MONITORING WELLS MW13, MW-14, AND MW-15 DURING THE PERIOD OF RECORD (SECOND QUARTER 2011 THROUGH FIRST QUARTER 2015)

3) THE MAXIMUM GROUNDWATER ELEVATION WAS 449.5 FT MSL AT MONITORING WELL MW-15 DURING SECOND QUARTER 2013.



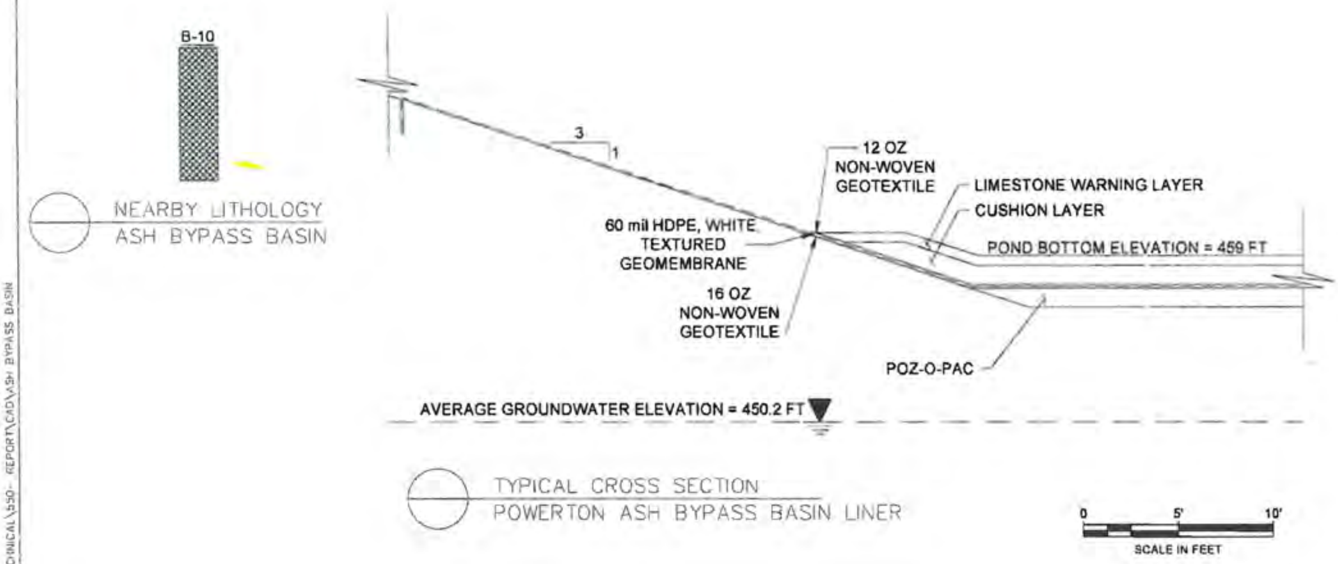

LEGEND:


POWERTON
TYPICAL CROSS-SECTION OF METAL CLEANING BASIN LINER AND NEARBY LITHOLOGY

Geosyntec consultants

FIGURE 5-6

PROJECT NO: CHE8303 | OCTOBER 2015




NOTES:

1) SITE LITHOLOGY TAKEN FROM LOGS OF BORINGS BY ENSR IN 1998.
2) GROUNDWATER ELEVATION BASED ON OBSERVED GROUNDWATER ELEVATIONS AT MONITORING WELL MW-12 DURING THE PERIOD OF RECORD (SECOND QUARTER 2011 THROUGH FIRST QUARTER 2015).
3) THE MAXIMUM GROUNDWATER ELEVATION WAS 452 FT MSL AT MONITORING WELL MW-12 DURING SECOND QUARTER 2013

LEGEND:

PRIMARY MATERIALS

- FILL W/ ASH
- FILL
- SAND & GRAVEL
- SAND & SILT
- SILT & CLAY
- ORGANIC CLAY
- ORGANIC SILT
- LIMESTONE BEDROCK

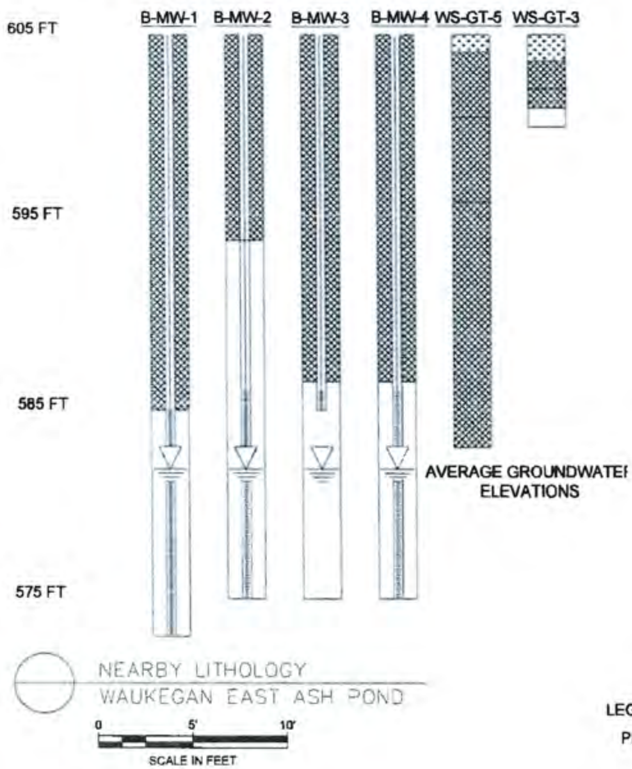
POWERTON
TYPICAL CROSS-SECTION OF ASH BYPASS BASIN LINER AND NEARBY LITHOLOGY

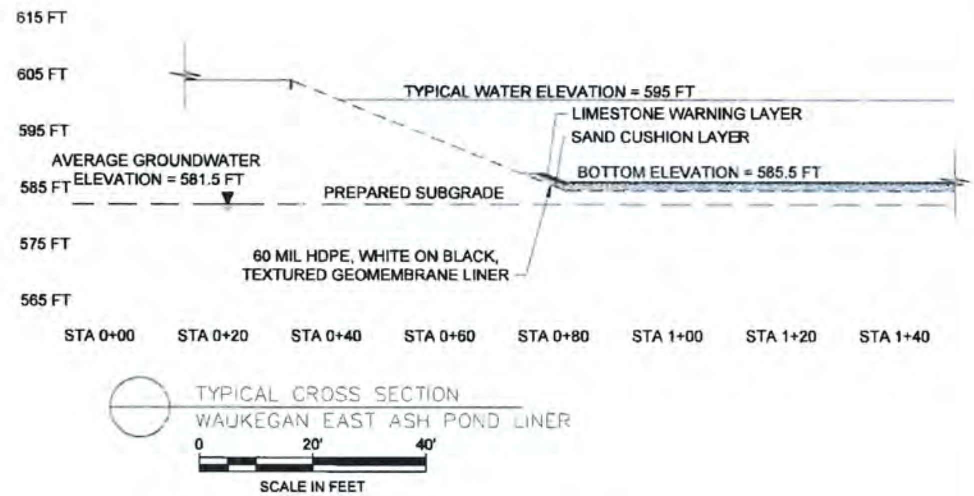
Geosyntec consultants

FIGURE 5-7

PROJECT NO: CHE8303 | OCTOBER 2015

G:\CWP\CHE8303-MIDWESTGEN-CONFIDENTIAL\500 - TECHNICAL\550 - REPORT\CAD\ASH BYPASS BASIN





NOTES:

1) SITE LITHOLOGY TAKEN FROM LOGS OF BORINGS BY KPRG IN 2005 AND PATRICK ENGINEERING IN 2010.

2) GROUNDWATER ELEVATIONS BASED ON OBSERVED GROUNDWATER ELEVATIONS AT MONITORING WELLS MW-1, MW-2, MW-3, AND MW-4 DURING THE PERIOD OF RECORD (SECOND QUARTER 2011 THROUGH FIRST QUARTER 2015).

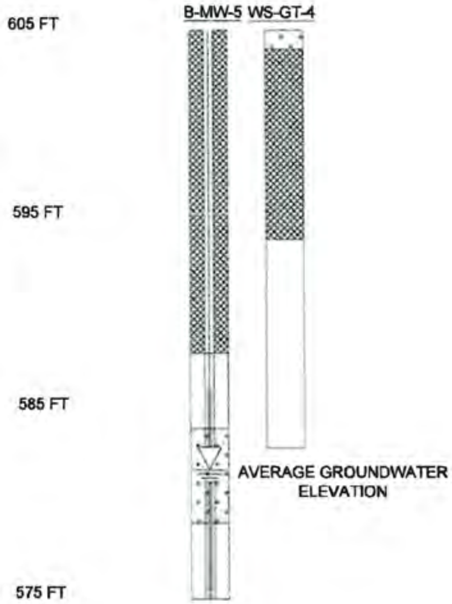
3) THE MAXIMUM GROUNDWATER ELEVATION WAS 583.4 FT MSL AT MONITORING WELL MW-4 DURING SECOND QUARTER 2011.

WAUKEGAN
TYPICAL CROSS SECTION OF EAST ASH POND LINER AND NEARBY LITHOLOGY

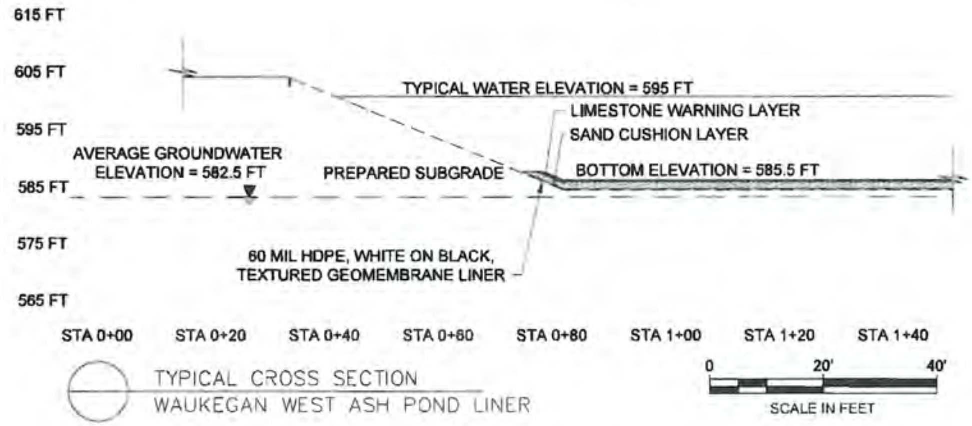
Geosyntec consultants

FIGURE 5-8

PROJECT NO: CHE8303 | OCTOBER 2015



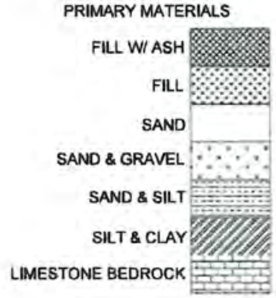

NEARBY LITHOLOGY
WAUKEGAN WEST ASH POND




TYPICAL CROSS SECTION
WAUKEGAN WEST ASH POND LINER

LEGEND:

PRIMARY MATERIALS




NOTES:

1) SITE LITHOLOGY TAKEN FROM LOGS OF BORINGS BY KPRG IN 2005 AND PATRICK ENGINEERING IN 2010.

2) GROUNDWATER ELEVATIONS BASED ON OBSERVED GROUNDWATER ELEVATIONS AT MONITORING WELL MW-5 DURING THE PERIOD OF RECORD (SECOND QUARTER 2011 THROUGH FIRST QUARTER 2015).

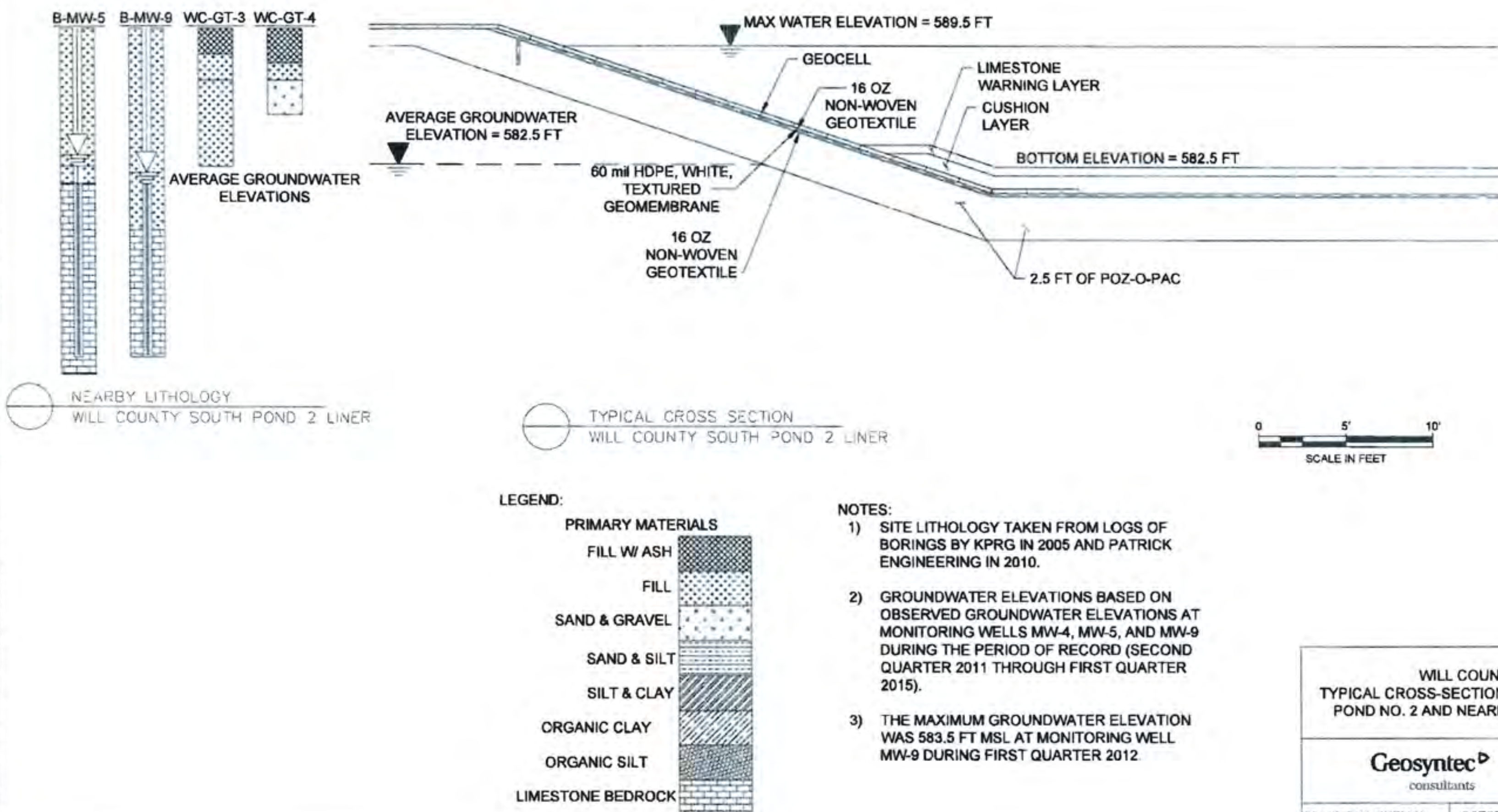
3) THE MAXIMUM GROUNDWATER ELEVATION WAS 584.5 FT MSL AT MONITORING WELL MW-5 DURING SECOND QUARTER 2011.

WAUKEGAN
TYPICAL CROSS SECTION OF WEST ASH POND LINER AND NEARBY LITHOLOGY

Geosyntec consultants

FIGURE 5-9

PROJECT NO: CHE8303 | OCTOBER 2015



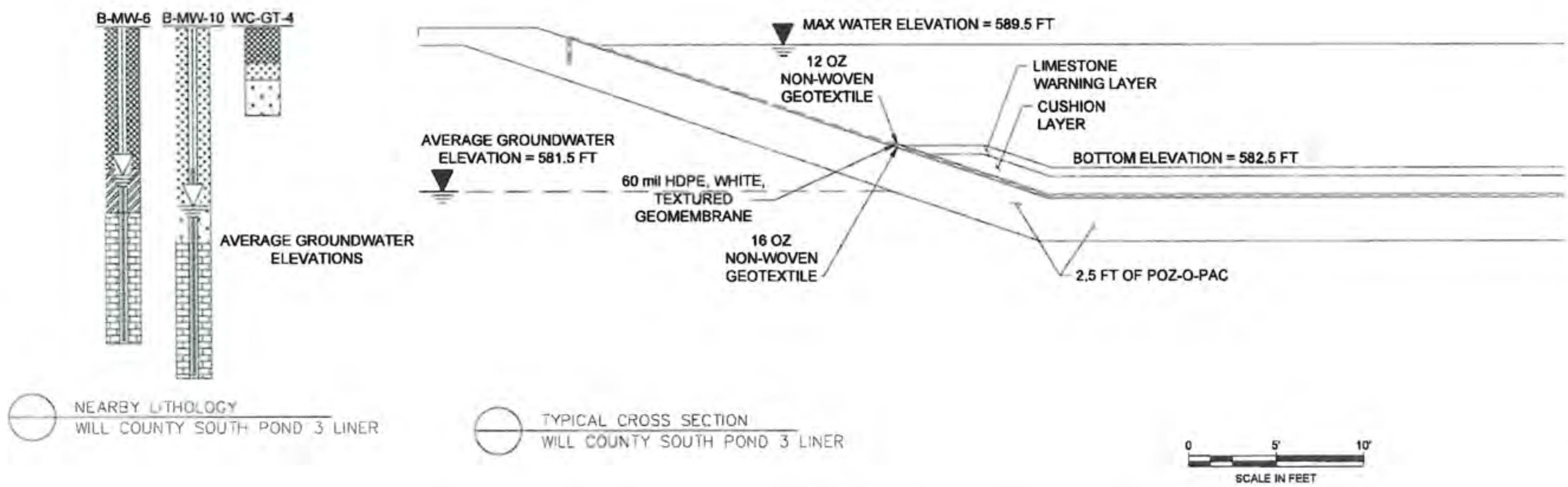

NOTES:
1) SITE LITHOLOGY TAKEN FROM LOGS OF BORINGS BY KPRG IN 2005 AND PATRICK ENGINEERING IN 2010.
2) GROUNDWATER ELEVATIONS BASED ON OBSERVED GROUNDWATER ELEVATIONS AT MONITORING WELLS MW-4, MW-5, AND MW-9 DURING THE PERIOD OF RECORD (SECOND QUARTER 2011 THROUGH FIRST QUARTER 2015).
3) THE MAXIMUM GROUNDWATER ELEVATION WAS 583.5 FT MSL AT MONITORING WELL MW-9 DURING FIRST QUARTER 2012.

WILL COUNTY
TYPICAL CROSS-SECTION OF SOUTH ASH POND NO. 2 AND NEARBY LITHOLOGY

Geosyntec consultants

FIGURE 5-10

PROJECT NO: CHE8303 | OCTOBER 2015




LEGEND:

PRIMARY MATERIALS

- FILL W/ ASH
- FILL
- SAND & GRAVEL
- SAND & SILT
- SILT & CLAY
- ORGANIC CLAY
- ORGANIC SILT
- LIMESTONE BEDROCK

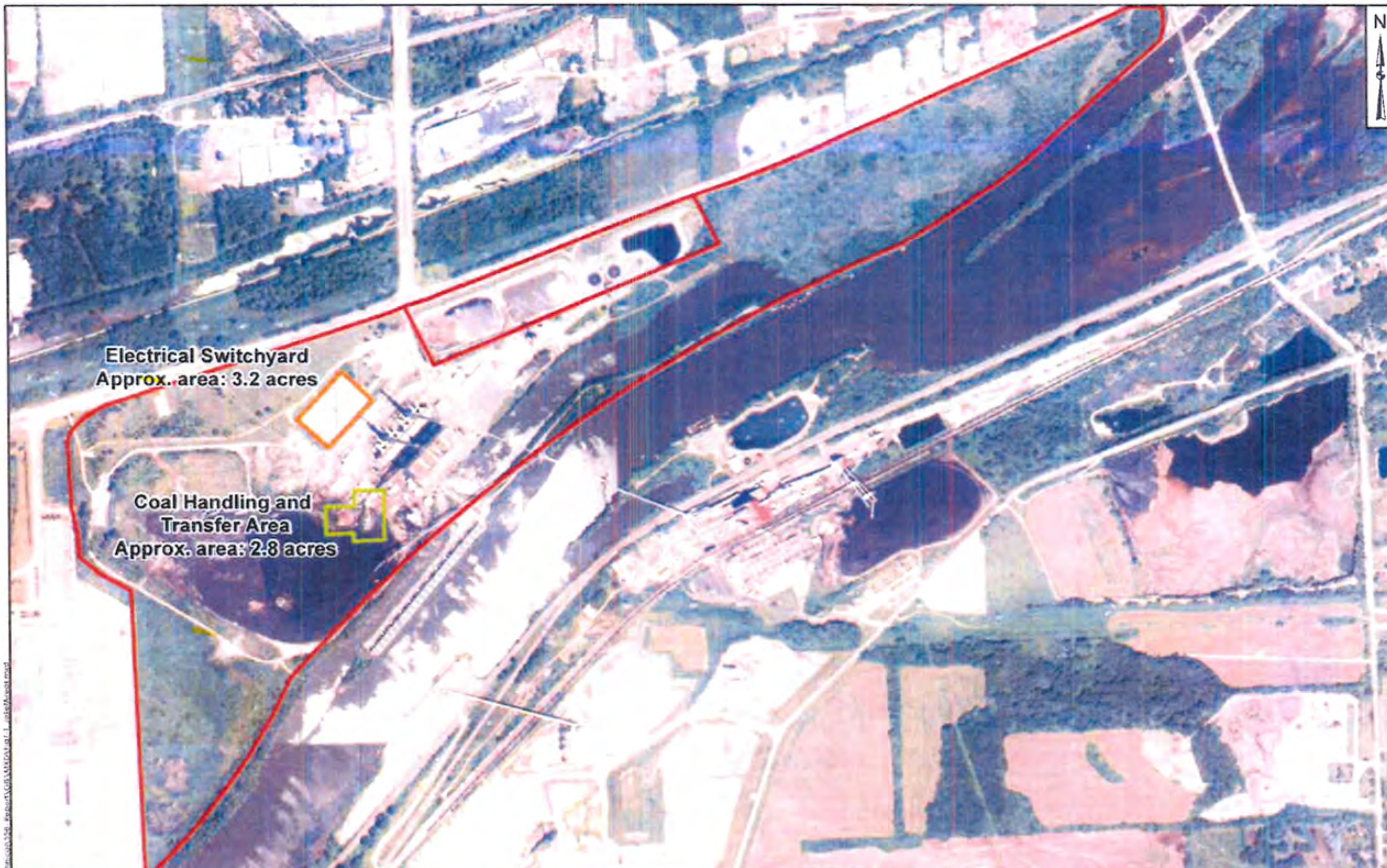
NOTES:

1) SITE LITHOLOGY TAKEN FROM LOGS OF BORINGS BY KPRG IN 2005 AND PATRICK ENGINEERING IN 2010.

2) GROUNDWATER ELEVATIONS BASED ON OBSERVED GROUNDWATER ELEVATIONS AT MONITORING WELLS MW-6 AND MW-10 DURING THE PERIOD OF RECORD (SECOND QUARTER 2011 THROUGH FIRST QUARTER 2015).

3) THE MAXIMUM GROUNDWATER ELEVATION WAS 582.5 FT MSL AT MONITORING WELL MW-6 DURING SECOND QUARTER 2011.

| | |
|---|---|
| WILL COUNTY<br>TYPICAL CROSS-SECTION OF SOUTH ASH POND NO. 3 AND NEARBY LITHOLOGY | |
| Geosyntec consultants | FIGURE |
| PROJECT NO: CHE8303 / OCTOBER 2015 | 5-11 |




**Legend**

- Coal Handling and Transfer Area
- Electrical Switchyard
- Approx. Site Area and Ponds

Note: Locations are approximate and based on aerial photographs.

1,000 500 0 1,000 Feet

**Joliet #29 Station Equipment Areas**

**Joliet, Illinois**

October 2015

Geosyntec consultants

Chicago

Figure 7-1


**Legend**

- Coal Handling and Transfer Area
- Electrical Switchyard
- Approx. Site Area and Ponds

Note: Locations are approximate and based on aerial photographs.

1,000 500 0 1,000 Feet

**Powerton Station Equipment Areas**

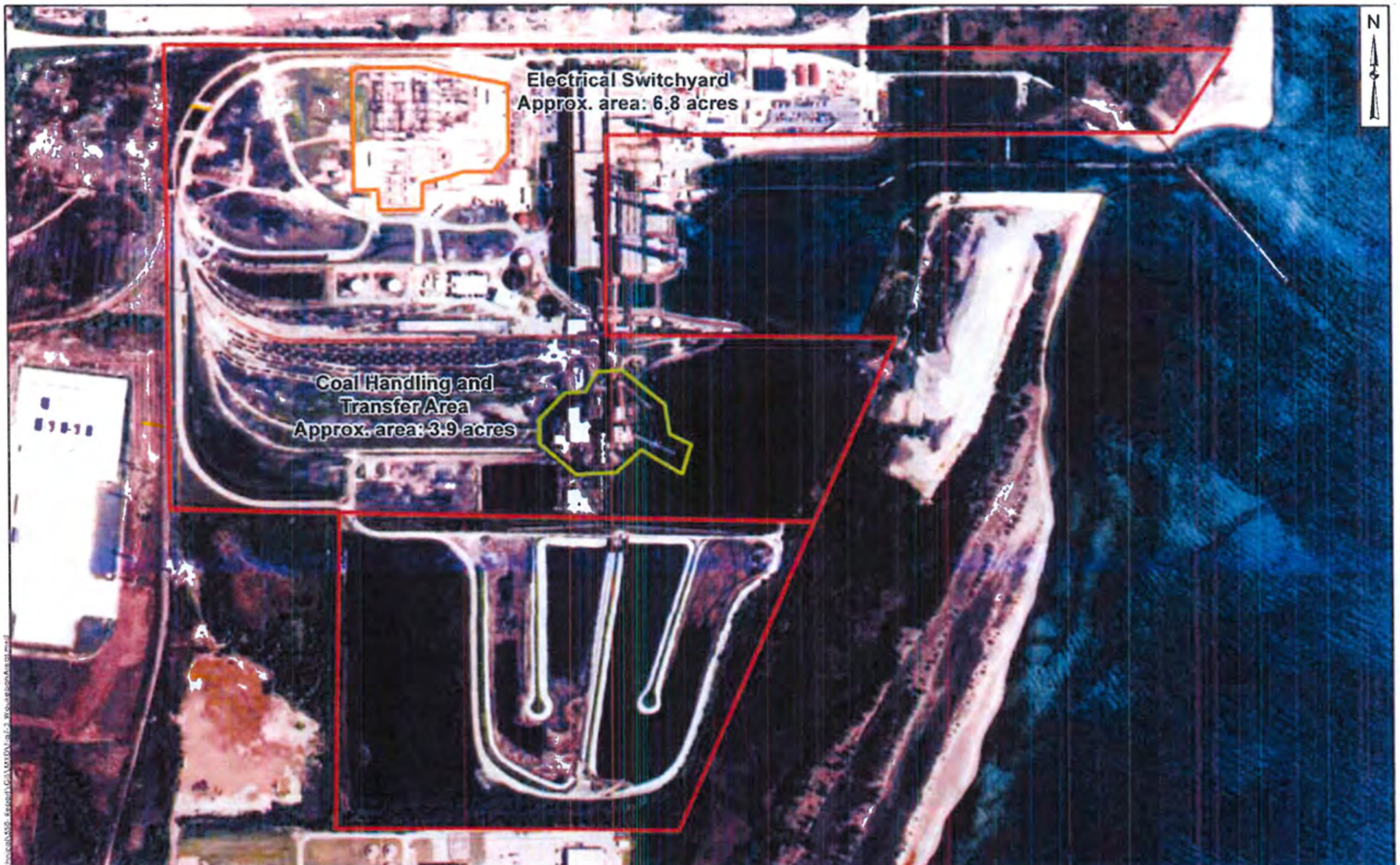
**Pekin, Illinois**

October 2015

Geosyntec consultants

Chicago

Figure **7-2**



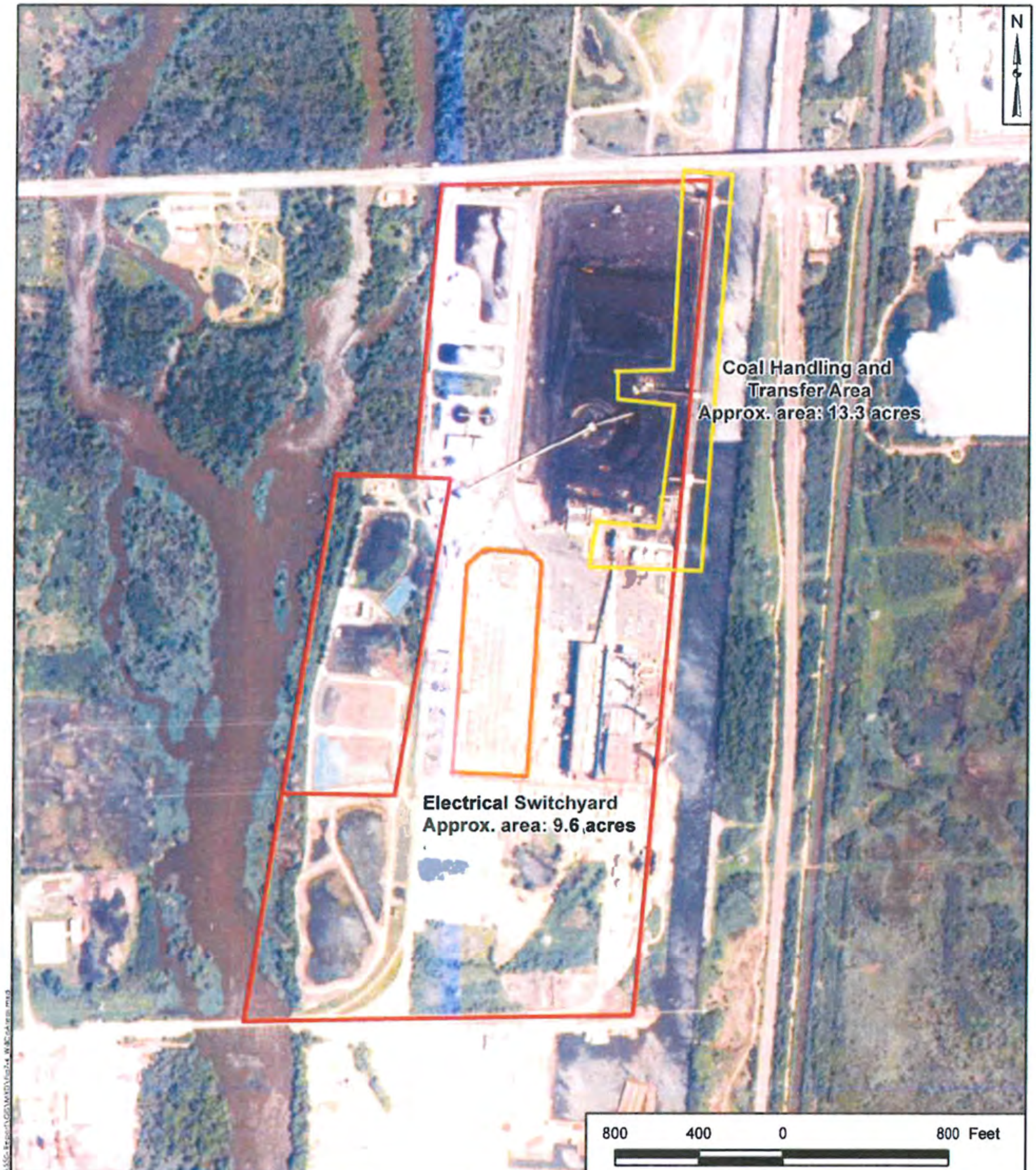

**Legend**

- Coal Handling and Transfer Area
- Electrical Switchyard
- Approx. Site Area and Ponds

Note: Locations are approximate and based on aerial photographs.

800 400 0 800 Feet

| | | |
|---|---|---|
| **Waukegan Station Equipment Areas**<br>**Waukegan, Illinois** | Geosyntec consultants | Figure<br>**7-3** |
| October 2015 | Chicago | |




**Legend**

- Coal Handling and Transfer Area
- Electrical Switchyard
- Approx. Site and Ponds

Note: Locations are approximate and based on aerial photographs.

**Will County Station Equipment Areas**

**Romeoville, Illinois**

Geosyntec consultants

Chicago | October 2015

Figure 7-4

# J.SEYMOUR EXPERT REPORT

## TABLES

**Table 4-1**
**Groundwater Elevations at Joliet No. 29 Generating Station**

| Date | Groundwater Elevations [1] (feet above MSL) | | | | | | | | | | | Statistics (feet above MSL) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MW-1 | MW-2 | MW-3 | MW-4 | MW-5 | MW-6 | MW-7 | MW-8 | MW-9 | MW-10 | MW-11 | Site-Wide Average | Minimum | Maximum | Range |
| 6/14/2011 | 507.69 | 507.62 | 507 97 | 507.93 | 507.87 | 507.83 | 507.83 | 507.91 | 507.88 | 508.19 | 509.29 | 508.00 | 507.62 | 509.29 | 1.67 |
| 9/14/2011 | 505.21 | 505.13 | 505.17 | 505.15 | 505.05 | 505.19 | 505.21 | 505.25 | 505.22 | 505.23 | 505.49 | 505.21 | 505.05 | 505.49 | 0.44 |
| 12/7/2011 | 505.39 | 505.36 | 505.38 | 505.34 | 505.23 | 505.36 | 505.37 | 505.49 | 505.46 | 505.43 | 505.77 | 505.42 | 505.23 | 505.77 | 0.54 |
| 3/15/2012 | 505.47 | 505.43 | 505.45 | 505.43 | 505.32 | 505.45 | 505.46 | 505.57 | 505.53 | 505.51 | 505.80 | 505.49 | 505.32 | 505.80 | 0.48 |
| 6/19/2012 | 505.23 | 505.18 | 505.23 | 505.21 | 505.11 | 505.26 | 505.28 | 505.32 | 505.29 | 505.28 | 505.51 | 505.26 | 505.11 | 505.51 | 0.40 |
| 9/19/2012 | 510.52 | 512.33 | 505.12 | 505.11 | 505.06 | 505.26 | 505.26 | 505.22 | 505.66 | 505.16 | 505.35 | 506.37 | 505.06 | 512.33 | 7.27 |
| 12/20/2012 | 505.42 | 505.33 | 505.25 | 505.25 | 505.22 | 505.25 | 505.24 | 505.40 | 505.36 | 505.30 | 505.44 | 505.31 | 505.22 | 505.44 | 0.22 |
| 3/5/2013 | 505.30 | 505.31 | 505.38 | 505.39 | 505.24 | 505.37 | 505.40 | 505.45 | 505.50 | 505.41 | 505.66 | 505.40 | 505.24 | 505.66 | 0.42 |
| 5/23/2013 | 505.81 | 505.82 | 505.87 | 503.94 | 506.03 | 506.06 | 506.17 | 505.91 | 505.91 | 505.99 | 506.46 | 505.82 | 503.94 | 506.46 | 2.52 |
| 7/22/2013 | 504.94 | 505.10 | 505.16 | 505.13 | 505.09 | 505.28 | 505.27 | 505.17 | 505.22 | 505.28 | 505.44 | 505.19 | 504.94 | 505.44 | 0.50 |
| 10/15/2013 | 504.93 | 505.05 | 505.04 | 505.07 | 504.99 | 505.12 | 505.13 | 505.13 | 505.10 | 505.10 | 505.32 | 505.09 | 504.93 | 505.32 | 0.39 |
| 2/21/2014 | NM | 505.99 | 505.29 | 505.99 | 505.97 | 506.10 | 506.16 | 505.94 | 505.30 | 505.35 | 506.19 | 505.83 | 505.29 | 506.19 | 0.90 |
| 5/1/2014 | 505.73 | 505.73 | 505.70 | 505.71 | 505.56 | 505.71 | 505.71 | 505.84 | 505.82 | 505.80 | 506.20 | 505.77 | 505.56 | 506.20 | 0.64 |
| 8/18/2014 | 506.75 | 506.05 | 506.26 | 506.28 | 506.10 | 506.22 | 506.27 | 506.19 | 506.18 | 506.41 | 507.14 | 506.35 | 506.05 | 507.14 | 1.09 |
| 10/23/2014 | 505.80 | 505.79 | 505.82 | 505.86 | 505.65 | 505.75 | 505.79 | 505.78 | 505.82 | 505.89 | 506.28 | 505.84 | 505.65 | 506.28 | 0.63 |
| 2/10/2015 | NM | 505.17 | 505.19 | 505.19 | 505.12 | 505.23 | 505.24 | 505.18 | 505.22 | 505.27 | 505.49 | 505.23 | 505.12 | 505.49 | 0.37 |

**Abbreviations:**
"MSL" = mean sea level
"NM" = not measured

**Notes:**
1. Groundwater elevations were reported in the First Quarter 2015 groundwater monitoring reports submitted by MWG to IEPA (MWG, 2015a).

**Table 4-2**
**Summary of Joliet #29 Constituents of Interest**

| Constituent of Interest |
|---|
| Antimony |
| Boron |
| Chloride |
| Iron |
| Manganese |
| pH |
| Sulfate |
| TDS |

**Note:**
1. Constituents of Interest are based on concentrations reported in the First Quarter 2015 groundwater monitoring reports submitted by MWG to IEPA (MWG, 2015a).

Table 4-3

**Groundwater Elevations at Powerton Generating Station**

| Date | Groundwater Elevations [1] (feet above MSL) | | | | | | | | | | | | | | | | Statistics (feet above MSL) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MW-1 | MW-2 | MW-3 | MW-4 | MW-5 | MW-6 | MW-7 | MW-8 | MW-9 | MW-10 | MW-11 | MW-12 | MW-13 | MW-14 | MW-15 | MW-16 | Site-Wide Average | Minimum | Maximum | Range |
| 9/19/2011 | 439.95 | 433.27 | 432.73 | 431.63 | 432.77 | 445.71 | 433.40 | 446.76 | 443.64 | 439.99 | 440.49 | 449.88 | 446.06 | 448.13 | 448.29 | NA | 440.85 | 431.63 | 449.88 | 18.25 |
| 12/12/2011 | 439.78 | 434.78 | 433.88 | 433.28 | 434.13 | 446.30 | 434.64 | 446.85 | 443.08 | 440.01 | 440.51 | 450.03 | 447.39 | 448.28 | 449.16 | NA | 441.47 | 433.28 | 450.03 | 16.75 |
| 3/19/2012 | 442.40 | 437.48 | 436.94 | 434.93 | 435.71 | 446.17 | 436.04 | 447.66 | 443.78 | 442.03 | 441.63 | 451.18 | 437.72 | 448.11 | 447.82 | NA | 441.97 | 434.93 | 451.18 | 16.25 |
| 4/4/2012 | 441.39 | 436.92 | 435.67 | 434.15 | 434.93 | 445.81 | 435.10 | 447.27 | 443.49 | 441.06 | 441.03 | 450.83 | 436.84 | 445.28 | 446.73 | NA | 441.10 | 434.15 | 450.83 | 16.68 |
| 6/25/2012 | 437.84 | 433.69 | 432.86 | 432.38 | 433.23 | 445.99 | 433.77 | 447.06 | 442.55 | 438.39 | 439.54 | 450.38 | 437.79 | 443.71 | 446.78 | NA | 439.73 | 432.38 | 450.38 | 18.00 |
| 9/18/2012 | 435.37 | 431.30 | 430.71 | 430.34 | 430.99 | 445.63 | 431.39 | 446.70 | 440.29 | 436.06 | 437.31 | 449.95 | 437.73 | 446.80 | 447.49 | NA | 438.54 | 430.34 | 449.95 | 19.61 |
| 12/12/2012 | 435.06 | 431.12 | 429.94 | 430.28 | 430.98 | 447.37 | 431.38 | 447.23 | 439.77 | 435.79 | 437.09 | 449.18 | 437.40 | 444.89 | 446.71 | 441.16 | 438.46 | 429.94 | 449.18 | 19.24 |
| 2/27/2013 | 439.56 | 436.02 | 436.39 | 434.36 | 434.93 | 448.45 | 435.30 | 448.53 | 441.69 | 439.50 | 439.79 | 451.07 | 437.99 | 447.29 | 448.48 | 442.56 | 441.37 | 434.36 | 451.07 | 16.71 |
| 5/29/2013 | 446.35 | 444.38 | 444.87 | 443.93 | 444.11 | 443.12 | 449.93 | 447.82 | 449.35 | 446.90 | 447.35 | 451.84 | 445.45 | 448.37 | 449.36 | 449.74 | 447.05 | 443.12 | 451.84 | 8.72 |
| 7/29/2013 | 441.71 | 434.84 | 434.87 | 432.86 | 433.63 | 449.46 | 433.88 | 448.53 | 444.99 | 441.21 | 441.49 | 449.45 | 437.59 | 447.59 | 448.70 | 446.17 | 441.69 | 432.86 | 449.46 | 16.60 |
| 10/21/2013 | 435.98 | 431.64 | 430.91 | 430.60 | 431.41 | 448.12 | 432.19 | 447.12 | 441.05 | 436.73 | 437.95 | 447.83 | 437.56 | 444.92 | 447.70 | 442.54 | 439.02 | 430.60 | 448.12 | 17.52 |
| 3/6/2014 | 442.20 | 442.74 | 442.23 | 442.09 | 442.36 | 449.65 | 442.61 | 447.89 | 444.36 | 442.64 | 443.65 | 451.45 | 443.96 | 446.32 | 447.52 | 444.36 | 444.75 | 442.09 | 451.45 | 9.36 |
| 5/27/2014 | 442.00 | 440.91 | 440.70 | 439.49 | 439.99 | 447.32 | 439.81 | 446.86 | 444.82 | 442.23 | 443.02 | 450.22 | 442.19 | 446.55 | 447.14 | 445.54 | 443.67 | 439.49 | 450.22 | 10.73 |
| 8/28/2014 | 439.33 | 436.20 | 434.72 | 435.10 | 436.01 | 447.00 | 438.63 | 446.35 | 443.42 | 440.07 | 441.27 | 449.49 | 440.82 | 445.81 | 446.52 | 443.83 | 441.54 | 434.72 | 449.49 | 14.77 |
| 10/29/2014 | 441.92 | 439.27 | 439.45 | 436.01 | 436.33 | 446.49 | 435.75 | 446.16 | 444.08 | 441.45 | 441.37 | 449.21 | 438.47 | 445.55 | 446.22 | 444.76 | 442.03 | 435.75 | 449.21 | 13.46 |
| 2/23/2015 | 441.45 | 435.54 | 436.26 | 432.09 | 432.97 | 447.80 | 433.66 | 446.67 | 443.11 | 440.88 | 440.57 | 451.43 | 437.57 | 441.69 | 446.41 | 443.74 | 440.74 | 432.09 | 451.43 | 19.34 |

**Abbreviations:**

"MSL" = mean sea level

"NA" = not available because monitoring event is before the well construction

**Notes:**

1. Groundwater elevations were reported in the First Quarter 2015 groundwater monitoring reports submitted by MWG to IEPA (MWG, 2015b).

**Table 4-4**
**Summary of Powerton Constituents of Interest**

| Constituent of Interest |
|---|
| Arsenic |
| Boron |
| Chloride |
| Iron |
| Lead |
| manganese |
| Nitrogen/Nitrate |
| pH |
| Selenium |
| Sulfate |
| TDS |
| Thallium |

**Note:**
1. Constituents of Interest are based on concentrations reported in the First Quarter 2015 groundwater monitoring reports submitted by MWG to IEPA (MWG, 2015b).

**Table 4-5**
**Groundwater Elevations at Waukegan Generating Station**

| Date | Groundwater Elevations [1] (feet above MSL) | | | | | | | Statistics (feet above MSL) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | MW-1 | MW-2 | MW-3 | MW-4 | MW-5 | MW-6 | MW-7 | Site-Wide Average | Minimum | Maximum | Range |
| 6/13/2011 | 583.34 | 583.31 | 583.34 | 583.35 | 584.55 | NA | NA | 583.58 | 583.31 | 584.55 | 1.24 |
| 9/13/2011 | 581.14 | 581.19 | 581.18 | 581.19 | 582.66 | NA | NA | 581.47 | 581.14 | 582.66 | 1.52 |
| 12/6/2011 | 581.15 | 581.22 | 581.22 | 581.23 | 582.82 | NA | NA | 581.53 | 581.15 | 582.82 | 1.67 |
| 3/14/2012 | 581.18 | 581.23 | 581.22 | 581.20 | 582.98 | NA | NA | 581.56 | 581.18 | 582.98 | 1.80 |
| 6/18/2012 | 580.86 | 580.89 | 580.92 | 580.88 | 582.22 | NA | NA | 581.15 | 580.86 | 582.22 | 1.36 |
| 9/28/2012 | 579.65 | 579.73 | 579.68 | 579.55 | 581.13 | NA | NA | 579.95 | 579.55 | 581.13 | 1.58 |
| 12/19/2012 | 579.42 | 579.27 | 579.45 | 579.34 | 580.65 | 580.89 | 579.57 | 579.80 | 579.27 | 580.89 | 1.62 |
| 3/7/2013 | 580.35 | 580.50 | 580.49 | 580.36 | 582.18 | 582.63 | 580.83 | 581.05 | 580.35 | 582.63 | 2.28 |
| 6/6/2013 | 582.38 | 582.34 | 582.38 | 582.38 | 583.44 | 583.58 | 582.61 | 582.73 | 582.34 | 583.58 | 1.24 |
| 7/25/2013 | 581.40 | 581.34 | 581.41 | 581.33 | 582.60 | 582.71 | 581.28 | 581.72 | 581.28 | 582.71 | 1.43 |
| 11/4/2013 | 581.32 | 581.23 | 581.29 | 581.13 | 582.03 | 582.71 | 580.80 | 581.50 | 580.80 | 582.71 | 1.91 |
| 3/10/2014 | 581.94 | 581.84 | 581.88 | 581.87 | 582.88 | 583.83 | 582.04 | 582.33 | 581.84 | 583.83 | 1.99 |
| 5/16/2014 | 583.07 | 582.95 | 583.02 | 583.11 | 583.71 | 584.56 | 584.35 | 583.54 | 582.95 | 584.56 | 1.61 |
| 8/21/2014 | 581.81 | 581.76 | 581.87 | 581.69 | 582.36 | 582.70 | 581.13 | 581.90 | 581.13 | 582.70 | 1.57 |
| 11/6/2014 | 582.01 | 581.91 | 581.97 | 581.86 | 582.54 | 582.92 | 581.39 | 582.09 | 581.39 | 582.92 | 1.53 |
| 2/17/2015 | 582.42 | 582.21 | 582.22 | 582.14 | 582.38 | 583.39 | 581.14 | 582.27 | 581.14 | 583.39 | 2.25 |

**Abbreviations:**
"MSL" = mean sea level
"NA" = not available because monitoring event is before the well construction

**Notes:**
1. Groundwater elevations were reported in the First Quarter 2015 groundwater monitoring reports submitted by MWG to IEPA (MWG, 2015c).

**Table 4-6**
**Summary of Waukegan Constituents of Interest**

| Constituent of Interest |
|---|
| Antimony |
| Arsenic |
| Boron |
| Chloride |
| Iron |
| Manganese |
| pH |
| Selenium |
| Sulfate |
| TDS |
| Vanadium |

**Note:**

1. Constituents of Interest are based on concentrations reported in the First Quarter 2015 groundwater monitoring reports submitted by MWG to IEPA (MWG, 2015c).

**Table 4-7**
**Groundwater Elevations at Will County Generating Station**

| Date | Groundwater Elevations [1] (feet above MSL) | | | | | | | | | | Statistics (feet above MSL) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MW-1 | MW-2 | MW-3 | MW-4 | MW-5 | MW-6 | MW-7 | MW-8 | MW-9 | MW-10 | Site-Wide Average | Minimum | Maximum | Range |
| 6/15/2011 | 583.67 | 583.87 | 583.76 | 583.49 | 583.47 | 582.52 | 582.96 | 582.24 | 582.81 | 580.90 | 582.97 | 580.90 | 583.87 | 2.97 |
| 9/15/2011 | 583.25 | 583.29 | 582.85 | 581.47 | 582.47 | 581.95 | 582.41 | 581.28 | 581.28 | 580.04 | 582.03 | 580.04 | 583.29 | 3.25 |
| 12/8/2011 | 583.44 | 583.56 | 583.36 | 582.07 | 583.17 | 582.16 | 582.82 | 582.38 | 583.36 | 580.59 | 582.69 | 580.59 | 583.56 | 2.97 |
| 3/16/2012 | 583.41 | 583.54 | 583.45 | 582.08 | 583.14 | 582.10 | 582.76 | 582.41 | 583.52 | 580.73 | 582.71 | 580.73 | 583.54 | 2.81 |
| 6/20/2012 | 583.20 | 583.31 | 582.95 | 581.60 | 582.60 | 581.76 | 582.24 | 581.54 | 581.51 | 579.70 | 582.04 | 579.70 | 583.31 | 3.61 |
| 6/24/2012 | 583.25 | 583.34 | 582.93 | 581.45 | 582.37 | 581.71 | 582.59 | 581.36 | 580.88 | 579.69 | 581.96 | 579.69 | 583.34 | 3.65 |
| 12/18/2012 | 583.27 | 583.39 | 583.10 | 581.71 | 582.79 | 581.75 | 582.67 | 582.22 | 583.10 | 579.92 | 582.39 | 579.92 | 583.39 | 3.47 |
| 3/6/2013 | 583.47 | 583.60 | 583.42 | 582.07 | 583.16 | 582.10 | 582.76 | 582.04 | 583.13 | 580.74 | 582.65 | 580.74 | 583.60 | 2.86 |
| 6/3/2013 | 583.37 | 583.35 | 583.53 | 582.00 | 583.22 | 582.24 | 582.46 | 582.06 | 582.46 | 580.43 | 582.51 | 580.43 | 583.53 | 3.10 |
| 8/14/2013 | 582.18 | 581.97 | 581.79 | 581.89 | 581.70 | 581.29 | 581.04 | 580.95 | 580.56 | 579.13 | 581.25 | 579.13 | 582.18 | 3.05 |
| 10/29/2013 | 581.87 | 581.76 | 581.86 | 582.07 | 582.16 | 581.21 | 580.99 | 581.05 | 581.87 | 579.37 | 581.42 | 579.37 | 582.16 | 2.79 |
| 2/20/2014 | 582.59 | 582.64 | 582.66 | 582.15 | 582.31 | 581.20 | 581.80 | 581.62 | 581.23 | 580.32 | 581.85 | 580.32 | 582.66 | 2.34 |
| 5/20/2014 | 583.31 | 583.22 | 583.37 | 583.14 | 583.09 | 582.02 | 582.29 | 581.69 | 582.76 | 580.79 | 582.57 | 580.79 | 583.37 | 2.58 |
| 8/13/2014 | 583.33 | 583.25 | 583.35 | 583.32 | 583.26 | 582.45 | 581.97 | 581.53 | 582.02 | 580.57 | 582.51 | 580.57 | 583.35 | 2.78 |
| 10/21/2014 | 583.21 | 583.11 | 583.30 | 583.04 | 583.01 | 581.77 | 582.20 | 581.51 | 581.40 | 580.50 | 582.31 | 580.50 | 583.30 | 2.80 |
| 2/4/2015 | 583.12 | 582.89 | 583.17 | 582.93 | 582.96 | 581.66 | 581.79 | 581.25 | 581.97 | 580.12 | 582.19 | 580.12 | 583.17 | 3.05 |

**Abbreviations:**
"MSL" = mean sea level

**Notes:**
1. Groundwater elevations were reported in the First Quarter 2015 groundwater monitoring reports submitted by MWG to IEPA (MWG, 2015d).

**Table 4-8**
**Summary of Will County Constituents of Interest**

| Constituent of Interest |
|---|
| Antimony |
| Arsenic |
| Boron |
| Chloride |
| Manganese |
| pH |
| Selenium |
| Sulfate |
| TDS |

**Note:**
1. Constituents of Interest are based on concentrations reported in the First Quarter 2015 groundwater monitoring reports submitted by MWG to IEPA (MWG, 2015d).

**Table 5-1**
**Summary of Neutral Leachate Extraction Test (NLET) Analyses of Bottom Ash at MWG Generating Stations**

| | Analytical Results for Leachate Analyses Performed on Settled Coal Combustion Residuals as Reported in MWG Documents | | | |
|---|---|---|---|---|
| Generating Station: | **Powerton** | **Waukegan** | | **Will County** |
| Sample Date: | March 2007 | July 2004 | July 2004 | December 2010 |
| Sample ID: | Powerton Bottom Ash | Bottom Ash-1 | Bottom Ash-2 | 3 South Bottom Ash |
| **Methods 6010B/6020/7041A/7470A/7841 (mg/L)** | | | | |
| Antimony | <0.0060 | <0.0060 | <0.0060 | <0.0060 |
| Arsenic | <0.050 | <0.050 | <0.050 | <0.050 |
| Barium | 0.27 | 0.19 | 0.12 | <0.50 |
| Beryllium | <0.0040 | <0.004 | <0.004 | <0.0040 |
| Boron | <0.10 | 1.1 | 2 | 1.3 |
| Cadmium | <0.0050 | <0.005 | <0.005 | <0.0050 |
| Chromium | <0.025 | <0.050 | <0.050 | <0.025 |
| Cobalt | <0.025 | <0.050 | <0.050 | <0.025 |
| Copper | <0.025 | <0.050 | <0.050 | <0.025 |
| Iron | <0.10 | <0.10 | <0.10 | <0.10 |
| Lead | <0.0075 | <0.0075 | <0.0075 | <0.0075 |
| Manganese | <0.025 | <0.050 | <0.050 | <0.025 |
| Mercury | <0.0020 | <0.0020 | <0.0020 | <0.0020 |
| Nickel | <0.025 | <0.050 | <0.050 | <0.050 |
| Selenium | <0.050 | NA | NA | <0.050 |
| Silver | <0.025 | <0.050 | <0.050 | <0.025 |
| Thallium | <0.0020 | <0.0020 | <0.0020 | <0.0020 |
| Zinc | <0.10 | <0.10 | <0.10 | <0.10 |
| **Methods 8260B and 8270C** | | | | |
| VOCs and SVOCs | NA | NA | NA | NA |
| **Methods 8081A and 8151A** | | | | |
| Pesticides | NA | NA | NA | NA |
| **Method 9056 (mg/L)** | | | | |
| Sulfate | NA | NA | NA | 49 |
| **SM 2540C (mg/L)** | | | | |
| Total dissolved solid | NA | NA | NA | 200 |
| **Sources** | MWG13-15_10948 | MWG13-15_12809 | MWG13-15_12809 | MWG13-15_14713 |

**Abbreviations:**

"mg/L" = milligrams per liter
"NA" = not analyzed by the laboratory
"<" = less than the indicated analytical detection limit
"MWG" = Midwest Generation
"NLET" = Neutral Leaching Extraction Test (ASTM D3987-85)

**Table 5-2**

**Summary of Ash Leachate Samples by Management Method and Coal Type (Source: EPRI, 2006)**

| **Analytical Constituent or Parameter** | **Analytical Results for Samples of Leachate Collected from Landfills and Impoundments as Reported by EPRI, 2006** | | | | |
|---|---|---|---|---|---|
| | Facility Type: | Landfill | | Impoundment | |
| | Coal Source Type: | Bituminous | Subbituminous/ Lignite | Bituminous | Subbituminous/ Lignite |
| Leachate pH (SU) | Minimum value | 6.5 | 8.8 | 4.3 | **8.0** |
| | Median value | 6.9 | 10.0 | 7.6 | **8.9** |
| | Maximum value | 7.4 | 11.0 | 11.0 | **12.0** |
| Aluminum Leachate Concentration (mg/L)[1] | Minimum value | <0.002 | 0.1 | <0.0059 | **0.7** |
| | Median value | 0.0 | 2.9 | 0.1 | **4.2** |
| | Maximum value | 0.1 | 17.5 | 15.1 | **5.9** |
| Antimony Leachate Concentration (mg/L)[1] | Minimum value | 0.00014 | 0.00067 | 0.00029 | **0.00024** |
| | Median value | 0.00250 | 0.00090 | 0.00610 | **0.00048** |
| | Maximum value | 0.00910 | 0.00520 | 0.05900 | **0.00062** |
| Arsenic Leachate Concentration (mg/L)[1] | Minimum value | 0.0014 | 0.0041 | 0.0051 | **0.0041** |
| | Median value | 0.0062 | 0.0450 | 0.0580 | **0.0051** |
| | Maximum value | 0.0110 | 0.0840 | 1.3800 | **0.0064** |
| Boron Leachate Concentration (mg/L)[1] | Minimum value | 11.10 | 6.08 | 0.21 | **0.47** |
| | Median value | 23.05 | 18.40 | 1.09 | **0.86** |
| | Maximum value | 89.50 | 41.50 | 112.00 | **3.89** |
| Barium Leachate Concentration (mg/L)[1] | Minimum value | 0.023 | <0.018 | <0.030 | **0.036** |
| | Median value | 0.045 | 0.018 | 0.141 | **0.140** |
| | Maximum value | 0.050 | 0.063 | 0.545 | **0.350** |
| Beryllium Leachate Concentration (mg/L)[1] | Minimum value | <0.0002 | <0.0002 | <0.0002 | **<0.0002** |
| | Median value | <0.0002 | <0.001 | <0.0004 | **<0.001** |
| | Maximum value | <0.0008 | <0.001 | 0.0 | **<0.001** |
| Calcium Leachate Concentration (mg/L) | Minimum value | 235.0 | 6.3 | 12.0 | **<2.5** |
| | Median value | 405.0 | 19.0 | 51.0 | **43.0** |
| | Maximum value | 431.0 | 596.0 | 681.0 | **81.0** |

**Table 5-2**

**Summary of Ash Leachate Samples by Management Method and Coal Type (Source: EPRI, 2006)**

| **Analytical Constituent or Parameter** | **Analytical Results for Samples of Leachate Collected from Landfills and Impoundments as Reported by EPRI, 2006** | | | | |
|---|---|---|---|---|---|
| | Facility Type: | Landfill | | Impoundment | |
| | Coal Source Type: | Bituminous | Subbituminous/ Lignite | Bituminous | Subbituminous/ Lignite |
| Cadmium Leachate Concentration (mg/L)[1] | Minimum value | 0.0 | 0.0 | <0.0002 | **<0.0003** |
| | Median value | 0.0 | 0.0 | 0.0 | **<0.0003** |
| | Maximum value | 0.0 | 0.1 | 0.0 | **0.0** |
| Chloride Leachate Concentration (mg/L) | Minimum value | 15.0 | 11.0 | 4.5 | **31.0** |
| | Median value | 29.0 | 28.0 | 15.0 | **72.0** |
| | Maximum value | 73.0 | 92.0 | 87.0 | **85.0** |
| Cobalt Leachate Concentration (mg/L)[1] | Minimum value | 0.0 | <0.00042 | <0.0002 | **<0.00004** |
| | Median value | 0.0 | 0.0 | 0.0 | **<0.001** |
| | Maximum value | 0.1 | 0.1 | 0.0 | **0.0011** |
| Carbonate Leachate Concentration (mg/L) | Minimum value | 0.0 | 2.5 | <0.01 | **1.1** |
| | Median value | 0.1 | 50.0 | 0.1 | **4.4** |
| | Maximum value | 0.2 | 152.0 | 16.0 | **36.0** |
| Chromium Leachate Concentration (mg/L)[1] | Minimum value | <0.0002 | 0.0005 | <0.0002 | **0.00066** |
| | Median value | 0.0002 | 2.0000 | <0.0005 | **0.0028** |
| | Maximum value | 0.0200 | 5.1000 | 0.0290 | **0.1080** |
| Copper Leachate Concentration (mg/L)[1] | Minimum value | <0.00091 | 0.0016 | <0.00038 | **0.0024** |
| | Median value | 0.0011 | 0.0430 | 0.0019 | **0.0071** |
| | Maximum value | 0.0028 | 0.4940 | 0.4520 | **0.0120** |
| Iron Leachate Concentration (mg/L)[1] | Minimum value | <0.008 | <0.003 | <0.005 | **<0.025** |
| | Median value | 0.0 | <0.050 | 0.0 | **<0.050** |
| | Maximum value | 0.1 | 0.0 | 14.7 | **<0.050** |
| Lead Leachate Concentration (mg/L)[1] | Minimum value | <0.00012 | <0.0002 | <0.0001 | **<0.00014** |
| | Median value | <0.00014 | 0.0 | <0.00015 | **<0.0002** |
| | Maximum value | 0.00012 | 0.00029 | 0.00800 | **0.00021** |

**Table 5-2**
**Summary of Ash Leachate Samples by Management Method and Coal Type (Source: EPRI, 2006)**

| **Analytical Constituent or Parameter** | **Analytical Results for Samples of Leachate Collected from Landfills and Impoundments as Reported by EPRI, 2006** | | | | |
|---|---|---|---|---|---|
| | Facility Type: | Landfill | | Impoundment | |
| | Coal Source Type: | Bituminous | Subbituminous/ Lignite | Bituminous | Subbituminous/ Lignite |
| Lithium Leachate Concentration (mg/L)[1] | Minimum value | 0.4 | <0.0044 | 0.0 | **<0.007** |
| | Median value | 5.7 | <0.020 | 0.2 | **<0.020** |
| | Maximum value | 23.600 | 0.027 | 1.060 | **0.016** |
| Magnesium Leachate Concentration (mg/L) | Minimum value | 69.0 | 0.5 | 0.1 | **<0.05** |
| | Median value | 188.0 | 6.7 | 6.8 | **21.0** |
| | Maximum value | 236.0 | 57.0 | 72.0 | **28.0** |
| Manganese Leachate Concentration (mg/L)[1] | Minimum value | 0.1 | <0.0015 | <0.0002 | **<0.0002** |
| | Median value | 2.1 | 0.0 | 0.1 | **<0.004** |
| | Maximum value | 4.110 | 0.008 | 4.170 | **0.014** |
| Mercury Leachate Concentration (mg/L)[2] | Minimum value | 0.0000021 | 0.0000140 | 0.0000004 | **0.0000054** |
| | Median value | 0.0000030 | 0.0000180 | 0.0000014 | **0.0000074** |
| | Maximum value | 0.0000038 | 0.0000370 | 0.0000052 | **0.0000094** |
| Molybdenum Leachate Concentration (mg/L)[1] | Minimum value | 0.8 | 2.7 | 0.0 | **<0.030** |
| | Median value | 3.28 | 5.72 | 0.21 | **0.08** |
| | Maximum value | 9.63 | 25.40 | 6.03 | **0.52** |
| Nickel Leachate Concentration (mg/L)[1] | Minimum value | 0.0 | 0.0 | <0.0006 | **<0.0006** |
| | Median value | 0.0180 | 0.0080 | 0.0071 | **0.0037** |
| | Maximum value | 0.1890 | 0.0750 | 0.0720 | **0.0071** |
| Potassium Leachate Concentration (mg/L) | Minimum value | 23.0 | 73.0 | <2.2 | **5.5** |
| | Median value | 170.0 | 80.0 | 9.2 | **7.7** |
| | Maximum value | 219.0 | 120.0 | 277.0 | **40.0** |
| Selenium Leachate Concentration (mg/L)[1] | Minimum value | 0.0007 | 0.0066 | 0.0001 | **0.0018** |
| | Median value | 0.0490 | 0.4130 | 0.0130 | **0.0025** |
| | Maximum value | 0.0910 | 1.7600 | 0.2830 | **0.1810** |

**Table 5-2**

**Summary of Ash Leachate Samples by Management Method and Coal Type (Source: EPRI, 2006)**

| Analytical Constituent or Parameter | Analytical Results for Samples of Leachate Collected from Landfills and Impoundments as Reported by EPRI, 2006 | | | | |
|---|---|---|---|---|---|
| | Facility Type: | Landfill | | Impoundment | |
| | Coal Source Type: | Bituminous | Subbituminous/ Lignite | Bituminous | Subbituminous/ Lignite |
| Silicon Leachate Concentration (mg/L)[1] | Minimum value | 2.3 | 0.2 | 0.7 | **2.2** |
| | Median value | 6.1 | 1.5 | 4.7 | **3.4** |
| | Maximum value | 9.4 | 9.9 | 18.5 | **10.3** |
| Silver Leachate Concentration (mg/L)[1] | Minimum value | <0.0002 | <0.0002 | <0.0002 | **<0.0002** |
| | Median value | <0.0002 | <0.0002 | <0.0002 | **<0.0002** |
| | Maximum value | <0.0002 | 0.0 | 0.0 | **<0.0002** |
| Sodium Leachate Concentration (mg/L) | Minimum value | 80.0 | 840.0 | 3.8 | **53.0** |
| | Median value | 188.0 | 1700.0 | 19.0 | **56.0** |
| | Maximum value | 455.0 | 3410.0 | 72.0 | **653.0** |
| Strontium Leachate Concentration (mg/L)[1] | Minimum value | 1.3 | <0.030 | 0.2 | **0.5** |
| | Median value | 4.6 | 0.3 | 0.7 | **0.6** |
| | Maximum value | 10.3 | 12.0 | 5.6 | **1.8** |
| Thallium Leachate Concentration (mg/L)[1] | Minimum value | <0.0001 | <0.0001 | <0.0001 | **<0.0001** |
| | Median value | 0.0 | <0.0001 | 0.0 | **<0.0001** |
| | Maximum value | 0.0 | <0.0005 | 0.0 | **<0.0001** |
| Uranium Leachate Concentration (mg/L)[1] | Minimum value | 0.0 | 0.0 | <0.0001 | **<0.00002** |
| | Median value | 0.0190 | 0.0057 | 0.0007 | **0.0011** |
| | Maximum value | 0.0370 | 0.0210 | 0.0610 | **0.0012** |
| Vanadium Leachate Concentration (mg/L)[1] | Minimum value | <0.00083 | 0.004 | 0.003 | **0.010** |
| | Median value | 0.003 | 0.635 | 0.039 | **0.017** |
| | Maximum value | 0.044 | 5.020 | 0.754 | **0.236** |
| Zinc Leachate Concentration (mg/L)[1] | Minimum value | <0.002 | <0.002 | 0.0 | **<0.002** |
| | Median value | 0.0450 | <0.005 | 0.0087 | **0.0084** |
| | Maximum value | 0.2890 | 0.0120 | 0.0900 | **0.0110** |

**Table 5-2**
**Summary of Ash Leachate Samples by Management Method and Coal Type (Source: EPRI, 2006)**

| **Analytical Constituent or Parameter** | **Analytical Results for Samples of Leachate Collected from Landfills and Impoundments as Reported by EPRI, 2006** | | | | |
|---|---|---|---|---|---|
| | Facility Type: | Landfill | | Impoundment | |
| | Coal Source Type: | Bituminous | Subbituminous/ Lignite | Bituminous | Subbituminous/ Lignite |
| Bicarbonate Leachate Concentration (mg/L) | Minimum value | 100.0 | 1.0 | 0.0 | **1.1** |
| | Median value | 229.0 | 108.0 | 28.0 | **110.0** |
| | Maximum value | 265.0 | 481.0 | 535.0 | **241.0** |
| Carbonic Acid Leachate Concentration (mg/L) | Minimum value | <0.01 | <0.01 | <0.01 | **<0.01** |
| | Median value | <0.01 | <0.01 | <0.01 | **<0.01** |
| | Maximum value | 0.0 | <0.01 | 3.4 | **<0.01** |
| Sulfate Leachate Concentration (mg/L) | Minimum value | 845.0 | 2870.0 | 45.0 | **91.0** |
| | Median value | 2350.0 | 3830.0 | 171.0 | **131.0** |
| | Maximum value | 2440.0 | 6690.0 | 1830.0 | **1120.0** |
| Total Inorganic Carbon Leachate Concentration (mg/L) | Minimum value | 24.0 | 1.7 | 0.8 | **5.9** |
| | Median value | 55.0 | 32.0 | 5.5 | **22.0** |
| | Maximum value | 80.0 | 105.0 | 115.0 | **49.0** |
| Total Organic Carbon Leachate Concentration (mg/L) | Minimum value | 1.3 | 5.3 | <0.09 | **0.4** |
| | Median value | 4.1 | 49.0 | 0.6 | **6.0** |
| | Maximum value | 4.6 | 55.0 | 22.0 | **7.9** |
| Dissolved Oxygen Leachate Concentration (%) | Minimum value | 16.0 | 0.2 | 2.9 | **1.6** |
| | Median value | 53.0 | 14.0 | 40.0 | **4.5** |
| | Maximum value | 95.0 | 87.0 | 165.0 | **35.0** |
| Leachate Oxidation-Reduction Potential (mV) | Minimum value | 213.0 | 111.0 | 41.0 | **225.0** |
| | Median value | 247.0 | 240.0 | 240.0 | **289.0** |
| | Maximum value | 280.0 | 276.0 | 409.0 | **303.0** |
| Leachate Electrical Conductivity (umho/cm) | Minimum value | 2000.0 | 6174.0 | 174.0 | **680.0** |
| | Median value | 3682.0 | 7690.0 | 578.0 | **990.0** |
| | Maximum value | 4915.0 | 12760.0 | 2980.0 | **4020.0** |

**Table 5-2**
**Summary of Ash Leachate Samples by Management Method and Coal Type (Source: EPRI, 2006)**

| **Analytical Constituent or Parameter** | **Analytical Results for Samples of Leachate Collected from Landfills and Impoundments as Reported by EPRI, 2006** | | | | |
|---|---|---|---|---|---|
| | Facility Type: | Landfill | | Impoundment | |
| | Coal Source Type: | Bituminous | Subbituminous/ Lignite | Bituminous | Subbituminous/ Lignite |
| Leachate Temperature (°C) | Minimum value | 14.0 | 11.0 | 10.0 | **16.0** |
| | Median value | 15.0 | 17.0 | 22.0 | **30.0** |
| | Maximum value | 17.0 | 22.0 | 32.0 | **36.0** |

1. Leachate concentration was reported in micrograms per liter (µg/L) in EPRI, 2006. The reported concentrations were converted to milligrams per liter (mg/L) by dividing the reported concentration by 1,000 µg/mg.

**Table 5-3**
**Comparison of Ash Leachate Characteristic Values to IEPA Class I Groundwater Standards**

| | MWG Bottom Ash Samples | | Impoundments from PRB-Sourced Coal by EPRI | | | IEPA Class I Groundwater Standards |
|---|---|---|---|---|---|---|
| | NLET | | Samples of leachate | | | |
| Constituent | Min | Max | Min | Median | Max | |
| Antimony | <0.0060 | <0.0060 | 0.00024 | 0.00048 | 0.00062 | 0.006 |
| Arsenic | <0.050 | <0.050 | 0.0041 | 0.0051 | 0.0064 | 0.01 |
| Barium | <0.50 | 0.27 | 0.036 | 0.14 | 0.35 | 2 |
| Beryllium | <0.0040 | <0.0040 | <0.0002 | <0.001 | <0.001 | 0.004 |
| Boron | <0.10 | 2 | 0.47 | 0.86 | **3.89** | 2 |
| Cadmium | <0.0050 | <0.0050 | <0.0003 | <0.0003 | 0.0021 | 0.005 |
| Chromium | <0.025 | <0.050 | 0.00066 | 0.0028 | **0.108** | 0.1 |
| Cobalt | <0.025 | <0.050 | <0.00004 | <0.001 | 0.0011 | 1 |
| Copper | <0.025 | <0.050 | 0.0024 | 0.0071 | 0.012 | 0.65 |
| Iron | <0.10 | <0.10 | <0.025 | <0.05 | <0.05 | 5 |
| Lead | <0.0075 | <0.0075 | <0.00014 | <0.0002 | 0.00021 | 0.0075 |
| Manganese | <0.025 | <0.050 | <0.0002 | <0.004 | 0.014 | 0.15 |
| Mercury | <0.0020 | <0.0020 | 0.0000054 | 0.0000074 | 0.0000094 | 0.002 |
| Nickel | <0.050 | <0.050 | <0.0006 | 0.0037 | 0.0071 | 0.1 |
| Selenium | <0.050 | <0.050 | 0.0018 | 0.0025 | **0.18** | 0.05 |
| Silver | <0.025 | <0.050 | <0.0002 | <0.0002 | <0.0002 | 0.05 |
| Sulfate | 49 | 49 | 91 | 131 | **1120** | 400 |
| Thallium | <0.0020 | <0.0020 | <0.0001 | <0.0001 | <0.0001 | 0.002 |
| Zinc | <0.10 | <0.10 | <0.002 | 0.0084 | 0.011 | 5 |

**Abbreviations:**

"mg/L" = milligrams per liter
"NA" = not analyzed by the laboratory
"<" = less than the indicated analytical detection limit
"MWG" = Midwest Generation
"NLET" = Neutral Leaching Extraction Test (ASTM D3987-85)
"PRB" = Powder River Basin

**Notes:**

**Bold font** indicates a detection above IEPA Class I Groundwater Standards.
Underlined values indicate detections relevant to Section 5.5.1.3 of the report text.

**Table 5-4**
**Summary of Constituents Detected during Most Recent Year (2014) of Quarterly Groundwater Monitoring Compared to Indicators of Leachate from Ash Currently Stored in Impoundments**
**Based on Site-Specific NLET Results for Bottom Ash and Actual Leachate Sample Results for Bituminous Ash Stored in Impoundments**

| Constituent | Constituent is an Indicator of Leachate from Ash Currently Stored in Impoundments [1] | Constituents Detected during Most Recent Year (2014) of Quarterly Groundwater Monitoring [2] | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Joliet No. 29 Generating Station | | | | | | | | | | |
| | | MW-1 | MW-2 | MW-3 | MW-4 | MW-5 | MW-6 | MW-7 | MW-8 | MW-9 | MW-10 | MW-11 |
| Antimony | Yes (Table 5-2) | | | | | | | | | | | |
| Arsenic | Yes (Table 5-2) | | | x | x | | x | x | | | | x |
| Barium | Yes (Table 5-2) | x | x | x | x | x | x | x | x | x | x | x |
| Beryllium | | | | | | | | | | | | |
| Boron | Yes (Table 5-2) | x | x | x | x | x | x | x | x | x | x | x |
| Cadmium | Yes (Table 5-2) | | | | | x | | | x | | | |
| Chromium | Yes (Table 5-2) | | | | | | | | | | | |
| Cobalt | Yes (Table 5-2) | | | | x | | x | | | x | | |
| Copper | Yes (Table 5-2) | | | | | x | x | x | x | | | |
| Iron | | | | | x | | | | x | x | | |
| Lead | Yes (Table 5-2) | | | | | | | | x | | | |
| Manganese | Yes (Table 5-2) | x | | | | x | | x | x | x | | |
| Mercury | Yes (Table 5-2) | | | | | | | | | | | |
| Nickel | Yes (Table 5-2) | x | x | x | x | x | x | x | x | x | x | x |
| Selenium | Yes (Table 5-2) | | x | x | | x | x | x | | | x | x |
| Silver | | | | | | | | | | | | |
| Sulfate | Yes (Table 5-2) | x | x | x | x | x | x | x | x | x | x | x |
| Thallium | | | | | | | | | | | | |
| Zinc | Yes (Table 5-2) | | | | | | | | x | | | |
| Number of Observed Constituents that are not Consistent with Indicators of Leachate from Ash Currently Stored in Impoundments [3] | | 10 | 10 | 9 | 10 | 7 | 7 | 7 | 7 | 10 | 10 | 9 |
| Percentage of Observed Constituents that are not Consistent with Indicators of Leachate from Ash Currently Stored in Impoundments [3] | | 53% | 53% | 47% | 53% | 37% | 37% | 37% | 37% | 53% | 53% | 47% |

Table 5-4

**Summary of Constituents Detected during Most Recent Year (2014) of Quarterly Groundwater Monitoring Compared to Indicators of Leachate from Ash Currently Stored in Impoundments**

**Based on Site-Specific NLET Results for Bottom Ash and Actual Leachate Sample Results for Bituminous Ash Stored in Impoundments**

| | | Constituents Detected during Most Recent Year (2014) of Quarterly Groundwater Monitoring [2] | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Powerton Generating Station | | | | | | | | | | | | | | | |
| Constituent | Constituent is an Indicator of Leachate from Ash Currently Stored in Impoundments [1] | MW-1 | MW-2 | MW-3 | MW-4 | MW-5 | MW-6 | MW-7 | MW-8 | MW-9 | MW-10 | MW-11 | MW-12 | MW-13 | MW-14 | MW-15 | MW-16 |
| Antimony | Yes (Table 5-2) | | | | | | | | | | | | | | | | |
| Arsenic | Yes (Table 5-2) | | | | | | x | x | x | x | | x | x | x | x | x | |
| Barium | Yes (Table 5-2) | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| Beryllium | | | | | | | | | | | | | | | | | |
| Boron | Yes (Table 5-2) | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| Cadmium | Yes (Table 5-2) | | | | | | | | | | | | | | x | | |
| Chromium | Yes (Table 5-2) | | | | | | | | | | | | | | | | |
| Cobalt | Yes (Table 5-2) | | | | | | x | x | | x | x | x | | | | | |
| Copper | Yes (Table 5-2) | | | x | x | x | | | | | x | | | | | | |
| Iron | | | | | | | x | x | x | | x | x | x | x | x | x | |
| Lead | Yes (Table 5-2) | | x | x | | | | x | | x | x | | | | | | |
| Manganese | Yes (Table 5-2) | | | | x | x | x | x | x | x | x | x | x | x | x | x | x |
| Mercury | Yes (Table 5-2) | | | | | | | | | | | | | | | | |
| Nickel | Yes (Table 5-2) | | | x | x | x | x | x | | x | x | x | x | | x | x | |
| Selenium | Yes (Table 5-2) | x | | | | x | | | | x | x | | | x | x | x | |
| Silver | | | | | | | | | | | | | | | | | |
| Sulfate | Yes (Table 5-2) | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| Thallium | | | | | | | | | | | | | | | x | | |
| Zinc | Yes (Table 5-2) | | | x | | | | | | | | | | | | | |
| Number of Observed Constituents that are not Consistent with Indicators of Leachate from Ash Currently Stored in Impoundments [3] | | 11 | 11 | 8 | 9 | 8 | 9 | 8 | 11 | 6 | 7 | 9 | 10 | 10 | 9 | 9 | 11 |
| Percentage of Observed Constituents that are not Consistent with Indicators of Leachate from Ash Currently Stored in Impoundments [3] | | 58% | 58% | 42% | 47% | 42% | 47% | 42% | 58% | 32% | 37% | 47% | 53% | 53% | 47% | 47% | 58% |

**Table 5-4**

**Summary of Constituents Detected during Most Recent Year (2014) of Quarterly Groundwater Monitoring Compared to Indicators of Leachate from Ash Currently Stored in Impoundments**

**Based on Site-Specific NLET Results for Bottom Ash and Actual Leachate Sample Results for Bituminous Ash Stored in Impoundments**

| Constituent | Constituent is an Indicator of Leachate from Ash Currently Stored in Impoundments [1] | Constituents Detected during Most Recent Year (2014) of Quarterly Groundwater Monitoring [2] — Waukegan Generating Station | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | MW-1 | MW-2 | MW-3 | MW-4 | MW-5 | MW-6 | MW-7 |
| Antimony | Yes (Table 5-2) | | | | | | | |
| Arsenic | Yes (Table 5-2) | x | x | x | x | x | x | x |
| Barium | Yes (Table 5-2) | x | x | x | x | x | x | x |
| Beryllium | | | | | | | | |
| Boron | Yes (Table 5-2) | x | x | x | x | x | x | x |
| Cadmium | Yes (Table 5-2) | | | | | | | |
| Chromium | Yes (Table 5-2) | | | | | | | |
| Cobalt | Yes (Table 5-2) | | | | | | | |
| Copper | Yes (Table 5-2) | x | | | | | x | |
| Iron | | | x | | | x | x | x |
| Lead | Yes (Table 5-2) | | | x | | | | |
| Manganese | Yes (Table 5-2) | x | x | x | x | x | x | x |
| Mercury | Yes (Table 5-2) | | | | | | | |
| Nickel | Yes (Table 5-2) | | | | | x | | |
| Selenium | Yes (Table 5-2) | x | x | x | x | | x | |
| Silver | | | | | | | | |
| Sulfate | Yes (Table 5-2) | x | x | x | x | x | x | x |
| Thallium | | | | | | | | |
| Zinc | Yes (Table 5-2) | | | | | | | |
| Number of Observed Constituents that are not Consistent with Indicators of Leachate from Ash Currently Stored in Impoundments [3] | | 8 | 10 | 8 | 9 | 10 | 9 | 11 |
| Percentage of Observed Constituents that are not Consistent with Indicators of Leachate from Ash Currently Stored in Impoundments [3] | | 42% | 53% | 42% | 47% | 53% | 47% | 58% |

Table 5-4

**Summary of Constituents Detected during Most Recent Year (2014) of Quarterly Groundwater Monitoring Compared to Indicators of Leachate from Ash Currently Stored in Impoundments**

**Based on Site-Specific NLET Results for Bottom Ash and Actual Leachate Sample Results for Bituminous Ash Stored in Impoundments**

| Constituent | Constituent is an Indicator of Leachate from Ash Currently Stored in Impoundments [1] | Constituents Detected during Most Recent Year (2014) of Quarterly Groundwater Monitoring [2] — Will County Generating Station | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | MW-1 | MW-2 | MW-3 | MW-4 | MW-5 | MW-6 | MW-7 | MW-8 | MW-9 | MW-10 |
| Antimony | Yes (Table 5-2) | | | | | | | | | | |
| Arsenic | Yes (Table 5-2) | | x | x | x | x | x | x | x | x | x |
| Barium | Yes (Table 5-2) | x | x | x | x | x | x | x | x | x | x |
| Beryllium | | | | | | | | | | | |
| Boron | Yes (Table 5-2) | x | x | x | x | x | x | x | x | x | x |
| Cadmium | Yes (Table 5-2) | | | | | | | | | | |
| Chromium | Yes (Table 5-2) | | | | | | | | | | |
| Cobalt | Yes (Table 5-2) | x | | x | x | | | | | | |
| Copper | Yes (Table 5-2) | | | | | | | | | | |
| Iron | | x | x | x | x | | x | x | x | | x |
| Lead | Yes (Table 5-2) | | | | | | | | | | |
| Manganese | Yes (Table 5-2) | x | x | x | x | x | x | x | x | x | x |
| Mercury | Yes (Table 5-2) | | | | x | | | | | | |
| Nickel | Yes (Table 5-2) | x | x | x | x | x | x | x | x | x | x |
| Selenium | Yes (Table 5-2) | x | | x | x | x | x | x | x | x | |
| Silver | | | | | | | | | | | |
| Sulfate | Yes (Table 5-2) | x | x | x | x | x | x | x | x | x | x |
| Thallium | | | | | | | | | | | |
| Zinc | Yes (Table 5-2) | | | | | | | | | | |
| Number of Observed Constituents that are not Consistent with Indicators of Leachate from Ash Currently Stored in Impoundments [3] | | 9 | 10 | 8 | 7 | 8 | 9 | 9 | 9 | 8 | 10 |
| Percentage of Observed Constituents that are not Consistent with Indicators of Leachate from Ash Currently Stored in Impoundments [3] | | 47% | 53% | 42% | 37% | 42% | 47% | 47% | 47% | 42% | 53% |

**Abbreviations:**

"TCLP" = Toxicity Characteristic Leaching Procedure (USEPA Method 1311)

"x" = constituent was detected above analytical detection limits during at least one quarterly groundwater monitoring event in 2014

**Table 5-4**
**Summary of Constituents Detected during Most Recent Year (2014) of Quarterly Groundwater Monitoring Compared to**
**Indicators of Leachate from Ash Currently Stored in Impoundments**
**Based on Site-Specific NLET Results for Bottom Ash and Actual Leachate Sample Results for Bituminous Ash Stored in Impoundments**

**Notes:**

1. Indicators of leachate from ash currently stored in impoundments are based on leachate sample results for bituminous ash stored in impoundments (Table 5-2) as denoted in this table as "Y TCLP)", and actual leachate sample results for bituminous ash stored in imp
2. Shading of cells is described below.
   Green shading indicates that a constituent that is an indicator of leachate from ash currently stored in the impoundments was not detected during quarterly groundwater monitoring in 2014.
   Blue shading indicates that a constituent that is not an indicator of leachate from ash currently stored in the impoundments was detected during at least one quarterly groundwater monitoring event in 2014.
   No shading indicates that either (1) a constituent that is an indicator of leachate from ash currently stored in the impoundments was detected during at least one quarterly groundwater monitoring event in 2014, or (2) a constituent that is not an indicator of leachate from ash currently stored in the impoundments was not detected during quarterly groundwater monitoring in 2014.
3. Green and blue shading (see Note 2) demonstrate observed constituents that are not consistent with indicators of leachate from ash current y stored in impoundments.

**Table 5-5**
**Summary of Constituents Detected during Most Recent Year (2014) of Quarterly Groundwater Monitoring Compared to Indicators of Leachate from Ash Currently Stored in Impoundments**
**Based on Site-Specific NLET Results for Bottom Ash**

| Constituent | Constituent is an Indicator of Leachate from Ash Currently Stored in Impoundments [1] | Constituents Detected during Most Recent Year (2014) of Quarterly Groundwater Monitoring [2] — Joliet No. 29 Generating Station | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | MW-1 | MW-2 | MW-3 | MW-4 | MW-5 | MW-6 | MW-7 | MW-8 | MW-9 | MW-10 | MW-11 |
| Antimony | | | | | | | | | | | | |
| Arsenic | | | | x | x | | x | x | | | | x |
| Barium | Yes (Table 5-1) | x | x | x | x | x | x | x | x | x | x | x |
| Beryllium | | | | | | | | | | | | |
| Boron | Yes (Table 5-1) | x | x | x | x | x | x | x | x | x | x | x |
| Cadmium | | | | | | x | | | x | | | |
| Chromium | | | | | | | | | | | | |
| Cobalt | | | | | x | | x | | | x | | |
| Copper | | | | | | x | x | x | x | | | |
| Iron | | | | | x | | | | x | x | | |
| Lead | | | | | | | | | x | | | |
| Manganese | | x | | | | x | | x | x | x | | |
| Mercury | | | | | | | | | | | | |
| Nickel | | x | x | x | x | x | x | x | x | x | x | x |
| Selenium | | | x | x | | x | x | x | | | x | x |
| Silver | | | | | | | | | | | | |
| Sulfate | Yes (Table 5-1) | x | x | x | x | x | x | x | x | x | x | x |
| Thallium | | | | | | | | | | | | |
| Zinc | | | | | | | | | x | | | |
| Number of Observed Constituents that are not Consistent with Indicators of Leachate from Ash Currently Stored in Impoundments [3] | | 2 | 2 | 3 | 4 | 5 | 5 | 5 | 7 | 4 | 2 | 3 |
| Percentage of Observed Constituents that are not Consistent with Indicators of Leachate from Ash Currently Stored in Impoundments [3] | | 11% | 11% | 16% | 21% | 26% | 26% | 26% | 37% | 21% | 11% | 16% |

**Table 5-5**
**Summary of Constituents Detected during Most Recent Year (2014) of Quarterly Groundwater Monitoring Compared to Indicators of Leachate from Ash Currently Stored in Impoundments**
**Based on Site-Specific NLET Results for Bottom Ash**

| Constituent | Constituent is an Indicator of Leachate from Ash Currently Stored in Impoundments [1] | Constituents Detected during Most Recent Year (2014) of Quarterly Groundwater Monitoring [2] | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Powerton Generating Station | | | | | | | | | | | | | | | |
| | | MW-1 | MW-2 | MW-3 | MW-4 | MW-5 | MW-6 | MW-7 | MW-8 | MW-9 | MW-10 | MW-11 | MW-12 | MW-13 | MW-14 | MW-15 | MW-16 |
| Antimony | | | | | | | | | | | | | | | | | |
| Arsenic | | | | | | | x | x | x | x | | x | x | x | x | x | |
| Barium | Yes (Table 5-1) | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| Beryllium | | | | | | | | | | | | | | | | | |
| Boron | Yes (Table 5-1) | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| Cadmium | | | | | | | | | | | | | | | x | | |
| Chromium | | | | | | | | | | | | | | | | | |
| Cobalt | | | | | | | x | x | | x | x | x | | | | | |
| Copper | | | | x | x | x | | | | | x | | | | | | |
| Iron | | | | | | | x | x | x | | x | x | x | x | x | x | |
| Lead | | | x | x | | | | x | | x | x | | | | | | |
| Manganese | | | | | x | x | x | x | x | x | x | x | x | x | x | x | x |
| Mercury | | | | | | | | | | | | | | | | | |
| Nickel | | | | x | x | x | x | x | | x | x | x | x | | x | x | |
| Selenium | | x | | | | x | | | | x | x | | | x | x | x | |
| Silver | | | | | | | | | | | | | | | | | |
| Sulfate | Yes (Table 5-1) | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| Thallium | | | | | | | | | | | | | | | x | | |
| Zinc | | | | x | | | | | | | | | | | | | |
| Number of Observed Constituents that are not Consistent with Indicators of Leachate from Ash Currently Stored in Impoundments [3] | | 1 | 1 | 4 | 3 | 4 | 5 | 6 | 3 | 6 | 7 | 5 | 4 | 4 | 7 | 5 | 1 |
| Percentage of Observed Constituents that are not Consistent with Indicators of Leachate from Ash Currently Stored in Impoundments [3] | | 5% | 5% | 21% | 16% | 21% | 26% | 32% | 16% | 32% | 37% | 26% | 21% | 21% | 37% | 26% | 5% |

**Table 5-5**
**Summary of Constituents Detected during Most Recent Year (2014) of Quarterly Groundwater Monitoring Compared to Indicators of Leachate from Ash Currently Stored in Impoundments**
**Based on Site-Specific NLET Results for Bottom Ash**

| Constituent | Constituent is an Indicator of Leachate from Ash Currently Stored in Impoundments (1) | Constituents Detected during Most Recent Year (2014) of Quarterly Groundwater Monitoring (2) — Waukegan Generating Station | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | MW-1 | MW-2 | MW-3 | MW-4 | MW-5 | MW-6 | MW-7 |
| Antimony | | | | | | | | |
| Arsenic | | x | x | x | x | x | x | x |
| Barium | Yes (Table 5-1) | x | x | x | x | x | x | x |
| Beryllium | | | | | | | | |
| Boron | Yes (Table 5-1) | x | x | x | x | x | x | x |
| Cadmium | | | | | | | | |
| Chromium | | | | | | | | |
| Cobalt | | | | | | | | |
| Copper | | x | | | | | x | |
| Iron | | | x | | | x | x | x |
| Lead | | | | x | | | | |
| Manganese | | x | x | x | x | x | x | x |
| Mercury | | | | | | | | |
| Nickel | | | | | | x | | |
| Selenium | | x | x | x | x | | x | |
| Silver | | | | | | | | |
| Sulfate | Yes (Table 5-1) | x | x | x | x | x | x | x |
| Thallium | | | | | | | | |
| Zinc | | | | | | | | |
| Number of Observed Constituents that are not Consistent with Indicators of Leachate from Ash Currently Stored in Impoundments (3) | | 4 | 4 | 4 | 3 | 4 | 5 | 3 |
| Percentage of Observed Constituents that are not Consistent with Indicators of Leachate from Ash Currently Stored in Impoundments (3) | | 21% | 21% | 21% | 16% | 21% | 26% | 16% |

**Table 5-5**
**Summary of Constituents Detected during Most Recent Year (2014) of Quarterly Groundwater Monitoring Compared to Indicators of Leachate from Ash Currently Stored in Impoundments**
**Based on Site-Specific NLET Results for Bottom Ash**

| Constituent | Constituent is an Indicator of Leachate from Ash Currently Stored in Impoundments [1] | Constituents Detected during Most Recent Year (2014) of Quarterly Groundwater Monitoring [2] | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Will County Generating Station | | | | | | | | | |
| | | MW-1 | MW-2 | MW-3 | MW-4 | MW-5 | MW-6 | MW-7 | MW-8 | MW-9 | MW-10 |
| Antimony | | | | | | | | | | | |
| Arsenic | | | x | x | x | x | x | x | x | x | x |
| Barium | Yes (Table 5-1) | x | x | x | x | x | x | x | x | x | x |
| Beryllium | | | | | | | | | | | |
| Boron | Yes (Table 5-1) | x | x | x | x | x | x | x | x | x | x |
| Cadmium | | | | | | | | | | | |
| Chromium | | | | | | | | | | | |
| Cobalt | | x | | x | x | | | | | | |
| Copper | | | | | | | | | | | |
| Iron | | x | x | x | x | | x | x | x | | x |
| Lead | | | | | | | | | | | |
| Manganese | | x | x | x | x | x | x | x | x | x | x |
| Mercury | | | | | x | | | | | | |
| Nickel | | x | x | x | x | x | x | x | x | x | x |
| Selenium | | x | | x | x | x | x | x | x | x | |
| Silver | | | | | | | | | | | |
| Sulfate | Yes (Table 5-1) | x | x | x | x | x | x | x | x | x | x |
| Thallium | | | | | | | | | | | |
| Zinc | | | | | | | | | | | |
| Number of Observed Constituents that are not Consistent with Indicators of Leachate from Ash Currently Stored in Impoundments [3] | | 5 | 4 | 6 | 7 | 4 | 5 | 5 | 5 | 4 | 4 |
| Percentage of Observed Constituents that are not Consistent with Indicators of Leachate from Ash Currently Stored in Impoundments [3] | | 26% | 21% | 32% | 37% | 21% | 26% | 26% | 26% | 21% | 21% |

**Abbreviations:**
"NLET" = neutral leaching extraction test (ASTM D3987-85)
"x" = constituent was detected above analytical detection limits during at least one quarterly groundwater monitoring event in 2014

**Table 5-5**
**Summary of Constituents Detected during Most Recent Year (2014) of Quarterly Groundwater Monitoring Compared to Indicators of Leachate from Ash Currently Stored in Impoundments**
**Based on Site-Specific NLET Results for Bottom Ash**

**Notes:**

1. Indicators of leachate from ash currently stored in impoundments is based on site-specific NLET results for bottom ash (Table 5-1).
2. Shading of cells is described below.

Green shading, which is not applicable ot this Table 2-6, would indicate that a constituent that is an indicator of leachate from ash currently stored in the impoundments was not detected during quarterly groundwater monitoring in 2014.

Blue shading indicates that a constituent that is not an indicator of leachate from ash currently stored in the impoundments was detected during at least one quarterly groundwater monitoring event in 2014.

No shading indicates that either (1) a constituent that is an indicator of leachate from ash currently stored in the impoundments was detected during at least one quarterly groundwater monitoring event in 2014, or (2) a constituent that is not an indicator of leachate from ash currently stored in the impoundments was not detected during quarterly groundwater monitoring in 2014.

3. Green and blue shading (see Note 2) demonstrate observed constituents that are not consistent with indicators of leachate from ash currently stored in impoundments.

# J.SEYMOUR EXPERT REPORT

## APPENDIX A
## JOHN SEYMOUR CURRICULUM VITAE

**JOHN SEYMOUR, P.E.**

**remediation**
**geoenvironmental engineering**
**geotechnical engineering**
**coal combustion residuals management**

## EDUCATION

M.S., Geotechnical Engineering, University of Michigan, Ann Arbor, Michigan, 1980
B.S., Civil Engineering, Michigan Technological University, Houghton, Michigan, 1976

## PROFESSIONAL REGISTRATIONS

Illinois P.E. Number 062-040562
Michigan P.E. Number 6201033056
West Virginia P.E. Number 017091
Wisconsin P.E. Number 26727

## CAREER SUMMARY

Mr. Seymour is a geotechnical engineer with nearly three decades of experience in the U.S., Canada, Spain, Guatemala and Korea in the areas of site remediation, deep foundations, and construction management. He has focused on waste management and remediation (Superfund (CERCLA) and RCRA) projects for 25 years, having had significant involvement in 17 sites providing professional services in the areas of project management, project coordination (client representative), site characterization, feasibility studies, bench/pilot studies, civil/geotechnical design, construction quality assurance (CQA), and operation and maintenance.

He has completed field studies including geologic and hydrogeologic studies, aquifer testing, seismic surveys, landfill settlement tests, and the characterization of volatile organic compounds (TCE and by-products), semivolatile organic compounds, PCBs, lead, and saline groundwater intrusion.

He has provided coal combustion residuals (CCRs) engineering services, regarding waste management of fly ash, bottom ash and flue gas desulfurization (FGD) waste for impoundments and landfills. These services have included geotechnical and environmental evaluations of waste disposal expansions, operations and closure, disposal permit application preparation for eight U.S coal power generation clients. Overall he has provided relevant consulting engineering services for 7 CCRs impoundments and 14 CCR landfills and provided records review, evaluation and engineering scope of work development for 4 additional CCR impoundments. He has translated some of his experience into 11 technical papers and recently submitted two final draft research guidance documents on CCR impoundments (co-investigator), and provided 10 technical presentations at conferences including at conferences focusing on CCR management.

His clients have primarily included major industrial manufacturers (utilities, automotive, tools, appliances) and waste management/disposal companies. He has been the lead in the design of 11 landfills. He has been the project lead for several major (multi-million dollar) remediation sites. He also has assisted in remedy negotiations with state and federal agencies at many sites.

In addition, he has geotechnical engineering experience with the design and construction of deep foundations, including drilled piers, tie backs, foundation grouting and soil improvement programs, and diaphragm (slurry) walls.

Highlights of Mr. Seymour's representative experience include:

**Geoenvironmental**

***J. C. Weadock Plant CCR Facility Engineering Study, Consumers Energy Company,*** *Michigan*. Mr. Seymour is the project director and senior technical reviewer for a study of the existing CCR facility. The study is to assess the future use and closure of the facility considering current regulations and future proposed federal regulations regarding CCRs under RCRA and the effluent limitation guidelines and standards for the steam electric power generating industry under the Clean Water Act.

***Rivesville and Albright Power Plants,*** *FirstEnergy*, *West Virginia.* Engineer of Record for the design of the closure of two CCR landfills.

***Coal Combustion Residuals Pond Closure Guidance Documents, Electric Power Research Institute,*** *Nationwide*. Mr. Seymour is a co-investigator/author and project manager for the completion of two guidance documents relating to CCR pond closures. They include: (i) "Coal Combustion Residuals Pond Closure- Dewatering and Capping Guidance", and (ii) "Coal Combustion Residuals Pond Closure- Construction over Closed Ponds".

***Confidential Power Plant,*** *Southern Ohio*. Mr. Seymour is the project manager for the conceptual design of a 300-acre fly ash disposal pond closure.

***General James M. Gavin Power Plant***, *American Electric Power, Cheshire, Ohio*. He managed the design of and the Permit to Install (PTI) application for a 50,000,000 cuyd residual waste landfill for the solid waste permit application under existing OEPA rules which incorporated relevant portions of the U.S. EPA proposed RCRA Subtitle D regulations.

***General James M. Gavin Power Plant**, American Electric Power, Cheshire, Ohio.* Mr. Seymour was the project manager for the focused feasibility evaluation (FFE) for a coal combustion residuals (CCR) landfill expansion and the resulting design and permit application for a landfill expansion.

***Monroe Power Plant,** DTE Energy, Monroe, MI.* Mr. Seymour managed the FGD Gypsum Disposal Facility Preliminary Engineering Study and was the project manager to assess disposal options for new flue gas desulphurization (FGD) gypsum that will be generated at this coal fired electrical generating station. Mr. Seymour is the project director and engineer of record to conduct an evaluation of the earthen containment dike around the ash basin and to assess the potential for a failure due to operating issues.

***Planta Las Palmas CCB Landfill Development Studies,** Duke Energy International Guatemala, Guatemala.* Mr. Seymour completed studies to optimize the development of a new coal ash landfill and prepare site investigation bid specifications. He was the project manager to prepare the detailed design and construction bid documents for the coal storage area, ash landfill, leachate treatment pond with discharge structure, and the power plant water intake structure.

***Wauconda Landfill Superfund Site Cover Evaluation,** Wauconda Task Force, Wauconda, IL.* Mr. Seymour was the project manager for the evaluation of the existing soil cover over Superfund site.

***R. Paul Smith CCB Landfill Expansion,** Allegheny Energy Supply, Berkeley County, WV.* Mr. Seymour was the project manager for the design and construction quality assurance of a coal combustion byproducts landfill at a coal-fired power plant in Maryland with the landfill located in adjacent West Virginia.

***MIG/DeWane Landfill Superfund Site Remedial Design,** Allied Waste Industries, Belvidere, IL.* Assisted the client with negotiations of a Statement of Work with the Illinois EPA for this CERCLA site. He is conducting a remedial design of a new cover system and gas collection system over the 50 acre landfill.

***Confidential Landfill Remedial Action Support Services,** Republic Services, north-central IL.* Providing technical support to legal counsel for the remedy selection process at a 40-acre solid waste facility closed in the 1970s and developed into a park.

***Planta Arizona, CCB Landfill Design Consulting,** Duke Energy International Guatemala, Guatemala.* Mr. Seymour provided consulting to DEIG to layout a new coal ash disposal facility for a coal-fired electrical generating station.

***Cardinal Plant Landfill Studies,** American Electric Power, Brilliant, OH.* Completed a feasibility study to assess the potential to develop a new flue gas desulphurization (FGD) waste landfill over an existing fly ash disposal area at a coal-fired power plant.

***Yeoman Creek Landfill Superfund Site,*** *PRP Group, Waukegan, IL.* Mr. Seymour was the project manager and Project Coordinator for this CERCLA site closure.

***Utility Company,*** *Multiple Sites, WI.* Contaminated site consulting services and ash landfill design, construction inspection/management services. Mr. Seymour was the Contract Manager and project manager for multiple sites, including evaluation of existing groundwater remediation system to improve performance and evaluate alternate technologies in Wisconsin, and development of an approach to address existing environmental impacts at an MGP site along the Fox River in Wisconsin

***Albion-Sheridan Township Landfill,*** *Cooper Industries and Corning, Inc., Albion, MI.* Project Coordinator, at CERCLA site. Provided solid and hazardous waste closure, construction management, remedial design, QA officer, closure certification, solid and hazardous waste remediation.

***McGraw-Edison Facility,*** *Cooper Industries, Centerville, IA.* Project manager for CERCLA Site that was a manufacturing facility in Iowa to remediate TCE in soil and groundwater. Provided design review and engineering oversight for the installation of an iron reactive permeable barrier wall for treatment of TCE in groundwater and a hydro-fracture enhanced vapor extraction system, including over one year of performance monitoring and evaluation, and fate and transport modeling of the TCE.

***J&L Landfill,*** *LTV Steel Company, Rochester Hills, MI.* Project Coordinator at this CERCLA site. Provided solid and hazardous waste landfill closure, construction management, remedy negotiation, closure design, QA officer, closure P.E. certification, solid and hazardous waste.

***Monroe Stamping Plant Lagoon Closure,*** *Ford Motor Company, Monroe, MI.* Project manager for the resident engineering services for this facility where 55 acres of lagoons were closed as a hazardous waste landfill under a RCRA corrective action.

***Rasmussen Landfill,*** *PRP Group, Green Oak Township, MI.* Project coordinator at CERCLA solid and hazardous waste site. Provided work plans, pre-design and remedial design, construction management for a hazardous waste landfill cover and groundwater pump and treat system, and closure P.E. certification. The project included: removal of hazardous waste drums; preload program to estimate waste consolidation; groundwater aquifer testing; and groundwater modeling.

***Motor Wheel Disposal Site,*** *WR Grace, Inc., Lansing, MI.* Project manager for cost allocation arbitration case among potentially responsible parties at CERCLA landfill.

***Brownfield Redevelopment Site,*** *WEPCo, Racine, WI.* Project manager and remediation design engineer for brownfield development with manufactured gas plant wastes (organic and inorganic compounds) in groundwater and soil, and VOCs in soil gas;

included groundwater aquifer testing, site investigation, aquifer modeling, remedial design, construction engineering/resident engineering, operation monitoring for a groundwater extraction system, and soil gas collection system for commercial and residential development at a former manufactured gas plant site.

***Janesville Disposal Facility,*** *City of Janesville, Janesville, WI.* Groundwater design task manager for this CERCLA site. The site had several landfills that required RCRA cap design and a groundwater extraction system design to prevent groundwater discharge to the Rock River. Based upon the reports, aquifer testing and groundwater modeling, developed the concept to eliminate the groundwater extraction and treatment system because the surface water discharge criteria would not be exceeded and there were no receptors between the landfill and the river.

***National Industrial Environmental Services,*** *Chemical Waste Management, Inc., near Wichita, KS.* Project engineering, design and project management for CERCLA/RCRA facility corrective action. The project included remediation of VOC groundwater contamination, treatment of sludges containing acids and metals and organics (SVOCs and VOCs) and sludge disposal into two new hazardous waste landfill cells and litigation support. The project also included aquifer tests, groundwater modeling, air monitoring, geophysical surveys, agency reporting, two RCRA Part B permit applications, and technical support for two trials.

***Equilon (Shell Oil) Wood River Facility,*** *Shell Oil Company, Roxana, IL.* RCRA Corrective Action project management for a refinery along the Mississippi River that had numerous disposal areas. This project included: i) preparation of a RCRA Facility Investigation (RFI) investigation work plan; ii) conduct of the RFI; iii) certification of closure of one RCRA management unit; and iv) RCRA Part B submittal.

***Berlin & Farro Liquid Incineration Site,*** *PRP Group, Swartz Creek, MI.* Conducted a CERCLA RI/FS, baseline risk assessment, negotiations with Region V EPA and MDEQ for cleanup, and litigation support. The RI included investigation of soil, soil gas, groundwater, surface water and sediment, and included seismic reflection and resistivity geophysical investigations.

***Butterworth Landfill,*** *PRP Group, Grand Rapids, MI.* Completion of a remedial design work plan that included predesign sampling of soil, groundwater, river sediment, and fish in the Grand River at this 180 acre solid and hazardous waste landfill under CERCLA.

***Bailey Dump Superfund Site,*** *Texas Water Commission, Bridge City, TX.* Site manager to perform a remedial investigation over a two-month period to characterize uncontrolled hazardous waste landfill under CERCLA.

***Salt Intrusion Groundwater Modeling and Feasibility Study,*** *Morton Salt/Rohm & Haas, Inc., Manistee, MI.* Project manager for conduct of a feasibility study and groundwater transport model to assess methods to mitigate salt intrusion into an unconfined aquifer in Manistee.

***Hartley & Hartley Landfill,*** *Joint Defense Group, Bay City, MI.* Project manager for site regulated by the NRC as an SDMP site regarding licensing, leachate management system design, and MDEQ/MDNR interface. The site contained low-level radiological thorium-bearing slag and hazardous and solid waste.

***LUST Sites.*** Management and/or director for over 10 leaking underground storage tank projects in Michigan and Illinois.

**Litigation Assignments**

***Confidential Client, 2014.*** Mr. Seymour was retained as an expert in the field of CCR landfill design over a closed coal ash pond.

***Confidential Client, 2013.*** Mr. Seymour was retained as an expert in the field of CCR ponds for the arbitration of a major insurance claim.

***AmForge Site Expert Witness,*** *Arvin-Meritor, Chicago, IL, 2006.* Provided engineering support in the areas of contaminant fate and transport, risk assessment, and site characterization in cost recovery case. The cost recovery was undertaken by private parties brought under CERCLA.

**Geotechnical**

***Baby Creek Overflow Treatment Facility,*** *Detroit Water and Sewerage Department, Detroit, MI.* Project manager for the geotechnical investigation and foundation design for a combined sewer treatment system.

***Co-generation Power Facility,*** *Sarnia, Canada.* Project manager for geotechnical site investigation for a co-generation (steam and electricity) facility.

***Vila Olympica Building,*** *Bovis International, Barcelona, Spain.* Project manager to provide deep foundation geotechnical engineering at this 50 story high rise building along the Mediterranean coast.

***Lucky-Goldstar Building,*** *Lucky Development Company, Seoul, South Korea.* Resident engineer and quality control manager for construction of the deep foundation and foundation grouting program.

***Phase I Dam Safety Inspections,*** *U.S. Army Corps of Engineers, Multiple Sites, MO.* Field inspection of five dams and reporting writing for approximately 15 dams undergoing Phase I (non-intrusive) safety inspections.

***Ann Arbor Wastewater Treatment Plant**, City of Ann Arbor, MI.* Field resident engineering support for construction of this new facility. His responsibilities included oversight of groundwater dewatering to avoid "bottom heave" of the excavation, compaction control and QC inspection of civil construction.

***Beaver Valley Power Station,** Duquesne Light, Shippingport, PA.* Field resident engineering for foundation construction of an 888 megawatt nuclear fuel power plant.

## PROFESSIONAL EXPERIENCE

Geosyntec Consultants, Chicago, IL, 2001-present
URS Corporation, Detroit, MI, 1997 – 2001
Woodward-Clyde Consultants (later URS), Chicago, IL and Detroit, MI, 1980-1997
Townsend and Bottum, Ann Arbor, MI, 1978-1979
Stone & Webster, Shippingport, PA, 1976-1978

## AFFILIATIONS

American Society of Civil Engineers

Midwest Coal Ash Association

Society of American Military Engineer

## REPRESENTATIVE PUBLICATIONS

15-05 "Reliability Analysis of an Existing Ash Basin Embankment" at the World of Coal Ash Conference, Nashville, TN, Omer Bozok, Burak F. Tanyu, Paul Sabatini, and John Seymour

15-01 "Conditions of Coal Ash Embankments", at the U.S. Society on Dams Conference, April 2015 I Louisville, KY, John Seymour, P.E., Omer Bozok, Amanda Hughes, Ph.D., Brad Bodine, P.E; & World of Coal Ash Conference, Nashville, TN, May 2015.

13-04 "Challenges of Closing Large Fly Ash Ponds", World of Coal Ash Conference, Lexington, Kentucky, April 2013.

11-05 "Advances in Design of Landfills over CCR Ponds and CCR Landfills", Proceedings from the World of Coal Ash conference, Denver, CO, John Seymour, P.E. and Michael F. Houlihan, P.E. BCEE, May 2011.

11-06 "Case Study: Stability of Two Horizontal to One Vertical Embankment", Proceedings from ASCE Geo-Frontiers 2011, Advances in Geotechnical

Engineering, Burak Tanyu, PhD, W. Neal, P.E., J Seymour, P.E., M ASCE, D. Bodinc, P.E. M ASCE, and O. Bozok.

08-04 "Use of Tire Chips in the Final Cover System of a Superfund Site Landfill", ACSE Proceedings from GeoCongress 2008 titled: "The Challenge of Sustainability in the Geoenvironment", Majdi A. Othman, M. ASCE, Ph.D., P.E., and John Seymour, P.E.

**INVITED PRESENTATIONS**

15-06 "Slope Stability, Inspections, and Monitoring Considerations under the CCR Rule", Technical Short Course Teacher at the EPRI CCR Program Summer Meeting, June 2015, Bar Harbor, ME.

13-12 "CCR Pond Closures: Major Difficulties and Solutions", presentation to the Utility Solid Waste Activities Group, Washington, D.C., December, 2013.

13-04 Presentation of: "Challenges of Closing Large Fly Ash Ponds", at the World of Coal Ash Conference, Lexington, Kentucky, April 2013.

13-04 "Hot Topics Regarding Coal Combustion Residuals Management, presentation to Winston & Strawn Environmental Group, Chicago, Illinois, April 2013.

11-05 Presentation of: "Advances in Design of Landfills over CCR Ponds and CCR Landfills", at the World of Coal Ash conference, Denver, CO, May 2011.

09-04 "Geotechnical Design Considerations for Landfill Construction Over an Ash Pond", World of Coal Ash, Lexington, KY, May 2009

# J.SEYMOUR EXPERT REPORT

## APPENDIX B
## SURFACE WATER RISK CHARACTERIZATION

# Appendix B to Expert Report of John Seymour, P.E.
# Surface Water Risk Characterization

## Section 1: Introduction

This focused risk characterization evaluates the potential for human health and ecological risks from an assumed exposure to constituents of interest (COIs) in groundwater associated with each of the four sites that may migrate to surface water. COIs are defined as described in Sections 4.1.6, 4.2.6, 4.3.6, and 4.4.6 of the Expert Report of John Seymour. These evaluations are conservative as they assume a complete exposure pathway exists between groundwater COIs and receptors in the adjacent surface water bodies, and do not fully analyze attenuation or dilution mechanisms. The screening assessment also considers background and upgradient source COIs that are not from the ponds, thereby overestimating the risk from the ponds.

# Section 2: Risk Evaluation Methods

## 2.1. Methods Overview

For this evaluation, potential risks to human health and the environment from COIs that could possibly migrate to surface water were evaluated using a screening-level approach that compared estimates of exposure to estimates of effect. This approach is commonly used to screen for the potential for risk and determine if additional assessment is required.

## 2.2. Definition of Risk

It is assumed that there are "no unacceptable risks" if site-specific groundwater concentrations are less than Illinois Water Quality Standards (WQS) or Water Quality Criteria (WQC) for surface water, which are considered to be protective of human health and the environment. These WQS/WQC incorporate toxicological (i.e., does-response) data as well policy-based assumptions, including the state-determined acceptable risk level. Therefore, a conclusion of "no unacceptable risk" is a conclusion based upon regulatory processes. If a site concentration is greater than a WQS/WQC, it cannot be concluded that a risk exists, only that further evaluation may be warranted or necessary. At this step, site-specific conditions are typically evaluated in a quantitative and/or qualitative manner to refine preliminary conclusions of the screening step. For this evaluation, the refinement step considers the exceedance location (relative to other wells and receiving water bodies), magnitude, and frequency. If these lines of evidence support that "no unacceptable risks" are likely at the point-of-exposure (i.e., the lake or river), then it is concluded that there is an unlikely potential for risk.

## 2.3. Risk Evaluation Inputs

Exposure and effect estimates used in this screening-level approach are discussed below.

Exposure: COI concentrations reported for onsite groundwater monitoring wells were conservatively assumed to represent exposure point concentrations (EPCs) for human and ecological receptors. This overestimates risk as human and ecological exposure to groundwater within these sites represents an incomplete exposure pathway. In other words, there are no onsite exposures and, therefore, no onsite risks. Human and ecological receptors may be present in the adjacent surface water bodies; however, groundwater is expected to undergo dilution and attenuation as it migrates through the subsurface and then mixes with surface water. Thus, this assumption overestimates risks to potential off-site receptors by overestimating the exposure concentration.

Effect: Effects values for this evaluation were Illinois chronic WQS or, if a WQS was not available, Illinois chronic WQC. Surface water effects values and their sources are provided in Table B-1. The Illinois Environmental Protection Agency (IEPA) specifies that acute WQS "*...shall not be exceeded at any time except for those waters for which a zone of initial dilution (ZID) has been approved by the Agency...*" For this evaluation, it was assumed that a ZID has not been approved and, thus, chronic values would be applicable. However, given the conservative assumptions about exposure, acute values could provide a secondary line of evidence for evaluating risk.

# Section 3: Site-Specific Risk Evaluations

## 3.1. Risk Evaluation – Joliet #29 Generating Station

### 3.1.1. Estimates of Exposure and Effect

Groundwater in the vicinity of the Joliet #29 Power Generating Station ash ponds discharges south to the Des Plaines River via the adjoining intake channel. Based on groundwater data collected between December 2010 and February 2015 from onsite monitoring wells (MW-01 through MW-11), COIs for this site are: antimony, boron, chloride, iron, manganese, sulfate, and total dissolved solids (TDS).

Analytical data used in this evaluation is provided in Table B-2-1. Well-specific summary statistics calculated for COIs are provided in Table B-2-2 (average concentrations) and Table B-2-3 (maximum concentrations). Additionally, the mean of averages and the mean of maximums are calculated to provide a preliminary estimate of area-wide EPCs. Monitoring well locations are shown in Figure 4-1.

### 3.1.2. Results of Risk Evaluation

Based on comparisons of maximum detected concentrations at the site to WQS/WQC, there are no unacceptable risks from antimony, boron, manganese, and TDS.

Maximum detected concentrations of chloride and sulfate exceeded chronic WQS in one well each (MW-08 and MW-09, respectively); however, the magnitude of exceedance was low and average concentrations within these wells were below chronic WQS. Therefore, there is an unlikely potential for risk from chloride and sulfate.

Maximum and average iron concentrations in well MW-09 exceeded the WQS. Maximum iron concentrations in MW-07 and MW-08 also exceeded the WQS; however, iron was infrequently detected (1 detection in 18 samples) in these wells and average iron concentrations were less than the WQS. Notably, in wells nearer to the river and downgradient of MW-09 (e.g., MW-03 and MW-04), iron has not been detected. Therefore there is an unlikely potential for risk from iron.

## 3.2. Risk Evaluation – Powerton Generating Station

### 3.2.1. Estimates of Exposure and Effect

The site area has two groundwater flow regimes. Groundwater in the vicinity of the Powerton Generating Station ash ponds that is within the silt/clay unit discharges in a westerly direction to the adjoining intake channel; groundwater that is within the gravelly sand unit discharges in a northerly direction to the Illinois River. Based on groundwater analytical data collected between December 2010 and February 2015 from onsite monitoring wells (MW0-01 through MW-16), COIs for this site are: arsenic, boron, chloride, iron, lead, manganese, nitrate, selenium, sulfate, thallium, pH, and TDS.

Analytical data used in this evaluation is provided in Table B-3-1. Well-specific summary statistics calculated for each COI are from this data are provided in Table B-3-2 (average concentrations) and Table B-3-3 (maximum concentrations). Additionally, the mean of averages and the mean of maximums are calculated to provide a preliminary estimate of area-wide EPCs. Monitoring well locations are shown in Figure 4-2.

### 3.2.2. Results of Risk Evaluation

Based on comparisons of maximum detected concentrations at the site to WQS/WQC, there are no unacceptable risks from boron, chloride, nitrate, selenium, sulfate, and TDS.

Maximum detected concentrations of arsenic exceeded the chronic WQS in wells MW-07 and MW-06; however, the magnitude of exceedance was low (<2x) and average concentrations within these wells were below the chronic WQS. The maximum detected concentration of lead exceeded the chronic WQS in well MW-12; however, the magnitude of exceedance was low (<4x) and the average concentration within this well was below the chronic WQS. The maximum detected concentration of thallium exceed the chronic WQC in well MW-14; however, the magnitude of exceedance was low (<2x) and the average concentration within this well was below the chronic WQC. Field-measured pH levels were periodically less than or greater than the WQS range; however, on average, pH levels were well within the range. Therefore, based on the screening-level comparisons and site-specific conditions, there is an unlikely potential for risk form arsenic, lead, thallium, and pH.

Maximum and average manganese concentrations in in wells MW-07, MW-11, and MW-13 exceeded the WQS. These wells are reported to be screened within the gravelly-sand unit where groundwater flows in a northerly direction toward the Illinois River (i.e., the receiving water body). However, maximum and average manganese concentrations reported in several downgradient wells located nearer to the river (MW-03, MW-04, and MW-05) were below the chronic WQS, indicating attenuation is occurring. Maximum manganese concentrations in wells MW-06 and MW-10 also exceeded the WQS at least once. MW-10 is reported to be screened within the gravelly-sand unit and is also upgradient of wells MW-03, MW-04, and MW-05. Exceedances within this well were of low magnitude (<2x) and the well-specific average concentration was less than the WQS. MW-06 exceedances were infrequent (1 in 18 samples), of low magnitude (<3x), and occurred in a monitoring well located adjacent to the intake channel, which conveys water from the river to the Site. Therefore, the transport of manganese via the channel to the river is not probable and there is an unlikely potential for risk from manganese.

Within the northerly-flowing gravelly-sand unit, maximum iron concentrations in wells MW-07, MW-10, MW-11, and MW-13 exceeded the chronic WQS. Importantly, however, maximum and average iron concentrations reported in several downgradient wells located nearer to the river (MW-03, MW-04, and MW-05) were below the chronic WQS. Within each of the five wells within the westerly-flowing silt-clay later, average and maximum iron concentrations exceeded the chronic WQS. These wells with exceedances are located adjacent to and flow westerly toward the intake channel, which conveys water from the river to the site. Thus, transport of iron via the channel to the river is not probable. Therefore, there is an unlikely potential for risk from iron.

## 3.3. Risk Evaluation – Waukegan Generating Station

### 3.3.1. Estimates of Exposure and Effect

Groundwater in the vicinity of the Waukegan Generating Station ash ponds discharges in an easterly direction to adjacent Lake Michigan. Based on the groundwater data collected between October 2010 and February 2015 from onsite monitoring wells (MW-01 through MW-09), COIs for this site are: antimony, arsenic, boron, chloride, iron, manganese, sulfate, pH, and TDS. Note that these COIs include inorganic constituents from upgradient and offsite sources, such as boron, which is migrating on to the Waukegan site from the former Greiss-Pfleger Tannery site.

Analytical data used in this evaluation is provided in Table B-4-1. Well-specific summary statistics calculated for COIs are provided in Table B-4-2 (average concentrations) and Table B-4-3 (maximum concentrations). Additionally, the mean of averages and the mean of maximums are calculated to provide a preliminary estimate of area-wide EPCs. Monitoring well locations are shown in Figure 4-3.

### 3.3.2. Results of Risk Evaluation

Based on comparisons of maximum detected concentrations to WQS/WQC, there are no unacceptable risks from antimony and manganese.

Maximum detected concentrations of the remaining COIs exceeded WQS/WQC in at least one well. Arsenic exceedances were limited to two samples from MW-01, are of low magnitude (<2x), and the average concentration in MW-01 was less than the WQS. Chloride exceedances were limited to two samples from MW-05, are of low magnitude (<2x), and the average concentration was less than the WQS. Elevated pH levels were limited to wells MW-01, MW-02, and MW-03; however, on average, pH levels were within the WQS range. Therefore, there is an unlikely potential for risk form arsenic, chloride, and pH.

In individual wells MW-05 through MW-09, which are west and southwest of the ponds, average concentrations of boron, iron, sulfate, and TDS exceeded chronic WQS on one or more occasions. Importantly, there are no unacceptable risks for boron, iron, sulfate, and TDS in wells MW-01 through MW-04, which represent the most downgradient wells at the site. MW-01 through MW-04 appear to be downgradient of MW-05, MW-06, MW-08, and MW-09, indicating attenuation is occurring. Although no wells are directly downgradient of MW-07, there is no data to indicate that similar attenuation is not occurring in this area.

## 3.4. Risk Evaluation – Will County Generating Station

### 3.4.1. Estimates of Exposure and Effect

Groundwater in the vicinity of the Will County Generating Station ash ponds discharges in a westerly direction to the adjacent Des Plaines River. Based on the groundwater data collected between December 2010 and February 2015 from onsite monitoring wells (MW-01 through MW-10), COIs for this site are: antimony, boron, chloride, manganese, sulfate, pH, and TDS.

Analytical data used in this evaluation is provided in Table B-5-1. Well-specific summary statistics calculated for COIs are provided in Table B-5-2 (average concentrations) and Table B-5-3 (maximum concentrations). Additionally, the mean of averages and the mean of maximums are calculated to provide a preliminary estimate of area-wide EPCs. Monitoring well locations are shown in Figure 4-5.

### 3.4.2. Results of Risk Evaluation

Based on comparisons of maximum detected concentrations to WQS/WQC, there are no unacceptable risks from antimony, boron, chloride, manganese, and TDS.

Maximum detected concentrations of sulfate exceeded the chronic WQS in two wells (MW-04 and MW-05). These two wells are located east (upgradient) of the ponds and are not adjacent to the river; no sulfate exceedances have occurred in those wells that are adjacent to the river (MW-07, MW-08, MW-09, and MW-10). Therefore, there is an unlikely potential for risk from sulfate.

Field-measured pH levels in individual wells were variable and periodically were less than or greater than the WQS range; however, with the exception of one well (MW-09), average pH levels were well within the range. For MW-09, pH levels exceeded the range in the majority of samples evaluated herein. MW-09 is located adjacent to the Des Plaines River; however, given that average pH concentrations in the remaining nine wells, including wells adjacent to the river, were within the acceptable range, there is an unlikely potential for risk from pH.

Table B-1
Surface Water Effects Values
Midwest Generation

| Constituent | CAS | Units | Surface Water Effects Values (1) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | General Use (2) | | | | Lake Michigan Basin (3) | | | |
| | | | Chronic | | Acute (4) | | Chronic | | Acute (4) | |
| Antimony | 7440-36-0 | mg/L | 0.32 | (2e) | 1.2 | (2e) | 0.32 | (3d) | 1.2 | (3d) |
| Arsenic | 7440-38-2 | mg/L | 0.19 | (2a) | 0.36 | (2a) | 0.148 | (3a) | 0.34 | (3a) |
| Boron | 7440-42-8 | mg/L | 7.6 | (2a) | 40.1 | (2a) | 7.6 | (3a) | 40.1 | (3a) |
| Chloride | 16887-00-6 | mg/L | 500 | (2b) | -- | | 500 | (3b) | -- | |
| Iron | 7439-89-6 | mg/L | 1.0 | (2b) | -- | | 1.0 | (3b) | -- | |
| Lead | 7439-92-1 | mg/L | 0.0485 | (2a.i) | 0.231 | (2a.i) | n/a | | n/a | |
| Manganese | 7439-96-5 | mg/L | 3.04 | (2a.ii) | 7.15 | (2a.ii) | 3.04 | (3a) | 7.15 | (3a) |
| Nitrate | 14797-55-8 | mg/L | -- | | -- | | n/a | | n/a | |
| pH | -- | s.u. | 6.5 - 9.0 | (2d) | -- | | 6.5 - 9.0 | (3c) | -- | |
| Selenium | 7782-49-2 | mg/L | 1.0 | (2b) | -- | | n/a | | n/a | |
| Sulfate | 18785-72-3 | mg/L | site-specific | (2c) | -- | | 500 | (3b) | -- | |
| *Joliet #29* | 18785-72-3 | mg/L | 1350 | (2c) | -- | | 500 | (3b) | -- | |
| *Powerton* | 18785-72-3 | mg/L | 1430 | (2c) | -- | | 500 | (3b) | -- | |
| *Waukegan* | 18785-72-3 | mg/L | 1410 | (2c) | -- | | 500 | (3b) | -- | |
| *Will County* | 18785-72-3 | mg/L | 1480 | (2c) | -- | | 500 | (3b) | -- | |
| Thallium | 7440-28-0 | mg/L | 0.0037 | (2f) | 0.086 | (2e) | n/a | | n/a | |
| Total Dissolved Solids | -- | mg/L | -- | | -- | | 1,000 | (3c) | -- | |

**Notes**

(1) Illinois Water Quality Standards (WQS) are used as surface water effects values for evaluating hypothetical human and ecological exposure scenarios. In the absence of a WQS, Illinois Water Quality Criteria (WQC) are used. Values are applicable to total (rather than dissolved) concentrations.

(2) Concentration represents an Illinois General Use WQS as defined in 35 IAC 302, Subpart B or an Illinois WQC (lower of aquatic life and human health WQC):

(a) 35 IAC 302.208(c), Numerical Water Quality Standards for the Protection of Aquatic Life

(i) Standard for total lead is a hardness (H)-dependent value, calculated as follows (see also footnote 5):

Chronic = exp[-2.863+1.273*ln(H)]*1E-3 mg/µg

Acute = exp[-1.301+1.273*ln(H)]*1E-3 mg/µg

(ii) Standard for total manganese is a hardness (H)-dependent value, calculated as follows (see also footnote 5):

Chronic = exp[4.0635+0.7467*ln(H)]*1E-3 mg/µg

Acute = exp[4.9187+0.7467*ln(H)]*1E-3 mg/µg

(b) 35 IAC 302.208(g), Single-Value Standards

(c) 35 IAC 302.208(h)(2)(A), Water Quality Standard for Sulfate; standard is hardness (H) and chloride (Cl) dependent, and calculated as follows (see also footnotes 5 and 6):

Chronic = exp[1276.7+5.508*(H)-1.457(Cl)]*0.65

(d) 35 IAC 302.204, pH

(e) Illinois WQC for the protection of aquatic life.

(f) Illinois WQC for the protection of human health (applicable to chronic values only).

(3) Concentration represents an Illinois Lake Michigan Basin WQS as defined in 35 IAC 302, Subpart E. Note that of the four subject sites, Lake Michigan Basin WQS are only applicable to the Waukegan Power Generating Station. "n/a" indicates a constituent is not of interest at the Waukegan Power Generating Station.

(a) 35 IAC 302.504(a), Lake Michigan Basin Water Quality Standards for Chemical Constituents. WQS for manganese and lead are calculated using the hardness-dependent GU equations.

(b) 35 IAC 302.504(b)

(c) IAC 302.503, pH

(d) If a Lake Michigan Basin WQS was not available, the General Use WQS was assumed to be applicable.

(4) Chronic values are used as the primary effects values for this evaluation; however, acute values are also presented for discussion purposes.

(5) Site-specific hardness data is not available. However, based on data from the Illinois Water Quality Database (http://ilrdss.isws.illinois.edu/WQ/), a value of 200 mg/L is considered a conservative estimate for the Site.

(6) Sulfate WQS calculated using the average chloride concentration for available data, which are as follows:

Joliet #29 212
Powerton 121
Waukegan 141
Will County 72.3

**Definitions**

"--" = value not available
n/a = not applicable
mg/L = milligram per liter
s.u. = standard unit

Table B-3-1
Groundwater Analytical Results for Constituents of Interest December 2010 to February 2015
Midwest Generation – Joliet #29 Generating Station – Joliet Will County Illinois

| Well | Constituent | Effects Values [1] | Units | Groundwater Analytical Results (Year [Month]) | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 2010 [12] | 2011 [03] | 2011 [06] | 2011 [09] | 2011 [12] | 2012 [03] [2] | 2012 [06] | 2012 [09] [3] | 2012 [12] | 2013 [03] | 2013 [05/06] [4] | 2013 [07] | 2013 [10] | 2014 [02] | 2014 [05] | 2014 [08] | 2014 [10] | 2015 [02] |
| MW-01 | Antimony | 0.32 | mg/L | 0.0043 | NS | <0.003 | NS | NS | NS | NS | <0.003 | NS | NS | 0.0032 | NS | NS | NS | NS | <0.003 | <0.003 | NS |
| MW-01 | Boron | 7.6 | mg/L | 0.31 | NS | 0.29 | NS | NS | NS | NS | 0.38 | NS | NS | 0.33 | NS | NS | NS | NS | 0.22 | 0.21 | NS |
| MW-01 | Chloride | 500 | mg/L | 140 | NS | 170 | NS | NS | NS | NS | 120 | NS | NS | 210 | NS | NS | NS | NS | 120 | 79 | NS |
| MW-01 | Iron | 1 | mg/L | <0.1 | NS | <0.1 | NS | NS | NS | NS | <0.1 | NS | NS | <0.1 | NS | NS | NS | NS | <0.1 | <0.1 | NS |
| MW-01 | Manganese | 3.0 | mg/L | <0.0025 | NS | <0.0025 | NS | NS | NS | NS | <0.0025 | NS | NS | <0.0025 | NS | NS | NS | NS | 0.012 | 0.015 | NS |
| MW-01 | Sulfate | 1350 | mg/L | 180 | NS | 81 | NS | NS | NS | NS | 240 | NS | NS | 140 | NS | NS | NS | NS | 55 | 65 | NS |
| MW-01 | Total Dissolved Solids | -- | | 590 | NS | 670 | NS | NS | NS | NS | 630 | NS | NS | 700 | NS | NS | NS | NS | 550 | 570 | NS |
| MW-02 | Antimony | 0.32 | mg/L | 0.012 | NS | 0.0042 | 0.0032 | <0.003 | <0.003 | NS | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 |
| MW-02 | Boron | 7.6 | mg/L | 0.31 | NS | 0.35 | 0.44 | 0.74 | 0.22 | NS | 0.35 | 0.42 | 0.41 | 0.35 | 0.29 | 0.41 | 0.34 | 0.25 | 0.22 | 0.22 | 0.23 |
| MW-02 | Chloride | 500 | mg/L | 140 | NS | 230 | 140 | 140 | 280 | NS | 120 | 150 | 200 | 250 | 310 | 180 | 240 | 350 | 280 | 240 | 190 |
| MW-02 | Iron | 1 | mg/L | <0.1 | NS | <0.5 | <0.1 | <0.1 | <0.1 | NS | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| MW-02 | Manganese | 3.0 | mg/L | <0.0025 | NS | <0.013 | 0.0025 | <0.0025 | <0.0025 | NS | <0.0025 | <0.0025 | <0.0025 | <0.0025 | 0.0036 | <0.0025 | <0.0025 | <0.0025 | <0.0025 | <0.0025 | <0.0025 |
| MW-02 | Sulfate | 1350 | mg/L | 190 | NS | 67 | 110 | 150 | 110 | NS | 190 | 140 | 130 | 150 | 140 | 180 | 61 | 68 | 85 | 72 | 67 |
| MW-02 | Total Dissolved Solids | -- | | 600 | NS | 720 | 690 | 750 | 800 | NS | 580 | 720 | 840 | 860 | 980 | 660 | 830 | 1100 | 850 | 810 | 730 |
| MW-03 | Antimony | 0.32 | mg/L | 0.004 | <0.003 | <0.003 | 0.0065 | 0.016 | 0.013 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 |
| MW-03 | Boron | 7.6 | mg/L | 0.24 | 0.36 | 0.46 | 0.24 | 0.23 | 0.26 | 0.31 | 0.22 | 0.28 | 0.29 | 0.74 | 0.67 | 0.27 | 0.45 | 0.27 | 0.37 | 0.45 | 0.52 |
| MW-03 | Chloride | 500 | mg/L | 260 | 240 | 300 | 160 | 260 | 250 | 200 | 330 | 290 | 260 | 300 | 210 | 250 | 260 | 300 | 220 | 180 | 160 |
| MW-03 | Iron | 1 | mg/L | <0.1 | <0.1 | <0.5 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| MW-03 | Manganese | 3.0 | mg/L | 0.1 | 0.048 | <0.013 | 0.0076 | 0.008 | 0.0095 | 0.014 | 0.011 | 0.0076 | 0.0068 | <0.0025 | <0.0025 | <0.0025 | <0.0025 | <0.0025 | <0.0025 | <0.0025 | <0.0025 |
| MW-03 | Sulfate | 1350 | mg/L | 120 | 160 | 120 | 120 | 160 | 190 | 160 | 150 | 110 | 140 | 250 | 260 | 210 | 85 | 110 | 84 | 130 | 58 |
| MW-03 | Total Dissolved Solids | -- | | 930 | 1100 | 1000 | 930 | 1100 | 1000 | 1100 | 1000 | 1100 | 950 | 1300 | 1000 | 910 | 890 | 1100 | 810 | 760 | 700 |
| MW-04 | Antimony | 0.32 | mg/L | <0.003 | <0.003 | <0.003 | <0.003 | 0.0067 | 0.0057 | <0.003 | <0.003 | <0.003 | <0.003 | 0.012 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 |
| MW-04 | Boron | 7.6 | mg/L | 0.46 | 0.37 | 0.38 | 0.25 | 0.34 | 0.29 | 0.48 | 0.34 | 0.38 | 0.4 | 0.4 | 0.5 | 0.45 | 0.35 | 0.32 | 0.35 | 0.41 | 0.49 |
| MW-04 | Chloride | 500 | mg/L | 270 | 270 | 250 | 150 | 200 | 210 | 270 | 260 | 250 | 230 | 270 | 200 | 210 | 220 | 270 | 210 | 160 | 180 |
| MW-04 | Iron | 1 | mg/L | <0.1 | <0.1 | <0.5 | 0.22 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | 0.46 | 0.17 | <0.1 | <0.1 | <0.1 | 0.18 | <0.1 | <0.1 | 0.14 |
| MW-04 | Manganese | 3.0 | mg/L | 0.23 | 0.048 | 0.018 | 0.066 | 0.029 | 0.038 | 0.082 | 0.043 | 0.029 | 0.057 | 0.0081 | <0.0025 | <0.0025 | <0.0025 | <0.0025 | <0.0025 | <0.0025 | 0.0044 |
| MW-04 | Sulfate | 1350 | mg/L | 300 | 140 | 84 | 74 | 170 | 210 | 110 | 180 | 130 | 110 | 120 | 170 | 230 | 110 | 140 | 89 | 160 | 65 |
| MW-04 | Total Dissolved Solids | -- | | 1100 | 1000 | 890 | 770 | 970 | 930 | 1100 | 990 | 1000 | 880 | 900 | 840 | 860 | 870 | 860 | 760 | 720 | 730 |
| MW-05 | Antimony | 0.32 | mg/L | <0.003 | <0.003 | <0.003 | <0.003 | 0.004 | 0.0035 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 |
| MW-05 | Boron | 7.6 | mg/L | 0.42 | 0.52 | 0.47 | 0.57 | 0.49 | 0.58 | 0.44 | 0.55 | 0.65 | 0.55 | 0.69 | 0.81 | 0.55 | 0.54 | 0.36 | 0.55 | 0.57 | 0.69 |
| MW-05 | Chloride | 500 | mg/L | 150 | 240 | 220 | 120 | 190 | 210 | 220 | 240 | 210 | 230 | 180 | 110 | 140 | 240 | 370 | 120 | 120 | 220 |
| MW-05 | Iron | 1 | mg/L | <0.1 | <0.1 | <0.5 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| MW-05 | Manganese | 3.0 | mg/L | 0.0065 | <0.0025 | <0.013 | <0.0025 | <0.0025 | <0.0025 | 0.004 | 0.081 | <0.0025 | 0.0037 | <0.0025 | <0.0025 | <0.0025 | <0.0025 | 0.035 | 0.0062 | <0.0025 | 0.0076 |
| MW-05 | Sulfate | 1350 | mg/L | 110 | 160 | 100 | 140 | 140 | 190 | 130 | 210 | 210 | 150 | 200 | 290 | 180 | 150 | 160 | 160 | 240 | 230 |
| MW-05 | Total Dissolved Solids | -- | | 750 | 990 | 850 | 800 | 900 | 930 | 1000 | 990 | 1000 | 960 | 1100 | 910 | 680 | 840 | 1100 | 1000 | 730 | 1000 |
| MW-06 | Antimony | 0.32 | mg/L | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 |
| MW-06 | Boron | 7.6 | mg/L | 0.32 | 0.44 | 0.32 | 0.27 | 0.3 | 0.25 | 0.26 | 0.25 | 0.31 | 0.33 | 0.23 | 0.23 | 0.22 | 0.26 | 0.17 | 0.26 | 0.19 | 0.22 |
| MW-06 | Chloride | 500 | mg/L | 130 | 270 | 140 | 140 | 130 | 240 | 210 | 190 | 150 | 160 | 170 | 120 | 120 | 370 | 340 | 120 | 100 | 150 |
| MW-06 | Iron | 1 | mg/L | <0.1 | <0.1 | <0.5 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| MW-06 | Manganese | 3.0 | mg/L | 0.16 | 0.033 | <0.013 | 0.036 | 0.024 | 0.015 | 0.008 | 0.0087 | 0.0076 | 0.0047 | <0.0025 | <0.0025 | <0.0025 | <0.0025 | <0.0025 | <0.0025 | <0.0025 | <0.0025 |
| MW-06 | Sulfate | 1350 | mg/L | 140 | 140 | 87 | 180 | 130 | 110 | 91 | 85 | 120 | 120 | 90 | 110 | 150 | 100 | 120 | 91 | 140 | 140 |
| MW-06 | Total Dissolved Solids | -- | | 650 | 1000 | 650 | 620 | 710 | 800 | 860 | 760 | 710 | 690 | 690 | 350 | 570 | 930 | 990 | 1000 | 530 | 710 |
| MW-07 | Antimony | 0.32 | mg/L | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 |
| MW-07 | Boron | 7.6 | mg/L | 0.51 | 0.39 | 0.25 | 0.29 | 0.35 | 0.3 | 0.25 | 0.31 | 0.41 | 0.39 | 0.21 | 0.21 | 0.24 | 0.3 | 0.15 | 0.22 | 0.17 | 0.21 |
| MW-07 | Chloride | 500 | mg/L | 430 | 320 | 140 | 99 | 140 | 300 | 170 | 170 | 140 | 190 | 170 | 95 | 130 | 470 | 350 | 110 | 98 | 210 |
| MW-07 | Iron | 1 | mg/L | <0.1 | <0.1 | <0.5 | 3.8 | <0.1 | <0.1 | 0.13 | <0.1 | <0.1 | <0.1 | 0.41 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | 0.13 | 0.13 |
| MW-07 | Manganese | 3.0 | mg/L | 0.29 | 0.014 | <0.013 | 0.08 | 0.0071 | 0.015 | 0.069 | 0.0041 | 0.0063 | 0.0044 | 0.012 | <0.0025 | <0.0025 | <0.0025 | <0.0025 | 0.0033 | 0.0091 | 0.0048 |
| MW-07 | Sulfate | 1350 | mg/L | 250 | 120 | 85 | 110 | 160 | 140 | 190 | 130 | 98 | 150 | 150 | 74 | 190 | 170 | 110 | 82 | 120 | 260 |
| MW-07 | Total Dissolved Solids | -- | | 1200 | 970 | 580 | 650 | 780 | 870 | 760 | 760 | 790 | 720 | 740 | 540 | 650 | 1200 | 860 | 570 | 520 | 1000 |

Table B-2-1
Groundwater Analytical Results for Constituents of Interest December 2010 to February 2015
Midwest Generation – Joliet #29 Generating Station - Joliet, Will County, Illinois

| Well | Constituent | Effects Values (1) | Units | Groundwater Analytical Results (Year [Month]): 2010 [12] | 2011 [03] | 2011 [06] | 2011 [09] | 2011 [12] | 2012 [03] (2) | 2012 [06] | 2012 [09] (3) | 2012 [12] | 2013 [03] | 2013 [05/06] (4) | 2013 [07] | 2013 [10] | 2014 [02] | 2014 [05] | 2014 [08] | 2014 [10] | 2015 [02] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MW-08 | Antimony | 0.32 | mg/L | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 |
| MW-08 | Boron | 7.6 | mg/L | 0.29 | 0.16 | 0.12 | 0.2 | 0.16 | 0.13 | 0.2 | 0.46 | 0.33 | 0.25 | V | 0.18 | 0.19 | 0.16 | 0.15 | 0.19 | 0.16 | 0.64 |
| MW-08 | Chloride | 500 | mg/L | 130 | 350 | 150 | 79 | 120 | 410 | 190 | 130 | 130 | 200 | 300 | 210 | 110 | 270 | **780** | 170 | 140 | 470 |
| MW-08 | Iron | 1 | mg/L | <0.1 | <0.1 | <0.5 | <0.1 | <0.1 | <0.1 | <0.1 | 0.24 | <0.1 | <0.1 | 0.23 | <0.1 | <0.1 | 0.11 | <0.1 | <0.1 | <0.1 | **18** |
| MW-08 | Manganese | 3.0 | mg/L | 0.0051 | 0.0026 | 0.017 | <0.0025 | <0.0025 | 0.0042 | 0.016 | 0.023 | 0.0044 | <0.0025 | 0.0065 | <0.0025 | <0.0025 | 0.0039 | <0.0025 | 0.017 | 0.0069 | 1.1 |
| MW-08 | Sulfate | 1350 | mg/L | 210 | 87 | 52 | 120 | 170 | 130 | 110 | 180 | 130 | 150 | 99 | 72 | 74 | 54 | 400 | 79 | 73 | 600 |
| MW-08 | Total Dissolved Solids | -- | | 670 | 990 | 580 | 690 | 800 | 1000 | 740 | 710 | 730 | 830 | 960 | 740 | 560 | 740 | 2100 | 610 | 560 | 2000 |
| MW-09 | Antimony | 0.32 | mg/L | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 |
| MW-09 | Boron | 7.6 | mg/L | 0.36 | 0.32 | 0.29 | 0.35 | 0.31 | 0.38 | 0.34 | 0.55 | 0.44 | 0.36 | 0.3 | 0.29 | 0.29 | 0.3 | 0.27 | 0.29 | 0.24 | 0.3 |
| MW-09 | Chloride | 500 | mg/L | 140 | 230 | 290 | 190 | 190 | 170 | 250 | 160 | 130 | 190 | 290 | 280 | 280 | 270 | 340 | 270 | 230 | 390 |
| MW-09 | Iron | 1 | mg/L | <0.1 | 0.18 | **7.3** | **3.8** | **1.5** | **5.5** | **8** | **4.7** | **13** | **15** | **160** | **50** | **25** | **12** | **8.4** | **130** | **45** | **23** |
| MW-09 | Manganese | 3.0 | mg/L | 1.1 | 1.6 | 0.95 | 0.82 | 0.66 | 1.3 | 1.2 | 0.68 | 0.44 | 0.43 | 1.6 | 0.81 | 0.52 | 0.34 | 0.3 | 0.72 | 0.38 | 0.54 |
| MW-09 | Sulfate | 1350 | mg/L | **1600** | 1100 | 580 | 750 | 130 | **1600** | **1500** | **1600** | 1100 | 700 | 1300 | 1000 | 680 | 560 | 560 | 880 | 960 | 820 |
| MW-09 | Total Dissolved Solids | -- | | 2600 | 2400 | 1500 | 1700 | 2400 | 2600 | 2800 | 2900 | 2000 | 1700 | 3000 | 2300 | 1700 | 1600 | 1700 | 2100 | 1700 | 2400 |
| MW-10 | Antimony | 0.32 | mg/L | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 |
| MW-10 | Boron | 7.6 | mg/L | 0.5 | 0.54 | 0.54 | 0.41 | 0.52 | 0.52 | 0.53 | 0.43 | 0.49 | 0.49 | 0.25 | 0.3 | 0.42 | 0.4 | 0.39 | 0.48 | 0.56 | 0.52 |
| MW-10 | Chloride | 500 | mg/L | 200 | 300 | 7.1 | 170 | 180 | 180 | 290 | 230 | 200 | 210 | 240 | 210 | 220 | 240 | 300 | 230 | 170 | 210 |
| MW-10 | Iron | 1 | mg/L | <0.1 | <0.1 | <0.5 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | 0.32 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| MW-10 | Manganese | 3.0 | mg/L | 0.12 | 0.0076 | <0.013 | <0.0025 | <0.0025 | <0.0025 | <0.0025 | <0.0025 | <0.0025 | <0.0025 | 0.01 | <0.0025 | <0.0025 | <0.0025 | <0.0025 | <0.0025 | <0.0025 | 0.0049 |
| MW-10 | Sulfate | 1350 | mg/L | 130 | 130 | 89 | 100 | 190 | 250 | 170 | 110 | 120 | 84 | 120 | 130 | 140 | 55 | 120 | 73 | 110 | 93 |
| MW-10 | Total Dissolved Solids | -- | | 860 | 1100 | 980 | 730 | 890 | 890 | 1100 | 870 | 860 | 830 | 850 | 910 | 880 | 870 | 890 | 910 | 740 | 810 |
| MW-11 | Antimony | 0.32 | mg/L | <0.003 | <0.003 | <0.015 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 |
| MW-11 | Boron | 7.6 | mg/L | 0.47 | 2.6 | 2.2 | 1.1 | 1.2 | 1.4 | 0.85 | 0.68 | 0.57 | 1.1 | 0.34 | 0.88 | 0.49 | 1.2 | 1.3 | 1.6 | 2 | 1.1 |
| MW-11 | Chloride | 500 | mg/L | 160 | 270 | 280 | 86 | 140 | 240 | 150 | 150 | 140 | 190 | 160 | 91 | 140 | 430 | 340 | 120 | 84 | 270 |
| MW-11 | Iron | 1 | mg/L | <0.1 | <0.1 | <0.5 | <0.1 | <0.1 | <0.1 | 0.23 | <0.1 | 0.42 | 0.15 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | 0.17 |
| MW-11 | Manganese | 3.0 | mg/L | 0.052 | 0.0047 | <0.013 | 0.0053 | 0.0047 | <0.0025 | 0.014 | <0.0025 | 0.042 | 0.016 | <0.0025 | <0.0025 | <0.0025 | <0.0025 | <0.0025 | <0.0025 | <0.0025 | 0.27 |
| MW-11 | Sulfate | 1350 | mg/L | 140 | 150 | 110 | 110 | 160 | 140 | 150 | 100 | 150 | 110 | 100 | 100 | 110 | 130 | 100 | 91 | 120 | 290 |
| MW-11 | Total Dissolved Solids | -- | | 770 | 1000 | 710 | 590 | 790 | 850 | 760 | 740 | 730 | 770 | 570 | 570 | 690 | 1100 | 850 | 720 | 580 | 1300 |

**Notes**

(1) Illinois General Use Water Quality Standards (WQS) and Illinois Water Quality Criteria (WQC) are used as surface water effects values
(2) Manganese results for March 2012 for wells MW-02, MW-03, and MW-04 were qualified as "^" by the laboratory, which denotes instrument-related QC exceeds the control limits
(3) Boron results for September 2012 were qualified as "^" by the laboratory, which denotes instrument-related QC exceeds the control limits
(4) Boron results for May 2013 for well MW-03 were qualified as "V" by the laboratory. A qualifier definition was not identified

mg/L = milligrams per liter
"--" = value not available
"<" = constituent was not detected; the reporting limit is presented
bold/shading = concentration exceeds effects value

Table B-2-2
Comparison Of Average Groundwater Analytical Results To Surface Water Effects Values
Midwest Generation -- Joliet #29 Generating Station - Joliet, Will County, Illinois

| Constituent | Units | Effects Value [1] | Groundwater Analytical Results - Average Concentrations [2] | | | | | | | | | | | Average [3] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | MW-01 | MW-02 | MW-03 | MW-04 | MW-05 | MW-06 | MW-07 | MW-08 | MW-09 | MW-10 | MW-11 | |
| Antimony | mg/L | 0.32 | 0.00258 | 0.00243 | 0.00336 | 0.00261 | 0.00175 | 0.00167 | 0.003 U | 0.003 U | 0.003 U | 0.003 U | 0.00367 U | 0.00202 |
| Boron | mg/L | 7.6 | 0.29 | 0.347 | 0.368 | 0.384 | 0.567 | 0.268 | 0.287 | 0.234 | 0.334 | 0.461 | 1.17 | 0.428 |
| Chloride | mg/L | 500 | 140 | 219 | 251 | 227 | 196 | 181 | 207 | 241 | 239 | 209 | 191 | 209 |
| Iron | mg/L | 1.0 | 0.1 U | 0.125 U | 0.122 U | 0.112 | 0.122 U | 0.122 U | 0.303 | 0.638 | **28.5** | 0.0761 | 0.104 | **2.73** |
| Manganese | mg/L | 3.04 | 0.00533 | 0.0018 | 0.0127 | 0.0428 | 0.00906 | 0.0163 | 0.0295 | 0.0675 | 0.799 | 0.00918 | 0.0237 | 0.0924 |
| Sulfate | mg/L | 1350 | 128 | 118 | 146 | 144 | 185 | 115 | 143 | 157 | 968 | 123 | 131 | 214 |
| Total Dissolved Solids | mg/L | -- | 618 | 783 | 982 | 898 | 918 | 712 | 785 | 884 | 2170 | 887 | 788 | 948 |

**Notes**
(1) Illinois General Use Water Quality Standards (WQS) and Illinois Water Quality Criteria (WQC) are used as surface water effects values
(2) Average of concentrations reported between December 2010 and February 2015. If a constituent was not detected during this timeframe, the average reporting limit is presented in the table, indicated with a "U" qualifier. Otherwise, non-detect results were included in the average calculation assuming one-half the reporting limit.
(3) Average of concentrations (averages) presented in the table, assuming one-half the reporting limit for non-detect results

mg/L = milligram per liter
s.u. = standard units
"--" = value not available
U = constituent not detected above its reporting limit; reporting limit presented
bold/shading = concentration exceeds effects value

Table B-2-3

Comparison Of Maximum Groundwater Analytical Results To Surface Water Effects Values

Midwest Generation -- Joliet #29 Generating Station - Joliet, Will County, Illinois

| Constituent | Units | Effects Value (1) | Groundwater Analytical Results - Maximum Concentrations (2) | | | | | | | | | | | Average (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | MW-01 | MW-02 | MW-03 | MW-04 | MW-05 | MW-06 | MW-07 | MW-08 | MW-09 | MW-10 | MW-11 | |
| Antimony | mg/L | 0.32 | 0.0052 | 0.012 | 0.016 | 0.012 | 0.004 | 0.0045 | 0.003 U | 0.003 U | 0.003 U | 0.003 U | 0.015 U | 0.00611 |
| Boron | mg/L | 7.6 | 0.38 | 0.74 | 0.74 | 0.5 | 0.95 | 0.44 | 0.51 | 0.64 | 0.59 | 0.56 | 2.6 | 0.786 |
| Chloride | mg/L | 500 | 210 | 350 | 380 | 270 | 370 | 370 | 470 | **780** | 390 | 300 | 430 | 393 |
| Iron | mg/L | 1.0 | 0.1 U | 0.5 U | 0.5 U | 0.46 | 0.5 U | 0.5 U | **3.8** | **10** | **160** | 0.32 | 0.42 | **16** |
| Manganese | mg/L | 3.04 | 0.015 | 0.0036 | 0.1 | 0.33 | 0.081 | 0.14 | 0.29 | 1.1 | 1.6 | 0.12 | 0.27 | 0.368 |
| Sulfate | mg/L | 1350 | 240 | 190 | 260 | 300 | 360 | 150 | 260 | 600 | **1600** | 250 | 290 | 409 |
| Total Dissolved Solids | mg/L | -- | 700 | 1100 | 1300 | 1100 | 1100 | 1000 | 1200 | 2100 | 3000 | 1100 | 1300 | 1360 |

**Notes**

(1) Illinois General Use Water Quality Standards (WQS) and Illinois Water Quality Criteria (WQC) are used as surface water effects values

(2) Maximum detected concentrations reported between December 2010 and February 2015. If a constituent was not detected during this timeframe, the maximum reporting limit is presented in the table, indicated with a "U" qualific

(3) Average of concentrations (maximums) presented in the table, assuming one-half the reporting limit for non-detect results

mg/L = milligram per liter

s.u. = standard units

"--" = value not available

U = constituent not detected above its reporting limit; reporting limit presented

bold/shading = concentration exceeds effects value

Table B-3-1
Groundwater Analytical Results for Constituents of Interest, December 2010 to February 2015
Midwest Generation – Powerton Generating Station - Pekin, Tazewell County, Illinois

| Well | Constituent | Effects Value (1) | Units | 2010 [12] | 2011 [02/03] | 2011 [04] | 2011 [06] | 2011 [08] | 2011 [09/10] | 2011 [12] | 2012 [03/04] | 2012 [06] | 2012 [09] | 2012 [12] | 2013 [02] | 2013 [05] | 2013 [07] | 2013 [10] | 2014 [03] (2) | 2014 [05] (3) | 2014 [08] (4) | 2014 [10] | 2015 [02] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Groundwater Analytical Results (Year [Month]) | | | | | | | | | | | | | | | | | | | |
| MW-01 | Arsenic | 0.19 | mg/L | <NP | <0.001 | -- | <0.001 | -- | <0.001 | <0.001 | <0.001 | 0.001 | <0.001 | <0.005 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| MW-01 | Boron | 7.6 | mg/L | 0.45 | 0.26 | -- | 0.33 | -- | 1 | 0.48 | 0.29 | 0.46 | 1.8 | <2 | 1.7 | 0.47 | 0.48 | 0.62 | 0.53 | 0.26 | 0.16 | 0.075 | 0.059 |
| MW-01 | Chloride | 500 | mg/L | 46 | 37 | -- | 40 | -- | 41 | 26 | 53 | 42 | 43 | 41 | 38 | 160 | 140 | 46 | 48 | 73 | 58 | 42 | 37 |
| MW-01 | Iron | 1 | mg/L | <NP | <0.01 | -- | <0.01 | -- | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | 0.17 | <0.01 | 0.43 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| MW-01 | Lead | 0.0485 | mg/L | <NP | <0.001 | -- | <0.001 | -- | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.005 | <0.001 | 0.0008 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 |
| MW-01 | Manganese | 3.04 | mg/L | <NP | <0.001 | -- | <0.001 | -- | <0.001 | <0.001 | <0.001 | <0.001 | 0.0027 | 0.018 | <0.001 | 0.027 | <0.0025 | <0.0025 | <0.0025 | <0.0025 | <0.0025 | <0.0025 | 0.0043 |
| MW-01 | Nitrogen/Nitrate | -- | mg/L | 7.2 | 4.3 | -- | 3.7 | -- | 11 | 4.1 | 7.3 | 6.5 | 5.4 | 7.2 | 7.4 | 0.23 | 0.42 | 4.5 | 4.7 | 2.2 | 1.3 | 4.4 | 4.1 |
| MW-01 | Nitrogen/Nitrate, Nitrite | -- | mg/L | NR | NR | -- | NR | -- | NR | NR | NR | NR | NR | NR | NR | 0.23 | 0.42 | 4.5 | 4.7 | 2.2 | 1.3 | 4.4 | 4.1 |
| MW-01 | pH | 6.5 - 9.0 | s.u. | 7.46 | 7.43 | -- | 7.38 | -- | 7.37 | [illegible] | 7.59 | 7.43 | 7.16 | 6.98 | 9.53 | 7.00 | 6.75 | 7.12 | 7.05 | 7.15 | 7.25 | 7.25 | 6.93 |
| MW-01 | Selenium | 1 | mg/L | 0.0016 | 0.0022 | -- | 0.0016 | -- | 0.0036 | 0.0027 | 0.0025 | 0.0042 | 0.005 | <0.005 | 0.0045 | <0.0025 | <0.0025 | 0.0042 | 0.004 | <0.0025 | <0.0025 | <0.0025 | <0.0025 |
| MW-01 | Sulfate | 1430 | mg/L | 50 | 30 | -- | 39 | -- | 83 | 31 | 61 | 68 | 72 | 91 | 77 | 330 | 270 | 85 | 91 | 51 | 36 | 54 | 43 |
| MW-01 | Thallium | 0.0037 | mg/L | <NP | <0.001 | -- | <0.001 | -- | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 |
| MW-01 | Total Dissolved Solids | -- | mg/L | 490 | 340 | -- | 410 | -- | 510 | 440 | 470 | 580 | 710 | 640 | 640 | 840 | 870 | 660 | 590 | 440 | 350 | 410 | 470 |
| MW-02 | Arsenic | 0.19 | mg/L | 0.0018 | 0.0015 | -- | 0.0017 | -- | <0.001 | <0.001 | <0.001 | 0.0011 | 0.0012 | <0.005 | 0.0011 | 0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | 0.0015 |
| MW-02 | Boron | 7.6 | mg/L | 0.38 | 0.23 | -- | 0.35 | -- | 0.83 | 0.69 | 0.27 | 0.74 | 0.65 | 0.8 | 0.29 | 0.21 | 1.4 | 2.7 | 0.28 | 0.38 | 1.1 | 0.078 | 0.092 |
| MW-02 | Chloride | 500 | mg/L | 45 | 43 | -- | 44 | -- | 46 | 40 | 53 | 51 | 45 | 48 | 52 | 53 | 48 | 90 | 46 | 91 | 58 | 44 | 54 |
| MW-02 | Iron | 1 | mg/L | <NP | <0.01 | -- | <0.01 | -- | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | 0.046 | 0.026 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| MW-02 | Lead | 0.0485 | mg/L | <NP | <0.001 | -- | <0.001 | -- | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.005 | <0.001 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | 0.0013 | <0.0005 |
| MW-02 | Manganese | 3.04 | mg/L | <NP | 0.0012 | -- | 0.0022 | -- | <0.001 | <0.001 | <0.001 | <0.001 | 0.0019 | 0.0063 | <0.001 | <0.0025 | 0.006 | 0.006 | <0.0025 | <0.0025 | <0.0025 | <0.0025 | <0.0025 |
| MW-02 | Nitrogen/Nitrate | -- | mg/L | 7.5 | 4.2 | -- | 3.7 | -- | 4.3 | 5.9 | 5.1 | 4.4 | 2.9 | 2.4 | 5.7 | 0.44 | 0.59 | 1.1 | 2.4 | 4 | 0.28 | 4.3 | 5.9 |
| MW-02 | Nitrogen/Nitrate, Nitrite | -- | mg/L | NR | NR | -- | NR | -- | NR | NR | NR | NR | NR | NR | NR | 0.48 | 0.59 | 1.1 | 2.4 | 4 | 0.28 | 4.3 | 5.9 |
| MW-02 | pH | 6.5 - 9.0 | s.u. | 7.91 | 7.78 | -- | 7.20 | -- | 7.52 | 6.41 | 7.92 | 7.35 | 7.32 | 7.38 | 7.53 | 7.39 | 7.03 | 7.20 | 8.21 | 7.15 | 7.01 | 7.17 | 8.13 |
| MW-02 | Selenium | 1 | mg/L | 0.0017 | 0.0035 | -- | 0.0014 | -- | 0.0032 | 0.0027 | <0.001 | 0.0039 | 0.0016 | <0.005 | 0.0032 | <0.0025 | <0.0025 | <0.0025 | <0.0025 | <0.0025 | <0.0025 | <0.0025 | <0.0025 |
| MW-02 | Sulfate | 1430 | mg/L | 52 | 42 | -- | 53 | -- | 70 | 69 | 55 | 73 | 69 | 93 | 53 | 96 | 140 | 190 | 53 | 63 | 76 | 49 | 57 |
| MW-02 | Thallium | 0.0037 | mg/L | <NP | <0.001 | -- | <0.001 | -- | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 |
| MW-02 | Total Dissolved Solids | -- | mg/L | 480 | 420 | -- | 470 | -- | 460 | 490 | 440 | 500 | 510 | 520 | 440 | 340 | 560 | 770 | 430 | 440 | 460 | 440 | 310 |
| MW-03 | Arsenic | 0.19 | mg/L | 0.0017 | <0.001 | -- | 0.0011 | -- | 0.0012 | 0.0012 | 0.0012 | <0.001 | 0.0015 | <0.005 | 0.0013 | 0.0012 | 0.0013 | 0.0011 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| MW-03 | Boron | 7.6 | mg/L | 0.75 | 0.18 | -- | 0.24 | -- | 0.64 | 0.7 | 0.56 | 0.63 | 0.64 | 0.63 | 0.65 | 0.21 | 0.47 | 0.46 | 0.14 | 0.15 | 0.37 | 0.14 | 0.32 |
| MW-03 | Chloride | 500 | mg/L | 39 | 52 | -- | 59 | -- | 62 | 39 | 54 | 57 | 54 | 58 | 53 | 55 | 60 | 57 | 120 | 100 | 79 | 47 | 47 |
| MW-03 | Iron | 1 | mg/L | <NP | <0.01 | -- | <0.01 | -- | 0.042 | <0.01 | <0.01 | <0.01 | <0.01 | 0.036 | 0.019 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| MW-03 | Lead | 0.0485 | mg/L | <NP | <0.001 | -- | <0.001 | -- | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.005 | <0.001 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | 0.00057 | <0.0005 | <0.0005 | <0.0005 |
| MW-03 | Manganese | 3.04 | mg/L | 0.0047 | 0.0023 | -- | <0.001 | -- | 0.0037 | 0.0014 | <0.001 | 0.0033 | 0.002 | 0.034 | 0.011 | <0.0025 | <0.0025 | 0.0039 | <0.0025 | <0.0025 | <0.0025 | <0.0025 | <0.0025 |
| MW-03 | Nitrogen/Nitrate | -- | mg/L | 9.4 | 5.2 | -- | 5.4 | -- | 0.2 | 0.2 | 2.1 | 0.37 | 0.08 | 0.13 | 2 | 0.15 | <0.1 | <0.1 | 2.6 | 5.3 | <0.1 | 2.4 | 2 |
| MW-03 | Nitrogen/Nitrate, Nitrite | -- | mg/L | NR | NR | -- | NR | -- | NR | NR | NR | NR | NR | NR | NR | 0.15 | <0.1 | <0.1 | 2.6 | 5.3 | <0.1 | 2.4 | 2 |
| MW-03 | pH | 6.5 - 9.0 | s.u. | 7.43 | 7.55 | -- | 7.33 | -- | 7.30 | 6.58 | 7.38 | 7.36 | 7.46 | 7.41 | 7.40 | 7.31 | 7.22 | 7.25 | 8.34 | 7.27 | 6.97 | 7.43 | 7.75 |
| MW-03 | Selenium | 1 | mg/L | <NP | 0.0036 | -- | 0.0015 | -- | 0.0036 | 0.0021 | 0.0067 | 0.0018 | 0.0033 | <0.005 | 0.0048 | <0.0025 | <0.0025 | <0.0025 | <0.0025 | <0.0025 | <0.0025 | <0.0025 | <0.0025 |
| MW-03 | Sulfate | 1430 | mg/L | 64 | 42 | -- | 47 | -- | 66 | 45 | 72 | 84 | 74 | 74 | 64 | 82 | 99 | 96 | 65 | 63 | 100 | 40 | 46 |
| MW-03 | Thallium | 0.0037 | mg/L | <NP | <0.001 | -- | <0.001 | -- | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 |
| MW-03 | Total Dissolved Solids | -- | mg/L | 480 | 450 | -- | 440 | -- | 460 | 480 | 450 | 520 | 520 | 460 | 500 | 310 | 460 | 430 | 490 | 440 | 490 | 440 | 400 |
| MW-04 | Arsenic | 0.19 | mg/L | <NP | <0.001 | -- | <0.001 | -- | <0.001 | <0.001 | <0.001 | <0.001 | 0.0012 | <0.005 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| MW-04 | Boron | 7.6 | mg/L | 0.77 | 0.83 | -- | 0.33 | -- | 0.84 | 0.79 | 0.78 | 0.83 | 0.76 | 0.74 | 0.97 | 0.23 | 0.67 | 0.81 | 0.81 | 0.94 | 1 | 0.77 | 0.94 |
| MW-04 | Chloride | 500 | mg/L | 150 | 77 | -- | 43 | -- | 86 | 8.1 | 58 | 75 | 110 | 130 | 90 | 54 | 70 | 150 | 130 | 92 | 95 | 96 | 74 |
| MW-04 | Iron | 1 | mg/L | <NP | 0.017 | -- | <0.01 | -- | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | 0.14 | 0.059 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| MW-04 | Lead | 0.0485 | mg/L | <NP | <0.001 | -- | <0.001 | -- | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.005 | <0.001 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 |
| MW-04 | Manganese | 3.04 | mg/L | 0.77 | 0.68 | -- | 0.41 | -- | 0.69 | 0.35 | 0.089 | 0.26 | 0.5 | 0.027 | 0.007 | <0.0025 | 0.13 | 0.27 | 0.026 | 0.029 | 0.24 | 0.075 | 1.018 |
| MW-04 | Nitrogen/Nitrate | -- | mg/L | 0.34 | 0.73 | -- | 2.7 | -- | 0.05 | 0.07 | 0.65 | 1.1 | 0.46 | 1 | 1.8 | <0.1 | <0.1 | 0.5 | <0.1 | <0.1 | <0.1 | 0.14 | 0.3 |
| MW-04 | Nitrogen/Nitrate, Nitrite | -- | mg/L | NR | NR | -- | NR | -- | NR | NR | NR | NR | NR | NR | NR | <0.1 | <0.1 | 0.5 | <0.1 | <0.1 | <0.1 | 0.14 | 0.3 |
| MW-04 | pH | 6.5 - 9.0 | s.u. | 7.27 | 7.48 | -- | 7.26 | -- | 7.22 | [illegible] | 7.24 | 7.04 | 7.13 | 7.14 | 7.37 | 7.30 | 7.02 | 7.00 | 8.00 | 7.64 | 7.66 | 7.20 | 7.63 |
| MW-04 | Selenium | 1 | mg/L | 0.0022 | 0.0037 | -- | 0.0022 | -- | 0.0039 | 0.002 | 0.0085 | 0.0035 | 0.0032 | <0.005 | 0.013 | <0.0025 | <0.0025 | <0.0025 | <0.0025 | <0.0025 | <0.0025 | <0.0025 | <0.0025 |
| MW-04 | Sulfate | 1430 | mg/L | 110 | 140 | -- | 48 | -- | 61 | 6.7 | 160 | 94 | 170 | 150 | 130 | 92 | 190 | 260 | 200 | 320 | 260 | 390 | 100 |
| MW-04 | Thallium | 0.0037 | mg/L | <NP | <0.001 | -- | <0.001 | -- | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 |
| MW-04 | Total Dissolved Solids | -- | mg/L | 680 | 620 | -- | 470 | -- | 580 | 520 | 660 | 600 | 800 | 720 | 640 | 350 | 670 | 980 | 780 | 980 | 880 | 1100 | 480 |

Table B-3-1
Groundwater Analytical Results for Constituents of Interest: December 2010 to February 2015
Midwest Generation -- Powerton Generating Station - Pekin, Tazewell County, Illinois

| Well | Constituent | Effects Value | Units | Groundwater Analytical Results (Year [Month]) | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 2010 [12] | 2011 [02/03] | 2011 [04] | 2011 [06] | 2011 [08] | 2011 [09/10] | 2011 [12] | 2012 [03/04] | 2012 [06] | 2012 [09] | 2012 [12] | 2013 [02] | 2013 [05] | 2013 [07] | 2013 [10] | 2014 [03] | 2014 [05] | 2014 [08] | 2014 [10] | 2015 [02] |
| MW-05 | Arsenic | 0.19 | mg/L | 0.0011 | <0.001 | -- | <0.001 | -- | <0.001 | 0.001 | <0.001 | <0.001 | <0.001 | <0.005 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| MW-05 | Boron | 7.6 | mg/L | 0.95 | 0.93 | -- | 0.79 | -- | 0.79 | 0.77 | 0.82 | 0.74 | 0.65 | 0.66 | 0.66 | 0.7 | 0.64 | 0.83 | 0.7 | 0.76 | 0.71 | <0.05 | 1.1 |
| MW-05 | Chloride | 500 | mg/L | 150 | 120 | -- | 49 | -- | 160 | 140 | 82 | 100 | 150 | 170 | 110 | 92 | 150 | 170 | 120 | 80 | 140 | 120 | 72 |
| MW-05 | Iron | 1 | mg/L | 0.13 | 0.05 | -- | 0.046 | -- | 0.082 | 0.056 | <0.01 | <0.01 | <0.01 | 0.43 | 0.052 | 0.2 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| MW-05 | Lead | 0.0485 | mg/L | <NP | <0.001 | -- | <0.001 | -- | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.005 | <0.001 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 |
| MW-05 | Manganese | 3.04 | mg/L | 0.51 | 0.49 | -- | 0.48 | -- | 0.64 | 0.5 | 0.26 | 0.41 | 1 | 0.59 | 0.21 | 0.67 | 0.29 | 0.62 | 0.077 | 0.043 | 0.016 | <0.0025 | 0.058 |
| MW-05 | Nitrogen/Nitrate | -- | mg/L | <NP | <0.02 | -- | 0.08 | -- | <0.02 | <0.02 | 1.6 | 0.04 | 0.04 | 0.04 | 0.19 | <0.1 | <0.1 | 0.34 | 0.74 | 2.2 | 0.11 | 0.2 | 0.74 |
| MW-05 | Nitrogen/Nitrate, Nitrite | -- | mg/L | NR | NR | -- | NR | -- | NR | NR | NR | NR | NR | NR | NR | <0.1 | <0.1 | 0.34 | 0.77 | 2.2 | 0.11 | 0.2 | 0.74 |
| MW-05 | pH | 6.5 - 9.0 | s.u. | 7.24 | 7.36 | -- | 7.29 | -- | 7.05 | **6.34** | 7.14 | 7.00 | 6.94 | 6.94 | 8.01 | 6.87 | 6.82 | 6.89 | 7.68 | 7.01 | 6.86 | 7.30 | 7.52 |
| MW-05 | Selenium | 1 | mg/L | 0.0019 | 0.003 | -- | <0.001 | -- | 0.0045 | 0.0023 | 0.0028 | 0.0033 | 0.0031 | <0.005 | 0.0029 | <0.0025 | <0.0025 | <0.0025 | <0.0025 | <0.0025 | 0.0028 | <0.0025 | <0.0025 |
| MW-05 | Sulfate | 1430 | mg/L | 160 | 170 | -- | 110 | -- | 250 | 170 | 120 | 130 | 200 | 200 | 180 | 310 | 290 | 260 | 180 | 150 | 200 | 110 | 110 |
| MW-05 | Thallium | 0.0037 | mg/L | <NP | <0.001 | -- | <0.001 | -- | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 |
| MW-05 | Total Dissolved Solids | -- | mg/L | 740 | 680 | -- | 640 | -- | 890 | 820 | 590 | 700 | 890 | 840 | 790 | 990 | 1000 | 1100 | 840 | 640 | 870 | 910 | 570 |
| MW-06 | Arsenic | 0.19 | mg/L | 0.0042 | 0.0024 | -- | 0.0029 | -- | 0.0031 | 0.0036 | 0.002 | 0.0021 | 0.0022 | <0.005 | 0.0017 | 0.0027 | 0.0037 | 0.0039 | 0.001 | **0.2** | 0.0024 | 0.0016 | 0.0011 |
| MW-06 | Boron | 7.6 | mg/L | 0.5 | 0.35 | -- | 0.43 | -- | 0.61 | 0.63 | 0.39 | 0.46 | 0.57 | 0.45 | 0.39 | 1 | 0.62 | 0.51 | 0.34 | 0.35 | 0.52 | 0.34 | 0.34 |
| MW-06 | Chloride | 500 | mg/L | 180 | 200 | -- | 160 | -- | 210 | 150 | 150 | 200 | 190 | 240 | 200 | 99 | 200 | 210 | 230 | 230 | 230 | 240 | 110 |
| MW-06 | Iron | 1 | mg/L | **1.6** | **1.6** | -- | **1.7** | -- | **1.8** | **1.9** | **1.7** | **1.9** | **1.9** | **1.6** | **1.1** | **1.8** | **2.2** | **1.8** | **1.5** | **22** | 1 | 0.81 | 1 |
| MW-06 | Lead | 0.0485 | mg/L | <NP | <0.001 | -- | <0.001 | -- | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.005 | <0.001 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | 0.00082 | <0.0005 |
| MW-06 | Manganese | 3.04 | mg/L | 0.68 | 0.68 | -- | 0.63 | -- | 0.66 | 0.63 | 0.61 | 0.71 | 0.64 | 0.61 | 0.5 | 1.3 | 3.7 | 0.58 | 0.68 | **9** | 0.71 | 0.57 | 0.86 |
| MW-06 | Nitrogen/Nitrate | -- | mg/L | 0.037 | <0.02 | -- | <0.02 | -- | 0.04 | 0.06 | <0.02 | <0.02 | 0.04 | 0.06 | 0.02 | <0.1 | <0.1 | 0.16 | <0.1 | <0.1 | <0.1 | 0.11 | <0.1 |
| MW-06 | Nitrogen/Nitrate, Nitrite | -- | mg/L | NR | NR | -- | NR | -- | NR | NR | NR | NR | NR | NR | NR | <0.1 | <0.1 | 0.16 | <0.1 | <0.1 | <0.1 | 0.11 | <0.1 |
| MW-06 | pH | 6.5 - 9.0 | s.u. | 7.67 | 7.97 | -- | 7.62 | -- | 7.61 | 7.35 | 7.68 | 7.59 | 7.73 | 7.68 | **9.30** | 7.23 | 7.37 | 7.55 | 8.21 | 7.45 | 7.73 | 7.60 | 8.05 |
| MW-06 | Selenium | 1 | mg/L | 0.0034 | <0.001 | -- | <0.001 | -- | 0.0025 | 0.0033 | <0.001 | 0.0013 | 0.0023 | <0.005 | 0.003 | 0.003 | <0.0025 | 0.0065 | <0.0025 | <0.0025 | <0.0025 | <0.0025 | <0.0025 |
| MW-06 | Sulfate | 1430 | mg/L | 210 | 250 | -- | 280 | -- | 260 | 170 | 250 | 450 | 340 | 440 | 320 | 360 | 440 | 310 | 410 | 530 | 360 | 380 | 370 |
| MW-06 | Thallium | 0.0037 | mg/L | <NP | <0.001 | -- | <0.001 | -- | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 |
| MW-06 | Total Dissolved Solids | -- | mg/L | 950 | 990 | -- | 1100 | -- | 970 | 1100 | 1100 | 1300 | 1200 | 1200 | 1100 | 1450 | 1200 | 1100 | 1100 | 1400 | 1300 | 1100 | 1100 |
| MW-07 | Arsenic | 0.19 | mg/L | 0.026 | 0.085 | -- | 0.12 | -- | 0.18 | **0.23** | **0.23** | 0.15 | 0.18 | **0.26** | 0.17 | 0.12 | **0.22** | **0.2** | 0.15 | <0.001 | 0.19 | **0.31** | 0.18 |
| MW-07 | Boron | 7.6 | mg/L | 0.61 | 0.44 | -- | 0.43 | -- | 0.38 | 0.34 | 0.35 | 0.41 | 0.36 | 0.41 | 0.47 | 0.52 | 0.41 | 0.46 | 0.37 | 1 | 0.33 | 0.27 | 0.36 |
| MW-07 | Chloride | 500 | mg/L | 170 | 200 | -- | 140 | -- | 130 | 81 | 99 | 130 | 130 | 150 | 160 | 180 | 150 | 160 | 170 | 150 | 160 | 150 | 130 |
| MW-07 | Iron | 1 | mg/L | **9** | **7.5** | -- | **10** | -- | **22** | **26** | **31** | **10** | **21** | **18** | **27** | **15** | **30** | **20** | **17** | 0.15 | **14** | **35** | **23** |
| MW-07 | Lead | 0.0485 | mg/L | 0.039 | <0.001 | -- | 0.0014 | -- | <0.001 | <0.001 | <0.001 | 0.0013 | <0.001 | <0.005 | <0.001 | <0.0005 | <0.0005 | <0.0005 | 0.0011 | <0.0005 | <0.0005 | <0.0005 | 0.0066 |
| MW-07 | Manganese | 3.04 | mg/L | **3.5** | **5.9** | -- | **6.4** | -- | **12** | **12** | **11** | **9.3** | **8** | **6.7** | **9.5** | **5.7** | **11** | **5.9** | **5.8** | 0.33 | **6.6** | **13** | **7** |
| MW-07 | Nitrogen/Nitrate | -- | mg/L | 0.043 | 0.08 | -- | <0.02 | -- | 0.31 | 0.03 | <0.02 | 0.02 | <0.02 | 0.03 | 0.06 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| MW-07 | Nitrogen/Nitrate, Nitrite | -- | mg/L | NR | NR | -- | NR | -- | NR | NR | NR | NR | NR | NR | NR | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| MW-07 | pH | 6.5 - 9.0 | s.u. | NM | 7.04 | -- | 6.78 | -- | 6.83 | **6.45** | 6.79 | 6.91 | 6.93 | 6.97 | 6.87 | 6.69 | 6.68 | 6.82 | 7.20 | 6.67 | 7.00 | 6.94 | 6.90 |
| MW-07 | Selenium | 1 | mg/L | 0.0043 | 0.0026 | -- | 0.0025 | -- | 0.0073 | 0.0054 | 0.0013 | 0.006 | 0.0047 | <0.005 | 0.0031 | 0.0028 | <0.0025 | 0.0056 | <0.0025 | <0.0025 | <0.0025 | <0.0025 | <0.0025 |
| MW-07 | Sulfate | 1430 | mg/L | 120 | 49 | -- | 25 | -- | 9.1 | 3.3 | 3 | 18 | 25 | 43 | 16 | 120 | 42 | 80 | 95 | 52 | 71 | 16 | 50 |
| MW-07 | Thallium | 0.0037 | mg/L | <NP | <0.001 | -- | <0.001 | -- | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 |
| MW-07 | Total Dissolved Solids | -- | mg/L | 860 | 1100 | -- | 1300 | -- | 1300 | 1300 | 1400 | 1300 | 1300 | 1100 | 1200 | 1030 | 1300 | 1200 | 1200 | 1200 | 1300 | 1300 | 1100 |
| MW-08 | Arsenic | 0.19 | mg/L | 0.0052 | 0.0039 | -- | 0.0044 | -- | 0.0036 | 0.0052 | 0.0038 | 0.004 | 0.0041 | 0.0062 | 0.005 | 0.0036 | 0.0041 | 0.0037 | 0.003 | <0.001 | 0.0025 | 0.0022 | 0.0026 |
| MW-08 | Boron | 7.6 | mg/L | 0.93 | 0.72 | -- | 0.64 | -- | 0.82 | 0.82 | 0.57 | 0.57 | 1 | 0.93 | 1.1 | 0.91 | 1.2 | 0.93 | 0.83 | 0.44 | 0.8 | 0.72 | 0.81 |
| MW-08 | Chloride | 500 | mg/L | 180 | 210 | -- | 140 | -- | 210 | 190 | 170 | 200 | 210 | 220 | 200 | 250 | 220 | 260 | 250 | 340 | 360 | 340 | 260 |
| MW-08 | Iron | 1 | mg/L | 0.56 | **2.1** | -- | **1.7** | -- | 0.97 | 0.94 | **2.3** | **1.2** | **1.3** | **2.1** | **6.5** | **2.3** | **6.6** | **1.3** | 0.89 | 0.24 | 0.62 | 0.53 | 0.17 |
| MW-08 | Lead | 0.0485 | mg/L | <NP | <0.001 | -- | <0.001 | -- | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.005 | <0.001 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 |
| MW-08 | Manganese | 3.04 | mg/L | 0.15 | 0.27 | -- | 0.29 | -- | 0.18 | 0.2 | 0.27 | 0.2 | 0.2 | 0.23 | 0.43 | 0.25 | 0.48 | 0.16 | 0.2 | 0.7 | 0.17 | 0.13 | 0.11 |
| MW-08 | Nitrogen/Nitrate | -- | mg/L | <NP | <0.02 | -- | 0.1 | -- | 1.6 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| MW-08 | Nitrogen/Nitrate, Nitrite | -- | mg/L | NR | NR | -- | NR | -- | NR | NR | NR | NR | NR | NR | NR | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| MW-08 | pH | 6.5 - 9.0 | s.u. | 8.24 | 8.17 | -- | 7.66 | -- | 8.24 | 7.87 | 7.97 | 8.20 | 8.23 | 8.09 | 7.72 | 7.81 | 7.39 | 8.16 | 8.46 | 7.72 | 8.12 | 7.89 | 8.62 |
| MW-08 | Selenium | 1 | mg/L | 0.0036 | 0.0013 | -- | <0.001 | -- | 0.0031 | 0.0036 | 0.0018 | 0.0018 | <0.001 | <0.005 | 0.002 | 0.0029 | <0.0025 | 0.0048 | <0.0025 | <0.0025 | <0.0025 | <0.0025 | <0.0025 |
| MW-08 | Sulfate | 1430 | mg/L | 160 | 240 | -- | 140 | -- | 200 | 200 | 300 | 440 | 330 | 360 | 330 | 400 | 380 | 350 | 320 | 300 | 240 | 290 | 160 |
| MW-08 | Thallium | 0.0037 | mg/L | <NP | <0.001 | -- | <0.001 | -- | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 |
| MW-08 | Total Dissolved Solids | -- | mg/L | 890 | 990 | -- | 570 | -- | 940 | 990 | 1200 | 1200 | 1200 | 1200 | 1100 | 1100 | 1100 | 1100 | 1200 | 1400 | 1400 | 1200 | 1100 |

Table B-3-1
Groundwater Analytical Results for Constituents of Interest - December 2010 to February 2015
Midwest Generation -- Powerton Generating Station - Pekin - Tazewell County, Illinois

| Well | Constituent | Effects Value [1] | Units | Groundwater Analytical Results (Year [Month]) | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 2010 [12] | 2011 [02/03] | 2011 [04] | 2011 [06] | 2011 [08] | 2011 [09/10] | 2011 [12] | 2012 [03/04] | 2012 [06] | 2012 [09] | 2012 [12] | 2013 [02] | 2013 [05] | 2013 [07] | 2013 [10] | 2014 [03] [2] | 2014 [05] [3] | 2014 [08] [4] | 2014 [10] | 2015 [02] |
| MW-09 | Arsenic | 0.19 | mg/L | <NP | 0.0018 | -- | 0.0017 | -- | <0.001 | 0.0012 | <0.001 | 0.0017 | <0.001 | <0.003 | 0.0013 | <0.001 | <0.001 | <0.001 | 0.0021 | <0.001 | <0.001 | <0.001 | <0.001 |
| MW-09 | Boron | 7.6 | mg/L | 2.1 | 1.9 | -- | 1.9 | -- | 2.5 | 2.7 | 2.6 | 2.6 | 2.9 | 3.2 | 4.3 | 3.2 | 2.5 | 1.6 | 1.7 | 2.5 | 2.4 | 1.6 | 3 |
| MW-09 | Chloride | 500 | mg/L | 25 | 28 | -- | 28 | -- | 30 | 30 | 30 | 27 | 28 | 31 | 27 | 29 | 31 | 42 | 25 | 34 | 33 | 32 | 34 |
| MW-09 | Iron | 1 | mg/L | <NP | 0.066 | -- | <0.01 | -- | <0.01 | <0.01 | 0.014 | <0.01 | <0.01 | <0.01 | 0.024 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| MW-09 | Lead | 0.0485 | mg/L | <NP | <0.001 | -- | <0.001 | -- | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.003 | <0.001 | <0.0005 | <0.0005 | <0.0005 | 0.00051 | <0.0005 | <0.0005 | <0.0005 | <0.0005 |
| MW-09 | Manganese | 3.04 | mg/L | 0.23 | 0.45 | -- | 0.48 | -- | 0.14 | 0.28 | 0.22 | 0.34 | 0.11 | 0.1 | 0.19 | 0.053 | 0.038 | 0.019 | 0.14 | 0.35 | 0.031 | 0.022 | 0.024 |
| MW-09 | Nitrogen/Nitrate | -- | mg/L | 2.9 | 3.6 | -- | 5.6 | -- | 3.7 | 2.0 | 5 | 2.8 | 4.3 | 10 | 12 | 11 | 7.9 | 4.6 | 3.2 | 11 | 1.6 | 5.9 | 13 |
| MW-09 | Nitrogen/Nitrate, Nitrite | -- | mg/L | NR | NR | -- | NR | -- | NR | NR | NR | NR | NR | NR | NR | 11 | 7.9 | 4.6 | 3.2 | 11 | 1.6 | 5.9 | 13 |
| MW-09 | pH | 6.5 - 9.0 | s.u. | 7.22 | 7.34 | -- | 7.10 | -- | 7.32 | **6.31** | 7.28 | 7.30 | 7.18 | 7.10 | 8.00 | 7.21 | 6.63 | 7.19 | 7.53 | 6.99 | 7.09 | 7.29 | 7.53 |
| MW-09 | Selenium | 1 | mg/L | 0.0024 | 0.0072 | -- | 0.0017 | -- | 0.0043 | 0.0041 | 0.0072 | 0.0047 | 0.0044 | 0.009 | 0.015 | 0.016 | 0.014 | 0.0047 | 0.003 | 0.0074 | 0.0061 | 0.0084 | 0.0091 |
| MW-09 | Sulfate | 1430 | mg/L | 110 | 110 | -- | 110 | -- | 130 | 110 | 120 | 130 | 120 | 130 | 140 | 140 | 130 | 90 | 110 | 110 | 100 | 160 | 110 |
| MW-09 | Thallium | 0.0037 | mg/L | <NP | <0.001 | -- | <0.001 | -- | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 |
| MW-09 | Total Dissolved Solids | -- | mg/L | 500 | 510 | -- | 540 | -- | 500 | 520 | 530 | 520 | 580 | 560 | 520 | 600 | 610 | 430 | 560 | 540 | 490 | 630 | 570 |
| MW-10 | Arsenic | 0.19 | mg/L | <NP | <0.001 | -- | 0.0015 | -- | <0.001 | <0.001 | <0.001 | 0.0015 | 0.0014 | <0.005 | 0.001 | 0.0012 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| MW-10 | Boron | 7.6 | mg/L | 0.48 | 0.48 | -- | 0.52 | -- | 0.42 | 0.57 | 0.54 | 0.54 | 0.42 | 0.46 | 0.64 | 0.98 | 1.9 | 0.61 | 2.1 | 1.2 | 1.9 | 0.84 | 0.83 |
| MW-10 | Chloride | 500 | mg/L | 40 | 43 | -- | 43 | -- | 49 | 42 | 45 | 46 | 45 | 45 | 37 | 41 | 40 | 54 | 40 | 37 | 57 | 62 | 22 |
| MW-10 | Iron | 1 | mg/L | <NP | <0.01 | -- | 0.044 | -- | <0.01 | <0.01 | <0.01 | 0.015 | 0.012 | 0.016 | <0.01 | **2.7** | <0.1 | 0.18 | 0.19 | 0.11 | 0.14 | <0.1 | 0.22 |
| MW-10 | Lead | 0.0485 | mg/L | <NP | <0.001 | -- | <0.001 | -- | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.005 | <0.001 | 0.012 | <0.0005 | <0.0005 | 0.0008 | <0.0005 | <0.0005 | <0.0005 | <0.0005 |
| MW-10 | Manganese | 3.04 | mg/L | 2.1 | 2.8 | -- | **3.8** | -- | 2.3 | 2.3 | 2.3 | 2.6 | 2.5 | 2.2 | 1.9 | **3.2** | 1.3 | 2 | **3.1** | 1.6 | 2.1 | 1.1 | 1.3 |
| MW-10 | Nitrogen/Nitrate | -- | mg/L | 3 | 4 | -- | 2.1 | -- | 4.5 | 4.9 | 6 | 2.5 | 5.2 | 4.8 | 3.3 | 1.9 | 1.5 | 1.2 | 2 | 2.1 | 0.41 | 0.67 | 0.9 |
| MW-10 | Nitrogen/Nitrate, Nitrite | -- | mg/L | NR | NR | -- | NR | -- | NR | NR | NR | NR | NR | NR | NR | 1.9 | 1.6 | 1.2 | 2 | 2.1 | 0.43 | 0.71 | 0.94 |
| MW-10 | pH | 6.5 - 9.0 | s.u. | 7.04 | 7.01 | -- | 6.88 | -- | 7.04 | **6.03** | 7.03 | 6.95 | 6.96 | 7.05 | 8.39 | 6.87 | 6.85 | 7.02 | 7.90 | 7.09 | 6.74 | 7.16 | 7.36 |
| MW-10 | Selenium | 1 | mg/L | 0.0042 | 0.0064 | -- | 0.0043 | -- | 0.0057 | 0.0065 | 0.0056 | 0.0056 | 0.0058 | 0.0074 | 0.0083 | 0.0043 | 0.0037 | 0.008 | <0.0025 | 0.0073 | 0.0057 | 0.0048 | 0.0028 |
| MW-10 | Sulfate | 1430 | mg/L | 62 | 64 | -- | 67 | -- | 64 | 72 | 76 | 63 | 58 | 59 | 69 | 92 | 150 | 90 | 160 | 140 | 110 | 95 | 46 |
| MW-10 | Thallium | 0.0037 | mg/L | <NP | <0.001 | -- | <0.001 | -- | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 |
| MW-10 | Total Dissolved Solids | -- | mg/L | 530 | 520 | -- | 650 | -- | 470 | 540 | 530 | 550 | 580 | 420 | 440 | 580 | 750 | 620 | 670 | 630 | 590 | 550 | 530 |
| MW-11 | Arsenic | 0.19 | mg/L | 0.0021 | 0.0025 | -- | 0.0019 | -- | 0.0016 | 0.0019 | 0.0021 | 0.0032 | 0.0035 | 0.03 | 0.045 | 0.023 | 0.038 | 0.038 | 0.037 | 0.036 | 0.068 | 0.045 | 0.022 |
| MW-11 | Boron | 7.6 | mg/L | 1.6 | 1.8 | -- | 1.6 | -- | 1.5 | 1.8 | 2.3 | 1.9 | 2.6 | <2 | 1.4 | 1.3 | 1.5 | 1.2 | 1.1 | 1.4 | 0.97 | 0.89 | 1.7 |
| MW-11 | Chloride | 500 | mg/L | 70 | 66 | -- | 120 | -- | 53 | 87 | 54 | 150 | 52 | 83 | 84 | 79 | 110 | 79 | 67 | 70 | 120 | 91 | 66 |
| MW-11 | Iron | 1 | mg/L | 0.44 | 0.01 | -- | 0.029 | -- | 0.018 | <0.01 | <0.01 | 0.056 | **2** | 0.7 | **2.4** | **3.1** | **3.9** | **3.3** | **5.8** | **3.8** | **5.5** | **5** | **2** |
| MW-11 | Lead | 0.0485 | mg/L | <NP | <NP | -- | <0.001 | -- | <0.001 | <0.001 | <0.001 | <0.001 | 0.0023 | <0.003 | <0.001 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 |
| MW-11 | Manganese | 3.04 | mg/L | **3.2** | **3.6** | -- | 2.9 | -- | 2.3 | 2.5 | 2.9 | **3.7** | **4.7** | **12** | **11** | **7.5** | **8** | **7.3** | **7.9** | **8** | **8.4** | **6.6** | **5.5** |
| MW-11 | Nitrogen/Nitrate | -- | mg/L | 0.41 | 0.17 | -- | 0.04 | -- | 0.74 | 1.5 | 0.39 | <0.02 | 4.6 | 0.39 | 0.33 | 1.1 | <0.1 | 0.18 | 0.34 | 0.27 | <0.1 | <0.1 | <0.1 |
| MW-11 | Nitrogen/Nitrate, Nitrite | -- | mg/L | NR | NR | -- | NR | -- | NR | NR | NR | NR | NR | NR | NR | 1.1 | <0.1 | 0.18 | 0.34 | 0.27 | <0.1 | <0.1 | <0.1 |
| MW-11 | pH | 6.5 - 9.0 | s.u. | 7.88 | 7.19 | -- | 7.02 | -- | 7.31 | **6.48** | 7.32 | 7.15 | 7.30 | 7.28 | 8.27 | 6.99 | 7.08 | 7.23 | 8.00 | 7.10 | 7.12 | 7.37 | 7.53 |
| MW-11 | Selenium | 1 | mg/L | 0.0026 | 0.0015 | -- | 0.0018 | -- | 0.004 | 0.0031 | 0.0039 | 0.0039 | 0.004 | <0.005 | 0.0014 | <0.0025 | <0.0025 | <0.0025 | <0.0025 | <0.0025 | <0.0025 | <0.0025 | <0.0025 |
| MW-11 | Sulfate | 1430 | mg/L | 170 | 160 | -- | 210 | -- | 140 | 160 | 130 | 320 | 170 | 200 | 150 | 240 | 280 | 180 | 210 | 170 | 200 | 200 | 120 |
| MW-11 | Thallium | 0.0037 | mg/L | <NP | <NP | -- | <0.001 | -- | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 |
| MW-11 | Total Dissolved Solids | -- | mg/L | 740 | 710 | -- | 930 | -- | 620 | 730 | 740 | 1000 | 760 | 970 | 840 | 850 | 990 | 770 | 760 | 660 | 860 | 790 | 700 |
| MW-12 | Arsenic | 0.19 | mg/L | 0.0088 | 0.013 | -- | 0.0064 | -- | 0.0087 | 0.0089 | 0.0042 | 0.014 | 0.011 | 0.022 | 0.0066 | 0.0031 | 0.016 | 0.018 | 0.0025 | 0.0017 | 0.0021 | 0.0019 | <0.001 |
| MW-12 | Boron | 7.6 | mg/L | 1.6 | 1.4 | -- | 1.3 | -- | 1.2 | 1.3 | 0.92 | 1.2 | 1.1 | 0.85 | 1.1 | 3.7 | 1.1 | 1.1 | 0.41 | 0.69 | 0.73 | 0.59 | 0.58 |
| MW-12 | Chloride | 500 | mg/L | 170 | 180 | -- | 180 | -- | 190 | 210 | 170 | 190 | 170 | 210 | 190 | 200 | 190 | 180 | 220 | 220 | 210 | 200 | 210 |
| MW-12 | Iron | 1 | mg/L | **5.5** | **6.3** | -- | **5.6** | -- | **4** | **3.1** | **4.8** | **9.2** | **8.9** | **6.4** | **5.8** | **8.9** | **4.5** | 0.23 | **2.4** | 0.39 | 0.17 | 0.33 | **1.7** |
| MW-12 | Lead | 0.0485 | mg/L | <NP | <NP | -- | <0.001 | -- | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.003 | <0.001 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | **0.17** |
| MW-12 | Manganese | 3.04 | mg/L | 0.32 | 0.58 | -- | 0.26 | -- | 0.37 | 0.25 | 0.13 | 0.71 | 0.64 | 1.7 | 0.38 | 0.24 | 1.3 | 1.3 | 0.23 | 0.65 | 1.2 | 1.2 | 0.17 |
| MW-12 | Nitrogen/Nitrate | -- | mg/L | <NP | <NP | -- | 0.14 | -- | <0.02 | <0.02 | 0.04 | <0.2 | 0.03 | <0.02 | <0.02 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| MW-12 | Nitrogen/Nitrate, Nitrite | -- | mg/L | NR | NR | -- | NR | -- | NR | NR | NR | NR | NR | NR | NR | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| MW-12 | pH | 6.5 - 9.0 | s.u. | 7.65 | 7.51 | -- | 6.98 | -- | 7.60 | 7.38 | 7.22 | 7.40 | 7.30 | 7.37 | 8.36 | 7.17 | 7.29 | 7.73 | 7.99 | 7.14 | 7.37 | 7.33 | 7.61 |
| MW-12 | Selenium | 1 | mg/L | 0.0026 | 0.0027 | -- | <0.001 | -- | 0.0023 | 0.0034 | 0.0043 | 0.0038 | 0.0016 | <0.005 | 0.002 | <0.0025 | <0.0025 | <0.0025 | <0.0025 | <0.0025 | <0.0025 | <0.0025 | <0.0025 |
| MW-12 | Sulfate | 1430 | mg/L | 290 | 270 | -- | 350 | -- | 360 | 300 | 310 | 430 | 370 | 300 | 350 | 410 | 420 | 270 | 330 | 360 | 310 | 420 | 450 |
| MW-12 | Thallium | 0.0037 | mg/L | <NP | <NP | -- | <0.001 | -- | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 |
| MW-12 | Total Dissolved Solids | -- | mg/L | 980 | 1000 | -- | 1100 | -- | 970 | 970 | 1000 | 1200 | 1200 | 1100 | 1000 | 1200 | 1200 | 1000 | 1400 | 1300 | 1100 | 1000 | 1300 |

Table 6-3-1
Groundwater Analytical Results for Constituents of Interest, December 2010 to February 2015
Midwest Generation -- Powerton Generating Station - Pekin, Tazewell County, Illinois

| Well | Constituent | Effects Value [2] | Units | Groundwater Analytical Results (Year [Month]) | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 2010 [12] | 2011 [02/03] | 2011 [04] | 2011 [06] | 2011 [08] | 2011 [09/10] | 2011 [12] | 2012 [03/04] | 2012 [06] | 2012 [09] | 2012 [12] | 2013 [02] | 2013 [05] | 2013 [07] | 2013 [10] | 2014 [03] [3] | 2014 [05] [3] | 2014 [08] [4] | 2014 [10] | 2015 [02] |
| MW-13 | Arsenic | 0.19 | mg/L | 0.011 | 0.0069 | 0.0063 | 0.0057 | 0.0048 | 0.0066 | 0.023 | 0.027 | -- | -- | 0.041 | 0.029 | 0.031 | 0.029 | 0.024 | 0.028 | 0.024 | 0.031 | 0.028 | 0.028 |
| MW-13 | Boron | 7.6 | mg/L | 3.9 | 3.1 | 2.6 | 3 | 2.7 | 3 | 4.1 | 4 | -- | -- | 3.6 | 4.2 | 1.6 | 3.8 | 3.5 | 2.9 | 3.5 | 3 | 2.2 | 3.5 |
| MW-13 | Chloride | 500 | mg/L | 160 | 120 | 100 | 86 | 110 | 110 | 180 | 170 | -- | -- | 210 | 170 | 191 | 190 | 180 | 190 | 180 | 190 | 180 | 180 |
| MW-13 | Iron | | mg/L | 0.69 | 0.052 | 0.077 | <0.01 | 0.043 | <0.01 | 0.11 | 0.2 | -- | -- | 0.066 | 0.28 | **1.3** | **1.6** | 0.29 | **1.8** | 0.74 | 0.63 | 0.98 | 0.69 |
| MW-13 | Lead | 0.0485 | mg/L | <NP | <NP | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | -- | -- | <0.005 | <0.00 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 |
| MW-13 | Manganese | 3.34 | mg/L | **5** | **3.8** | 2.7 | 2.9 | 2.6 | **3.6** | **3.5** | **3.5** | -- | -- | **3.7** | **3.5** | **3.9** | **4** | 2.8 | 2.9 | **3.4** | **3.5** | **3.8** | **3.8** |
| MW-13 | Nitrogen/Nitrate | -- | mg/L | 0.14 | 1.3 | 1.8 | 2.2 | 3.0 | 1.6 | 0.07 | 0.06 | -- | -- | <0.02 | <0.02 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| MW-13 | Nitrogen/Nitrate, Nitrite | -- | mg/L | NR | NR | NR | NR | NR | NR | NR | NR | -- | -- | NR | NR | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| MW-13 | pH | 6.5 - 9.0 | s.u. | 7.68 | 7.53 | 7.26 | 6.75 | 7.13 | 7.31 | 7.19 | 8.49 | -- | -- | 7.92 | 8.20 | 7.65 | 7.61 | 7.81 | 8.67 | 7.71 | 7.82 | 7.72 | 8.23 |
| MW-13 | Selenium | 1 | mg/L | 0.0046 | 0.0046 | 0.0045 | 0.0029 | 0.0056 | 0.004 | 0.0036 | 0.0037 | -- | -- | <0.005 | 0.0025 | 0.01 | 0.0095 | <0.0025 | <0.0025 | <0.0025 | 0.0047 | 0.0045 | <0.0025 |
| MW-13 | Sulfate | 1430 | mg/L | 1400 | 770 | 580 | 540 | 440 | 660 | 1100 | 1100 | -- | -- | 1100 | 730 | 880 | 1000 | 690 | 660 | 630 | 740 | 1400 | 1000 |
| MW-13 | Thallium | 0.037 | mg/L | <NP | <NP | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | -- | -- | <0.001 | <0.00 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 |
| MW-13 | Total Dissolved Solids | -- | mg/L | 2600 | 1600 | 1400 | 1300 | 1100 | 1500 | 2100 | 2300 | -- | -- | 1900 | 1600 | 2000 | 2000 | 1700 | 1900 | 2100 | 2300 | 2200 | 2300 |
| MW-14 | Arsenic | 0.19 | mg/L | 0.024 | 0.019 | 0.0084 | 0.005 | 0.0062 | 0.015 | 0.0033 | 0.0039 | -- | -- | 0.0053 | 0.0066 | 0.0023 | 0.0016 | <0.001 | 0.0016 | 0.0011 | 0.0032 | 0.0063 | 0.0011 |
| MW-14 | Boron | 7.6 | mg/L | 2 | 1.9 | 1.9 | 1.9 | 1.8 | 1.9 | 1.9 | 1.8 | -- | -- | <2 | 1.9 | 1.7 | 1.7 | 2 | 1.6 | 1.8 | 1.9 | 2.2 | 2.2 |
| MW-14 | Chloride | 500 | mg/L | 160 | 160 | 160 | 160 | 240 | 200 | 200 | 190 | -- | -- | 190 | 92 | 163 | 150 | 190 | 220 | 140 | 190 | 180 | 180 |
| MW-14 | Iron | | mg/L | **2.2** | 0.94 | 0.36 | 0.3 | 0.71 | **2** | 0.12 | 0.77 | -- | -- | 0.012 | 0.02 | <0.1 | <0.1 | 0.39 | **1.2** | 0.6 | 4.6 | 5.3 | **0.17** |
| MW-14 | Lead | 0.0485 | mg/L | <NP | <NP | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | 0.0035 | -- | -- | <0.005 | <0.00 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | 0.00078 | <0.0005 |
| MW-14 | Manganese | 3.34 | mg/L | 0.68 | 0.81 | 0.29 | 0.36 | 0.57 | 0.84 | 0.067 | 0.63 | -- | -- | 0.11 | 0.12 | 0.72 | 0.32 | 1.2 | 1.3 | 0.34 | 1.8 | 1.5 | 0.15 |
| MW-14 | Nitrogen/Nitrate | -- | mg/L | 0.036 | <NP | 1 | 0.27 | 0.05 | <0.02 | 0.33 | 0.31 | -- | -- | 0.32 | 3.5 | <0.1 | <0.1 | 0.16 | <0.1 | 0.22 | <0.1 | <0.1 | 0.24 |
| MW-14 | Nitrogen/Nitrate, Nitrite | -- | mg/L | NR | NR | NR | NR | NR | NR | NR | NR | -- | -- | NR | NR | <0.1 | <0.1 | 0.18 | <0.1 | 0.22 | <0.1 | <0.1 | 0.24 |
| MW-14 | pH | 6.5 - 9.0 | s.u. | 7.55 | 7.75 | 7.27 | 7.15 | 7.08 | 7.40 | **6.05** | 8.35 | -- | -- | 7.13 | 8.21 | 7.03 | 6.93 | 7.11 | 7.72 | 6.99 | 7.17 | 7.31 | 7.28 |
| MW-14 | Selenium | 1 | mg/L | 0.0024 | 0.0015 | 0.065 | 0.0035 | 0.003 | 0.0017 | 0.0037 | 0.022 | -- | -- | 0.0055 | 0.15 | <0.0025 | <0.0025 | <0.0025 | 0.02 | 0.014 | <0.0025 | <0.0025 | 0.023 |
| MW-14 | Sulfate | 1430 | mg/L | 960 | 820 | 770 | 810 | 940 | 850 | 880 | 990 | -- | -- | 810 | 390 | 800 | 900 | 840 | 680 | 720 | 1100 | 1300 | 850 |
| MW-14 | Thallium | 0.037 | mg/L | 0.0019 | 0.0018 | 0.0035 | **0.0039** | 0.0027 | 0.0016 | 0.0016 | 0.0034 | -- | -- | 0.0025 | **0.0043** | 0.0025 | **0.0043** | 0.0022 | 0.0023 | 0.0026 | 0.0023 | <0.002 | <0.002 |
| MW-14 | Total Dissolved Solids | -- | mg/L | 1800 | 1700 | 1800 | 1500 | 2000 | 1800 | 1800 | 2200 | -- | -- | 1700 | 1300 | 2000 | 2100 | 2100 | 1900 | 1700 | 2000 | 2200 | 2300 |
| MW-15 | Arsenic | 0.19 | mg/L | 0.0099 | 0.0092 | 0.0064 | 0.0052 | 0.0051 | 0.011 | 0.0097 | 0.0061 | -- | -- | 0.011 | 0.0078 | 0.0037 | 0.0046 | 0.0066 | 0.0072 | 0.0019 | 0.0029 | 0.0059 | 0.0017 |
| MW-15 | Boron | 7.6 | mg/L | 1.6 | 1.4 | 1.5 | 1.6 | 1.3 | 1.2 | 1.2 | 1.4 | -- | -- | <2 | 1.7 | 1.5 | 1.6 | 1.2 | 1.1 | 1.2 | 0.95 | 0.74 | 1.1 |
| MW-15 | Chloride | 500 | mg/L | 180 | 190 | 190 | 170 | 210 | 180 | 200 | 200 | -- | -- | 220 | 200 | 210 | 220 | 210 | 240 | 220 | 240 | 230 | 240 |
| MW-15 | Iron | | mg/L | **3.3** | **2.4** | **2.1** | 0.7 | **2.1** | **2.6** | **2.1** | **1.1** | -- | -- | **1.9** | **1.5** | 0.83 | **1.3** | **1.1** | **2** | 0.37 | 0.78 | **2.1** | **0.28** |
| MW-15 | Lead | 0.0485 | mg/L | <NP | <NP | 0.0012 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | -- | -- | <0.005 | <0.00 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 |
| MW-15 | Manganese | 3.34 | mg/L | 0.56 | 0.43 | 0.36 | 0.6 | 0.37 | 0.48 | 0.39 | 0.25 | -- | -- | 0.51 | 0.35 | 0.27 | 0.3 | 0.43 | 0.59 | 0.2 | 0.95 | 0.87 | 0.6 |
| MW-15 | Nitrogen/Nitrate | -- | mg/L | 0.08 | 0.066 | 0.14 | 0.07 | 0.05 | <0.02 | 0.07 | 0.12 | -- | -- | 0.12 | 0.02 | <0.1 | <0.1 | 0.22 | <0.1 | 0.6 | <0.1 | <0.1 | 0.16 |
| MW-15 | Nitrogen/Nitrate, Nitrite | -- | mg/L | NR | NR | NR | NR | NR | NR | NR | NR | -- | -- | NR | NR | <0.1 | <0.1 | 0.22 | <0.1 | 0.6 | <0.1 | <0.1 | 0.16 |
| MW-15 | pH | 6.5 - 9.0 | s.u. | 7.43 | 7.23 | 7.06 | 6.79 | 6.89 | 7.37 | 6.84 | 8.23 | -- | -- | 7.30 | 8.09 | 6.71 | 6.93 | 7.18 | 7.73 | 6.99 | 7.05 | 7.30 | 7.53 |
| MW-15 | Selenium | 1 | mg/L | 0.0042 | 0.0079 | 0.017 | 0.004 | 0.002 | 0.004 | 0.0047 | 0.025 | -- | -- | <0.005 | 0.0024 | 0.0065 | <0.0025 | 0.013 | <0.0025 | 0.033 | <0.0025 | 0.003 | 0.008 |
| MW-15 | Sulfate | 1430 | mg/L | 300 | 220 | 270 | 650 | 250 | 180 | 140 | 200 | -- | -- | 320 | 280 | 370 | 460 | 420 | 260 | 390 | 620 | 600 | 460 |
| MW-15 | Thallium | 0.037 | mg/L | <NP | <NP | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | -- | -- | <0.001 | <0.00 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 |
| MW-15 | Total Dissolved Solids | -- | mg/L | 1000 | 1000 | 1100 | 1000 | 1000 | 890 | 840 | 1000 | -- | -- | 1100 | 1100 | 1700 | 1400 | 1400 | 1300 | 1300 | 1800 | 1600 | 1400 |
| MW-16 | Arsenic | 0.19 | mg/L | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | <0.005 | <0.00 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| MW-16 | Boron | 7.6 | mg/L | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | <0.2 | 0.13 | 0.2 | 0.26 | 0.35 | 0.17 | 0.17 | 0.15 | 0.14 | 0.17 |
| MW-16 | Chloride | 500 | mg/L | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 26 | 18 | 19 | 21 | 35 | 230 | 20 | 25 | 24 | 24 |
| MW-16 | Iron | | mg/L | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 0.012 | 0.019 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| MW-16 | Lead | 0.0485 | mg/L | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | <0.005 | <0.00 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 |
| MW-16 | Manganese | 3.34 | mg/L | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 0.022 | 0.0053 | <0.0025 | <0.0025 | <0.0025 | 0.0035 | <0.0025 | <0.0025 | <0.0025 | 0.0025 |
| MW-16 | Nitrogen/Nitrate | -- | mg/L | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 18 | 23 | 20 | 3 | 19 | 16 | 21 | 22 | 28 | 28 |
| MW-16 | Nitrogen/Nitrate, Nitrite | -- | mg/L | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | NR | NR | 20 | 3 | 19 | 16 | 21 | 22 | 28 | 28 |
| MW-16 | pH | 6.5 - 9.0 | s.u. | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 7.38 | 8.31 | 7.10 | 7.18 | 7.27 | 7.85 | 7.20 | 7.41 | 7.30 | 7.55 |
| MW-16 | Selenium | 1 | mg/L | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | <0.005 | 0.0015 | <0.0025 | <0.0025 | <0.0025 | <0.0025 | <0.0025 | <0.0025 | <0.0025 | <0.0025 |
| MW-16 | Sulfate | 1430 | mg/L | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 37 | 31 | 58 | 55 | 55 | 34 | 40 | 35 | 51 | 27 |
| MW-16 | Thallium | 0.037 | mg/L | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | <0.001 | <0.00 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 |
| MW-16 | Total Dissolved Solids | -- | mg/L | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 520 | 420 | 460 | 440 | 540 | 800 | 390 | 440 | 510 | 490 |

Table B-3-1
Groundwater Analytical Results for Constituents of Interest, December 2010 to February 2015
Midwest Generation – Powerton Generating Station - Pekin, Tazewell County, Illinois

| Well | Constituent | Effects Value [1] | Units | Groundwater Analytical Results (Year [Month]) | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 2010 (12) | 2011 (02/03) | 2011 (04) | 2011 (06) | 2011 (08) | 2011 (09/10) | 2011 (12) | 2012 (03/04) | 2012 (06) | 2012 (09) | 2012 (12) | 2013 (02) | 2013 (05) | 2013 (07) | 2013 (10) | 2014 (03) [2] | 2014 (05) [3] | 2014 (08) [4] | 2014 (10) | 2015 (02) |

Notes
(1) Illinois General Use Water Quality Standards (WQS) and Illinois Water Quality Criteria (WQC) are used as surface water effects values
(2) The manganese result for March 2014 for MW-07 was qualified as "E" by the laboratory. A qualifier definition was not identified.
(3) The total dissolved solids result for May 2014 for MW-12 was qualified as "H" by the laboratory. A qualifier definition was not identified
(4) Chloride results for August 2014 for wells MW-02, MW-06, MW-07, and MW-12 were qualified as "^" by the laboratory, which denotes instrument-related QC exceeds the control limits

mg/L = milligrams per liter
s.u. = standard units
"--" = value was not available
"<" = constituent was not detected; the reporting limit is presented.
bold/shading = concentration exceeds effects value

Table B-3-2
Comparison Of Average Groundwater Analytical Results To Surface Water Effects Values
Midwest Generation – Powerton Generating Station - Pekin, Tazewell County, Illinois

| Constituent | Units | Effects Value (1) | Groundwater Analytical Results - Average Concentrations (2) | | | | | | | | | | | | | | | | Average (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Gravelly Sand Unit (4) | | | | | | | | | | | Silt/Clay Unit (4) | | | | | |
| | | | MW-01 | MW-02 | MW-03 | MW-04 | MW-05 | MW-07 | MW-09 | MW-10 | MW-11 | MW-13 | MW-16 | MW-06 | MW-08 | MW-12 | MW-14 | MW-15 | |
| Arsenic | mg/L | 0.19 | 0.00061 | 0.00099 | 0.00104 | 0.00062 | 0.00067 | 0.167 | 0.00096 | 0.00081 | 0.0237 | 0.0214 | 0.0014 U | 0.0135 | 0.00376 | 0.0083 | 0.00647 | 0.00643 | 0.0161 |
| Boron | mg/L | 7.6 | 0.579 | 0.637 | 0.438 | 0.767 | 0.735 | 0.442 | 2.51 | 0.968 | 1.53 | 3.23 | 0.184 | 0.489 | 0.819 | 1.16 | 1.84 | 1.29 | 1.1 |
| Chloride | mg/L | 500 | 56.2 | 55.2 | 60.7 | 88.2 | 123 | 147 | 30.3 | 43.8 | 83.4 | 161 | 44.2 | 191 | 233 | 194 | 176 | 208 | 119 |
| Iron | mg/L | 1 | 0.055 | 0.0282 | 0.0293 | 0.0359 | 0.0773 | **18.4** | 0.0297 | 0.22 | **2.11** | 0.531 | 0.0431 | **2.72** | **1.8** | **4.29** | **1.1** | **1.59** | **2.08** |
| Lead | mg/L | 0.0485 | 0.0005 | 0.00053 | 0.00051 | 0.001 U | 0.001 U | 0.00313 | 0.00049 | 0.00116 | 0.00054 | 0.001 U | 0.001 U | 0.0065 | 0.001 U | 0.00088 | 0.00064 | 0.00048 | 0.0013 |
| Manganese | mg/L | 3.04 | 0.0035 | 0.00187 | 0.00423 | 0.31 | 0.381 | **7.56** | 0.218 | 2.26 | **5.99** | **3.49** | 0.00408 | 1.1 | 0.257 | 0.657 | 0.645 | 0.467 | 1.47 |
| Nitrogen/Nitrate | mg/L | – | 4.9 | 3.75 | 2.09 | 0.561 | 0.358 | 0.0557 | 6.37 | 2.85 | 0.593 | 0.622 | 20.8 | 0.0482 | 0.121 | 0.0417 | 0.372 | 0.0926 | 2.73 |
| Nitrogen/Nitrate, Nitrite | mg/L | – | 2.76 | 2.38 | 1.58 | 0.149 | 0.558 | 0.1 U | 7.28 | 1.36 | 0.261 | 0.1 U | 20.9 | 0.0713 | 0.1 U | 0.1 U | 0.111 | 0.13 | 2.36 |
| pH | s.u. | 6.5 - 9.0 | 7.33 | 7.44 | 7.38 | 7.21 | 7.13 | 6.85 | 7.2 | 7.08 | 7.31 | 7.71 | 7.46 | 7.74 | 8.03 | 7.48 | 7.3 | 7.28 | 7.4 |
| Selenium | mg/L | 1 | 0.00256 | 0.00194 | 0.00222 | 0.00304 | 0.00213 | 0.00309 | 0.00715 | 0.0057 | 0.00215 | 0.00401 | 0.0014 | 0.00193 | 0.00199 | 0.00198 | 0.0179 | 0.0112 | 0.0044 |
| Sulfate | mg/L | 1430 | 87.2 | 75.3 | 68.1 | 160 | 194 | 47.6 | 121 | 85.4 | 189 | 857 | 41.8 | 348 | 289 | 372 | 856 | 369 | 260 |
| Thallium | mg/L | 0.0037 | 0.00147 U | 0.00147 U | 0.00147 U | 0.00147 U | 0.00147 U | 0.00147 U | 0.00147 U | 0.00147 U | 0.0015 U | 0.0015 U | 0.0018 U | 0.00147 U | 0.00147 U | 0.0015 U | 0.00252 | 0.0013 U | 0.000861 |
| Total Dissolved Solids | mg/L | – | 548 | 482 | 456 | 701 | 806 | 1210 | 539 | 553 | 801 | 1880 | 501 | 1150 | 1160 | 1110 | 1920 | 1250 | 942 |

Notes
(1) Illinois General Use Water Quality Standards (WQS) and Illinois Water Quality Criteria (WQC) are used as surface water effects values.
(2) Average of concentrations reported between December 2010 and February 2015. If a constituent was not detected during this timeframe, the average reporting limit is presented in the table, indicated with a "U" qualifier. Otherwise, non-detect results were included in the average calculation assuming one-half the reporting limit.
(3) Average of concentrations (averages) presented in the table, assuming one-half the reporting limit for non-detect results.
(4) Groundwater in the gravelly sand unit flows in a northerly direction. Groundwater in the localized silt/clay units flows in a westerly direction. Summary statistics do not distinguish between these two units.

mg/L = milligram per liter
s.u. = standard units
"–" = value not available
U = constituent not detected above its reporting limit
bold/shading = concentration exceeds effects value

Table B-3-3
Comparison Of Maximum Groundwater Analytical Results To Surface Water Effects Values
Midwest Generation – Powerton Generating Station - Pekin Tazewell County Illinois

| Constituent | Units | Effects Value (1) | Groundwater Analytical Results - Maximum Concentrations (2) | | | | | | | | | | | | | | | | | Average (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Gravelly Sand Unit (4) | | | | | | | | | | | Silt/Clay Unit (4) | | | | | | |
| | | | MW-01 | MW-02 | MW-03 | MW-04 | MW-05 | MW-07 | MW-09 | MW-10 | MW-11 | MW-13 | MW-16 | MW-06 | MW-08 | MW-12 | MW-14 | MW-15 | |
| Arsenic | mg/L | 0.19 | 0.001 | 0.0018 | 0.0017 | 0.0012 | 0.0011 | **0.31** | 0.0021 | 0.0015 | 0.068 | 0.041 | 0.005 U | **0.2** | 0.0062 | 0.022 | 0.024 | 0.011 | 0.0434 |
| Boron | mg/L | 7.6 | 1.8 | 2.7 | 0.75 | 1 | 1.1 | 1 | 4.3 | 3.2 | 3.6 | 4.2 | 0.35 | 1 | 1.2 | 3.7 | 2.2 | 1.7 | 2.05 |
| Chloride | mg/L | 500 | 160 | 91 | 120 | 150 | 170 | 200 | 42 | 62 | 150 | 210 | 230 | 240 | 380 | 220 | 240 | 240 | 182 |
| Iron | mg/L | 1 | 0.43 | 0.046 | 0.042 | 0.14 | 0.43 | **35** | 0.066 | **2.7** | **5.8** | **1.8** | 0.019 | **22** | **6.6** | **8.9** | **5.3** | **3.3** | 5.79 |
| Lead | mg/L | 0.0485 | 0.0008 | 0.0013 | 0.00097 | 0.005 U | 0.005 U | 0.039 | 0.00051 | 0.012 | 0.0023 | 0.005 U | 0.005 U | 0.00082 | 0.005 U | **0.17** | 0.0035 | 0.0012 | 0.0153 |
| Manganese | mg/L | 3.04 | 0.027 | 0.0063 | 0.034 | 1.018 | 1 | **13** | 0.84 | **3.8** | **12** | **5** | 0.022 | **8** | 0.7 | 1.7 | 1.8 | 0.95 | 3.12 |
| Nitrogen/Nitrate | mg/L | -- | 11 | 7.5 | 9.4 | 2.7 | 2.2 | 0.31 | 13 | 6 | 4.6 | 3.6 | 28 | 0.16 | 1.6 | 0.14 | 3.5 | 0.4 | 5.88 |
| Nitrogen/Nitrate Nitrite | mg/L | -- | 4.7 | 5.9 | 5.3 | 0.5 | 2.2 | 0.1 U | 13 | 2.1 | 1.1 | 0.1 U | 28 | 0.16 | 0.1 U | 0.1 U | 0.24 | 0.4 | 3.99 |
| pH | s.u. | 6.5 - 9.0 | **6.39-9.53** | **6.41-8.21** | 6.58-8.34 | **6.37-8** | **6.34-8.01** | **6.45-7.2** | **6.31-8** | **6.03-8.39** | **6.48-8.27** | 6.75-8.67 | 7.1-8.31 | **7.23-9.3** | 7.39-8.46 | 6.98-8.36 | **6.05-8.35** | 6.71-8.23 | 6.6-8.35 |
| Selenium | mg/L | 1 | 0.005 | 0.0039 | 0.0067 | 0.013 | 0.0045 | 0.0073 | 0.016 | 0.0087 | 0.004 | 0.01 | 0.0015 | 0.0065 | 0.0048 | 0.0043 | 0.15 | 0.068 | 0.0196 |
| Sulfate | mg/L | 1430 | 330 | 190 | 100 | 390 | 310 | 120 | 160 | 160 | 320 | 1400 | 55 | 560 | 460 | 560 | 1300 | 660 | 442 |
| Thallium | mg/L | 0.0037 | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | **0.0043** | 0.002 U | 0.00121 |
| Total Dissolved Solids | mg/L | -- | 870 | 770 | 520 | 1100 | 1100 | 1400 | 630 | 670 | 1000 | 2600 | 800 | 1400 | 1400 | 1400 | 2400 | 1800 | 1240 |

**Notes**
(1) Illinois General Use Water Quality Standards (WQS) and Illinois Water Quality Criteria (WQC) are used as surface water effects values
(2) Maximum detected concentrations reported between December 2010 and February 2015 If a constituent was not detected during this timeframe, the maximum reporting limit is presented in the table indicated with a "U" qualifier For pH, the range is presented
(3) Average of well-specific concentrations (maximums) presented in the table. If the maximum is a non-detect result, one-half the reporting limit was used as a surrogate concentration in the calculation For pH, the range presented in the "average" column is the average minimum and average maximum
(4) Groundwater in the gravelly sand unit flows in a northerly direction Groundwater in the localized silt/clay units flows in a westerly direction Summary statistics (averages) do not distinguish between these two units

mg/L = milligram per liter
s.u. = standard units
"--" = value not available
U = constituent not detected above its reporting limit
bold/shading = concentration exceeds effects value

Table B-4-1
Groundwater Analytical Results for Constituents of Interest December 2010 to May 2014
Midwest Generation – Waukegan Generating Station - Waukegan, Lake County, Illinois

| Well | Constituent | Effects Values (a) | Units | 2010 [10] | 2011 [03] | 2011 [06] | 2011 [09] | 2011 [12] | 2012 [03] (b) | 2012 [06] | 2012 [09] (b) | 2012 [12] | 2013 [03] | 2013 [06] | 2013 [07] | 2013 [11] | 2014 [03] | 2014 [05] | 2014 [08] | 2014 [11] | 2015 [02] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Groundwater Analytical Results (Year [Month]) | | | | | | | | | | | | | | | | | |
| MW-01 | Antimony | 0.32 | mg/L | 0.0052 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | 0.0056 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 |
| MW-01 | Arsenic | 0.148 | mg/L | 0.054 | 0.04 | **0.17** | 0.077 | 0.057 | 0.078 | 0.07 | 0.07 | 0.091 | 0.098 | 0.036 | 0.055 | 0.046 | 0.051 | 0.036 | 0.019 | **0.21** | 0.036 |
| MW-01 | Boron | 7.6 | mg/L | 2.6 | 2 | 2.6 | 2.5 | 2.8 | 2.5 | 2 | 1.9 | 1.9 | 2.2 | 2.2 | 2.3 | 3.1 | 1.9 | 2 | 2 | 2.2 | 1.7 |
| MW-01 | Chloride | 500 | mg/L | 39 | 48 | 52 | 41 | 32 | 47 | 46 | 47 | 48 | 45 | 34 | 42 | 28 | 33 | 31 | 73 | 70 | 31 |
| MW-01 | Iron | 1 | mg/L | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| MW-01 | Manganese | 3.04 | mg/L | <0.0025 | 0.0027 | 0.0086 | 0.02 | 0.011 | 0.0052 | <0.0025 | <0.0025 | <0.0025 | 0.0047 | 0.011 | 0.011 | 0.021 | 0.0073 | <0.0025 | 0.026 | 0.0054 | <0.0025 |
| MW-01 | pH | 6.5 - 9.0 | s.u. | **10.41** | **9.92** | **9.97** | 8.78 | 8.62 | **9.54** | **9.75** | **10.78** | **10.47** | **9.85** | 8.37 | 8.81 | 8.42 | 8.99 | 8.88 | 7.92 | **10.54** | 8.88 |
| MW-01 | Sulfate | 500 | mg/L | 350 | 230 | 200 | 280 | 330 | 390 | 300 | 240 | 200 | 250 | 260 | 300 | 260 | 130 | 170 | 130 | 270 | 170 |
| MW-01 | Total Dissolved Solids | 1000 | mg/L | 460 | 470 | 460 | 570 | 750 | 630 | 630 | 450 | 460 | 510 | 660 | 580 | 580 | 290 | 300 | 300 | 450 | 300 |
| MW-02 | Antimony | 0.32 | mg/L | 0.015 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 |
| MW-02 | Arsenic | 0.148 | mg/L | 0.025 | 0.016 | 0.012 | 0.0087 | 0.0094 | 0.009 | 0.011 | 0.011 | 0.0085 | 0.012 | 0.009 | 0.0087 | 0.0091 | 0.0085 | 0.0062 | 0.0081 | 0.0095 | 0.0062 |
| MW-02 | Boron | 7.6 | mg/L | 2.2 | 2.2 | 2 | 1.7 | 1.9 | 2 | 2.6 | 2.1 | 1.9 | 2.2 | 1.9 | 2.1 | 2.2 | 2.8 | 2.6 | 2 | 3 | 3.2 |
| MW-02 | Chloride | 500 | mg/L | 42 | 45 | 46 | 45 | 50 | 53 | 48 | 55 | 54 | 50 | 52 | 47 | 55 | 51 | 57 | 47 | 48 | 57 |
| MW-02 | Iron | 1 | mg/L | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | 0.16 | <0.1 | <0.1 | 0.16 |
| MW-02 | Manganese | 3.04 | mg/L | 0.0034 | 0.018 | 0.032 | 0.038 | 0.035 | 0.028 | 0.031 | 0.025 | 0.023 | 0.039 | 0.051 | 0.069 | 0.094 | 0.085 | 0.16 | 0.05 | 0.041 | 0.16 |
| MW-02 | pH | 6.5 - 9.0 | s.u. | **9.98** | **9.31** | 8.65 | 7.82 | 7.77 | 7.82 | 7.9 | 8.24 | 7.94 | 8.95 | 7.63 | 7.61 | 7.97 | 8.38 | 7.65 | 8.3 | 8.61 | 7.65 |
| MW-02 | Sulfate | 500 | mg/L | 230 | 160 | 150 | 200 | 180 | 200 | 210 | 270 | 210 | 230 | 220 | 260 | 290 | 370 | 250 | 200 | 350 | 280 |
| MW-02 | Total Dissolved Solids | 1000 | mg/L | 410 | 400 | 410 | 460 | 490 | 400 | 520 | 540 | 500 | 520 | 550 | 530 | 770 | 670 | 710 | 550 | 510 | 710 |
| MW-03 | Antimony | 0.32 | mg/L | 0.0051 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 |
| MW-03 | Arsenic | 0.148 | mg/L | 0.0043 | 0.0041 | 0.0045 | 0.0077 | 0.0049 | 0.0071 | 0.003 | 0.0044 | 0.0031 | 0.0018 | 0.014 | 0.0025 | 0.005 | 0.0013 | 0.002 | 0.0041 | 0.0029 | 0.002 |
| MW-03 | Boron | 7.6 | mg/L | 1.7 | 2.2 | 2.3 | 1.6 | 1.6 | 1.5 | 1.3 | 1.4 | 1.9 | 2 | 2.5 | 1.8 | 1.9 | 1.1 | 1.2 | 2.3 | 2.3 | 1.6 |
| MW-03 | Chloride | 500 | mg/L | 53 | 49 | 53 | 49 | 51 | 52 | 41 | 47 | 49 | 45 | 39 | 43 | 25 | 37 | 37 | 82 | 64 | 37 |
| MW-03 | Iron | 1 | mg/L | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| MW-03 | Manganese | 3.04 | mg/L | <0.0025 | 0.0059 | 0.0044 | <0.0025 | 0.0054 | 0.0036 | 0.0067 | 0.003 | 0.0034 | 0.015 | 0.0062 | 0.0031 | 0.0082 | 0.0069 | 0.0028 | 0.0083 | 0.0035 | 0.0029 |
| MW-03 | pH | 6.5 - 9.0 | s.u. | **9.21** | 8.58 | 8.64 | **9.2** | 8.61 | 8.89 | 7.58 | **9.14** | 8.22 | 8.55 | 7.13 | 7.46 | 7.26 | 7.38 | 8.47 | 7.52 | 6.95 | 8.47 |
| MW-03 | Sulfate | 500 | mg/L | 120 | 130 | 130 | 97 | 110 | 140 | 150 | 260 | 240 | 240 | 290 | 240 | 140 | 170 | 100 | 130 | 240 | 100 |
| MW-03 | Total Dissolved Solids | 1000 | mg/L | 280 | 350 | 340 | 300 | 380 | 340 | 420 | 480 | 520 | 470 | 460 | 530 | 380 | 340 | 210 | 470 | 400 | 210 |
| MW-04 | Antimony | 0.32 | mg/L | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 |
| MW-04 | Arsenic | 0.148 | mg/L | 0.006 | 0.0077 | 0.0059 | 0.0058 | 0.0065 | 0.0066 | 0.0091 | 0.0079 | 0.008 | 0.0081 | 0.0032 | 0.0044 | 0.0055 | 0.0062 | 0.0061 | 0.0064 | 0.006 | 0.0061 |
| MW-04 | Boron | 7.6 | mg/L | 2 | 2.1 | 2 | 1.8 | 2.1 | 2.2 | 2.5 | 2.2 | 2.3 | 2.4 | 2.3 | 2.5 | 2.8 | 3 | 2.7 | 1.5 | 1.6 | 2 |
| MW-04 | Chloride | 500 | mg/L | 39 | 47 | 45 | 59 | 60 | 71 | 53 | 55 | 53 | 50 | 51 | 42 | 46 | 41 | 34 | 33 | 36 | 34 |
| MW-04 | Iron | 1 | mg/L | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| MW-04 | Manganese | 3.04 | mg/L | 0.058 | 0.035 | 0.028 | 0.36 | 0.025 | 0.038 | 0.041 | 0.028 | 0.031 | 0.034 | 0.016 | 0.024 | 0.036 | 0.074 | 0.052 | 0.046 | 0.035 | 0.052 |
| MW-04 | pH | 6.5 - 9.0 | s.u. | 7.8 | 8.54 | 7.69 | 7.42 | 7.35 | 7.25 | 7.51 | 8.63 | 8.41 | 8.93 | 7.23 | 7.18 | 7.35 | 7.99 | 7.76 | 7.74 | 7.53 | 7.76 |
| MW-04 | Sulfate | 500 | mg/L | 250 | 170 | 160 | 160 | 160 | 280 | 250 | 210 | 220 | 230 | 260 | 300 | 270 | 360 | 140 | 130 | 200 | 140 |
| MW-04 | Total Dissolved Solids | 1000 | mg/L | 430 | 400 | 380 | 470 | 480 | 490 | 540 | 440 | 510 | 460 | 660 | 610 | 630 | 680 | 470 | 370 | 290 | 470 |
| MW-05 | Antimony | 0.32 | mg/L | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 |
| MW-05 | Arsenic | 0.148 | mg/L | 0.0076 | 0.0082 | 0.0013 | <0.001 | 0.01 | 0.01 | 0.0098 | 0.012 | 0.011 | 0.012 | <0.001 | 0.0013 | 0.0086 | 0.0097 | 0.009 | 0.0015 | 0.0097 | 0.009 |
| MW-05 | Boron | 7.6 | mg/L | **28** | **33** | **12** | **30** | **37** | **44** | **47** | **41** | **27** | **33** | **12** | **29** | **32** | **31** | **36** | **35** | **36** | **32** |
| MW-05 | Chloride | 500 | mg/L | 100 | 120 | **540** | 220 | 110 | 50 | 50 | 170 | 220 | 68 | **600** | 210 | 49 | 45 | 47 | 47 | 42 | 47 |
| MW-05 | Iron | 1 | mg/L | **3.5** | **2.8** | 0.95 | 0.42 | **5.6** | **6.6** | **5.9** | **5.1** | **3.9** | **4** | 0.41 | **1.1** | **4.6** | **5.5** | **5.5** | **4** | **8.6** | **5.5** |
| MW-05 | Manganese | 3.04 | mg/L | 0.71 | 0.6 | 0.28 | 0.03 | 0.99 | 0.76 | 0.75 | 0.57 | 0.48 | 0.51 | 0.17 | 0.44 | 0.54 | 0.62 | 0.49 | 0.65 | 0.62 | 0.49 |
| MW-05 | pH | 6.5 - 9.0 | s.u. | 7.21 | 7.56 | 6.72 | 6.87 | 7.15 | 7.45 | 6.97 | 7.32 | 7.36 | 7.33 | 6.61 | 6.74 | 7.2 | 7.64 | 7.07 | 7.06 | 7.1 | 7.67 |
| MW-05 | Sulfate | 500 | mg/L | **920** | **780** | **1100** | **810** | **1100** | **990** | **800** | **710** | **550** | **650** | **1200** | **890** | **870** | **640** | **630** | **640** | **840** | **630** |
| MW-05 | Total Dissolved Solids | 1000 | mg/L | **1500** | **1800** | **3300** | **2300** | **2300** | **2000** | **2000** | **1900** | **1800** | **1600** | **3500** | **2000** | **1600** | **1400** | **1500** | **1600** | **1500** | **1500** |
| MW-06 | Antimony | 0.32 | mg/L | NS | NS | NS | NS | NS | NS | NS | NS | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 |
| MW-06 | Arsenic | 0.148 | mg/L | NS | NS | NS | NS | NS | NS | NS | NS | 0.0029 | 0.0019 | 0.0065 | 0.0096 | 0.0034 | 0.0017 | 0.0043 | 0.0053 | 0.0045 | 0.0047 |
| MW-06 | Boron | 7.6 | mg/L | NS | NS | NS | NS | NS | NS | NS | NS | 1.1 | 2.8 | 1.7 | 4.3 | 2.4 | 2 | 2.2 | 2.9 | 3.7 | 3.5 |
| MW-06 | Chloride | 500 | mg/L | NS | NS | NS | NS | NS | NS | NS | NS | 110 | 61 | 48 | 69 | 85 | 8 | 84 | 94 | 97 | 84 |
| MW-06 | Iron | 1 | mg/L | NS | NS | NS | NS | NS | NS | NS | NS | **2.6** | **2** | **6.2** | **16** | **4.1** | 1.19 | **3** | **9.2** | **6.7** | **3** |
| MW-06 | Manganese | 3.04 | mg/L | NS | NS | NS | NS | NS | NS | NS | NS | 0.21 | 0.16 | 0.75 | 0.72 | 0.44 | 0.0073 | 0.17 | 0.8 | 0.44 | 0.17 |
| MW-06 | pH | 6.5 - 9.0 | s.u. | NS | NS | NS | NS | NS | NS | NS | NS | 7.52 | 7.42 | 6.83 | 6.88 | 7.24 | 7.64 | 7.18 | 7.1 | 7.31 | 7.18 |
| MW-06 | Sulfate | 500 | mg/L | NS | NS | NS | NS | NS | NS | NS | NS | 160 | 380 | 990 | 360 | 130 | 93 | 170 | 130 | 240 | 170 |
| MW-06 | Total Dissolved Solids | 1000 | mg/L | NS | NS | NS | NS | NS | NS | NS | NS | 940 | **1100** | **1100** | **1100** | **1200** | 970 | 870 | 950 | 890 | 870 |
| MW-07 | Antimony | 0.32 | mg/L | NS | NS | NS | NS | NS | NS | NS | NS | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 |
| MW-07 | Arsenic | 0.148 | mg/L | NS | NS | NS | NS | NS | NS | NS | NS | 0.0099 | 0.012 | 0.01 | 0.011 | 0.012 | 0.0056 | 0.0078 | 0.011 | 0.0095 | 0.0059 |
| MW-07 | Boron | 7.6 | mg/L | NS | NS | NS | NS | NS | NS | NS | NS | **43** | **49** | **42** | **44** | **45** | **39** | **27** | **40** | **41** | **37** |
| MW-07 | Chloride | 500 | mg/L | NS | NS | NS | NS | NS | NS | NS | NS | 60 | 54 | 44 | 33 | 33 | 34 | 35 | 34 | 18 | 35 |
| MW-07 | Iron | 1 | mg/L | NS | NS | NS | NS | NS | NS | NS | NS | **12** | **12** | **13** | **13** | **13** | **11** | **12** | **11** | **9.4** | **12** |
| MW-07 | Manganese | 3.04 | mg/L | NS | NS | NS | NS | NS | NS | NS | NS | 0.46 | 0.49 | 0.48 | 0.46 | 0.46 | 0.46 | 0.6 | 0.4 | 0.34 | 0.6 |

Table B-4-1
Groundwater Analytical Results for Constituents of Interest December 2010 to May 2014
Midwest Generation – Waukegan Generating Station - Waukegan Lake County Illinois

| Well | Constituent | Effects Values (1) | Units | Groundwater Analytical Results (Year [Month]) | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 2010 [10] | 2011 [03] | 2011 [06] | 2011 [09] | 2011 [12] | 2012 [03] (2) | 2012 [06] | 2012 [09] (3) | 2012 [12] | 2013 [03] | 2013 [06] | 2013 [07] | 2013 [11] | 2014 [03] | 2014 [05] | 2014 [08] | 2014 [11] | 2015 [02] |
| MW-07 | pH | 6.5 - 9.0 | s.u. | NS | NS | NS | NS | NS | NS | NS | NS | 7.27 | 8.24 | 7.00 | 7.1 | 7.18 | 7.67 | 6.89 | 7.25 | 7.46 | 6.89 |
| MW-07 | Sulfate | 500 | mg/l | NS | NS | NS | NS | NS | NS | NS | NS | **630** | **710** | **650** | **860** | **770** | **540** | 370 | **690** | **880** | 330 |
| MW-07 | Total Dissolved Solids | 1000 | mg/l | NS | NS | NS | NS | NS | NS | NS | NS | **1800** | **1800** | **1900** | **1800** | **1800** | **1600** | **1300** | **1600** | **1500** | **1300** |
| MW-08 | Antimony | 0.32 | mg/l | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | <0.003 | <0.003 | <0.003 | <0.003 |
| MW-08 | Arsenic | 0.148 | mg/l | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | 0.0049 | 0.0057 | 0.0054 | 0.0049 |
| MW-08 | Boron | 7.6 | mg/l | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | **19** | **24** | **28** | NS |
| MW-08 | Chloride | 500 | mg/l | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | 39 | 56 | 39 | 56 |
| MW-08 | Iron | 1 | mg/l | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | **5** | **7** | **6.2** | **5** |
| MW-08 | Manganese | 3.04 | mg/l | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | 0.34 | 0.35 | 0.33 | 0.31 |
| MW-08 | pH | 6.5 - 9.0 | s.u. | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | 6.92 | 6.97 | 7.16 | 6.92 |
| MW-08 | Sulfate | 500 | mg/l | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | 250 | 470 | 500 | 250 |
| MW-08 | Total Dissolved Solids | 1000 | mg/l | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | 1000 | **1200** | **1200** | 1000 |
| MW-09 | Antimony | 0.32 | mg/l | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | <0.004 | <0.003 | <0.003 | <0.003 |
| MW-09 | Arsenic | 0.148 | mg/l | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | 0.0012 | <0.001 | <0.001 | 0.0012 |
| MW-09 | Boron | 7.6 | mg/l | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | **16** | 6.3 | **13** | NS |
| MW-09 | Chloride | 500 | mg/l | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | 370 | 380 | 430 | 370 |
| MW-09 | Iron | 1 | mg/l | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | 0.81 | 0.12 | 0.14 | 0.81 |
| MW-09 | Manganese | 3.04 | mg/l | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | 0.14 | 0.05 | 0.048 | 0.14 |
| MW-09 | pH | 6.5 - 9.0 | s.u. | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | 6.94 | 6.9 | 7.2 | 6.94 |
| MW-09 | Sulfate | 500 | mg/l | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | 360 | 230 | 430 | 360 |
| MW-09 | Total Dissolved Solids | 1000 | mg/l | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | **1600** | **1300** | **1400** | **1600** |

Notes:
(1) Illinois Lake Michigan (LM) Basin Water Quality Standards (WQS) and Illinois LM Basin Water Quality Criteria (WQC) are used as surface water effects values
(2) Manganese results for March 2012 for wells MW-01 through MW-05 were qualified as "^" by the laboratory, which denotes instrument-related QC exceeds the control limits
(3) Iron results for September 2012 for wells MW-01 through MW-05 were qualified as "^" by the laboratory, which denotes instrument-related QC exceeds the control limits
(2) Antimony results for November 2014 for wells MW-01 through MW-03 and MW-05 through MW-09 were qualified as "^" by the laboratory, which denotes instrument-related QC exceeds the control limits

mg/l = milligrams per liter
NS = not sampled
"--" = value not available
"<" = constituent was not detected, the reporting limit is presented
bold/shading = concentration exceeds effects value

Table B-4-2
Comparison Of Average Groundwater Analytical Results To Surface Water Effects Values
Midwest Generation -- Waukegan Generating Station - Waukegan, Lake County, Illinois

| Constituent | Units | Effects Value (1) | Groundwater Analytical Results - Average Concentrations (2) | | | | | | | | | Average (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | MW-01 | MW-02 | MW-03 | MW-04 | MW-05 | MW-06 | MW-07 | MW-08 | MW-09 | |
| Antimony | mg/L | 0.32 | 0.00193 | 0.00225 | 0.0017 | 0.003 U | 0.003 U | 0.003 U | 0.003 U | 0.003 U | 0.003 U | 0.00165 |
| Arsenic | mg/L | 0.148 | 0.0708 | 0.0105 | 0.00369 | 0.00654 | 0.00734 | 0.00474 | 0.0105 | 0.00523 | 0.00097 | 0.0134 |
| Boron | mg/L | 7.6 | 2.24 | 2.31 | 1.79 | 2.23 | **31.9** | 3.16 | **40.7** | **23.7** | **11.8** | **13.3** |
| Chloride | mg/L | 500 | 44.1 | 50.1 | 47.8 | 47.3 | 152 | 74.4 | 43.2 | 46.5 | 388 | 99.3 |
| Iron | mg/L | 1.0 | 0.1 U | 0.0622 | 0.1 U | 0.1 U | **4.11** | **5.3** | **11.8** | **5.8** | 0.47 | **3.1** |
| Manganese | mg/L | 3.04 | 0.00786 | 0.0512 | 0.00513 | 0.0563 | 0.539 | 0.365 | 0.475 | 0.32 | 0.0945 | 0.213 |
| Sulfate | mg/L | 500 | 251 | 239 | 167 | 216 | **819** | 243 | **639** | 343 | 345 | 362 |
| pH | s.u. | 6.5 - 9.0 | **9.38** | 8.22 | 8.2 | 7.78 | 7.15 | 7.26 | 7.3 | 6.99 | 7 | 7.7 |
| Total Dissolved Solids | mg/L | 1000 | 501 | 536 | 404 | 487 | **1950** | 921 | **1630** | 1100 | **1480** | **1000** |

**Notes**

(1) Illinois Lake Michigan (LM) Basin Water Quality Standards (WQS) and Illinois LM Basin Water Quality Criteria (WQC) are used as surface water effects values

(2) Average of concentrations reported between December 2010 and February 2015. If a constituent was not detected during this timeframe, the average reporting limit is presented in the table, indicated with a "U" qualifier. Otherwise, non-detect results were included in the average calculation assuming one-half the reporting limit

(3) Average of concentrations (averages) presented in the table, assuming one-half the reporting limit for non-detect results

mg/L = milligram per liter
s.u. = standard units
"--" = value not available
U = constituent not detected above its reporting limit
bold/shading = concentration exceeds effects value

Table B-4-3
Comparison Of Maximum Groundwater Analytical Results To Surface Water Effects Values
Midwest Generation -- Waukegan Generating Station - Waukegan, Lake County, Illinois

| Constituent | Units | Effects Value [1] | Groundwater Analytical Results - Maximum Concentrations [2] | | | | | | | | | Average [3] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | MW-01 | MW-02 | MW-03 | MW-04 | MW-05 | MW-06 | MW-07 | MW-08 | MW-09 | |
| Antimony | mg/L | 0.32 | 0.0056 | 0.015 | 0.0051 | 0.003 U | 0.003 U | 0.003 U | 0.003 U | 0.003 U | 0.003 U | 0.00386 |
| Arsenic | mg/L | 0.148 | **0.21** | 0.025 | 0.0077 | 0.0091 | 0.012 | 0.0096 | 0.012 | 0.0057 | 0.0012 | 0.0325 |
| Boron | mg/L | 7.6 | 3.1 | 3.2 | 2.5 | 3 | **47** | 6.7 | **49** | **28** | **16** | **17.6** |
| Chloride | mg/L | 500 | 79 | 57 | 89 | 71 | **600** | 110 | 60 | 56 | 430 | 172 |
| Iron | mg/L | 1.0 | 0.1 U | 0.16 | 0.1 U | 0.1 U | **8.6** | **16** | **13** | **7** | 0.81 | **5.08** |
| Manganese | mg/L | 3.04 | 0.026 | 0.16 | 0.015 | 0.36 | 0.99 | 0.75 | 0.6 | 0.33 | 0.14 | 0.375 |
| Sulfate | mg/L | 500 | 390 | 370 | 290 | 360 | **1200** | 390 | **880** | 500 | 430 | **534** |
| pH | s.u. | 6.5 - 9.0 | **7.92-10.78** | **7.61-9.98** | **6.95-9.21** | 7.18-8.93 | 6.61-7.64 | 6.83-7.94 | 6.89-8.24 | 6.92-7.16 | 6.9-7.2 | 7.09-8.56 |
| Total Dissolved Solids | mg/L | 1000 | 750 | 770 | 860 | 680 | **3500** | **1200** | **1800** | **1200** | **1600** | **1370** |

**Notes**

(1) Illinois Lake Michigan (LM) Basin Water Quality Standards (WQS) and Illinois LM Basin Water Quality Criteria (WQC) are used as surface water effects values.

(2) Maximum detected concentrations reported between December 2010 and February 2015. If a constituent was not detected during this timeframe, the maximum reporting limit is presented in the table, indicated with a "U" qualifier. For pH, the range is presented.

(3) Average of well-specific concentrations (maximums) presented in the table. If the maximum is a non-detect result, one-half the reporting limit was used as a surrogate concentration in the calculation. For pH, the range presented in the "average" column is the average minimum and average maximum.

mg/L = milligram per liter
s.u. = standard units
"--" = value not available
U = constituent not detected above its reporting limit; reporting limit presented
bold/shading = concentration exceeds effects value

Table B-5-1
Groundwater Analytical Results for Constituents of Interest December 2010 to February 2015
Midwest Generation -- Will County Generating Station - Romeoville, Will County, Illinois

| Well | Constituent | Effects Values [a] | Units | 2010 [12] | 2011 [03] | 2011 [06] | 2011 [09] | 2011 [12] | 2012 [03] | 2012 [06] | 2012 [09] | 2012 [12] [b] | 2013 [03] | 2013 [05/06] | 2013 [08] | 2013 [10] | 2014 [02] | 2014 [05] | 2014 [08] | 2014 [10] | 2015 [02] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Groundwater Analytical Results (Year [Month]) | | | | | | | | | | | | | | | | | |
| MW-01 | Antimony | 0.32 | mg/L | <0.003 | <0.003 | <0.003 | <0.003 | 0.0063 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 |
| MW-01 | Boron | 7.6 | mg/L | 1.8 | 1.6 | 1.8 | 1.7 | 1.6 | 1.5 | 2.1 | 1.9 | 1.9 | 1.9 | 2.4 | 2.3 | 2.6 | 2.4 | 2.5 | 2 | 0.96 | 0.98 |
| MW-01 | Chloride | 500 | mg/L | 110 | 210 | 110 | 120 | 140 | 190 | 170 | 120 | 160 | 220 | 150 | 120 | 160 | 120 | 87 | 45 | 29 | 30 |
| MW-01 | Manganese | 3.04 | mg/L | 0.2 | 0.15 | 0.22 | 0.16 | 0.17 | 0.16 | 0.16 | 0.15 | 0.18 | 0.17 | 0.13 | 0.22 | 0.28 | 0.3 | 0.26 | 0.24 | 0.17 | 0.076 |
| MW-01 | pH | 6.5 - 9.0 | s.u. | 7.89 | 8.05 | 7.28 | 7.57 | 7.16 | 7.84 | 7.55 | 7.7 | 7.79 | 8.41 | 7.56 | 7.18 | 7.04 | 8.96 | 7.19 | 6.91 | 7.12 | 7.41 |
| MW-01 | Sulfate | 1350 | mg/L | 530 | 390 | 280 | 320 | 270 | 430 | 390 | 390 | 290 | 310 | 460 | 540 | 430 | 390 | 230 | 71 | 150 | 99 |
| MW-01 | Total Dissolved Solids | -- | | 1100 | 1100 | 1100 | 760 | 770 | 910 | 950 | 790 | 880 | 930 | 1100 | 1300 | 1300 | 1300 | 890 | 400 | 600 | 570 |
| MW-02 | Antimony | 0.32 | mg/L | <0.003 | <0.003 | <0.015 | 0.0073 | 0.017 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 |
| MW-02 | Boron | 7.6 | mg/L | 1.8 | 1.7 | 2.3 | 2.3 | 1.7 | 1.7 | 2 | 2.2 | 1.8 | 1.7 | 1.9 | 2.2 | 2.4 | 2.4 | 2.8 | 3 | 3.6 | 3.8 |
| MW-02 | Chloride | 500 | mg/L | 110 | 250 | 150 | 110 | 120 | 140 | 150 | 110 | 130 | 190 | 200 | 170 | 180 | 170 | 130 | 100 | 97 | 130 |
| MW-02 | Manganese | 3.04 | mg/L | 0.032 | 0.032 | 0.041 | 0.016 | 0.031 | 0.031 | 0.038 | 0.029 | 0.033 | 0.029 | 0.041 | 0.041 | 0.044 | 0.044 | 0.024 | 0.074 | 0.083 | 0.064 |
| MW-02 | pH | 6.5 - 9.0 | s.u. | 8.62 | 8.62 | 8 | 8.11 | 7.8 | 8.34 | 8.23 | 8.37 | 8.4 | 7.79 | 8 | 7.93 | 8.06 | 8.97 | 7.74 | 7.59 | 6.94 | 8.14 |
| MW-02 | Sulfate | 1350 | mg/L | 430 | 280 | 400 | 330 | 220 | 330 | 340 | 280 | 250 | 260 | 250 | 300 | 280 | 210 | 300 | 340 | 510 | 400 |
| MW-02 | Total Dissolved Solids | -- | | 870 | 970 | 900 | 720 | 650 | 810 | 850 | 610 | 710 | 740 | 800 | 900 | 950 | 1000 | 1000 | 1100 | 1200 | 1200 |
| MW-03 | Antimony | 0.32 | mg/L | <0.003 | <0.003 | <0.015 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 |
| MW-03 | Boron | 7.6 | mg/L | 2.7 | 2.4 | 2.6 | 3.3 | 2.8 | 2.7 | 4.1 | 3.9 | 3.4 | 3.2 | 3.7 | 3.6 | 3.5 | 3.2 | 3.3 | 3.5 | 3.6 | 2.9 |
| MW-03 | Chloride | 500 | mg/L | 54 | 250 | 100 | 130 | 100 | 95 | 88 | 96 | 100 | 87 | 110 | 100 | 110 | 69 | 62 | 71 | 57 | 43 |
| MW-03 | Manganese | 3.04 | mg/L | 0.34 | 0.31 | 0.34 | 0.26 | 0.29 | 0.27 | 0.37 | 0.24 | 0.25 | 0.20 | 0.22 | 0.19 | 0.16 | 0.45 | 0.25 | 0.16 | 0.29 | 0.47 |
| MW-03 | pH | 6.5 - 9.0 | s.u. | 7.21 | 7.72 | 7.01 | 7.18 | 6.55 | 7.24 | 6.79 | 7.12 | 7.21 | 7.88 | 7.21 | 7.2 | 7.24 | 7.03 | 7.21 | 7.39 | **6.06** | 7.11 |
| MW-03 | Sulfate | 1350 | mg/L | 330 | 270 | 240 | 250 | 280 | 320 | 500 | 440 | 480 | 390 | 610 | 550 | 540 | 500 | 560 | 270 | 570 | 320 |
| MW-03 | Total Dissolved Solids | -- | | 940 | 1000 | 950 | 1000 | 930 | 1000 | 1400 | 1100 | 1100 | 1400 | 1200 | 1200 | 1100 | 1200 | 1200 | 1100 | 1100 | 1100 |
| MW-04 | Antimony | 0.32 | mg/L | <0.003 | <0.003 | <0.015 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 |
| MW-04 | Boron | 7.6 | mg/L | 3.7 | 3.3 | 3.6 | 4.3 | 3 | 4 | 5.3 | 6.2 | 5.2 | 4.5 | 3.8 | 5.1 | 5.6 | 4.6 | 4.2 | 4.8 | 4.5 | 3.9 |
| MW-04 | Chloride | 500 | mg/L | 120 | 190 | 120 | 170 | 150 | 150 | 140 | 170 | 170 | 150 | 110 | 120 | 89 | 110 | 85 | 67 | 82 | 120 |
| MW-04 | Manganese | 3.04 | mg/L | 0.52 | 0.58 | 0.7 | 1 | 0.62 | 0.6 | 0.7 | 0.99 | 0.62 | 0.47 | 0.44 | 0.58 | 0.65 | 0.72 | 0.49 | 0.88 | 0.64 | 0.52 |
| MW-04 | pH | 6.5 - 9.0 | s.u. | 7.37 | 7.66 | 7.23 | 7.21 | 6.38 | 7.27 | 7.1 | 7.29 | 7.34 | 6.61 | 7.67 | 7.15 | 6.74 | 7.03 | 6.96 | 6.75 | **5.87** | 7.17 |
| MW-04 | Sulfate | 1350 | mg/L | **1500** | **1500** | **1600** | **4800** | **1600** | **2000** | **2800** | **3200** | **2200** | **2000** | **1500** | **2200** | 1100 | **1400** | 1100 | 1200 | **1600** | 1100 |
| MW-04 | Total Dissolved Solids | -- | | 2500 | 2600 | 2800 | 6000 | 3100 | 3700 | 4300 | 4400 | 4000 | 3600 | 2900 | 3500 | 2400 | 2800 | 2500 | 2200 | 2600 | 2600 |
| MW-05 | Antimony | 0.32 | mg/L | <0.003 | <0.003 | <0.015 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 |
| MW-05 | Boron | 7.6 | mg/L | 2.6 | 2.7 | 3.2 | 4 | 3.2 | 2.9 | 2.3 | 3.8 | 2.5 | 2.6 | 3.6 | 3.5 | 4.1 | 2.7 | 2.9 | 2.7 | 4.7 | 2.4 |
| MW-05 | Chloride | 500 | mg/L | 110 | 150 | 140 | 150 | 130 | 170 | 150 | 160 | 150 | 140 | 110 | 120 | 130 | 130 | 160 | 170 | 81 | 200 |
| MW-05 | Manganese | 3.04 | mg/L | 0.0079 | 0.0067 | 0.055 | 0.14 | 0.038 | 0.032 | 0.014 | 0.073 | 0.023 | 0.036 | 0.15 | 0.05 | 0.11 | 0.053 | 0.11 | 0.062 | 0.2 | 0.065 |
| MW-05 | pH | 6.5 - 9.0 | s.u. | **9.58** | **9.51** | 7.44 | 7.38 | 8.2 | **9.3** | **9.41** | 7.54 | **9.37** | 7.43 | 7 | 7.88 | 6.75 | 8.45 | 7.07 | 7.36 | 6.87 | **9.7** |
| MW-05 | Sulfate | 1350 | mg/L | 580 | 570 | 540 | 690 | 500 | 370 | 410 | 540 | 280 | 320 | 650 | 500 | 560 | 600 | **1700** | 410 | 840 | 130 |
| MW-05 | Total Dissolved Solids | -- | | 1000 | 1300 | 1400 | 1500 | 1000 | 1000 | 750 | 1100 | 820 | 940 | 1600 | 1100 | 1300 | 1400 | 1000 | 1400 | 2100 | 1100 |
| MW-06 | Antimony | 0.32 | mg/L | <0.003 | <0.003 | <0.015 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 |
| MW-06 | Boron | 7.6 | mg/L | 2.7 | 2.5 | 2.4 | 3 | 2.5 | 2.5 | 2.9 | 3 | 3 | 2.7 | 2.8 | 2.9 | 3.7 | 3 | 2.9 | 2.8 | 3.4 | 3.2 |
| MW-06 | Chloride | 500 | mg/L | 120 | 210 | 150 | 120 | 120 | 110 | 92 | 110 | 110 | 130 | 110 | 91 | 76 | 55 | 120 | 120 | 81 | 49 |
| MW-06 | Manganese | 3.04 | mg/L | 0.073 | 0.051 | 0.047 | 0.024 | 0.038 | 0.020 | 0.033 | 0.038 | 0.034 | 0.03 | 0.082 | 0.023 | 0.083 | 0.099 | 0.056 | 0.028 | 0.11 | 0.12 |
| MW-06 | pH | 6.5 - 9.0 | s.u. | 8.89 | **9.65** | **9.27** | **9.44** | 8.82 | **9.29** | **9.07** | **9.17** | **9.18** | 8.22 | 8.41 | **9.13** | 8.5 | 8.27 | 8.52 | 8.16 | 7.26 | 8.38 |
| MW-06 | Sulfate | 1350 | mg/L | 500 | 340 | 570 | 420 | 440 | 380 | 450 | 550 | 360 | 370 | 360 | 400 | 310 | 270 | 320 | 200 | 420 | 310 |
| MW-06 | Total Dissolved Solids | -- | | 990 | 1100 | 1200 | 870 | 880 | 920 | 770 | 890 | 820 | 840 | 880 | 860 | 790 | 780 | 840 | 1600 | 800 | 770 |
| MW-07 | Antimony | 0.32 | mg/L | <0.003 | <0.003 | <0.015 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 |
| MW-07 | Boron | 7.6 | mg/L | 4.7 | 5 | 5.7 | 3.4 | 5 | 5.1 | 5.6 | 5.5 | 5.1 | 4.3 | 2.6 | 3.5 | 3 | 4 | 4.8 | 3.9 | 5.1 | 3 |
| MW-07 | Chloride | 500 | mg/L | 160 | 140 | 140 | 160 | 150 | 130 | 120 | 150 | 140 | 140 | 190 | 180 | 190 | 210 | 190 | 200 | 190 | 170 |
| MW-07 | Manganese | 3.04 | mg/L | 0.12 | 0.11 | 0.15 | 0.18 | 0.2 | 0.2 | 0.19 | 0.19 | 0.19 | 0.15 | 0.043 | 0.064 | 0.049 | 0.16 | 0.12 | 0.1 | 0.12 | 0.031 |
| MW-07 | pH | 6.5 - 9.0 | s.u. | 8.61 | 8.79 | 8.13 | 7.91 | 7.69 | 8.16 | 7.92 | 8.92 | 7.75 | 8.08 | 8.14 | 8.43 | 8.07 | 8.18 | 8.22 | 8.26 | 7.88 | 8.06 |
| MW-07 | Sulfate | 1350 | mg/L | 610 | 650 | 1000 | 710 | 710 | 770 | 670 | 690 | 480 | 400 | 390 | 360 | 510 | 380 | 540 | 270 | 600 | 400 |
| MW-07 | Total Dissolved Solids | -- | | 1300 | 1500 | 1600 | 1400 | 1300 | 1400 | 1300 | 1200 | 1200 | 1000 | 1100 | 1100 | 1200 | 1300 | 1300 | 1400 | 1500 | 1100 |

Table B-5-1
Groundwater Analytical Results for Constituents of Interest December 2010 to February 2015
Midwest Generation – Will County Generating Station - Romeoville, Will County, Illinois

| Well | Constituent | Effects Values [1] | Units | Groundwater Analytical Results (Year [Month]) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 2010 [12] | 2011 [03] | 2011 [06] | 2011 [09] | 2011 [12] | 2012 [03] | 2012 [06] |
| MW-08 | Antimony | 0.32 | mg/L | <0.003 | <0.003 | <0.015 | <0.003 | <0.003 | <0.003 | <0.003 |
| MW-08 | Boron | 7.6 | mg/L | 1.7 | 1.3 | 1.7 | 2.3 | 1.9 | 1.5 | 2 |
| MW-08 | Chloride | 500 | mg/L | 93 | 270 | 200 | 160 | 130 | 160 | 160 |
| MW-08 | Manganese | 3.04 | mg/L | 0.33 | 0.44 | 0.47 | 0.45 | 0.4 | <0.005 | 0.36 |
| MW-08 | pH | 6.5 - 9.0 | s.u. | 7.65 | 8.17 | 7.47 | 7.3 | 6.99 | 7.61 | 7.36 |
| MW-08 | Sulfate | 1350 | mg/L | 440 | 440 | 420 | 600 | 350 | 330 | 370 |
| MW-08 | Total Dissolved Solids | — | | 930 | 1200 | 1100 | 1300 | 980 | 910 | 1000 |
| MW-09 | Antimony | 0.32 | mg/L | <0.003 | <0.003 | <0.015 | <0.003 | <0.003 | <0.003 | <0.003 |
| MW-09 | Boron | 7.6 | mg/L | 2.2 | 1.4 | 1.7 | 2 | 1.9 | 1.4 | 1.8 |
| MW-09 | Chloride | 500 | mg/L | 100 | 280 | 230 | 190 | 140 | 200 | 160 |
| MW-09 | Manganese | 3.04 | mg/L | <0.0025 | <0.0025 | <0.013 | <0.0025 | <0.0025 | <0.0025 | <0.0025 |
| MW-09 | pH | 6.5 - 9.0 | s.u. | **10.88** | **10.87** | **10.44** | **10.27** | **9.55** | **10.56** | **10.31** |
| MW-09 | Sulfate | 1350 | mg/L | 410 | 320 | 410 | 400 | 270 | 320 | 340 |
| MW-09 | Total Dissolved Solids | — | | 800 | 1000 | 940 | 850 | 660 | 820 | 880 |
| MW-10 | Antimony | 0.32 | mg/L | <0.003 | <0.003 | <0.015 | <0.003 | <0.003 | <0.003 | <0.003 |
| MW-10 | Boron | 7.6 | mg/L | 2.1 | 1.8 | 2.2 | 2.8 | 2.5 | 2.1 | 2.1 |
| MW-10 | Chloride | 500 | mg/L | 92 | 130 | 150 | 120 | 120 | 100 | 130 |
| MW-10 | Manganese | 3.04 | mg/L | 0.25 | 0.22 | 0.25 | 0.27 | 0.26 | 0.25 | 0.30 |
| MW-10 | pH | 6.5 - 9.0 | s.u. | 7.61 | 8.14 | 7.53 | 7.45 | 7.1 | 7.59 | 7.39 |
| MW-10 | Sulfate | 1350 | mg/L | 370 | 370 | 350 | 420 | 290 | 330 | 350 |
| MW-10 | Total Dissolved Solids | — | | 990 | 960 | 990 | 1000 | 1100 | 990 | 1000 |

| Well | Constituent | Groundwater Analytical Results (Year [Month]) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2012 [09] | 2012 [12] [2] | 2013 [03] | 2013 [05/06] | 2013 [08] | 2013 [10] | 2014 [02] | 2014 [05] | 2014 [08] | 2014 [10] | 2015 [02] |
| MW-08 | Antimony | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 |
| MW-08 | Boron | 2.6 | 2.1 | 1.8 | 1.9 | 2.4 | 3.2 | 2 | 2.3 | 2.4 | 2.8 | 2.3 |
| MW-08 | Chloride | 150 | 150 | 150 | 190 | 170 | 150 | 180 | 160 | 170 | 180 | 170 |
| MW-08 | Manganese | 0.41 | 0.43 | 0.73 | 0.47 | 0.31 | 0.42 | 0.39 | 0.35 | 0.3 | 0.44 | 0.31 |
| MW-08 | pH | 7.31 | 7.43 | 7.87 | 7.19 | 7.46 | 6.87 | 8.18 | 7.04 | 7.09 | 7.01 | 7.24 |
| MW-08 | Sulfate | 630 | 380 | 360 | 270 | 440 | 650 | 330 | 450 | 430 | 730 | 330 |
| MW-08 | Total Dissolved Solids | 1200 | 1200 | 1000 | 1100 | 1100 | 1600 | 1300 | 1400 | 1200 | 1500 | 1400 |
| MW-09 | Antimony | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 |
| MW-09 | Boron | 2 | 1.7 | 1.5 | 1.7 | 1.9 | 2.2 | 1.4 | 1.5 | 1.7 | 1.9 | 1.4 |
| MW-09 | Chloride | 160 | 130 | 140 | 160 | 170 | 110 | 270 | 250 | 210 | 200 | 200 |
| MW-09 | Manganese | 0.0036 | <0.0025 | <0.0025 | <0.0025 | 0.0043 | <0.0025 | <0.0025 | <0.0025 | <0.0025 | 0.0025 | 0.0026 |
| MW-09 | pH | [illegible] | [illegible] | **10.39** | **9.93** | [illegible] | **10.01** | **9.69** | **9.71** | **9.26** | 8.73 | **9.48** |
| MW-09 | Sulfate | 300 | 310 | 250 | 320 | 310 | 330 | 220 | 300 | 310 | 430 | 300 |
| MW-09 | Total Dissolved Solids | 800 | 780 | 600 | 690 | 700 | 680 | 790 | 880 | 670 | 820 | 810 |
| MW-10 | Antimony | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 |
| MW-10 | Boron | 3.2 | 2.7 | 2.7 | 2.7 | 2.3 | 1.8 | 2.5 | 2.2 | 2.1 | 3.3 | 3.3 |
| MW-10 | Chloride | 140 | 140 | 130 | 140 | 130 | 140 | 140 | 140 | 140 | 140 | 110 |
| MW-10 | Manganese | 0.23 | 0.20 | 0.25 | 0.24 | 0.14 | 0.22 | 0.18 | 0.12 | 0.12 | 0.25 | 0.38 |
| MW-10 | pH | 7.6 | 7.47 | 7.34 | 7.53 | 7.38 | 7.27 | **9.18** | 7.54 | 7.54 | 6.84 | 7.32 |
| MW-10 | Sulfate | 380 | 270 | 350 | 350 | 300 | 330 | 290 | 270 | 260 | 380 | 260 |
| MW-10 | Total Dissolved Solids | 970 | 1100 | 1000 | 1100 | 900 | 920 | 1000 | 940 | 880 | 1100 | 1100 |

Notes
(1) Illinois General Use Water Quality Standards (WQS) and Illinois Water Quality Criteria (WQC) are used as surface water effects values
(2) Antimony results (all non-detects) for December 2012 for wells MW-01 through MW-10 were qualified as "^" by the laboratory, which denotes instrument-related QC exceeds the control limits

mg/L = milligrams per liter
s.u. = standard units
"—" = value not available
"<" = constituent was not detected, the reporting limit is presented
bold/shading = concentration exceeds effects value

Table B-5-2
Comparison Of Average Groundwater Analytical Results To Surface Water Effects Values
Midwest Generation -- Will County Generating Station - Romeoville, Will County, Illinois

| Constituent | Units | Effects Value [1] | Groundwater Analytical Results - Average Concentrations [2] | | | | | | | | | | Average [3] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | MW-01 | MW-02 | MW-03 | MW-04 | MW-05 | MW-06 | MW-07 | MW-08 | MW-09 | MW-10 | |
| Antimony | mg/L | 0 32 | 0 00177 | 0.00302 | 0 00367 U | 0 00367 U | 0.00367 U | 0.00367 U | 0 00367 U | 0.00367 U | 0.00367 U | 0 00367 U | 0 00195 |
| Boron | mg/L | 7 6 | 1 84 | 2 29 | 3 19 | 4 42 | 3.13 | 2 88 | 4 41 | 2.13 | 1 73 | 2 58 | 2.86 |
| Chloride | mg/L | 500 | 129 | 148 | 96 8 | 129 | 142 | 110 | 163 | 166 | 183 | 129 | 140 |
| Manganese | mg/L | 3 04 | 0 189 | 0 0416 | 0.286 | 0.651 | 0 067 | 0 0554 | 0 132 | 0 367 | 0.00199 | 0 236 | 0.20 |
| Sulfate | mg/L | 1480 | 333 | 317 | 431 | **1920** | 599 | 398 | 586 | 452 | 334 | 329 | 570 |
| pH | s u | 6 5 - 9 0 | 7 59 | 8 09 | 7 13 | 7 02 | 8.12 | 8 76 | 8 16 | 7 4 | **10** | 7 56 | 7 98 |
| Total Dissolved Solids | mg/L | -- | 942 | 897 | 1100 | 3250 | 1250 | 869 | 1280 | 1190 | 798 | 1000 | 1260 |

**Notes**

(1) Illinois General Use Water Quality Standards (WQS) and Illinois Water Quality Criteria (WQC) are used as surface water effects values

(2) Average of concentrations reported between December 2010 and February 2015. If a constituent was not detected during this timeframe, the average reporting limit is presented in the table, indicated with a "U" qualifier. Otherwise, non-detect results were included in the average calculation assuming one-half the reporting limit

(3) Average of concentrations (averages) presented in the table, assuming one-half the reporting limit for non-detect results.

mg/L = milligram per liter
s u = standard units
"--" = value not available
U = constituent not detected above its reporting limit
bold/shading = concentration exceeds effects value

Table B-5-3
Comparison Of Maximum Groundwater Analytical Results To Surface Water Effects Values
Midwest Generation -- Will County Generating Station - Romeoville, Will County, Illinois

| Constituent | Units | Effects Value (1) | Groundwater Analytical Results - Maximum Concentrations (2) | | | | | | | | | | Average (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | MW-01 | MW-02 | MW-03 | MW-04 | MW-05 | MW-06 | MW-07 | MW-08 | MW-09 | MW-10 | |
| Antimony | mg/L | 0 32 | 0.0063 | 0 017 | 0 015 U | 0 015 U | 0.015 U | 0 015 U | 0 015 U | 0.015 U | 0 015 U | 0 015 U | 0 00833 |
| Boron | mg/L | 7 6 | 2.6 | 3.6 | 3 9 | 6 2 | 4 7 | 3 7 | 5 7 | 3 2 | 2.2 | 3 8 | 3 96 |
| Chloride | mg/L | 500 | 220 | 250 | 250 | 190 | 170 | 210 | 210 | 270 | 280 | 150 | 220 |
| Manganese | mg/L | 3 04 | 0.3 | 0 083 | 0 45 | 1 | 0 2 | 0 12 | 0 2 | 0 47 | 0 0043 | 0 38 | 0 32 |
| Sulfate | mg/L | 1480 | 540 | 510 | 610 | **4800** | **1700** | 570 | 1000 | 730 | 430 | 420 | 1130 |
| pH | s.u. | 6 5 - 9 0 | 6 91-8.96 | 6 94-8 97 | **6.06-7.88** | **5.87-7.66** | **6.75-9.70** | **7.26-9.65** | 7 69-8 79 | 6 87-8 18 | **8.73-10.88** | **6.84-9.18** | 6.99-8 99 |
| Total Dissolved Solids | mg/L | -- | 1300 | 1200 | 1400 | 6000 | 2100 | 1200 | 1600 | 1600 | 1000 | 1100 | 1850 |

**Notes**

(1) Illinois General Use Water Quality Standards (WQS) and Illinois Water Quality Criteria (WQC) are used as surface water effects values

(2) Maximum detected concentrations reported between December 2010 and February 2015 If a constituent was not detected during this timeframe, the maximum reporting limit is presented in the table, indicated with a "U" qualifier For pH, the range is presented.

(3) Average of well-specific concentrations (maximums) presented in the table If the maximum is a non-detect result, one-half the reporting limit was used as a surrogate concentration in the calculation For pH, the range presented in the "average" column is the average minimum and average maximum

mg/L = milligram per liter
s u = standard units
"--" = value not available
U = constituent not detected above its reporting limit
bold/shading = concentration exceeds effects value

***SIERRA CLUB, ET AL. V. MIDWEST GENERATION, LLC* PCB 13-15**

**RESPONSE TO MOTION TO STRIKE**

# EXHIBIT C

# REBUTTAL REPORT TO EXPERT REPORT OF JOHN SEYMOUR, P.E.

James R. Kunkel, Ph.D., P.E.
11341 West Exposition Drive
Lakewood, CO 80226

| | | |
|---|---|---|
| In the Matter of: | ) | |
| | ) | |
| SIERRA CLUB, ENVIRONMENTAL | ) | |
| LAW AND POLICY CENTER, | ) | |
| PRAIRIE RIVERS NETWORK, and | ) | |
| CITIZENS AGAINST RUINING THE | ) | |
| ENVIRONMENT | ) | |
| Complainants, | ) | PCB 2013-015 |
| v. | ) | (Enforcement – Water) |
| MIDWEST GENERATION, LLC, | ) | |
| Respondent. | ) | |
| | ) | |
| | ) | |
| | ) | |
| | ) | |

# Rebuttal Report to Expert Report of John Seymour, P.E.

## James R. Kunkel, Ph.D., P.E.

## December 8, 2015

Tel: 303-986-0562 Cel: 720-443-9136

## INTRODUCTION,

This expert rebuttal report provides my responses to expert opinions of John Seymour, P.E. related to my Expert Report on Ground-water Contamination (Kunkel, 2015a) and my Expert Report on Remedy for Ground-water Contamination (Kunkel 2015b) for Midwest Generation, LLC's (MWG's) Joliet #29, Powerton, Waukegan, and Will County coal-fired power plants.

My rebuttal responses will emphasize, but not necessarily be limited to, the following:

- Much of Seymour's expert report (Seymour, 2015) is unsound and incorrectly interprets the available data and information;
- The indicator pollutants I use for ground-water contamination from coal ash are consistent with USEPA, EPRI and IEPA documents;
- The concentrations of the indicator pollutants in ground water at the four plant sites are much higher than background. This shows that the ground water at the four sites is likely contaminated by a coal ash source. I utilized the same background data for the indicator pollutants as IEPA utilized in their coal ash assessment, except at Powerton where background data at MW-16 (the only true background well at the four plant sites) agrees with the IEPA background for sand and gravel aquifers;
- At Joliet #29, Powerton and Will County sites, no other potential sources of indicator pollutants, except coal ash, are present up-gradient. At Waukegan, ground-water from the Greiss-Phleger Tannery site is not reaching the monitoring well network. Even if boron from the tannery site were reaching the monitoring network, the concentrations of boron in the tannery ELUC wells (up-gradient) are much lower than in monitoring wells located within the old ash storage area just west of the ash ponds. Therefore, I conclude that none of the boron is coming from the tannery;
- The ground-water concentrations are temporally and spatially consistent at each of the four plant sites;
- Ground-water contamination at all four plant sites has generally remained the same, at high concentrations for the monitoring period between Dec. 2010 through present, which confirms my opinion that the actions taken by MWG will not solve the ground-water contamination issues at the four sites;
- MWG's actions will not significantly reduce or eliminate ground-water contamination from coal ash at the four sites; and
- My proposed remedy (Kunkel, 2015b) is economically reasonable compared to other source-term removal remedies or ground-water remediation.

## CONTAMINATION IN THE MONITORING WELLS AT THE FOUR SITES IS COMING FROM COAL ASH

I chose the correct indicator pollutants, which are those accepted by other experts and regulators (Kosson and others, 2009; EPRI, 2012; IEPA, 2013; USEPA, 2015). These indicator pollutants, comprised of boron (B), manganese (Mn) and sulfate ($SO_4$), are known to be the result of leaching of coal ash. As I indicated in my contamination report (Kunkel, 2015a), it is highly unlikely that the presence of these indicator pollutants together in the high concentrations found in the ground water at the four sites is the result of naturally occurring hydrogeologic formations or industrial processes other than coal-fired power plants. USEPA (2015) proposes using the following indicator constituents of ground-water contamination: B, chloride (Cl), conductivity, fluoride (F), pH, $SO_4$, sulfide ($S^{2-}$), and total dissolved solids. EPA makes special note of B and $SO_4$: "The high mobility of boron and sulfate explains the prevalence of these constituents in damage cases that are associated with groundwater impacts." (USEPA, 2015, p. 21456). In its technical support document for coal combustion waste impoundments in Illinois, IEPA (2013) states that "Boron, sulfate, and manganese are the same contaminants that have been found in recent hydrogeologic assessments of groundwater in multiple confirmed sample results collected from down-gradient dedicated monitoring wells adjacent to surface impoundment units containing

CCW at power generating facilities in Illinois. These contaminants were found to be attributable to these surface impoundment units".

I chose the correct background concentrations. IEPA (2013), in its technical support document for coal combustion waste impoundments in Illinois, utilized certain ground-water background concentrations for sand and gravel aquifers and bedrock aquifers to assess if contamination was present. I utilized these same background concentrations for my indicator pollutants at the Joliet #29, Waukegan and Will County sites because there are no up-gradient, background wells at these sites. The monitoring wells at these sites are immediately adjacent to the coal ash ponds and cannot be considered to be either up-gradient or background, because they are impacted by the coal ash ponds. At Powerton, MW-16 is likely up-gradient and has background ground-water concentrations of the indicator pollutants which closely match IEPA's background concentrations for sand and gravel aquifers. In my contamination report, the concentrations of indicator pollutants in MW-16 were utilized as up-gradient, background ground-water concentrations at Powerton.

The indicator contaminants are present in ground water in concentrations much higher than background. There is no evidence that there are up-gradient, off-site sources for the indicator pollutants at the four sites. Seymour (2015, numerous pages) opines that the post-2013 continuing ground-water contamination at the four sites is being caused by up-gradient, off-site sources. My ground-water contamination report (Kunkel, 2015a) describes the historical land uses up-gradient and off-site at each of MWG plant areas. At Joliet, the historical land use north and east of the property was mostly undeveloped land with the Des Plaines River on the south border of the property. There is no evidence of sources of B, Mn or $SO_4$ that could migrate on-site from adjacent properties. At Joliet #29, B concentrations are up to 21.7 times higher than the background B concentration of 0.12 mg/L. Mn concentrations are up to 22.2 times higher than the background Mn concentration of 0.072 mg/L. $SO_4$ concentrations are up to 7.4 times higher than the background $SO_4$ concentration of 54 mg/L. I conclude from this that there is past and continuing ground-water contamination by the indicator pollutants of B, Mn and $SO_4$ at the Joliet #29 site and this contamination is from on-site sources.

At Powerton, the historical and current land use comprises the Illinois River to the north, industrial and residential properties to the east, agricultural land to the south, and Lake Powerton (Powerton Fish and Wildlife Area) to the west. There is no indication that these land uses could be sources for B, Mn, and $SO_4$ at the site. This is confirmed by Well MW-16, which is considered to be an up-gradient, background well. At Powerton, B concentrations are up to 21.5 times higher than the background B concentration of 0.20 mg/L. Mn concentrations are up to 4,330 times higher than the background Mn concentration of 0.003 mg/L. $SO_4$ concentrations are up to 32.6 times higher than the background $SO_4$ concentration of 43 mg/L at MW-16. I conclude from this that there is past and continuing ground-water contamination by the indicator pollutants of B, Mn and $SO_4$ at the Powerton site and this contamination is from on-site sources.

At Waukegan, the historical land use of interest was the Greiss-Phleger Tannery, which MWG alleges is the up-gradient source of B at the coal ash pond monitoring wells. This is highly unlikely for three reasons: (1) the ground-water flow away (down-gradient) from the tannery site is not toward the coal ash ponds or the monitoring wells, (2) the concentrations of B in the MW-10 through MW-14 (MW-13 is inactive) ELUC monitoring wells are the direct result of these wells having their screens completed in coal ash, and (3) the B concentrations in MW-10 through MW-14 are much less than those in the MW-5, MW-6, MW-7, MW-8, MW-9 and MW-15.

For example, Figure 1 shows recent MWG ground-water B concentration data for monitoring wells MW-5 through MW-15. Wells MW-10 through -14 (MW-13 is inactive) are ELUC wells which are up-gradient from the old coal ash storage area, and wells MW-5 through -9 and MW-15 are downgradient from the old coal ash storage area. Interpretation of the B concentrations on Figure 1 clearly show that the up-gradient wells (dashed lines) have B concentrations much lower than the down-gradient wells (solid lines). ENSR (1998d) boreholes

located near wells MW-10 through MW-14 (MW-13 is inactive) show that there is ash present in the soil which can account for the B and Mn concentrations at these monitoring wells, which were not part of the ash pond ground-water monitoring network.

At Waukegan, B concentrations in MW-1 through MW-9 are up to 408 times higher than the background B concentration of 0.12 mg/L. Mn concentrations are up to 13.8 times higher than the background Mn concentration of 0.072 mg/L. $SO_4$ concentrations are up to 22.2 times higher than the background $SO_4$ concentration of 54 mg/L. I conclude from this that there is past and continuing ground-water contamination by the indicator pollutants of B, Mn and $SO_4$ at the Waukegan site and this contamination is from on-site sources.

At Will County, the historical and current land uses consist of undeveloped land to the north, the Chicago Sanitary and Ship (CSS) Canal to the east, a quarry to the south, and the Des Plaines River to the west. There is no indication that these land uses could be sources for B, Mn and $SO_4$ in ground water at the site. At Will County, B concentrations are up to 22.1 times higher than the background B concentration of 0.12 mg/L. Mn concentrations are up to 34.5 times higher than the background Mn concentration of 0.072 mg/L. $SO_4$ concentrations are up to 45.3 times higher than the background $SO_4$ concentration of 54 mg/L. I conclude from this that there is past and continuing ground-water contamination by the indicator pollutants of B, Mn and $SO_4$ at the Will County site and this contamination is from on-site sources.

My rebuttal responses above to Seymour's allegations regarding the ground-water contamination at the four MWG plant sites include several important facts which show Seymour is incorrect in his allegations or has misinterpreted the ground-water quality data and other information which universally has been agreed to by MWG and IEPA since before the site characterization in late 2010.

**The Leachate Test that Seymour Utilized is not Representative of Field Conditions in the Coal Ash Ponds**

Seymour (2015, p. 40) claims that *"Recent Groundwater Concentrations are Not the Result of Ash Stored in Lined Ponds"*, but rather ground-water contamination is from up-gradient, off-site sources entering each site. Seymour (2015, p. 51) concludes that *"Bottom Ash Indicator Constituents from Leachate Do Not Match the Groundwater Chemistry"*. Seymour bases these conclusions on the neutral leaching procedure from the American Society for Testing and Materials (ASTM) given in its D3987 test. This test, as established by IEPA in *415 Illinois Compiled Statutes 5/3.135* to determine if coal ash may be classified for beneficial use, is not appropriate or valid for establishing long-term leaching of coal ash (ASTM, 2012), which is occurring at the four plant sites. In its most recent publication of the neutral leaching test, ASTM (2012), in part, states the following in the Significance and Use section of the ASTM D3987-12 procedure:

- "4.1 This practice is intended as a rapid means for obtaining an extract of solid waste. The extract may be used to estimate the release of constituents of the solid waste under the laboratory conditions described in this procedure".
- "4.2 This practice is not intended to provide an extract that is representative of the actual leachate produced from a solid waste in the field or to produce extracts to be used as the sole basis of engineering design".
- "4.3 This practice is not intended to simulate site-specific leaching conditions. It has not been demonstrated to simulate actual disposal site leaching conditions".

Hattaway and others (2013) have proposed guidelines for a suite of test methods for coal ash which are more representative of field conditions. This suite of tests is known as the Leaching Environmental Assessment Framework (LEAF) and is designed to replace the single-point pH tests such as the Toxicity Characteristic Leaching Procedure (TCLP), Synthetic Precipitation Leaching Procedure (SPLP) and ASTM D3987, which

typically utilize large liquid to solids (by weight) ratios which are not representative of field conditions. An appropriate LEAF test for the ash pond solids is EPA 1313 (Hattaway and others, 2013). LEAF tests were utilized by the USEPA (Kosson and others, 2009) in their coal ash characterization report. I relied on Kosson and others (2009) for my opinions in my ground-water contamination report (Kunkel, 2015a).

The two main reasons that the ASTM D3987 test does not accurately measure field leaching of coal ash is that (1) the liquid to solids ratio within the ponds and in the ground water is much lower than the 20 (liquid) to 1 (solids) ratio of the laboratory test, and (2) the pH of the laboratory test (pH = 7) is not representative of either the coal ash in the ponds or outside the ponds.

I conclude from the above that the use of ASTM D3987 by Seymour and other MWG consultants is incorrect and gives concentrations in the resulting test extracts which are much lower than would be expected from field conditions.

**Seymour's Matching Analysis of Coal Ash Leachate is Flawed**

Seymour's matching analyses is flawed for two reasons. Firstly, detection monitoring does not work on the assumption that you must match each ground-water constituent; instead the principle is that any one of the indicator pollutants can suggest the presence of coal ash leachate (EPRI, 2012). Secondly, a pollutant is not absent just because it is present at a concentration less than the detection limit. The detection limits used in the ASTM D3987-85 test procedure were sometimes 200 times higher than the quarterly ground-water detection limits. The constituents that were not detected in the ASTM test were, in fact, shown to be detected in the MWG 2014 quarterly ground water as well as in actual coal ash pond leachate for subbituminous/lignite impoundment leachate values (Seymour, 2015, Table 5-2). Seymour should have utilized those pond leachate data found in his Table 5-2 for his matching analyses.

Not only was Seymour's approach to matching flawed, but it was misapplied. If he had applied his approach correctly, he would have found a near-100 percent match to all the MWG 2014 quarterly ground-water sampling data. For example, I reanalyzed the "matching" of the ASTM D3987-85 test procedure results obtained by Seymour (Table 5-1) to the 2014 MWG quarterly ground-water sampling data at the Waukegan plant site. Seymour (2015, Table 5-5) indicated that there was a match of between 74 and 84 percent of the time between the ASTM D3987-85 test procedure results and the Waukegan ground-water results for wells MW-1 through MW-7 for the 2014 quarterly data. I have reanalyzed the match because the detection limits used in the ASTM D3987-85 test procedure were sometimes 200 times higher than the quarterly ground-water detection limits. I also utilized the EPRI (Seymour, 2015, Table 5-2) subbituminous/lignite impoundment leachate values and detection limits for comparison to the MWG 2014 quarterly ground-water values to determine if there was a match to ground-water concentrations if the ASTM D3987-85 test procedure results in Seymour's (2015) Table 5-1 showed a non-detect.

The attached Table 1 is my reanalysis of the Waukegan 2014 quarterly ground-water data to Seymour's list of indicator constituents which are found in impoundment coal ash leachate. My interpretation is that there is a nearly perfect match of the Waukegan 2014 quarterly ground-water data to indicator constituents of coal ash leachate presented by Seymour (2015) in his Tables 5-1 and 5-2. This match varies from a 95 percent match to the impoundment leachate indicator constituents for wells MW-2, MW-5, MW-6 and MW-7, to a 100 percent match for wells MW-1, MW-3 and MW-4.

Analyses of my Table 1 shows that the ASTM D3987-85 test procedure results (Seymour, 2015, Table 5-1) and the EPRI impoundment leachate results (Seymour, 2015, Table 5-2) showed consistency for all the leachate indictor constituents except for iron. Therefore, my method of matching using MWG's 2014 quarterly ground-

water data and Seymour's (2015) Tables 5-1 and 5-2 provide near perfect matches to the observed ground-water contamination at Waukegan.

Additionally, if only my three indicator pollutants (B, Mn and $SO_4$) are analyzed, there is a 100 percent match to Seymour's leachate indicator constituents. Therefore, I further conclude that Seymour's use of the results from the ASTM D3987 to determine if the leachate "matches" the chemistry of the ground water underlying the ponds is incorrect and a gross misuse of the ASTM D3987 procedure and that there were leachate data available from his Table 5-2 which should have been utilized for these matches.

**<u>The Leachate Test that Seymour Utilized is not Representative of Field Conditions in Coal Ash Deposits Outside the Ash Ponds</u>**

Seymour (2015, p. 45) claims that *"Historical Ash in Fill Materials Outside of the Ponds is Not Adversely Impacting Groundwater"*, but rather ground-water contamination is from up-gradient, off-site sources entering each site. Seymour (2015, p. 52) concludes that *"There is No Evidence That Historical Coal Ash Outside of the Ash Ponds is a Source of Groundwater Impacts"*. Leaching of coal ash deposits outside the ash ponds at the four plant sites involves two possible scenarios: (1) leaching of coal ash by percolating rainfall and snowmelt, and (2) leaching of coal ash by the rising and falling of seasonal ground-water levels.

Leachate from this intermittent wetting and drying of coal ash will be significantly different than the extractant resulting from the ASTM D3987 procedure. Therefore, the ASTM D3987 procedure utilized by Seymour and other MWG consultants to characterize the coal ash outside the ponds is not applicable. In fact, the chemical process going on beneath the ponds, which leaked in the past and may continue to leak now, is one of pore-water equilibrating with the ash and or soil/ash mixtures in the ground water. This means that there are much lower liquid-to-solids ratios in the coal ash within the ponds and in the coal ash/soil outside the ponds. Additionally, a variable pH depending on the expected initial liquid pH, i.e. rain water, higher pH ground water, or other leaching solutions also is different than the neutral pH of 7 utilized in the ASTM D3987 test procedure.

Values of pH in the environment vary with both space and time. Rainfall pH (typically acidic; pH <7) is very different from ground-water pH (typically basic; pH >7) as well as coal ash leachate pH (typically basic). All rainfall ranges in pH from about 5.6 to 6.0 (nationwide) due to dissolution of $CO_2$ which forms carbonic acid (Skilling, 2002). In and near Chicago, June and August rainfall is most acidic with a pH of about 4.65. At other times during the year pH varies from about 4.79 to 5.68. Thus, using a neutral pH of 7.0 for the ASTM D3987 leach test will underestimate the concentrations of inorganics in leachate produced by the test procedure. Additionally, the ASTM D3987 procedure's Significance and Use item 4.1 through 4.3 above indicate that the test is not representative of field conditions (ASTM, 2012).

Time series data of ground-water quality collected at the four sites since late 2010 also shows that the existing ground water at all four sites is typically greater than pH 7 and often is greater than pH 8. As with lower (acidic) pH values, higher, more basic pH can facilitate greater leaching than neutral pH. This indicates that the use of the ASTM D3987 procedure to assess leachate concentrations from coal ash is invalid. As indicated above, the processes occurring both at the ground surface and beneath the ground surface relative to coal ash leaching are not single-point pH related but rather chemical equilibration of the liquid phase with the solid coal ash phase to produce the site-specific concentrations of contaminants presented in MWG's quarterly reports. An appropriate LEAF test for the coal ash within and outside the ash ponds is EPA 1313 (Hattaway and others, 2013), the same test procedure utilized by Kosson and others (2009) to characterize coal ash leachate. I relied on Kosson and others (2009) for my opinions in my ground-water contamination report (Kunkel, 2015a).

**<u>Seymour is Incorrect that there is no Evidence of Spatial and Temporal Consistency in Ground-Water Impacts</u>**

Seymour (2015, pp. 15, 18, 21 and 23) claims that there is no "... evidence that there is spatial or temporal consistency in groundwater impacts, [and] it is my opinion that there is no plume ..." at the four MWG plant sites. This is incorrect. A contaminant plume can exist without spatial or temporal consistency but in this case there is both spatial and temporal consistency as well as a contaminant plume at each of the four plant sites. The monitoring networks at each plant site show consistently high ground-water contamination by the indicator pollutants since monitoring began. Nearly all the monitoring wells are downgradient from the coal ash ponds and other coal ash deposits.

What variability there is in the ground-water concentrations is consistent with continued contamination from coal ash. Continued leaching of coal ash outside the ponds by rising and falling ground-water levels will contribute to the observed ground-water contamination at each of the plant sites. Seasonal variations in ground-water contamination from the indicator pollutants would be expected at each site due to these rising and falling ground-water levels. There is both spatial and temporal consistency in accordance with seasonal variability.

**MWG'S ACTIONS ARE NOT APPROPRIATE TO SIGNIFICANTLY REDUCE OR ELIMINATE GROUND-WATER CONTAMINATION FROM COAL ASH AT THE FOUR SITES**

My rebuttal responses to MWG's past actions at the four power plant sites include the following:

- The Compliance Commitment Agreement (CCA) remedies for each of the four sites will not reduce existing or future ground-water contamination from coal ash deposits and leaky liners;
- Liner construction did not follow normally acceptable engineering standards;
- Dredging of coal ash from the ponds will continue to be a potential source of liner tears and leaks;
- GMZ's and ELUC's do not address the continuing ground-water contamination at the four sites; and
- Monitoring is not addressing the reduction or elimination of ground-water contamination.

The CCA remedies for each of the four sites will not reduce existing or future ground-water contamination from coal ash deposits and leaky liners. The CCAs (IEPA, 2012a, b, c and d) set forth various supposedly remedial actions by MWG to eliminate ground-water contamination at the four sites. Ground water at the four sites is contaminated with constituents including Sb, As, B, Cl, Fe, Mn, $NO_3$, Hg, $SO_4$ and Se. Additionally, ground-water at the sites is affected by high pH and TDS immediately up-gradient and down-gradient from the ash ponds. The CCA remedies will not, in my opinion, reduce the ground-water contamination at any of the four sites because:

(1) Continued ground-water monitoring will not eliminate the ash pond liner leaks nor leaching of contaminants from past coal ash placement outside the existing ash ponds;
(2) None of the coal ash pond liners meet the engineering standards given by the USEPA (2015) coal ash rule;
(3) There is no provision in the CCA for cessation of use and removal of coal ash from the three ash ponds;
(4) There is no provision in the CCA for clean-up and removal of fill/construction coal ash placed outside the ash ponds nor for coal ash disposed of on land surface;
(5) Since MWG is continuing to use the same ash dredging techniques as in the past, relining the ash ponds will not reduce liner damage and subsequent liner leakage; and
(6) Hydrostatic uplift of plastic liners can occur at high ground-water levels.

Without removal of the coal ash sources at the four plant sites, ground-water contamination will continue unabated into the future. Creation of a Groundwater Management Zone (GMZ) or an Environmental Land Use Control (ELUC) area and installation of additional ground-water monitoring wells will not prevent the existing coal

ash sources from continuing to cause ground-water contamination into the future. Only partial or total removal of the coal ash sources can reduce ground-water contamination at the four power plant sites.

Liner construction during lining or relining of the coal ash ponds at the four sites did not follow normally acceptable engineering standards. Seymour (2015, p. 54) says that *"Ash Ponds are not Leaking and Construction Quality is Consistent with the Ash Pond Lining Quality Management Standards for Long-Term Use"*. Seymour (2015, p. 54. Footnote 158) claims that "... Schroeder (1994) [...] does not consider the frequency of leaks when certain construction quality assurance protocols are followed". This is untrue. Schroeder and others (1994) relate the frequency of liner construction defects to the degree of contact the plastic liner makes with the underlying subbase as summarized in Kunkel (2015a). They define this contact as either poor, fair, good or excellent. No matter how good the construction quality assurance is, there is a small likelihood that the degree of contact will be excellent, which can be achieved only in the laboratory or in small field lysimeters. Good contact is defined by Schroeder and others (1994) as good field installation with well-prepared, smooth soil surface and geomembrane wrinkle control to insure good contact between geomembrane and adjacent soil that limits the drainage rate through a liner defect.

Schroeder and others (1994) also discusses a liner placement quality known as "geotextile separating geomembrane liner and drainage limiting soil" which assumes liner leakage spreading, with the rate of leakage determined by the in-plane transmissivity of the geotextile separating the geomembrane and the adjacent soil or Poz-o-Pac layer that would have otherwise limited the drainage (Schroeder and others, 1994). In the case of the four MWG plant sites, the subbase is either unspecified prepared subgrade or Poz-o-Pac (Seymour, 2015, pp. 28–35). It is well documented by MWG that when some of the ponds were relined, the Poz-o-Pac was partially removed and geotextile placed between the Poz-o-Pac and/or soil subbase and the HDPE liner (Bates Nos. 9584, 9642, , 28418-28586, 49477-49478). The surface of the remaining Poz-o-Pac could not have been smooth enough to ensure a "good" contact with the HDPE liner. This conclusion is strongly supported by Bates Nos. 66-69, which mention that the MWG Poz-o-Pac liners are in "poor" condition. This type of construction is not standard engineering practice.

My opinion is that the existing ponds at the four plant sites do not meet the engineering standards set by the USEPA (2015) coal ash rule for lined ponds. That rule states (p. 21474) that, for existing coal ash surface impoundments, "... the owner or operator of an existing CCR surface impoundment must document whether or not such unit was constructed with any one of the following: (i) A liner consisting of a minimum of two feet of compacted soil with a hydraulic conductivity of no more than $1 \times 10^{-7}$ cm/sec; (ii) A composite liner that meets the requirements of §257.70(b); or (iii) An alternative composite liner that meets the requirements of §257.70(c). (2) The hydraulic conductivity of the compacted soil must be determined using recognized and generally accepted methods".

§257.70(b) of the rule states:

> "... A *composite liner* must consist of two components; the upper component consisting of, at a minimum, a 30-mil geomembrane liner (GM), and the lower component consisting of at least a two foot layer of compacted soil with a hydraulic conductivity of no more than $1 \times 10^{-7}$ centimeters per second (cm/sec). GM components consisting of high density polyethylene (HDPE) must be at least 60-mil thick. The GM or upper liner component must be installed in direct and uniform contact with the compacted soil or lower liner component. The composite liner must be: (1) Constructed of materials that have appropriate chemical properties and sufficient strength and thickness to prevent failure due to pressure gradients (including static head and external hydrogeologic forces), physical contact with the CCR or leachate to which they are exposed, climatic conditions, the stress of installation, and the stress of daily operation; (2) Constructed of materials that provide appropriate shear resistance of the upper and lower component interface to

prevent sliding of the upper component including on slopes; (3) Placed upon a foundation or base capable of providing support to the liner and resistance to pressure gradients above and below the liner to prevent failure of the liner due to settlement, compression, or uplift; and (4) Installed to cover all surrounding earth likely to be in contact with the CCR or leachate".

§257.70(c) of the rule states:

"If the owner or operator elects to install an alternative composite liner, all of the following requirements must be met: (1) An *alternative composite liner* must consist of two components; the upper component consisting of, at a minimum, a 30-mil GM, and a lower component, that is not a geomembrane, with a liquid flow rate no greater than the liquid flow rate of two feet of compacted soil with a hydraulic conductivity of no more than $1 \times 10^{-7}$ cm/sec. GM components consisting of high density polyethylene (HDPE) must be at least 60-mil thick. If the lower component of the alternative liner is compacted soil, the GM must be installed in direct and uniform contact with the compacted soil. (2) The owner or operator must obtain certification from a qualified professional engineer that the liquid flow rate through the lower component of the alternative composite liner is no greater than the liquid flow rate through two feet of compacted soil with a hydraulic conductivity of $1 \times 10^{-7}$ cm/sec. The hydraulic conductivity for the two feet of compacted soil used in the comparison shall be no greater than $1 \times 10^{-7}$ cm/sec. The hydraulic conductivity of any alternative to the two feet of compacted soil must be determined using recognized and generally accepted methods. The liquid flow rate comparison must be made using Equation 1 of this section, which is derived from Darcy's Law for gravity flow through porous media.

(Eq. 1) $$\frac{Q}{A} = q = k\left(\frac{h}{t} + 1\right)$$

Where, Q = flow rate (cubic centimeters/second);
A = surface area of the liner (squared centimeters);
q = flow rate per unit area (cubic centimeters/second/squared centimeter);
k = hydraulic conductivity of the liner (centimeters/second);
h = hydraulic head above the liner (centimeters); and
t = thickness of the liner (centimeters).

(3) The alternative composite liner must meet the requirements specified in paragraphs (b)(1) through (4) of this section".

There is no evidence in the record that MWG's coal ash ponds meet the above definitions of a lined pond in the USEPA (2015) coal ash rule.

Seymour (2015, p. 55) says that *"O&M of the Ash Ponds are Not Expected to Cause Leaks and O&M are Conducted in Accordance with Consistent Operating Procedures"*. Dredging of coal ash from the ponds will continue to be a potential source of liner tears and leaks. Excavators can damage plastic liners if less than 2-ft of soil overlies the plastic. Seymour's use of static load bearing calculations of equipment is not acceptable to assess the potential for liner damage from equipment because movement of the equipment, especially turning the equipment or suddenly braking the equipment, is a dynamic load which can cause stresses which will tear the liner. Even with 2 ft of protective soil over the liner, turns and sudden braking by trucks, excavators, and even pickups is discouraged (Narejo and Corcoran, 1996, Bates Nos. 49293-49361). MWG has photographs

and other documentation showing construction equipment on the pond liners covered only with the 1-ft sand "cushion" layer (Bates Nos. 49495, 49504). This is not acceptable engineering practice for liner construction.

GMZ's and ELUC's do not address the continuing ground-water contamination at the four sites. The GMZ's and ELUC's may not be large enough to ensure that they are effective in eliminating ground-water exposure pathways at the four sites. During establishment of the GMZ's/ELUC's, no consideration was given to the extent of other coal ash deposits at each site. GMZ's and ELUC's generally have not and will not lead to reductions in ground-water contamination at the four plant sites because they do not provide partial or total removal of the coal ash source terms which lead to ground-water contamination. At Will County, retirement of the Ponds 1-N and 1-S did not remove all of the coal ash and water and thus coal ash leachate has continued to enter the ground water.

Monitoring is not addressing the reduction or elimination of ground-water contamination. There were and are pathways for contamination from the ponds to enter the ground water prior to and after ash pond lining. The evidence does not show that site characterization, ground-water analytics, and implementation of administrative controls have eliminated exposure pathways nor ground-water impacts at any of the four sites. Kunkel (2015a) on Figures 5 through 7, 13 through 15, 22 through 25, and 29 through 31 shows the time series of the indicator pollutants at the four plant sites since monitoring began at the end of 2010. These figures show the following:

(1) At Joliet #29, the indicator pollutant concentrations in ground-water have increased in four monitoring wells and stayed essentially the same in seven monitoring wells.
(2) At Powerton, the indicator pollutant concentrations in ground-water have increased in six monitoring wells and stayed essentially the same in 10 monitoring wells.
(3) At Waukegan, the indicator pollutant concentrations in ground-water have increased in five monitoring wells and essentially stayed the same in 10 monitoring wells.
(4) At Will County, the indicator pollutant concentrations in ground water have increased in seven monitoring wells and essentially stayed the same in three monitoring wells.

The monitoring data do not show that contamination has been significantly reduced, let alone eliminated, after lining the ponds. My opinion is that ground-water monitoring does not show mitigation of ground-water contamination or exposure pathways.

Temporary or seasonal water table elevations at or above the pond liners (not necessarily the pond bottoms) are causes for concern due to the potential for hydrostatic uplift, reduction of the load-bearing capacity of the underlying soils, and ground-water inflows through cracks in the old Poz-o-Pac liners. Additionally, temporary or seasonal water table elevations at or above the pond liners are not permitted under the USEPA (2015) coal ash rule. Under the rule, the liners must be 5 ft above the highest ground-water elevation of the uppermost aquifer (§257.60 of the rule). Thus, except for possibly the Joliet #29 site, none of the MWG coal ash ponds can attain this 5-ft distance under their present locations.

It is untrue that hydrostatic uplift is a potential issue only for soil liners and not geomembrane liners. I have personal experience at the Colstrip Montana Steam Electric Station where ground-water hydrostatic uplift on a plastic liner caused the liner to fail. A rock underdrain was installed to reduce the ground-water hydrostatic uplift pressures. Also see §257.70(b) of the USEPA (2015) coal ash rule.

Seymour's evaluation of hydrostatic uplift assumed that the Poz-o-Pac liners were impermeable and added weight to offset the hydrostatic uplift. We have documentation at the Will County site that the Poz-o-Pac is cracked and allows ground-water to percolate upward into at least one ash pond (Bates Nos. 28850, 28862). We know that, as of 2006, all of the Poz-o-Pac liners dated from the late 1970s and were in poor condition (Bates

66-69). It is therefore reasonable to expect that other Poz-o-Pac liners are cracked, especially those ponds where part of the Poz-o-Pac was removed to maintain ash storage capacity when they were relined. If the ground-water rises above the bottom of the ponds only temporarily, there could still be hydrostatic uplift and the potential for liner failure.

Seymour (2015, p. 37) states that liner leak testing was done either prior to or after placement of the 1-ft sand "cushion" layer. Evidence (Bates Nos. 49495, 49504) shows that trucks drove on this 1-ft sand cushion layer to place the 6-in crushed limestone warning layer. This is not good engineering practice because the turning trucks, dozer spreading of the crushed limestone, and sudden braking or reversals of equipment could cause liner tears. No additional liner leak testing was done after placement of the 6-in crushed limestone warning layer in the ponds.

After dredging of the ash ponds using heavy equipment, there is no visual method to check for liner leaks caused by the dredging equipment. MWG has documented liner tears during dredging (for example, Bates No. 44621), but it is highly likely that some liner tears have gone unnoticed because of coal ash and the warning layer covering these liner failures.

**ECONOMIC REASONABLENESS OF THE PROPOSED REMEDY**

My remedy report (Kunkel, 2015b) has the only economically reasonable remedy to reduce the source terms for the indicator pollutants at the four plant sites. This remedy removes the coal ash ponds and selected ash storage areas outside the ash ponds. MWG's remedies of establishing GMZ's, ELUC's and ground-water monitoring does nothing to reduce the source terms. Lining of the coal ash ponds at the four plant sites also has not significantly reduced the indicator pollutant ground-water contamination at the four sites.

I conclude that removal of at least some of the coal ash source terms at the four plant sites is the most cost-effective method to reduce continuing ground water contamination. Other ground-water "clean-up" methods such as pump-and-treat or natural attenuation will be effective only if all, or a portion of, the source terms are removed. Additionally, pump-and-treat for B and $SO_4$ involves elaborate and expensive treatment processes such as membrane technologies and also would involve treatment of large volumes of water because all four plant sites are adjacent to water bodies. I conclude that source removal is more cost-effective than pump-and-treat, because it is more effective in reducing ground-water contamination and less costly. Source removal also is more cost-effective than natural attenuation even though natural attenuation is less costly.

MWG's remedial approach does not address all of the ground-water contamination source terms at the four sites. Seymour misinterprets the Kunkel (2015b) remedy report, which does not recommend removal of <u>all</u> the coal ash at the four plant sites, but rather removal of only the ash ponds and ash immediately adjacent to the ash ponds, the former fly ash disposal area at Waukegan, and, for Joliet #29, additional removal of the northeast ash landfill.

Seymour (2015, p. 63) objects to Kunkel's *"Costs of Soil Disposal at a Permitted Landfill."* Seymour states "It is my opinion that the Kunkel Remedy Report significantly underestimates the cost of proposed cleanup to remove all ash ponds and all CCRs in fill at the plants". He continues that Kunkel's proposed remedy (1) "... fails to incorporate the costs of disposal at a permitted landfill ..."; (2) "... does not account for significant and costly disruption at the generating plants ..."; (3) "... results in significant impacts to the surrounding communities, including dust, noise, and traffic ..."; and (4) "... fails to consider the impact of vehicle carbon dioxide emissions ...".

I utilized a cost range of $29.27 (low unit cost) to $42.95 (high unit cost) per ton for estimating the cost to remove the existing coal ash ponds and coal ash-impacted soils at each site, to haul the material removed to an existing landfill and to backfill the excavated areas for the proposed remedy. The unit soil tonnages and costs for the proposed remedy are based on a total impacted area of 196 acres for all four sites rather than the 1,064 acres assumed by Seymour (2015, p. 64). The remedy includes only ash pond removal and ash fill very near the ponds at the four sites, except at Waukegan where the costs include removal of the former fly ash disposal area, and at Joliet #29 where the costs include the removal of ash from the old NE Ash Landfill (Kunkel, 2015b, Table 6). Thus, all of Seymour's objections and his estimated costs and impacts are unwarranted because the remedy at any one of the four sites is most likely no different than a moderate construction project.

**CONCLUSIONS**

I have shown in this rebuttal report that:

(1) Much of Seymour's expert report (Seymour, 2015) is unsound and incorrectly interprets the available data and information;
(2) The indicator pollutants I use for ground-water contamination from coal ash are consistent with USEPA, EPRI and IEPA documents;
(3) The concentrations of the indicator pollutants in ground water at the four plant sites are much higher than background;
(4) I utilized the same background data for the indicator pollutants as IEPA utilized in their coal ash assessment, except at Powerton where background data at MW-16 (the only true background well at the four plant sites) agrees with the IEPA background for sand and gravel aquifers;
(5) At Joliet #29, Powerton and Will County sites, no other potential sources of indicator pollutants, except coal ash, are present up-gradient;
(6) At Waukegan, ground-water from the Greiss-Phleger Tannery site is not reaching the monitoring well network and, therefore, I conclude that none of the boron is coming from the tannery;
(7) The ground-water concentrations are temporally and spatially consistent at each of the four plant sites;
(8) Ground-water contamination at all four plant sites has generally remained the same, at high concentrations for the monitoring period between Dec. 2010 through present;
(9) MWG's actions will not significantly reduce or eliminate ground-water contamination from coal ash at the four sites; and
(10) My proposed remedy (Kunkel, 2015b) is economically reasonable compared to other source-term removal remedies or ground-water remediation.

Yours truly,

**JAMES R. KUNKEL, Ph.D., P.E.**

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**ATTACHMENTS**