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

RESPONSE TO MOTION FOR PARTIAL SUMMARY JUDGMENT

EXHIBIT 10

EXPERT REPORT ON GROUNDWATER CONTAMINATION BY JAMES R. KUNKEL
JULY 1, 2015

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Lakewood, CO 80226

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

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July 1, 2015

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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.

<u>Definitions of Terms Used in this Report</u>

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.

Methodology

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 - <u>Results and Evaluation of Environmental Contamination</u>"**. 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.

<u>Why the Powerton CCA will not Reduce Ground-water Contamination at the Powerton Site.</u>

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

<u>Conceptual Site Model</u>

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.

<u>**Available Data**</u>

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 - Results and Evaluation of Environmental Contamination"**, 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 - Results and Evaluation of Environmental Contamination"**. 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.

Why the Will County CCA will not Reduce Ground-water Contamination at the Will County Site

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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ATTACHMENTS

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Table 1

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

			Illinois State Water Quality		Federal Water Quality	
Constituent	**CAS**	**Units**	**Class I Groundwater MCLs (a)**	**Class II Groundwater MCLs (b)**	**USEPA MCLs (c)**	**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]		
	B	Mn	SO_4
Date	(mg/L)	(mg/L)	(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)

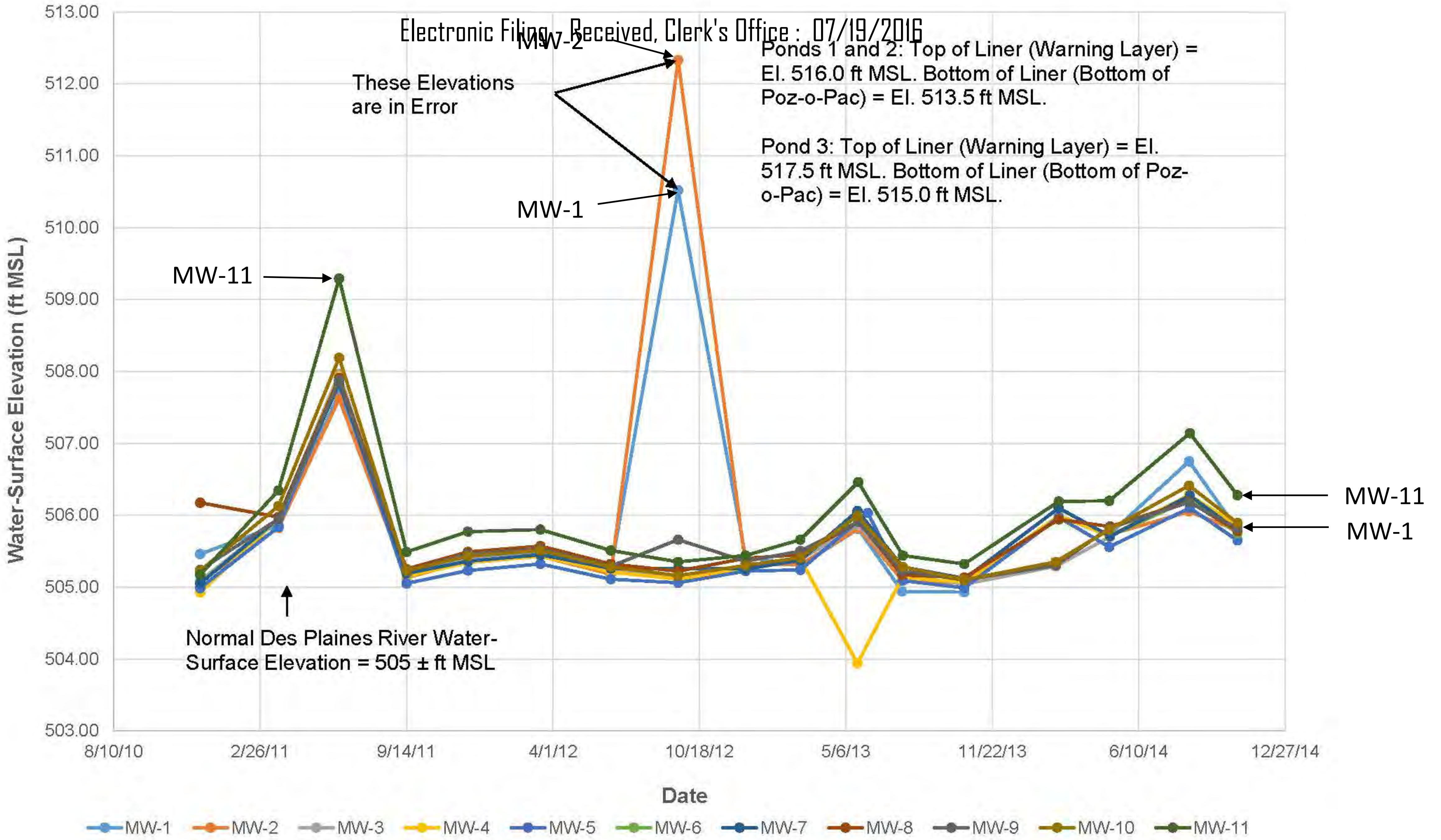


Figure 4 Joliet #29 Site Historical Ground-water Elevations (PCB 2013-015)

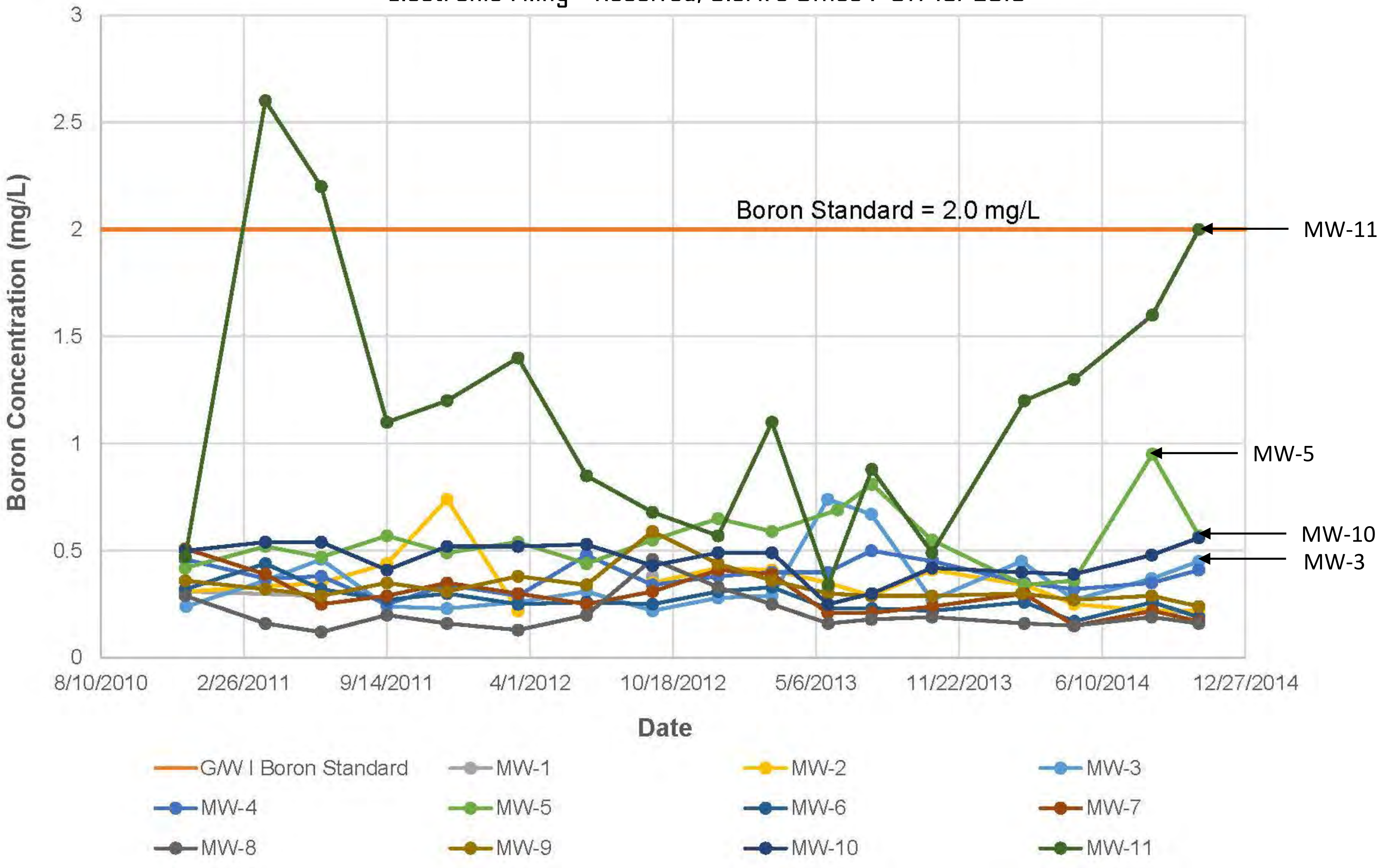


Figure 5 Boron Concentrations in Ground Water
Joliet #29 Site (PCB 2013-015)

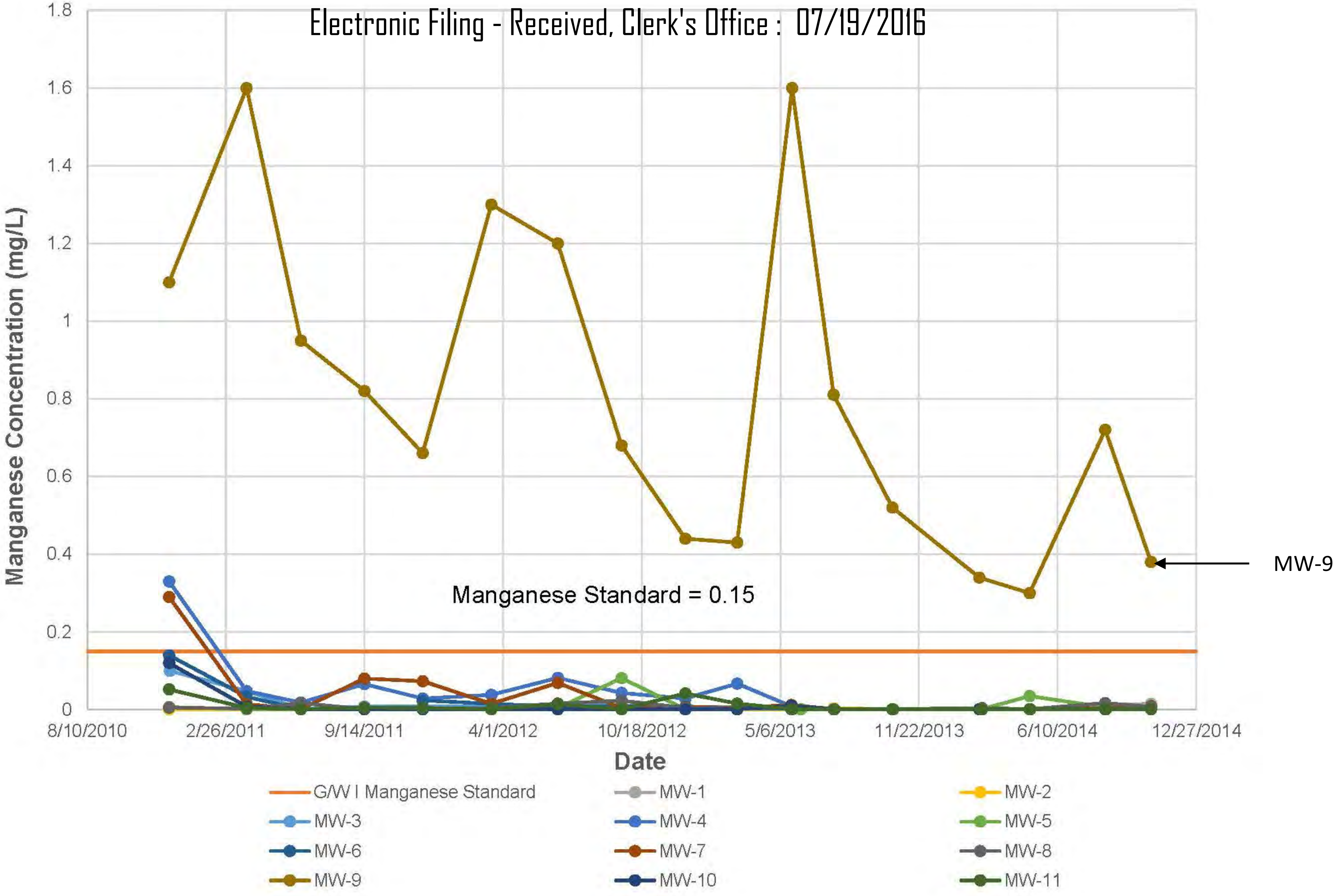


Figure 6 Manganese Concentrations in Ground Water
Joliet #29 Site (PCB 2013-015)

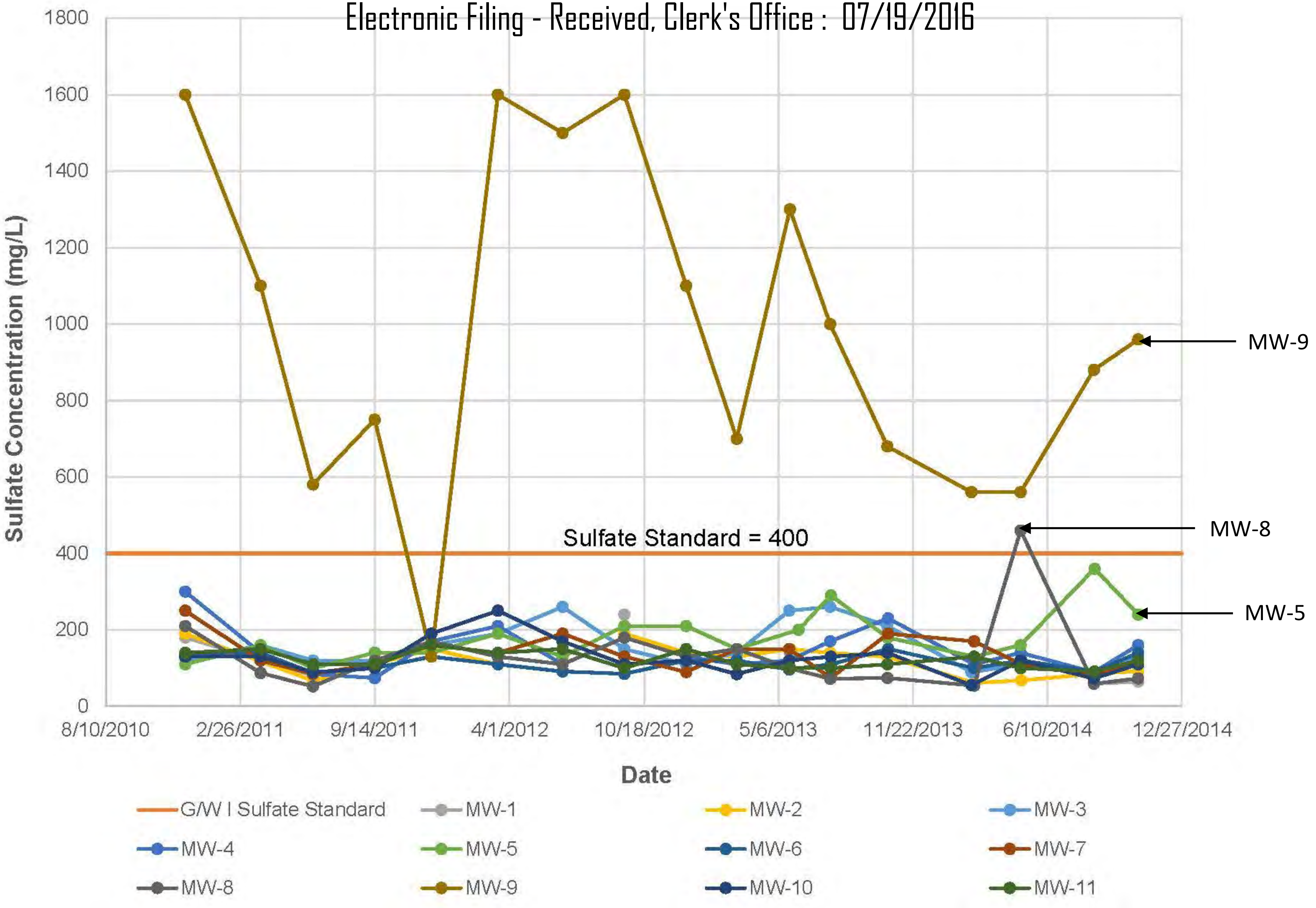


Figure 7 Sulfate Concentrations in Ground Water Joliet #29 Site (PCB 2013-015)

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

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

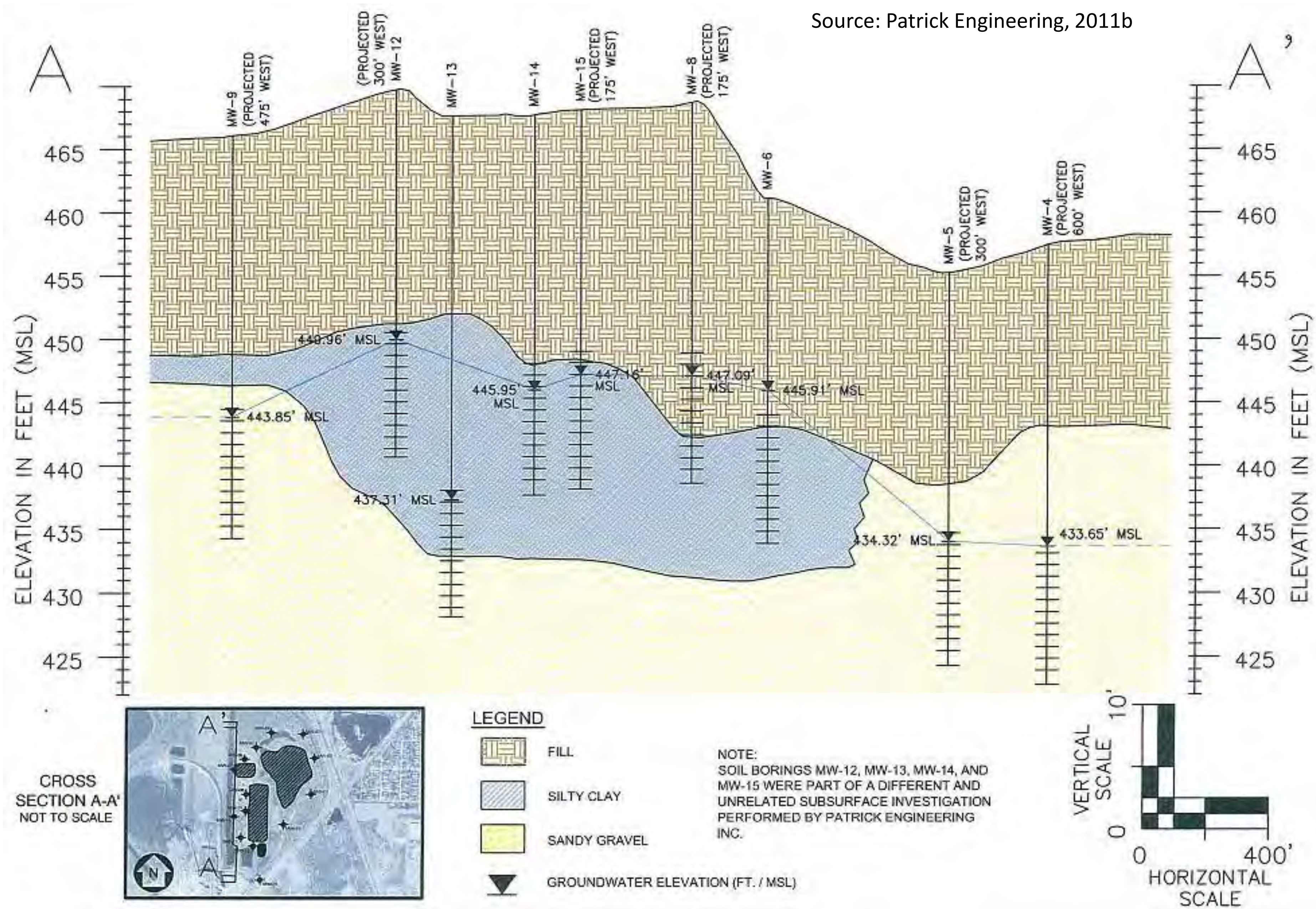


Figure 10 Powerton Soil Stratigraphy (PCB 2013-015)

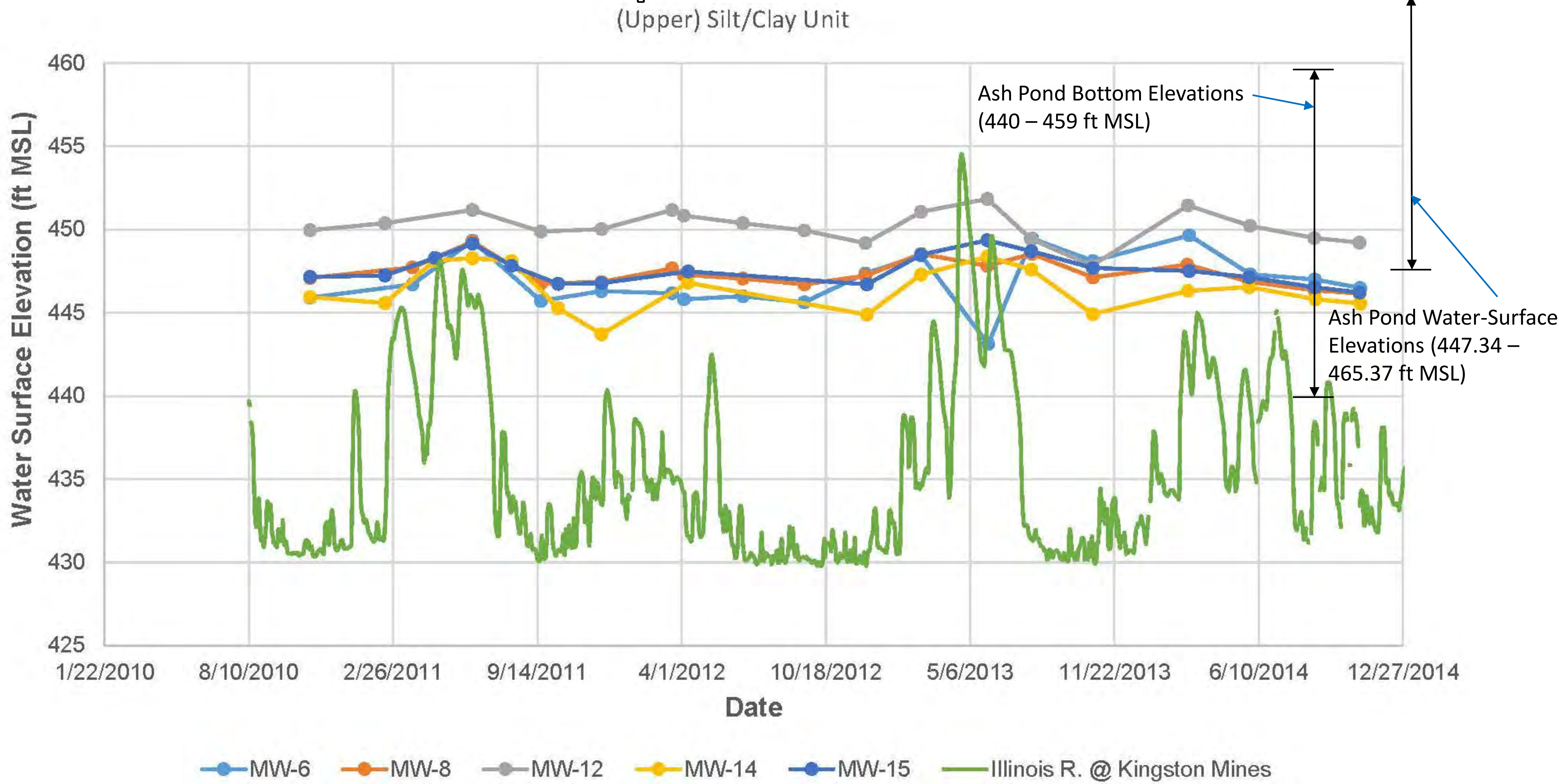


Figure 11 Powerton Site Historical Ground-water, Illinois River and Ash Pond Water-surface Elevations – Clay/Silt Unit (PCB 2013-015)

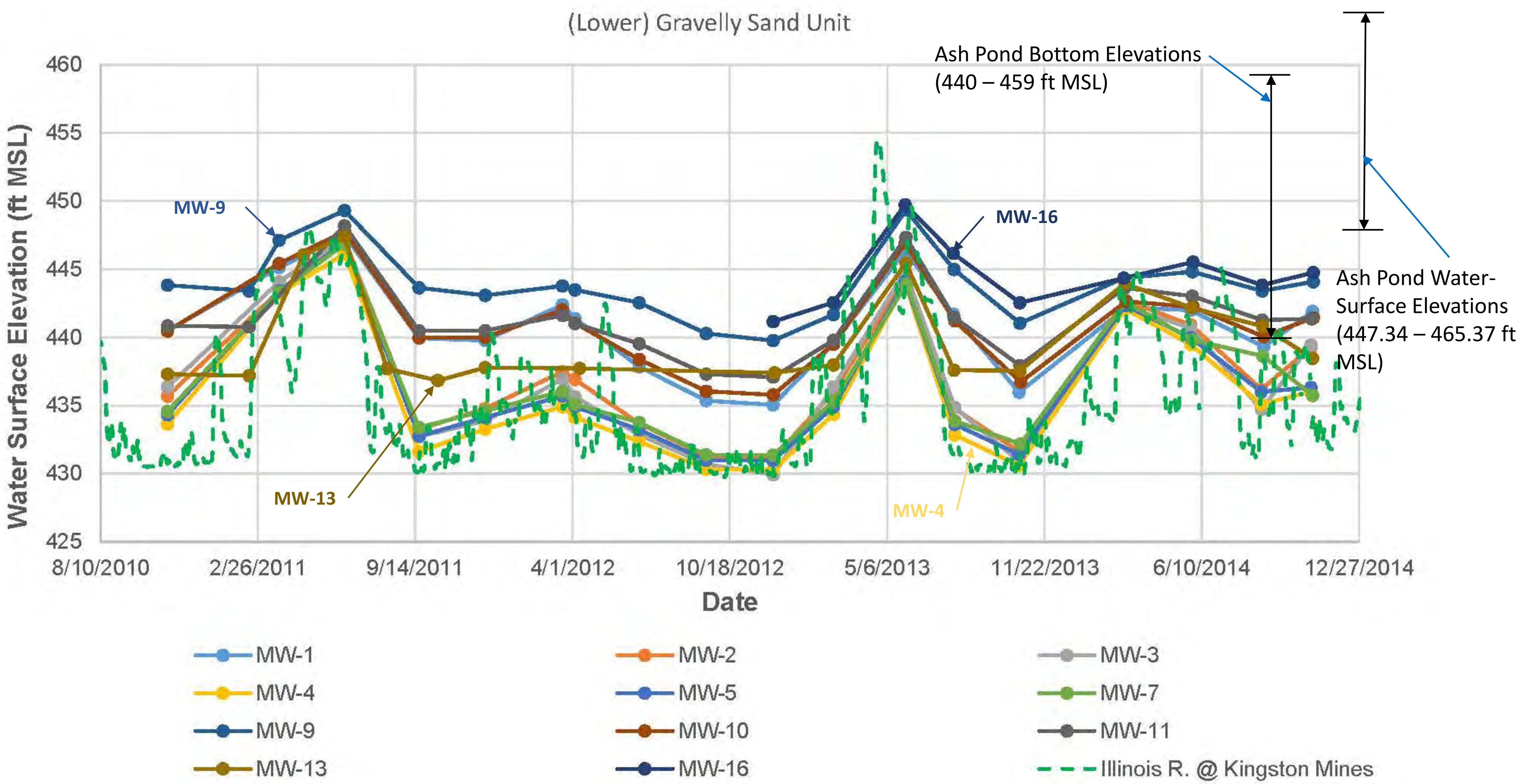


Figure 12 Powerton Site Historical Ground-water, Illinois River and Ash Pond Water-surface Elevations – Gravelly Sand Unit (PCB 2013-015)

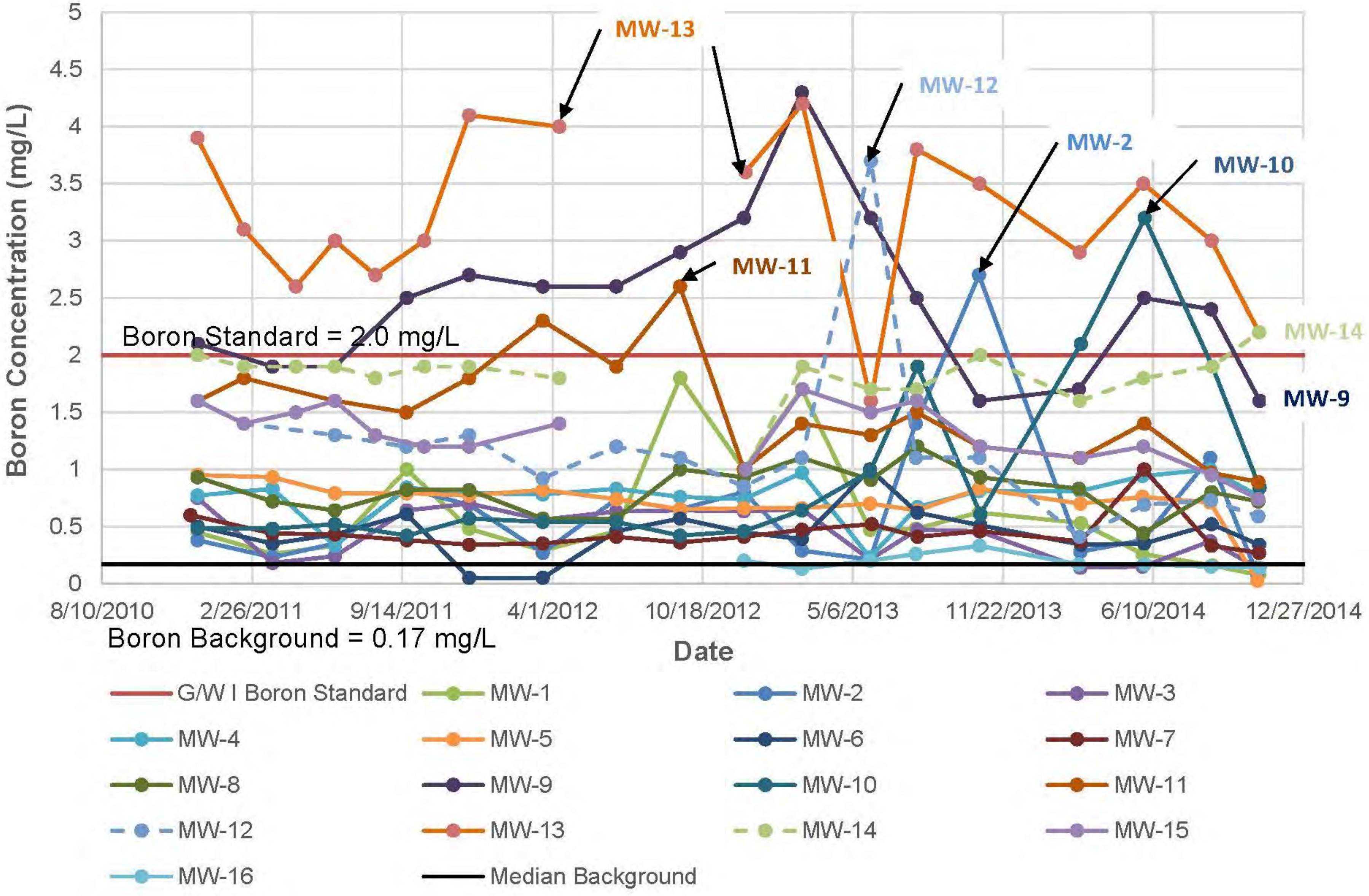


Figure 13 Boron Concentrations in Ground Water
Powerton Site (PCB 2013-015)

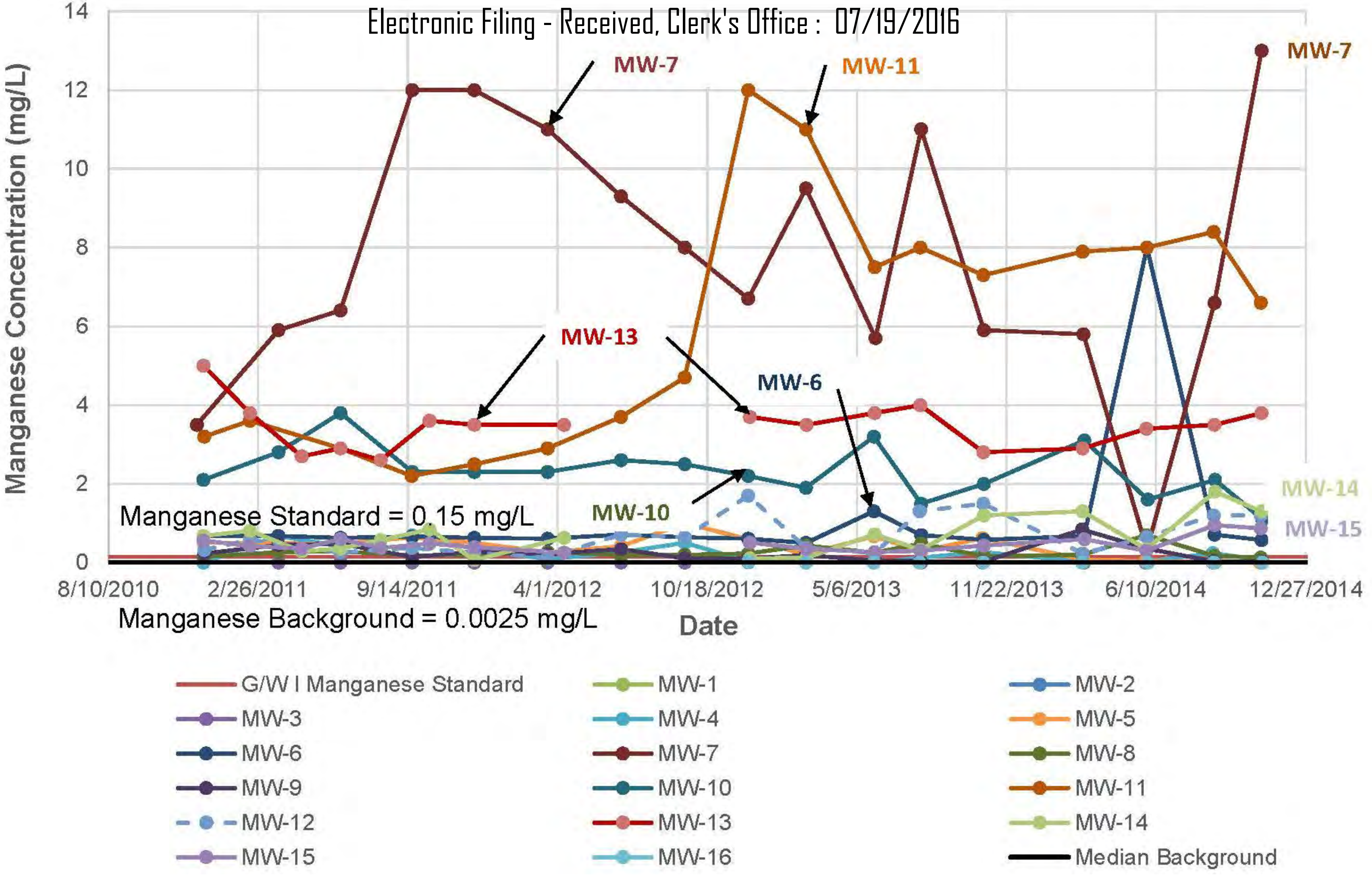


Figure 14 Manganese Concentrations in Ground Water Powerton Site (PCB 2013-015)

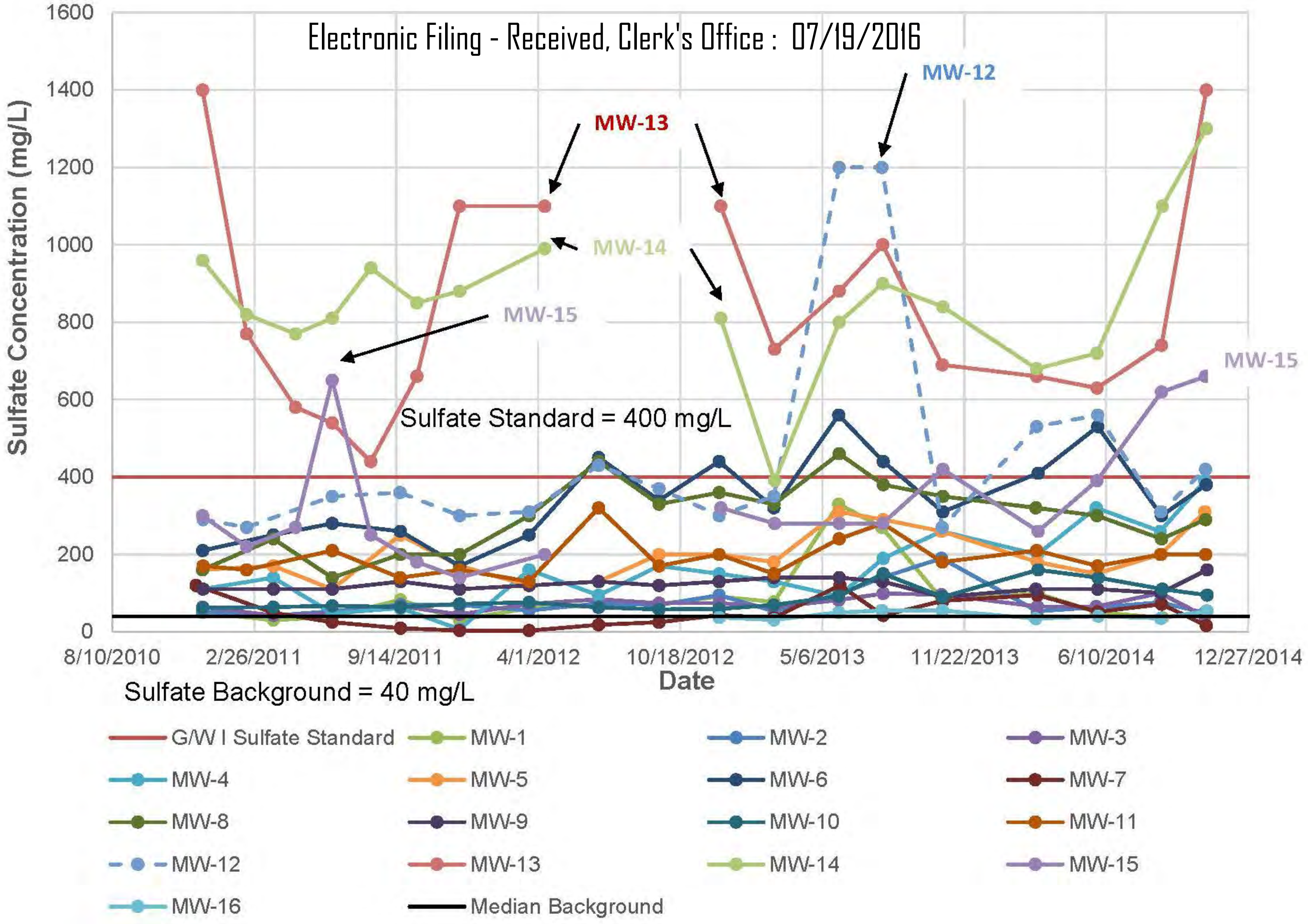


Figure 15 Sulfate Concentrations in Ground Water Powerton Site (PCB 2013-015)

DRAFT

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

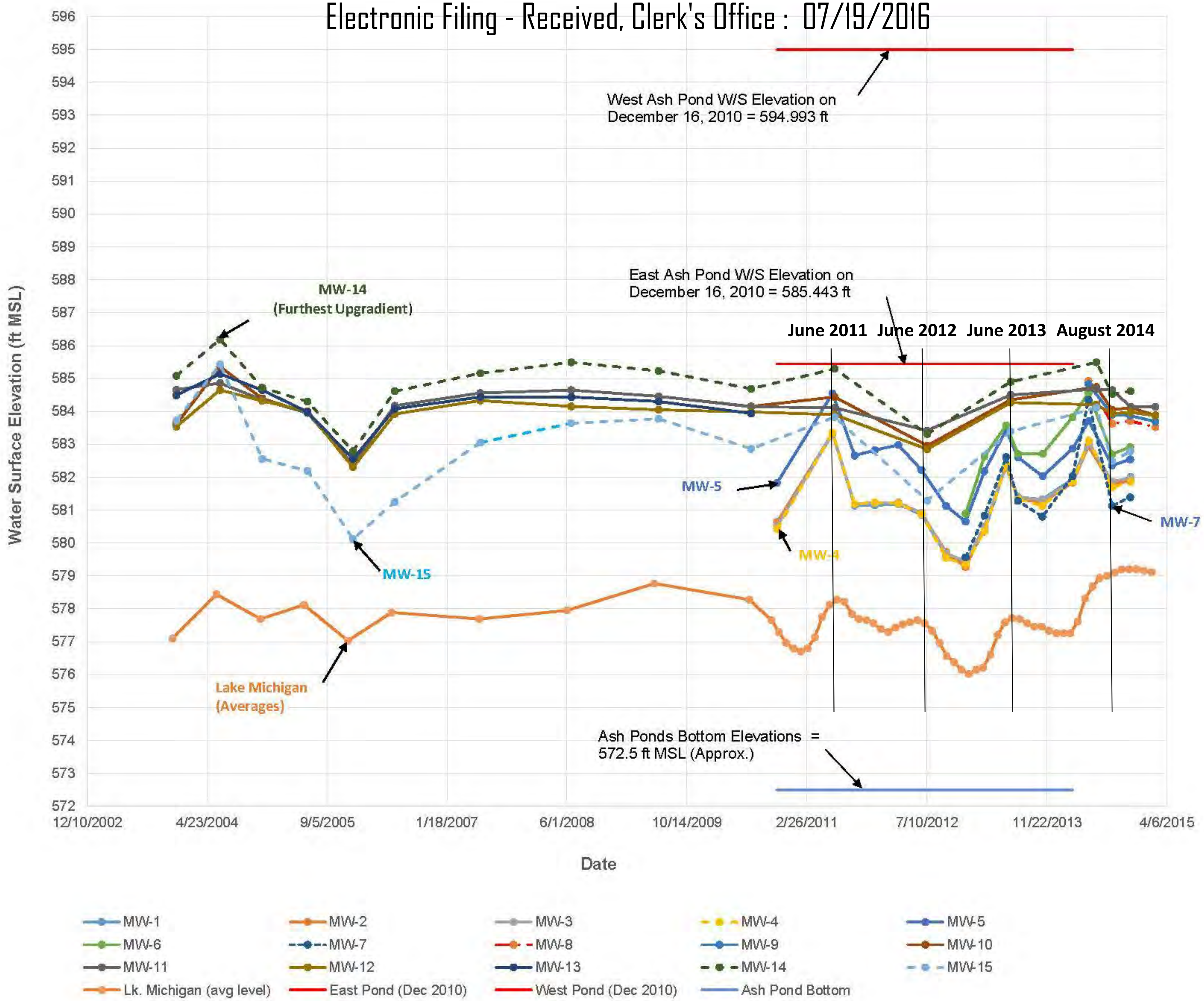


Figure 17 Waukegan Site Historical Ground-water, Lake Michigan and Ash Pond Water-surface Elevations (PCB 2013-015)

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)

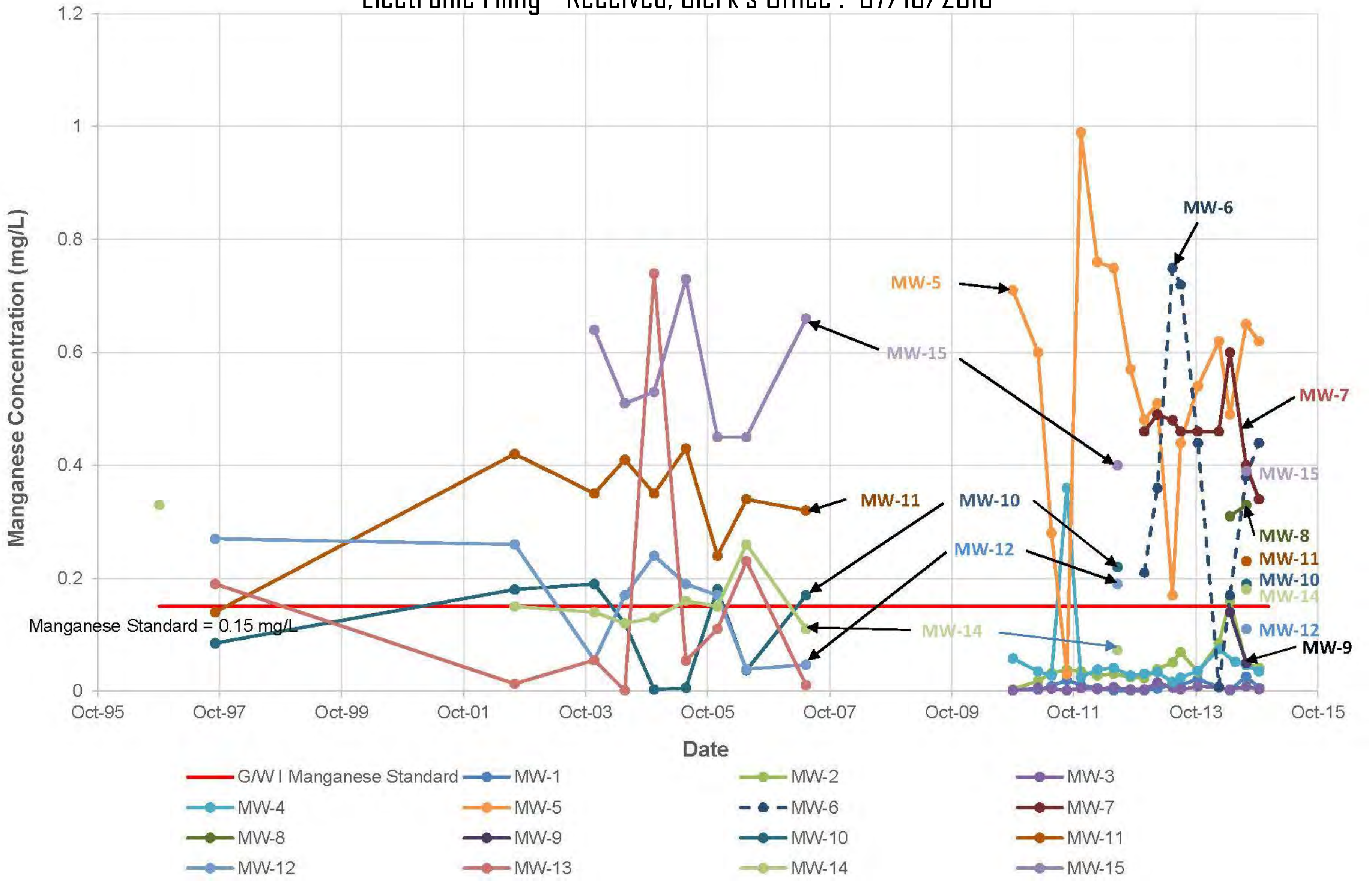


Figure 22 Manganese Concentrations in Ground Water Waukegan Site (PCB 2013-015)

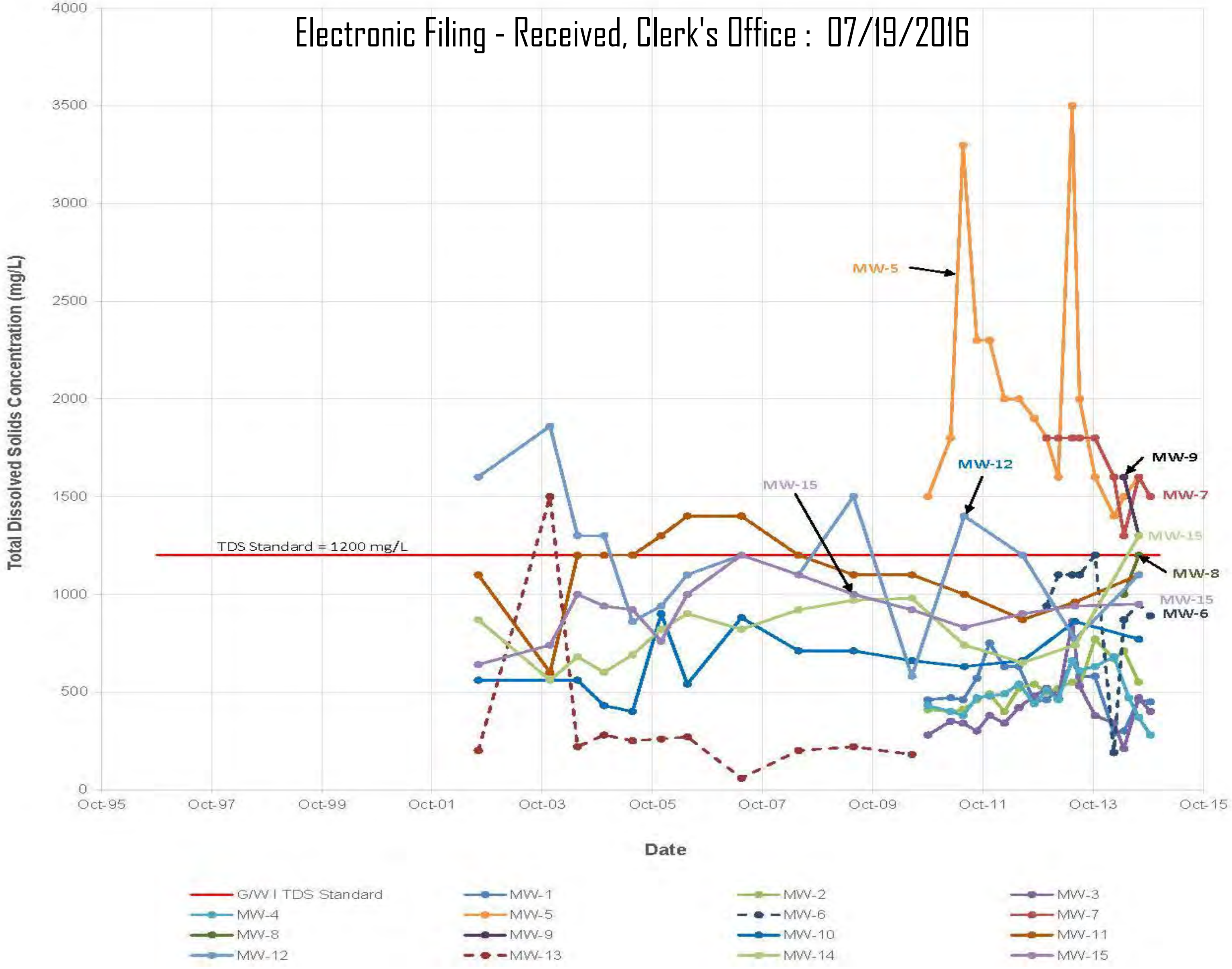


Figure 23 TDS Concentrations in Ground Water
Waukegan Site (PCB 2013-015)

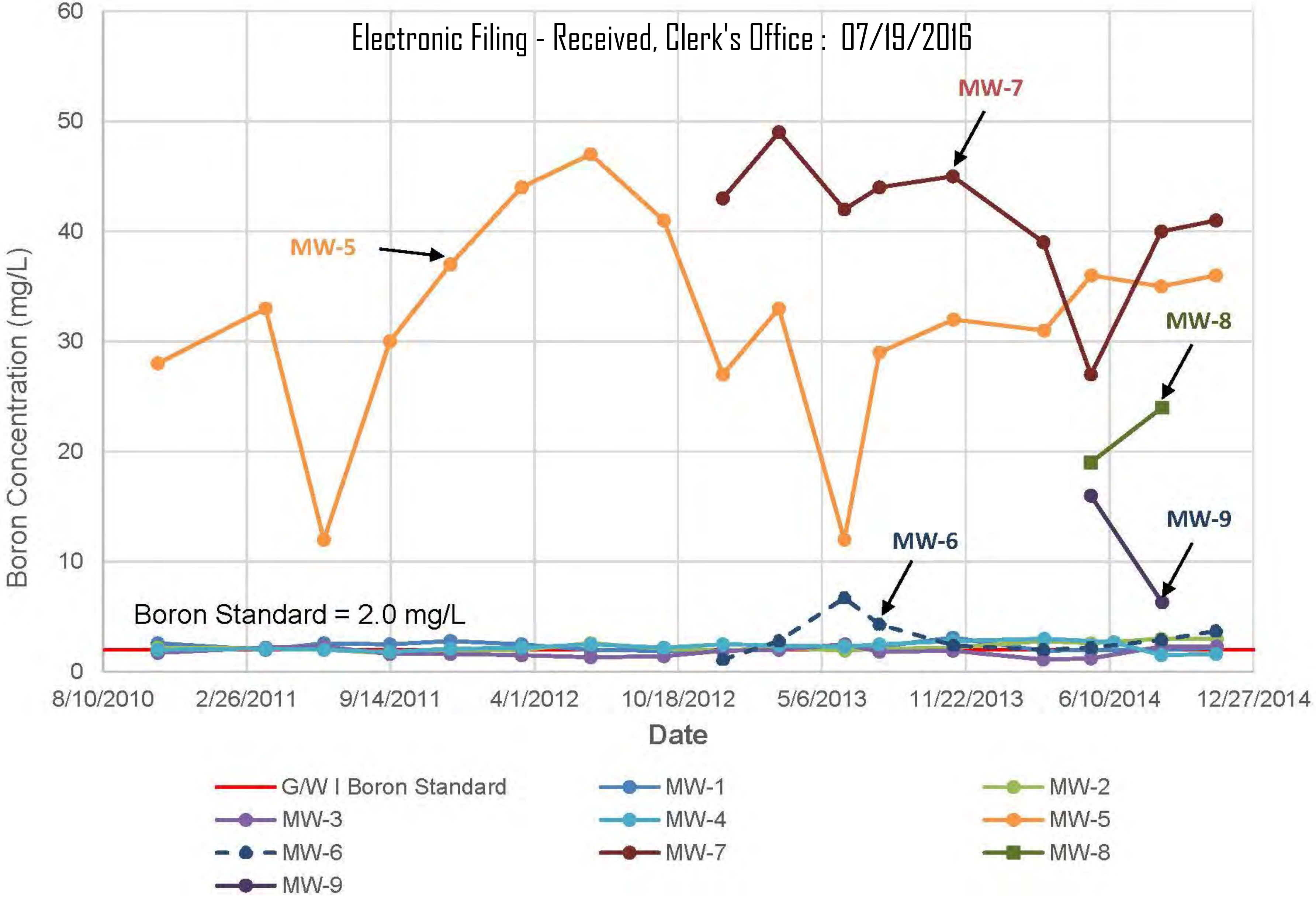


Figure 24 Boron Concentrations in Ground Water
Waukegan Site (PCB 2013-015)

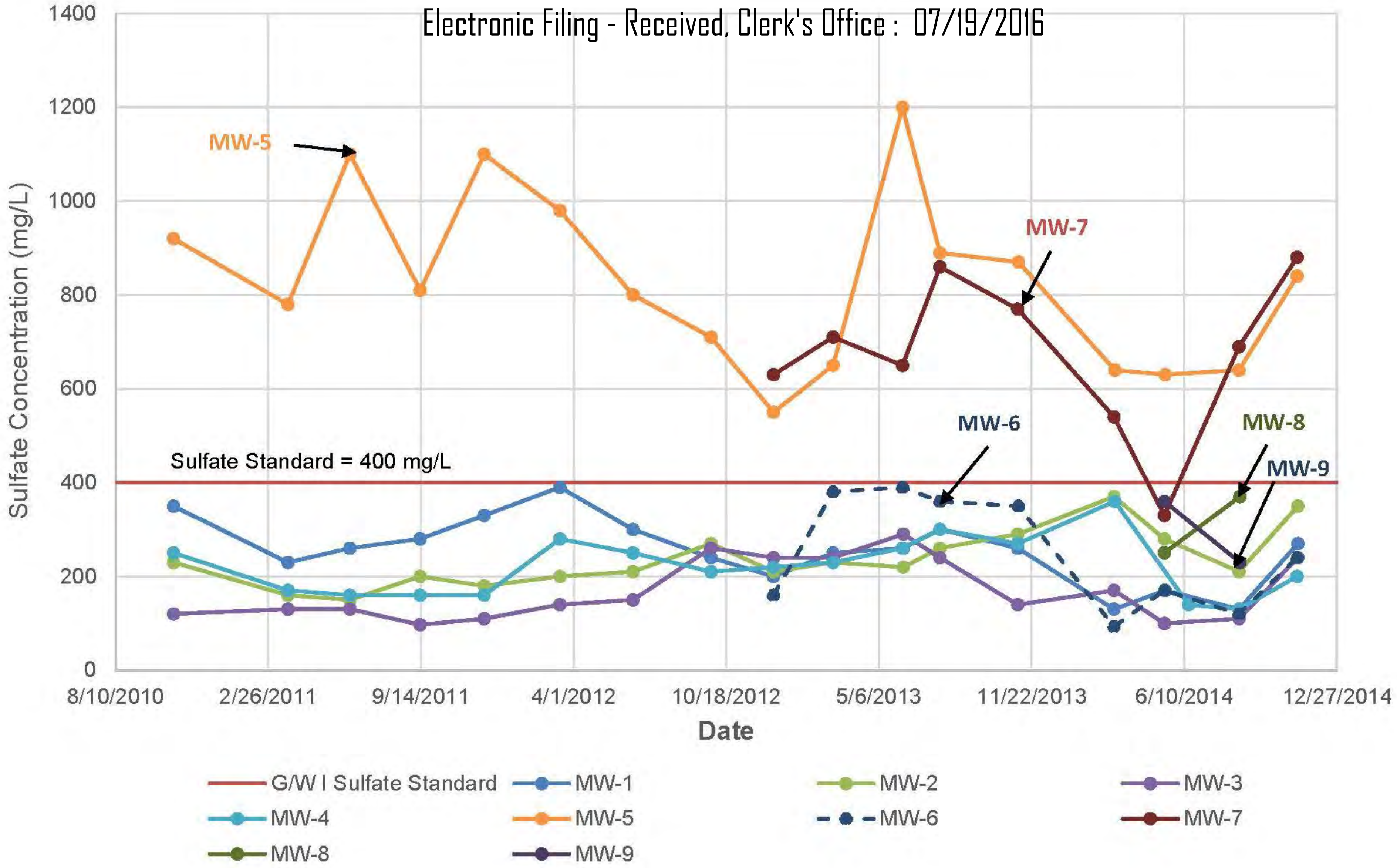


Figure 25 Sulfate Concentrations in Ground Water
Waukegan Site (PCB 2013-015)

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

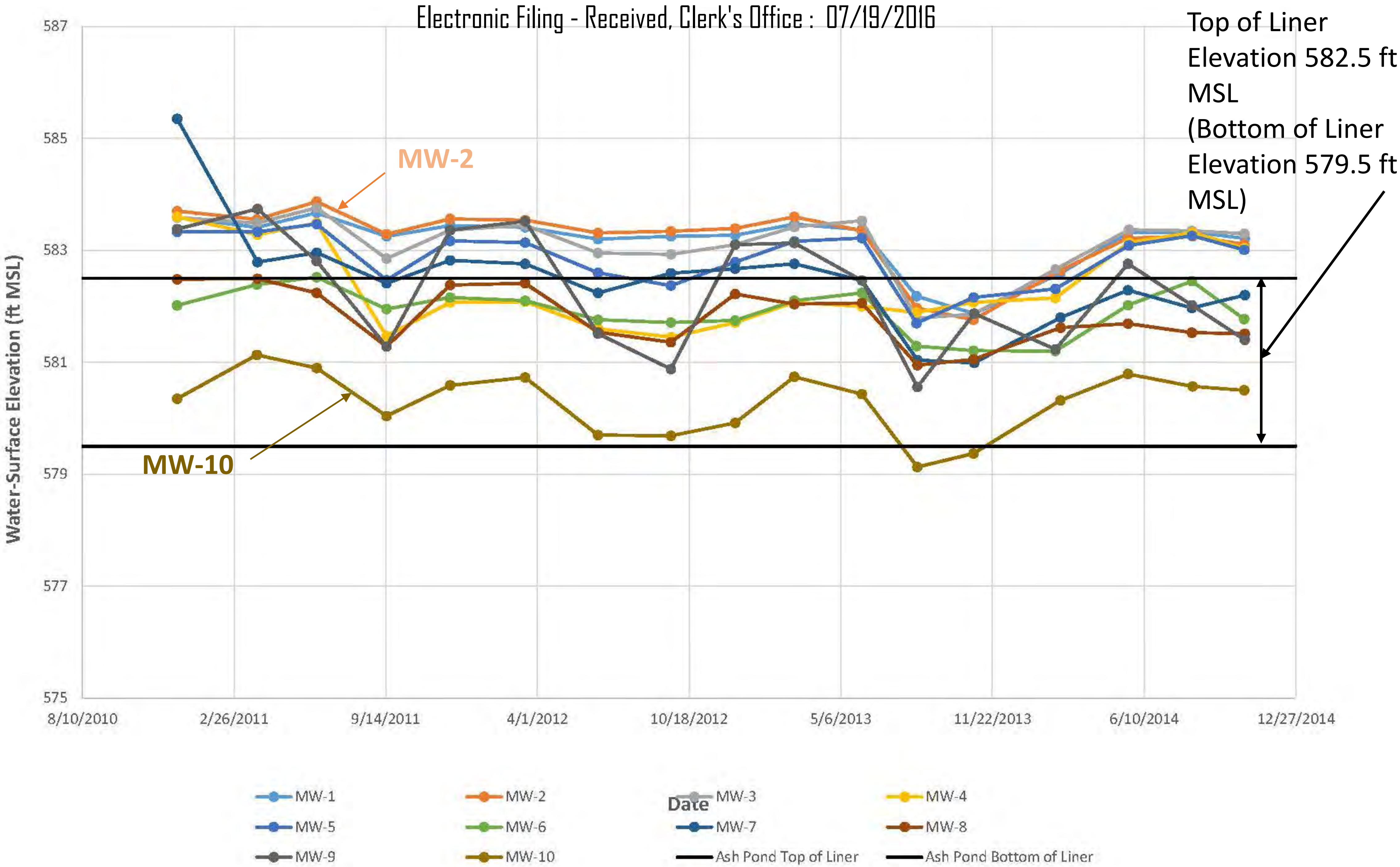


Figure 27 Will County Site Historical Ground-water Elevations (PCB 2013-015)

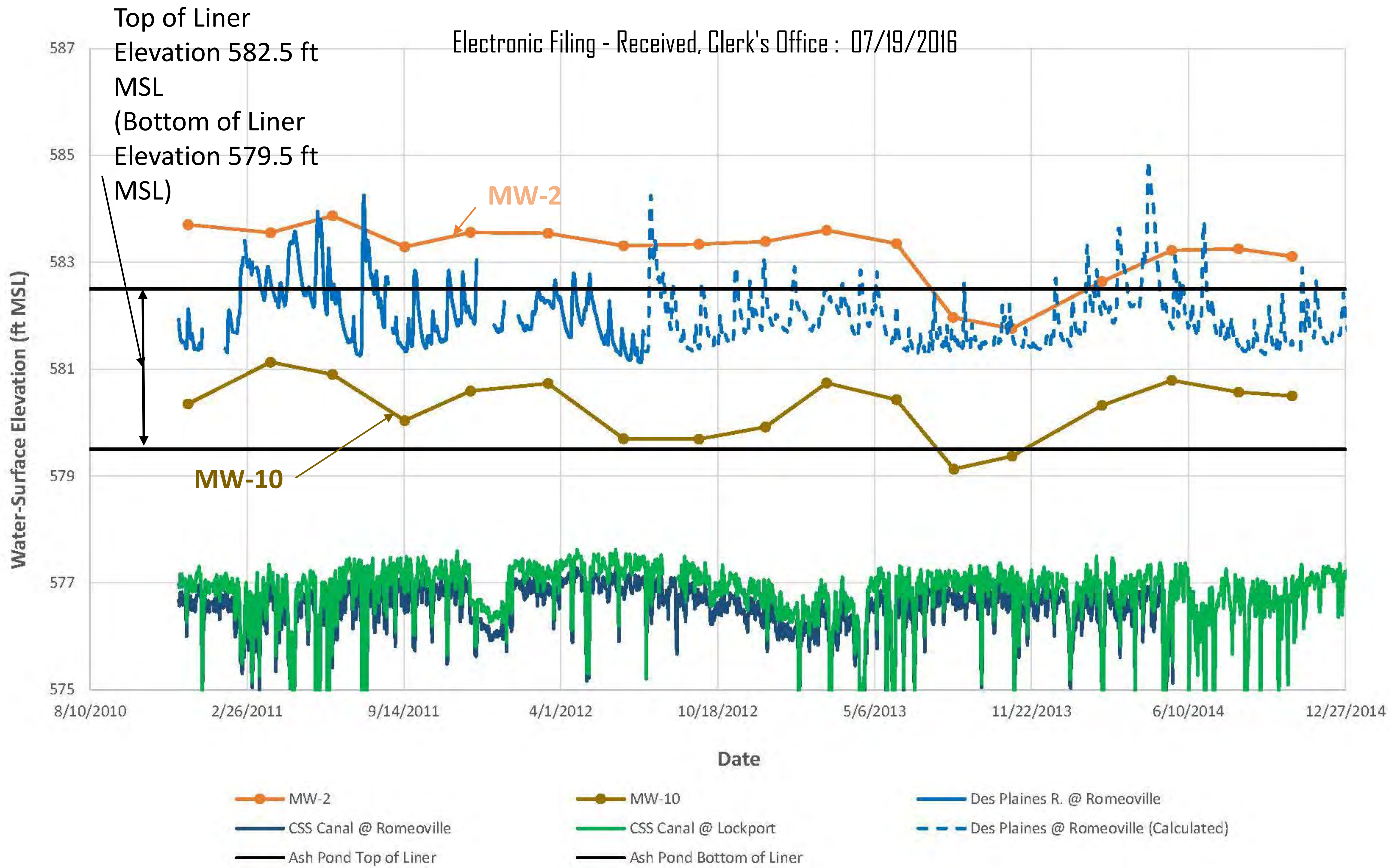


Figure 28 Will County Site Historical Des Plaines River and CSS Canal Water-surface Elevations (PCB 2013-015)

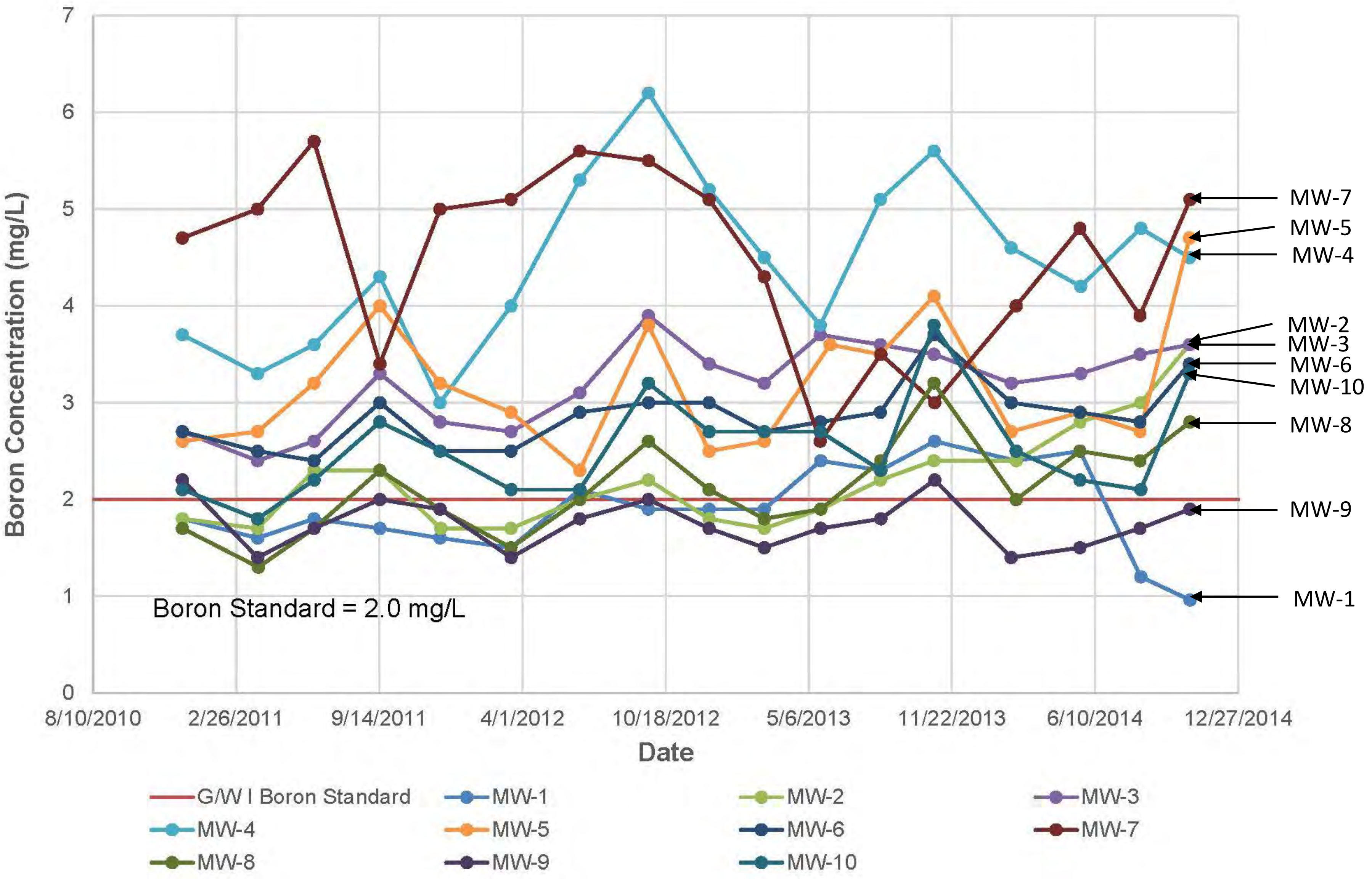


Figure 29 Boron Concentrations in Ground Water
Will County Site (PCB 2013-015)

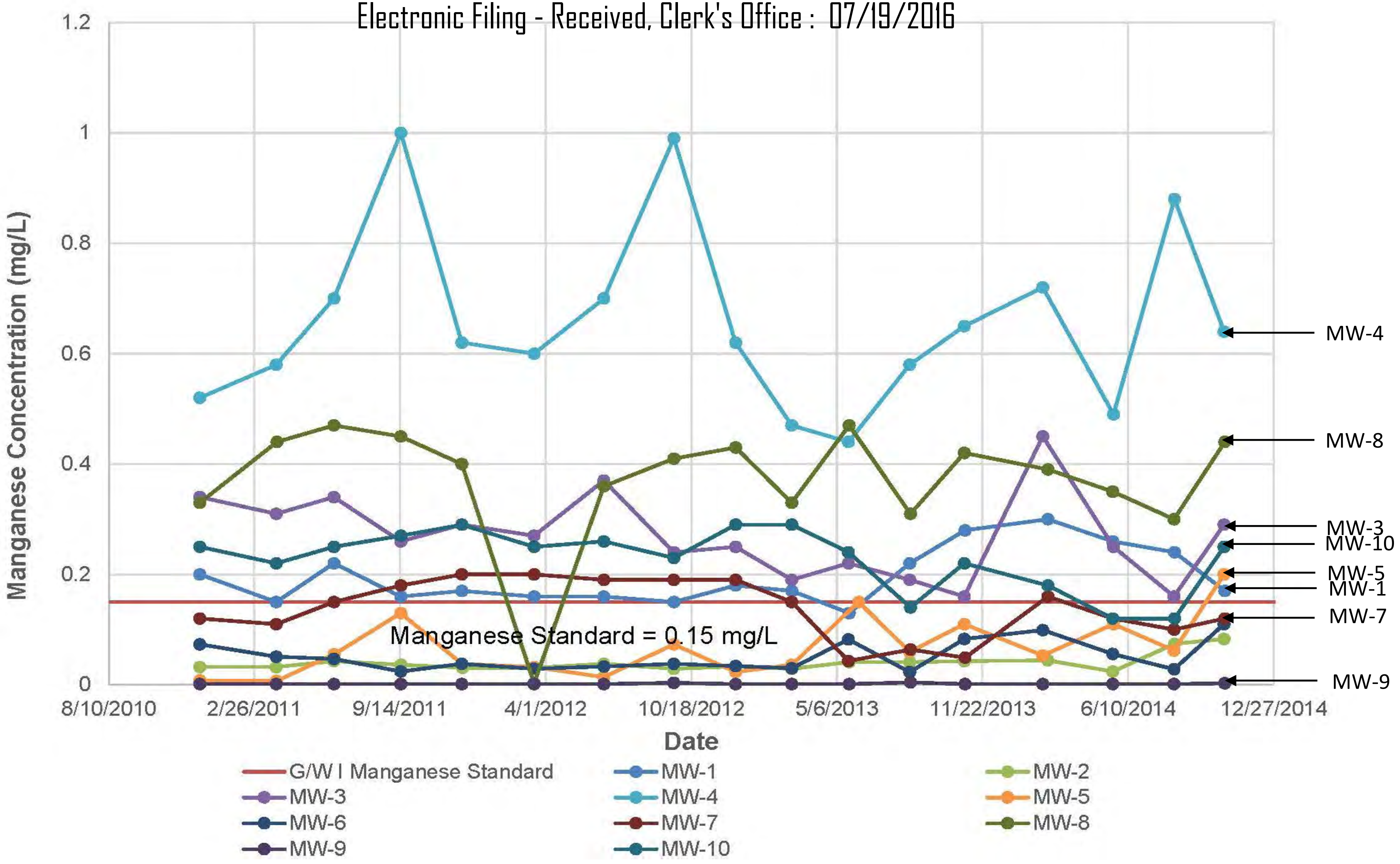


Figure 30 Manganese Concentrations in Ground Water Will County Site (PCB 2013-015)

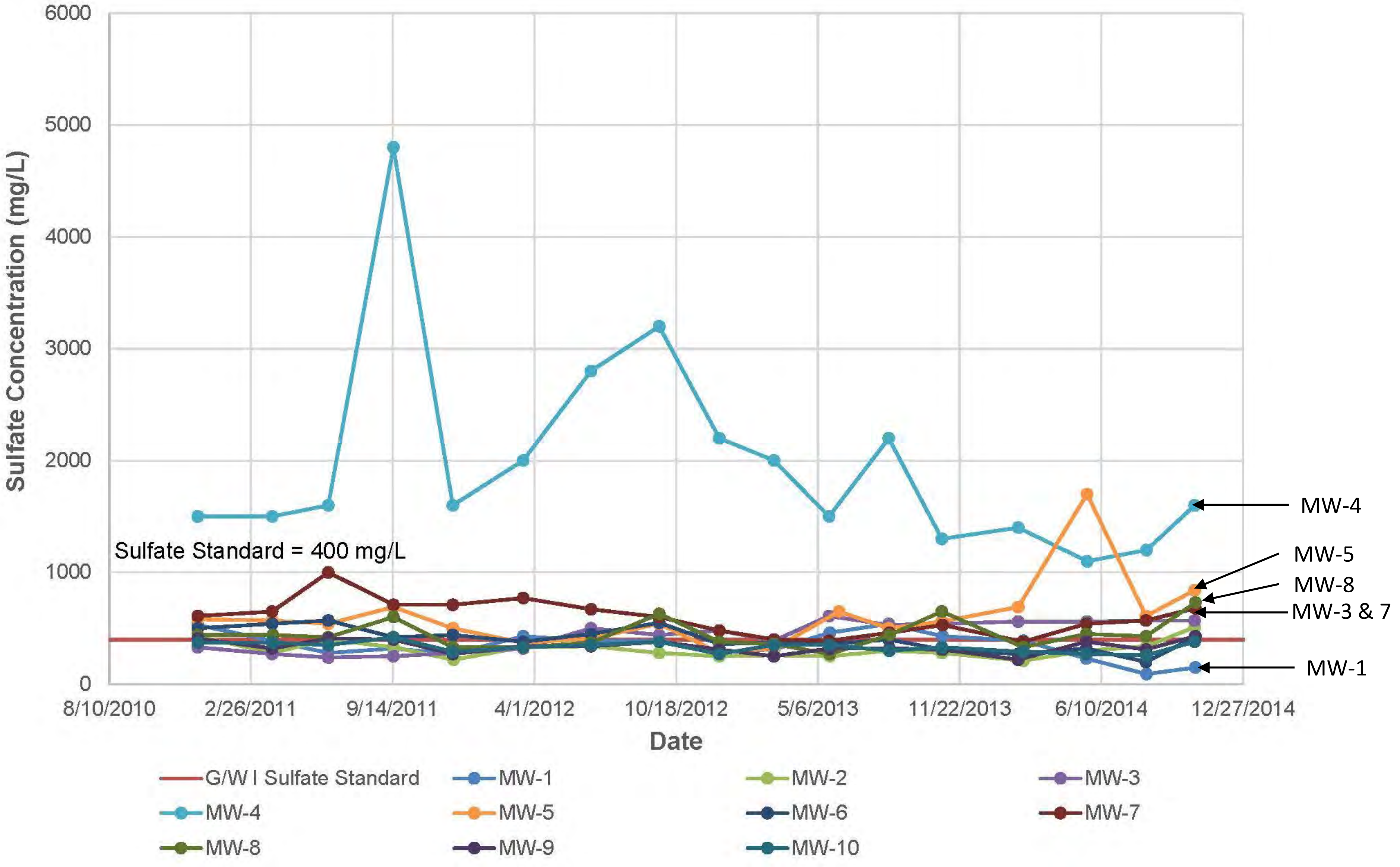


Figure 31 Sulfate Concentrations in Ground Water
Will County Site (PCB 2013-015)

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

RESPONSE TO MOTION FOR PARTIAL SUMMARY JUDGMENT

EXHIBIT 11

RELEVANT PAGES OF THE EXPERT DEPOSITION OF JAMES R. KUNKEL

BEFORE THE ILLINOIS POLLUTION CONTROL BOARD

\- - -

SIERRA CLUB, ENVIRONMENTAL LAW AND POLICY CENTER, PRAIRIE RIVERS NETWORK, and CITIZENS AGAINST RUINING THE ENVIRONMENT,)

Complainants,)

vs.) No. PCB 2013-015

MIDWEST GENERATION, LLC,)

Respondent.)

DEPOSITION OF

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

CHICAGO, ILLINOIS

MARCH 17, 2016

ATKINSON-BAKER, INC.
COURT REPORTERS
(800) 288-3376
www.depo.com

REPORTED BY: HEATHER PERKINS, CSR NO. 84-3714

FILE NO.: AA02A71

keep that one out -- this is an EPRI document, an article entitled "Coal Ash Characteristics, Management, and Environmental Issues." Do you recognize this document? 09:46:18 09:46:38 09:46:41 09:46:43

A. Yes, uh-huh, I do. 09:46:44

Q. Okay. And if you would look at Page 7 of this article -- no, I'm sorry, I'm on the wrong page. 09:46:45 09:46:51 09:46:57

Page 5, do you see that same chart? 09:46:58

A. Correct. 09:47:05

Q. So this article is where that chart comes from? 09:47:06 09:47:08

A. It is. 09:47:09

Q. Okay. Go to the bottom of Page 3 of the article. Under "Chemical Composition," it states, "The chemical composition of coal ash is determined primarily by the chemistry of the source coal and the combustion process." Do you see that? 09:47:10 09:47:17 09:47:27 09:47:31 09:47:34 09:47:37

A. Yes. 09:47:37

Q. And you agree with that statement? 09:47:38

A. Yes. 09:47:39

Q. Okay. And that would explain, correct, why Table 2 has a range of the chemical 09:47:40 09:47:43

northwest. It will cross the river and go down the other side. 10:48:37 10:48:40

Q. So you believe that it would also go through what you are marking as the former ash disposal area? 10:48:41 10:48:43 10:48:45

A. Yes, yes, across the river. 10:48:46

Q. And across? 10:48:48

A. Across the river, and then come down the other side, and it will be the same elevation, okay? 10:48:48 10:48:50 10:48:52

Then the next contour downstream will be inside this one (indicating), go up, cross the river and come down, and it will all be the same groundwater elevation. 10:48:55 10:48:57 10:48:59 10:49:02

Q. And do you have groundwater elevation data from the site that confirms this? 10:49:04 10:49:08

A. Actually, we have groundwater data from the site that doesn't even come close to showing that in any case, whether it is KPRG or whether it is Patrick, which my interpretation of the Patrick data was that these contours -- 10:49:10 10:49:13 10:49:16 10:49:19 10:49:22

Q. Hold on. I don't want to keep going. I just need the answer to my question. 10:49:25 10:49:27

A. Okay. 10:49:29

the CCA, the purpose of the CCA, is to attain compliance with alleged violations. 11:36:13 11:36:18

MS. BUGEL: Objection, calls for a legal conclusion. 11:36:20 11:36:22

THE WITNESS: I don't know. 11:36:22

BY MS. NIJMAN: 11:36:23

Q. Okay. So, again, my question was you have no evidence to suggest that they -- Joliet 29 has not attained compliance, with alleged violations, correct? 11:36:23 11:36:25 11:36:27 11:36:31

MS. BUGEL: Objection, calls for a legal conclusion. 11:36:32 11:36:33

THE WITNESS: I can't answer that, yes. 11:36:33

BY MS. NIJMAN: 11:36:34

Q. And you can't answer it because? 11:36:35

A. Well, because, in my opinion, there are still contaminants being discharged into the groundwater from the Joliet site, either from ash on the surface that's being leached or from leaky ponds, and to distinguish between the two is impossible. 11:36:36 11:36:40 11:36:43 11:36:45 11:36:49 11:36:51

Q. And to distinguish when is impossible? 11:36:53

A. Well, when is impossible because you only have quarterly data. So I don't know when 11:36:56 11:36:59

A. No, I have not. 12:03:19
Q. And in that same paragraph, you have provided -- I have asked you this question before for the other sites, and I will -- we have to, sort of, do it for each one. 12:03:21 12:03:27 12:03:29 12:03:32
You present three different alternatives for the manganese results? 12:03:34 12:03:36
A. Yes. 12:03:39
Q. And you are saying each one is equally possible; you don't know? 12:03:39 12:03:42
A. Can you tell me in the report here? 12:03:43
Q. Yes, top paragraph. You say, in the first full sentence, "The highest manganese," starting there. 12:03:51 12:03:59 12:04:01
Okay. "As a result of apparent ash pond liner leaks and, perhaps, also downward movement from the overlying silty clay and/or leaching of historic coal ash deposits outside the basin." 12:04:02 12:04:04 12:04:08 12:04:12 12:04:16
A. Yes, those are not mutually exclusive. It is any or all of those three reasons. 12:04:16 12:04:19
Q. Right. 12:04:21
But we don't know? 12:04:21
A. Which one, no, not exactly. There is 12:04:22

no way to know. We don't have sufficient data. 12:04:24

Q. At the bottom of Page 20, you state that the Powerton site groundwater is contaminated, and you list a whole lot of constituents, correct? Do you see that? 12:04:35 12:04:39 12:04:43 12:04:45

A. Oh, down here, yes, yes. 12:04:48

Q. Yes. 12:04:52

And you mention mercury? 12:04:52

A. Yes, yes. 12:04:54

Q. Okay. And that was a one-time hit for mercury, correct? You can look at your chart. 12:04:56 12:05:00

A. I think so. That's part of the complaint, I think. 12:05:03 12:05:05

Q. And, in fact, that was a transcription error by Patrick? 12:05:05 12:05:07

A. Oh, it could have been, yes. Patrick had lots of errors; didn't they? It makes it difficult to interpret. 12:05:09 12:05:11 12:05:17

Q. You also state that the groundwater is affected by pH there? 12:05:18 12:05:20

A. Yes. 12:05:23

Q. What's the relevance of that point? 12:05:24

A. Well, because we know that the pH of the leachate and probably -- and the pond water 12:05:25 12:05:28

coal ash's construction material." 13:41:46

A. Yes. 13:41:46

Q. "Leaks in the ash pond liners." 13:41:49

A. Yes, those three. 13:41:52

Q. And then you continue and say, "Spikes in your indicator concentrations could be results" -- are -- you say "are the result of leachate from liner leaks, leachate from coal ash deposited in the past outside the ponds, and/or changes in groundwater elevations as a result of changes primarily in Des Plaines." 13:41:53 13:41:56 13:42:01 13:42:02 13:42:05 13:42:08 13:42:11

A. Yes. 13:42:13

Q. Yes? 13:42:13

A. Yes, any and all at the same time or individually. 13:42:15 13:42:17

Q. It could be any of them, it could be one of them? 13:42:18 13:42:21

A. Yes. We have no way to determine. 13:42:21

Q. Let's turn to your remedy report. 13:42:25

A. Remedy, yes. 13:42:36

Am I'm missing Page 1 of 11? I am missing Page 1 of -- no, I'm missing Page 1 of 11 in Exhibit 4. 13:42:43 13:42:48 13:42:51

Do you want to check it? 13:42:57

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

RESPONSE TO MOTION FOR PARTIAL SUMMARY JUDGMENT

EXHIBIT 12

ENSR PHASE I OF THE WAUKEGAN STATION, 1998

Commonwealth Edison Company

Chicago, Illinois

Phase I Environmental Site Assessment of Commonwealth Edison Waukegan Generating Station, 10 Greenwood Avenue, Waukegan, Illinois.

ENSR Consulting – Engineering – Remediation

October 1998

Document Number 1801-023-600

CONTENTS

LIST OF FIGURES

1.0 INTRODUCTION

1.1 Objectives and Scope of Work

ENSR was retained by Commonwealth Edison (ComEd) to perform a Phase I Environmental Site Assessment of the Waukegan Generating Station facility located at 10 Greenwood Avenue in Waukegan, Illinois.

The purpose of this Phase I ESA was to assess the environmental status of the subject site with regard to "recognized environmental conditions", which are defined by the ASTM (see E 1527-97) as, "the presence or likely presence of any hazardous substances or petroleum products on a property under conditions that indicate an existing release, a past release, or a material threat of a release of any hazardous substances or petroleum products into structures on the property or into the ground, groundwater, or surface water of the property." According to the ASTM, "the term is not intended to include *de minimis* conditions that generally do not present a material risk of harm to public health or the environment and that generally would not be the subject of an enforcement action if brought to the attention of appropriate government agencies."

The ESA was conducted in accordance with the Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process established by the ASTM (ASTM Designation E-1527-97).

1.2 Study Limitations

This report describes the results of ENSR's initial due diligence investigation to identify the presence of recognized environmental conditions affecting the subject facility and/or property. In the conduct of this due diligence investigation, ENSR has attempted to independently assess the presence of such problems within the limits of the established scope of work, as described in ENSR's July 31, 1998, proposal.

As with any due diligence evaluation, there is a certain degree of dependence upon oral information provided by facility or site representatives which is not readily verifiable through visual inspection or supported by any available written documentation. ENSR shall not be held responsible for conditions or consequences arising from relevant facts that were misconstrued, concealed, withheld, or not fully disclosed by facility or site representatives at the time this investigation was performed.

This report and all field data and notes were gathered and/or prepared by ENSR in accordance with the agreed upon scope of work and generally accepted engineering and scientific practice in effect at the time of ENSR's investigation of the site.

This report, including all supporting field data and notes (collectively referred to hereinafter as "information"), was prepared or collected by ENSR for the benefit of its Client, Commonwealth Edison (ComEd). ENSR's Client may release the information to other third parties, whom may use and rely upon the information to the same extent as ENSR's Client. However, any use of or reliance upon the information by a party other than specifically named above shall be solely at the risk of such third party and without legal recourse against ENSR, its parent or its subsidiaries and affiliates, or their respective employees, officers or directors, regardless of whether the action in which recovery of damages is sought is based upon contract, tort (including the sole, concurrent or other negligence and strict liability of ENSR), statute or otherwise. This information shall not be used or relied upon by a party that does not agree to be bound by the above statement.

1.3 Report Organization

ENSR reviewed a substantial volume of information regarding the ComEd facility during the course of this Phase I assessment. This report represents our best efforts to synthesize the most salient information collected and reviewed. The report contains the following sections:

- *Chapter 2: Site Location and Description*, provides an overview of the subject property, including a description of the site history and a discussion of the various activities currently taking place.
- *Chapter 3: Environmental Document Review*, provides a description of ComEd's documents reviewed at each facility and at ComEd's corporate office. The document review included only materials that pertained to site contamination and not documents regarding environmental regulatory compliance.
- *Chapter 4: On-Site Contamination Potential*, evaluates the subject property for the presence of a hazardous material or petroleum hydrocarbon contamination problem due to past or present activities taking place on the site. This analysis also considers land uses in the immediate vicinity that may adversely affect the subject property through off-site migration of contaminants from known releases.
- *Chapter 5: Summary of Findings*, provides our summary regarding recognized environmental conditions.

- *Chapter 6: References*, identifies the various sources of information used in the preparation of this report, including persons interviewed, and documents and files evaluated.

- *Chapter 7: Signatures and Quality Control Review*, identifies the report author and individual responsible for conducting senior review.

2.0 SITE LOCATION AND DESCRIPTION

2.1 Site Location

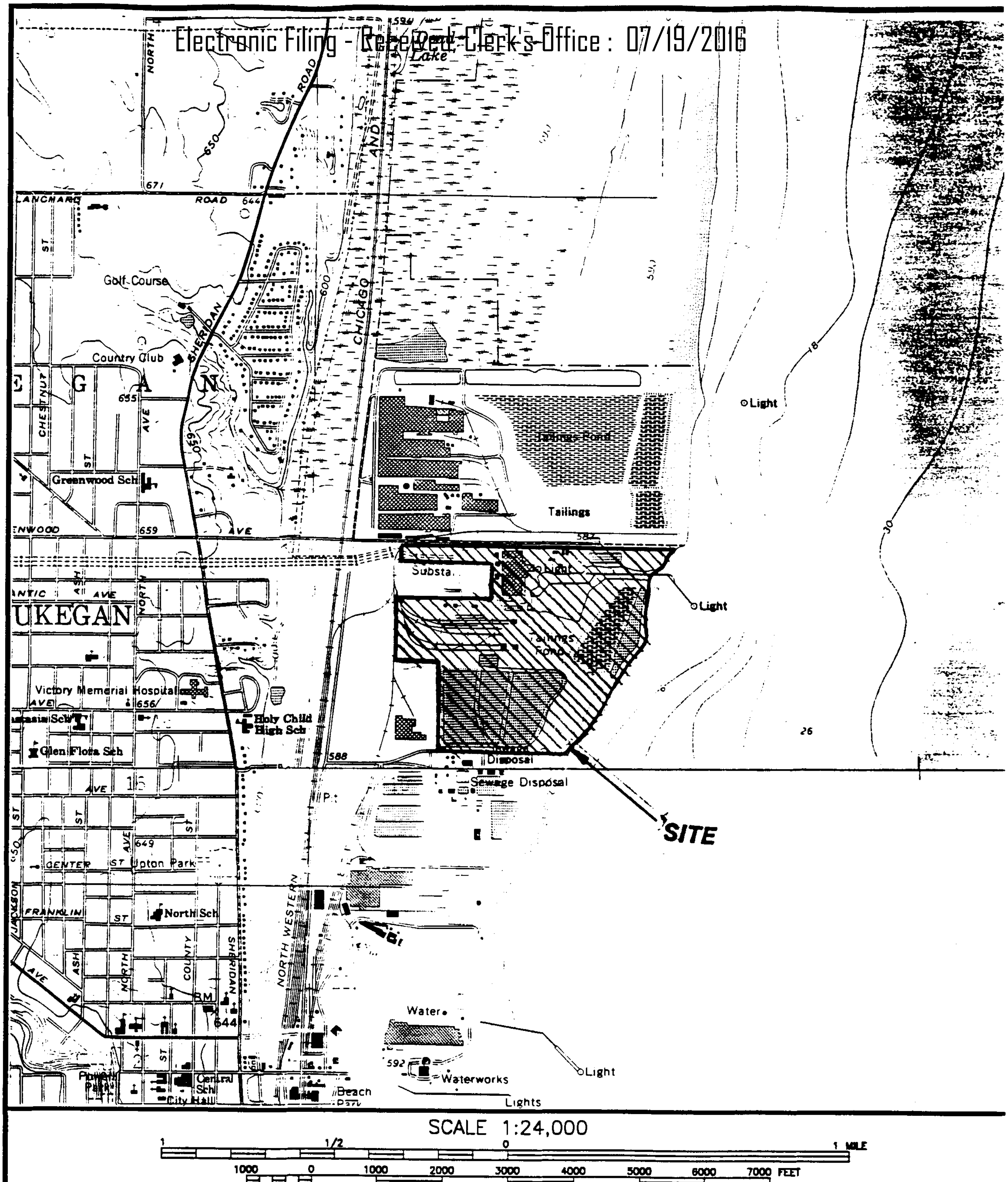
ComEd operates a coal fueled electric power generating facility known as Waukegan Station, located at 10 Greenwood Avenue in Waukegan, Illinois. The subject property is located in the northeast side of the city of Waukegan, at Greenwood Avenue and Lake Michigan.

The subject property is bordered to the north by Greenwood Avenue, beyond which is the Johns Manville Corporation. To the east is Lake Michigan and to the west are the station's main electrical switching yards, a wood chip staging/recycling area, and a construction material excavation area owned by ComEd. To the south is the North Shore Sanitary District (a wastewater treatment facility). Access to the subject property is from Greenwood Avenue to the north. Figure 2-1 is a site location map.

2.2 Description of Property and Facility Layout

The subject property encompasses approximately 194 acres and is occupied by the main generating building near the north central portion of the property, and several other ancillary buildings, settling basins, and conveyors. Rail lines pass through the site from northwest to southeast on the west and south sides of the main building. Low sulfur coal is mined in the Powder River Basin area of northeast Wyoming and delivered to the Waukegan Station via the Chicago & Northwestern Railroad. The delivered coal is staged in an uncovered coal storage area with a capacity of over 750,000 tons, located to the southeast of the main building. Storm water runoff from the coal pile is contained in the coal pile runoff basin located west of the coal pile and southwest of the main building. Cooling water is drawn from Lake Michigan and returned to the lake through a canal system. The canals are periodically dredged and the sediments (i.e. beach sand) are stored in piles along the eastern boundary of the subject property. Bottom ash and slag settles out in two synthetically-lined basins located south of the main building. Site runoff is collected and directed to either of two wastewater treatment settling basins located northeast and southwest of the main building. The wastewater basins are lined with packed clay. Sanitary waste produced at the station is piped off-site to the North Shore Sanitary District for treatment and disposal. Figure 2-2 is a site plan for the facility.

The main structure on the subject property was originally constructed in 1923 with several building additions occurring from 1925 to 1962. The main building is 16-stories at the tallest point and is a steel framed, brick and metal sided building that houses three active electric generating units (i.e.



SCALE 1:24,000

Contour interval 5 feet

Dwg No: WAUKEGANSL1

U.S.G.S.
ZION, IL, &
WAUKEGAN, IL.

SITE LOCATION MAP

WAUKEGAN GENERATING STATION
10 GREENWOOD AVENUE
WAUKEGAN, ILLINOIS

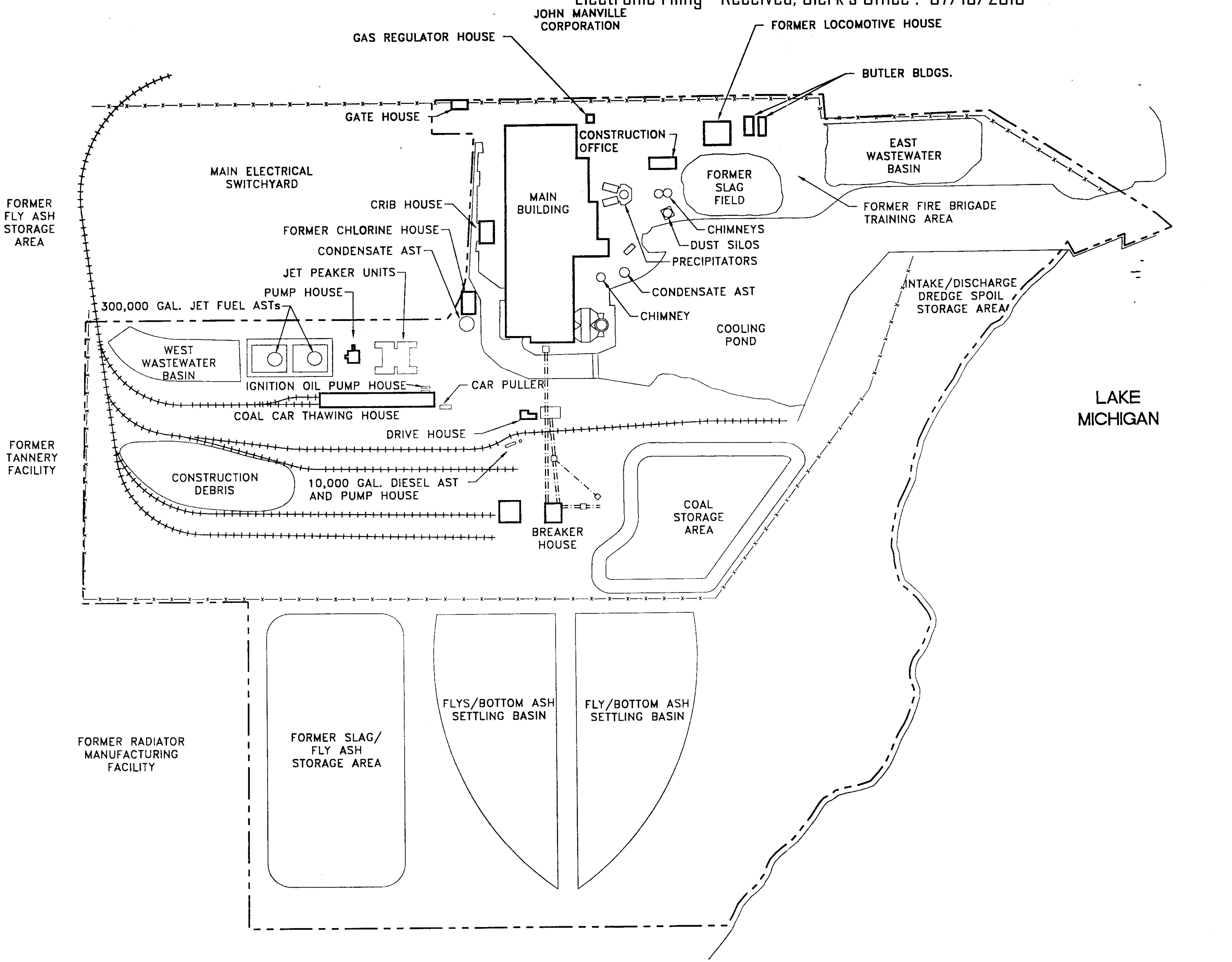
COMMONWEALTH EDISON COMPANY

September 1998 File No: 1801-023-600

FIGURE 1

ENSR

MWG13-15_12011



LEGEND:

- PROPERTY BOUNDARY
- RAILROAD LINE
- FENCE
- CONVEYOR LINE

Note:
- All dimensions and locations are approximate.

Source:
- ENSR field observations.

Dwg No: WAUKEGAN

WAUKEGAN GENERATING STATION NO. 16
10 GREENLAND AVENUE
WAUKEGAN, ILLINOIS

COMMONWEALTH EDISON COMPANY

September 1998 File No: 1801-023-600

SITE PLAN

N

NOT TO SCALE

FIGURE 2

ENSR

MWG13-15_12012

Units #6 through #8). The main building also contains Units #1 through #5 that were in service from the early 1920s through the late 1970s, at which time were all retired and decommissioned. Units #1 through #4 were deemed inaccessible by ComEd personnel, and therefore not inspected by ENSR during the site visit. The turbines associated with Units #1 through #4 have been removed from the facility, but Unit #5 remains substantially intact. Units #1 and #2 were each equipped with a single generator unit and three boilers. Unit #3 was equipped with a single generator unit and four boilers. Units #4 and #5 were each equipped with a single generator unit and three boilers.

Unit #6 was brought on line in 1952 and is equipped with a single generator unit and one boiler. Unit #7 and Unit #8 were brought on line in 1958 and 1962, respectively, and are each equipped with a single generator and a 16-story boiler. The main building also contains offices and employee locker rooms. The main stack for Units #6 through #8 extends from the roof of the main building to a height of 450 feet above surrounding grade. Air emission control equipment (i.e. electrostatic precipitators) is mounted in a structure on the roof of the main building. Main and auxiliary transformers are located outside the east and west sides of the main building.

The subject property consists of numerous outlying structures and facilities, which are described as follows starting with the coal storage area in the southeast and moving clockwise around the main building. The main coal storage area is located southeast of the main building. Coal storage area related structures include two bottom ash settling basins, a coal pile-runoff ditch and settling basin, a tractor repair building, machine shed, coal pile chemical building, coal handling equipment storage building, breaker house, conveyors, 10,000-gallon diesel AST (tractor fueling station), train car "drive house", train car "dump house". The main wastewater house, wastewater collection and make-up aboveground storage tanks (ASTs), wastewater pump house, and wastewater treatment/storage system including clarifiers are located north/northwest of the coal pile handling structures. West of wastewater structures is the ignition fuel pump house, coal car "thawing house", carbon dioxide AST, jet-fuel fired "peaker" units, peaker pump house/mechanics shed, two 300,000-gallon jet-fuel ASTs, west wastewater collection basin, 5,000-gallon west basin waste oil separator, and 7,500-gallon west basin waste oil AST. The main electrical switching yard, containing numerous large capacitors, is located just north of the jet-fuel peaker area. It should be noted: for the purpose of this report that the switchyard is not considered part of the subject property. South and west of the main building is the intake channel, lawn equipment storage shed (old chlorine house), nitrogen AST, wastewater AST, and crib house. Various transformers and capacitors are located west of the main building and expand westward into the switchyard. Northwest of the main building is the main gate house with a paved parking lot and Greenwood Avenue to the north. Northwest of the main building is the east gate house, paved parking lots, 500-gallon diesel AST, 500-gallon gasoline AST, old locomotive house, two butler buildings, fire brigade area, east wastewater building, east wastewater collection basin, 8,000-gallon east wastewater oil water separator, and 7,500-gallon east wastewater waste oil AST. East of the main building is a group of structures consisting of the ash silos, welding shop, cooling water discharge channel, intake channel and lake intake dredge storage piles.

2.3 Topography, Hydrology, and Geology

According to the USGS Zion, Illinois Quadrangle 7.5 Minute Series Topographic map, the topographic elevation of the main building and lakefront area is approximately 590 feet above mean sea level. The developed portion of the subject property slopes easterly toward Lake Michigan.

According to the USDA SCS Soil Survey for Lake County, Illinois, the soils on the subject property consist of mostly sand and silty loams, and the estimated depth to shallow groundwater is between five and ten feet below grade surface (bgs). The groundwater in the region is expected to flow toward Lake Michigan, which is located adjacent to the east of the subject property. In addition, subsurface investigations previously conducted identified glacial till and stratified outwash deposits on-site. Areas of fill were also identified and consist of silty sand, clayey sand, slag and fly ash. Bedrock at the site was identified as limestone ranging in depth from 50 to 100 feet below grade.

2.4 Site History

Historical information for the subject site is based on a review of building department records, tax assessors records, aerial photographs, Sanborn Fire Insurance maps, a topographic quadrangle map, city directories, ComEd files, and interviews from site personnel and local government officials.

A 1939 aerial photograph shows the subject property to be occupied by a coal-fired power plant. The facility appears to be approximately one-half the size of the current facility. A coal pile is depicted on the southeastern portion of the subject property with fly-ash and slag piles located on the south and west portions of the subject property, respectively. The west wastewater treatment settling basin and the fly-ash/bottom ash settling basins were not depicted on this photograph.

A 1959 aerial photograph shows expansion of the coal-fired power plant. The main building has been expanded in a southerly direction. The outlying structures appeared the same as the 1939 aerial photograph.

Aerial photographs dated 1964, 1975, 1985, 1990, and 1995 show the subject property virtually as it currently exists with the main building occupying the majority of the subject property. Fly-ash/bottom ash, east and west wastewater settling basins, and intake canal dredge spoil piles are depicted in their current locations.

According to building department records, several permits were issued between 1979 and 1995 for the following activities:

- Building Permit #9880 issued in 1979 was for the construction of a 12' X 12' metal meter house.

- Building Permit #0240 issued in 1982 was for the installation of a new roof on an unspecified ComEd structure. In addition, the permit covered the installation of wastewater treatment facilities consisting of chemical control buildings, pump and filter building, two clarifiers, three oil water separators, five collection basins, chemical feed equipment, related piping, and appurtenances.

- Building Permit #3397 issued in 1984 was for the construction of a 3,850 square foot storage building.

- Building Permit #5484 issued in 1985 was to erect a heavy equipment storage shed.

- Building Permit #9071 issued in 1987 was for the installation of two sloped loading docks with automatic door openers and weather protection devices.

- Building Permit #003 issued in 1995 to demolish an unspecified ComEd building.

Assessment records indicate the subject property was occupied by the Public Service Company of Northern Illinois from approximately 1923 until 1953. In 1953, ComEd acquired the property through a merger with the former power company.

The USGS Zion, Illinois Quadrangle Topographic map dated 1960, photorevised in 1972 and 1980, shows the subject property to be occupied by a power plant facility equipped with tailings ponds, rail spurs, and electrical substations. Mr. Dave Raudio, ComEd Construction Specialist, confirmed that ComEd took over operations at the subject property in 1953.

City directories dated 1948 through 1968 list the subject property as occupied by the Public Service Company of Northern Illinois. City directories dated 1973 through 1993 list ComEd at the subject property address.

The 1924 and 1929 Sanborn Fire Insurance maps show the subject property as occupied by the Public Service Company of Northern Illinois (Power Plant #6). The main building and the majority of the outlying structures are located in the northeast portion of the property. The only outlying structures depicted south of the intake pond are rail spurs and conveyor systems.

The 1949 Sanborn Fire Insurance map shows the addition of three boilers in the main building and several storage and coal handling structures located east and south of the main building.

The 1969 Sanborn Fire Insurance map shows the addition of Units #6 through #8 and associated facilities in the main building. Several train car buildings, storage, and coal handling structures were also added to the east, west, and south portions of the subject property.

Based on a review of the Station's oil and hazardous material incident files, there have been several petroleum hydrocarbon spills on site. The majority of the spills did not impact soil and/or groundwater quality. Rather, they directly affected the cooling water intake and/or discharge canals.

2.5 Adjacent Site History

Historical information for the subject site vicinity is based on a review of aerial photographs, a topographic quadrangle map, city directories, Sanborn Fire Insurance maps, and interviews from site personnel and local government officials.

Currently, the subject property is bordered to the north by Greenwood Avenue, beyond which is the Johns Manville Company. The 1924, 1929, 1949, and 1969 Sanborn Fire Insurance maps also show the abutting property to the north as the Johns Manville Company. The 1939, 1959, 1964, 1975, 1985, 1990 and 1995 aerial photographs show the abutting properties to the north as the Johns Manville facility. A USGS topographic map dated 1960, photorevised in 1972 and 1980 shows the north abutting properties in their current configuration with the Manville plant, tailings ponds, and tailings storage piles. According to Mr. Raudio, the abutting properties to the north were developed during the early 1920s. City directories dated 1948 through 1954 did not contain a listing for the north abutting property. City directories dated 1959 through 1993 list the Johns Manville Product Corporation at the north abutting property address.

Currently, the subject property is bordered to the west by the station's main electrical switching yard, a wood chip staging/recycling area, and a construction material storage area owned by ComEd, beyond which is Pershing Road and Amstutz Expressway. The 1924, 1929, 1949, and 1969 Sanborn Fire Insurance maps show the abutting property to the west as the main station electrical switching yard, Greiss Pleger Tannery, and the U.S. Radiator Corporation of New Jersey. The 1939, 1959, 1964, 1975, 1985, 1990 and 1995 aerial photographs show the abutting properties to the west as developed with industrial type facilities. A USGS topographic map dated 1960, photorevised in 1972 and 1980 shows the west abutting properties to be developed with industrial type facilities, rail spurs, and electrical substations. According to Mr. Raudio, the abutting properties to the west were occupied by the main station electrical switching yard, a tannery, and radiator manufacturing facility since the 1920s. City directories dated 1948 through 1993 did not contain a listing for the west abutting properties.

Currently, the subject property is bordered to the south by the North Shore Sanitary District. The 1924, 1929, 1949, and 1969 Sanborn Fire Insurance maps show the abutting property to the south as the city of Waukegan Water Works. The 1939, 1959, 1964, 1975, 1985, 1990 and 1995 aerial photographs show the abutting properties to the south as developed with the North Shore Sanitary District facility. A USGS topographic map dated 1960, photorevised in 1972 and 1980 shows the south abutting properties to be developed with the aforementioned sewage treatment and disposal facility. According to Mr. Raudio, the abutting properties to the south have been occupied by city of Waukegan Water Works Department/North Shore Sanitation District since the 1920s. City directories dated 1948 through 1993 did not contain a listing for the south abutting properties.

2.6 Description of Operations

The subject property is a coal-fired electric power generating station. Additional operations include machinery and mechanical maintenance, wastewater treatment, and other plant maintenance operations. Electrical power is transmitted from the site to the area grid through overhead transmission power lines.

The generating station receives coal by rail south of the main building. Coal is transferred by a conveyor system from the coal dumper to the large coal storage area to the southeast. Coal is fed into active boilers associated with Units #6, #7 & #8 via conveyors through the breaker house on the south side of the main building.

Condenser cooling water is drawn from and returned to Lake Michigan at a rate of approximately 691 million gallons per day (MGD). Boiler make-up water is obtained from on-site ASTs storing demineralized Lake Michigan water. Water treatment chemicals, including ammonia, hydrazine, and sodium phosphate are added to the boiler make-up water lines to soften the water and inhibit corrosion and scaling. Sulfuric acid and sodium hydroxide are used to regenerate the demineralizer resins. Sodium hypochlorite is used to treat service water for biofouling control. No chemicals are added to condenser cooling water.

The burning of coal produces waste fly ash, bottom ash, and slag. Fly ash is collected in hoppers located east of the main building and is sold as construction material by Material Solutions, Inc. Bottom ash and slag are piped as slurry to the settling basins located south of the main building.

The cooling water intake and discharge canals are periodically dredged and the spoils (i.e. beach sand) are stock piled in a bermed area along the eastern boundary of the subject property. ComEd has dredging permits that stipulate the dredged sand be used by the State of Illinois as beach nourishment.

Site-generated sanitary wastewater is piped off-site to the North Shore Sanitary District. Process wastewater from facility operations is treated on-site and stored in wastewater treatment basins. Wastewater basin effluent is discharged to Lake Michigan under the conditions of a NPDES permit. The NPDES permit covers discharges from the property including storm water runoff, cooling water, and any other process water.

The facility stores large quantities of the following materials: turbine oil, sulfuric acid, sodium hydroxide, lubricating oil, liquid nitrogen, ion exchange resin, diesel fuel, jet fuel, hydrazine, gasoline, fuel oil, fly ash, ethylene glycol, elemental sulfur, coal pile binder, coal pile surfactant, and carbon dioxide. Jet fuel is stored on-site in two 300,000-gallon ASTs. This fuel is used in eight jet engine peaker units and to ignite the three generating units. The fast start "peaker" system was installed in 1968 to meet heavy electrical demands during peak demand periods (i.e. summer).

2.7 Utilities

Currently, the Waukegan generating station obtains potable water from the city of Waukegan.

As previously indicated, the Waukegan generating station pipes sanitary wastewater off-site to the North Shore Sanitary District. Wastewater from facility operations is treated on-site and stored in wastewater treatment basins. Treated wastewater basin effluent is discharged to Lake Michigan under the conditions of a NPDES permit. The NPDES permit covers discharges from the property including storm water runoff, cooling water, and any other process water. The Northern Illinois Gas Company provides natural gas to the subject property. The Waukegan Station provides its own electrical power.

3.0 ENVIRONMENTAL DOCUMENT REVIEW

3.1 Introduction

This environmental document review is based upon an analysis of information provided by ComEd coupled with observations made by Jeffrey Menter and Aaron Gesin of ENSR during the site visit, which took place on August 31, 1998 and September 1, 1998. The information provided by ComEd included documents relative to the various regulatory areas described below.

3.2 Air Quality

Although no formal emissions inventory was prepared as part of this Phase I investigation, a preliminary review of the facility indicates air permits are required for the facility. The Illinois Environmental Protection Agency (IEPA) oversees the state's air permitting compliance programs. The facility currently has four operating permits from the IEPA. The air permits cover the operation of three boilers with electrostatic precipitators, turbine oil tanks, coal ash silos, fuel handling (coal) with a radial boom stacker and conveyor belt, ash handling, a fuel dispensing facility, and jet-fuel "peaker" units. This station has submitted a Title V permit application and is awaiting its approval.

3.3 Water Resources

The facility is permitted to discharge all treated wastewater, condenser cooling water, demineralizer regenerant wastes, boiler blowdown water, and storm water runoff to Lake Michigan under the provisions set forth in the NPDES permit issued August 9, 1995 expiring August 1, 2000. Storm water runoff from the main building area is directed towards numerous drains, catch basins, and/or sumps and discharged to the east and/or west wastewater basins. Storm water from the coal pile is directed toward and collected in the coal pile runoff basin. Storm water runoff from process areas of the station is treated in the existing wastewater treatment facility. Per the stations NPDES permit, this constitutes BAT for the treatment and discharge of storm water runoff, therefore the Waukegan Station is not required to maintain a Storm Water Pollution Prevention Plan (SWPP). The remaining storm water runoff from undeveloped areas of the subject property naturally percolates into the soil or runs off-site.

3.4 Oil and Hazardous Material Storage and Use

3.4.1 Material Storage and Use

Several types of oils and hazardous materials are used on site. Several aboveground tanks, drums, and various types of containers located outdoors are used to store fuel oil, jet fuel, kerosene, hydraulic fluid, lubricating oil, antifreeze, and motor oil. Many of these containers were not equipped with secondary containment structures. However, surface run-off from these areas is directed toward the east and/or west wastewater basins, which is discharged under the provisions of the NPDES permit.

The facility has prepared contingency plans, including a Spill Prevention Countermeasure and Control Plan (SPCC) dated November 17, 1994, to prevent the discharge of oil from the aforementioned containers, and to mitigate any adverse effects from such a spill. An updated SPCC plan has been prepared and is under professional engineering review.

Based on interviews with facility personnel, and review of available information, no underground storage tanks are currently in use at the plant, however three USTs were retired in place and/or removed from the plant between 1986 and 1990 (see Section 4.2.1).

3.4.2 Principal Waste Streams

The facility generates several waste streams from its operation and maintenance activities, some of which are considered hazardous waste. The hazardous wastes may be generated on an intermittent or one-time basis. Regulatory database information identifies the ComEd Waukegan Station as a large quantity hazardous waste generator (ILD000803635). According to the ComEd Compliance Specialist, Ms. Jenni Cawein, the Waukegan Station generated hazardous waste in various forms, including used parts washer solvent prior to 1994. The Waukegan Station has used a non-hazardous parts cleaner supplied and disposed by Solvent Systems of Hampshire, Illinois from 1994 to present. Since 1994 when the station switched from a hazardous to non-hazardous parts cleaner, only minor amounts of hazardous waste are generated. Occasionally, ComEd generates medical waste, as result of personal injury accidents. When necessary, the medical wastes are disposed/treated off site by BFI of Waukegan, Illinois.

Non-hazardous wastes typically generated on site include general refuse, used hydraulic oil, used oil, used oil filters, oil soaked absorbents, slag, fly ash, antifreeze, boiler chemical cleaning waste, and boiler bottom ash. These wastes are stored in various types of containers, including dumpsters, drums, bins, silos, and basins. With exception of the waste oil, antifreeze, and boiler chemical cleaning waste; which the plant has a permit to burn in its boilers, the non-hazardous wastes are disposed/reused off site using one of ComEd's approved vendors. A historic list of approved vendors and disposal sites are provided below.

Waste Transportation Vendors

SET Environmental - Wheeling, Illinois
BFI - Waukegan, Illinois
Solvent Systems – Hampshire, Illinois
Solar Environmental – Gary, Indiana
ENSR Fleet Trucking – Columbus, Ohio
South Chicago Disposal – Chicago, Illinois
Waste Management, Cicero, Illinois
Sun Ohio - Canton, Ohio
Clean Harbors – Blue Island, Illinois
United Scrap - Cicero, Illinois

Disposal Sites

Great Northern – Huntington, Indiana
Great Northern – Huntington, Indiana
Madison Prairie Landfill – Wisconsin
Spring Grove Resource – Cincinnati, Ohio
Forest Lawn Landfill - Three Oaks, MI
Treatment One – Houston, Texas
Madison Prairie Landfill - Wisconsin

4.0 ON-SITE CONTAMINATION POTENTIAL

4.1 Introduction

Based on ENSR's review of the facility there is a potential for on-site contamination at the ComEd Waukegan Station located in Waukegan, Illinois.

4.2 Above and Underground Storage Tanks

4.2.1 Inventory of Underground Tanks

According to Ms. Cawein, there are currently no active underground storage tanks (USTs) located on the subject property, however three USTs have either been removed and/or retired in place. Two 12,000-gallon ignition fuel USTs were installed in 1931 and retired in place in 1986. A 500-gallon gasoline UST was installed in 1931 and removed in 1990. An internal memorandum in ComEd's files indicates that soil samples were collected from the walls of the tank pit following the removal of the 500-gallon gasoline UST. The samples were analyzed for benzene, toluene, ethylbenzene, and xylene (BTEX). None of those compounds was detected in the soil samples. A 5,000-gallon oil/water separator was also apparently located at the subject property, but the date of installation was not available from ComEd, the Waukegan Fire Department, or the OSFM. No visual evidence of the UST (i.e., fill pipes) was observed during ENSR's site visit.

4.2.2 Inventory of Aboveground Storage Tanks

Table 4-1 provides a list of aboveground storage tanks identified at the Waukegan Station.

Table 4-1
Aboveground Storage Tanks
Waukegan Station

TANK TYPE	TANK LOCATION	ESTIMATED CAPACITY
Jet Fuel - Oil Tank	West of Jet Peaker Building	300,000 – gallons
Jet Fuel - Oil Tank	West of Jet Peaker Building	300,000 – gallons
Jet Fuel – Oil Additive	West of Jet Peaker Building	1,000 – gallons
Unit #5 – Turbine Oil	Basement of Unit #5	6,400 – gallons
Unit #6 – Turbine Oil	Basement of Unit #6	6,600 – gallons
#2 Diesel – Oil Tank	West of Coal Pile	10,000 – gallons

TANK TYPE	TANK LOCATION	ESTIMATED CAPACITY
#2 Diesel – Oil Tank	Tractor Repair Building	275 – gallons
#2 Diesel – Oil Tank	Machinery Shed	275 – gallons
#2 Diesel – Oil Tank	West of Locomotive House	500 – gallons
Oil Separator Tank	East Wastewater Basin	8,000 – gallons
Waste Oil Tank	East Wastewater Basin	7,500 – gallons
Oil Separator Tank	West Wastewater Basin	5,000 – gallons
Waste Oil Tank	West Wastewater Basin	7,500 – gallons
Waste Oil Tank	East of Main Building	10,000 – gallons
Gasoline Tank	West of Locomotive House	500 – gallons
Antifreeze Tank	Machinery Shed	275 – gallons
Antifreeze Tank	Machinery Shed	275 – gallons
Oil Tank	Machinery Shed	275 – gallons
Oil Tank	Machinery Shed	275 – gallons
Oil Tank	Machinery Shed	275 – gallons
Oil Tank	Machinery Shed	275 – gallons
Oil Tank	Machinery Shed	275 – gallons
Oil Tank	Machinery Shed	275 – gallons
Oil Tank	Machinery Shed	275 – gallons
Oil Tank	Machinery Shed	275 – gallons
Kerosene Tank	Southeast Corner of Main Building	500 – gallons
Gasoline Tank	Fire Brigade	250 – gallons
Surfactant Tank	Coal Pile Chemical Building	1,000 – gallons
Binder Tank	Coal Pile Chemical Building	7,500 – gallons
Suppressant Tank	Coal Pile Chemical Building	7,500 – gallons
Water Tank	Coal Pile Chemical Building	5,000 – gallons
Liquid Nitrogen	East of Main Building	1,500 – gallons
Sodium Hydroxide	Main Building	10,000 – gallons
Sulfuric Acid	Main Building	10,000 – gallons
Carbon Dioxide	Peaker Building	2,500 – gallons
Carbon Dioxide	Main Building	2,500 – gallons

Many of the ASTs and chemical storage areas were not equipped with secondary containment structures, and petroleum stains were observed on the concrete floors within the main building and several of the outlying structures. Petroleum stains were also observed on exterior paved, gravel, and soil covered surfaces adjacent to the main building and outlying structures. However, surface run-off from these areas is directed toward the east and/or west wastewater basins, which is discharged under the provisions of the NPDES permit. A listing of these stained areas is provided in Section 4.5.

4.3 Polychlorinated Biphenyls (PCBs)

There are numerous liquid-cooled transformers on the site. According to Mr. Dave Rubner, ComEd PCB Specialist, a fluid exchange process to remove PCB containing dielectric fluid from transformers at all of the ComEd stations was conducted during the 1980s. Since the completion of the fluid exchange process, all transformers at the Waukegan Station are currently PCB free (i.e. below 50 ppm) and are considered to have extremely low potential for leachback to levels in excess of 50 ppm. Based on these statistics, ComEd does not intend to perform any additional testing of the transformers at the Waukegan Station.

However, ENSR observed evidence of mislabeling (i.e. multiple labels on a single transformer listing different PCB concentrations) and oil staining around many of the pad-mounted electrical transformers located along the east and west sides of the main building. Although no permitting requirements currently apply to the use of equipment containing or potentially containing PCB coolants, equipment containing more than 50 ppm PCBs must be marked with the appropriate warning labels (40 CFR 761.45, PCB).

4.4 Asbestos-Containing Materials

ENSR representatives who are State of Illinois Department of Public Health licensed Asbestos Building Inspectors performed a visual suspect asbestos-containing material (ACM) inspection of the main building and outlying structures as part of this investigation, however, bulk sampling was not performed. The types and quantities of suspect materials identified during the meticulous walk-through of each on-site structure at the Waukegan Station included pipe and pipe fitting insulation, boiler and equipment insulation, tank insulation, pump insulation, vinyl floor tile, suspended ceiling tile, and spray-on insulation. Although the removal of all ACM is not required at this time, Table 4-3 presents the types and estimated quantities of suspect ACM, as well as estimated removal costs.

Table 4-3
Asbestos-Containing Materials
Waukegan Station

TYPE OF MATERIAL	ESTIMATED QUANTITY	REMOVAL COST ESTIMATES
Pipe & Pipe Fitting Insulation	1,205,000 Linear Feet	$2,410,000
Boiler & Equipment Insulation	212,000 Square Feet	$5,300,000
Tank & Pump Insulation	6,500 Square Feet	$162, 500
Vinyl Floor Tile	2,000 Square Feet	$10,000
Suspended Ceiling Tile	3,000 Square Feet	$30,000

TYPE OF MATERIAL	ESTIMATED QUANTITY	REMOVAL COST ESTIMATES
Spray-on Insulation	50,000 Square Feet	$1,250,000

The total suspect ACM removal cost is estimated at $9.2 million. The cost estimate is based on ACM location and quantity information provided by ComEd, ENSR's visual inspection of accessible areas of the facility, and generally accepted ACM removal unit costs. The cost estimate does not include project consulting or reinsulation fees. The estimated removal cost provided above is subject to change as a result of the potential variability in material quantities and locations, contractor fees, disposal fees, and project scheduling. Based on the aforementioned variables, the removal costs may fluctuate as much as 50%.

An additional asbestos issue was also identified at the Waukegan Station during ENSR's investigation. Asbestos in the form of transite brake shoes was observed in the dredge spoils and along the lakefront of the subject property. According to ComEd personnel, the Waukegan Station has not manufactured asbestos products and the presence of the transite brake shoes is likely from an off-site source. Estimated quantities and removal costs associated with the cleanup of the transite could not be provided at this time.

4.5 Areas of Surface Staining

The ENSR site inspection was conducted between August 31, 1998 and September 1, 1998. In general, housekeeping conditions at the subject facility were good, with individual areas requiring more attention than others. The following areas of surface staining were identified during the environmental investigation of the subject property:

- Petroleum stains were observed on the concrete floor in the indoor oil storage area. The oil storage room serves as secondary containment with a raised berm protecting the doorway.

- Petroleum stains were observed on the concrete floor within the machinery storage shed and also on the ground surface adjacent to the exterior of the shed.

- Petroleum stains were noted on the ground surface adjacent to the east and west basin oil/water separators and oil storage tanks.

- Petroleum stains were noted on the gravel parking lot surface adjacent to the waste oil AST and wastewater pump system located east of the main building.

- Petroleum surface staining and areas of distressed vegetation were observed east of the Butlers buildings in the old fire brigade training area of the subject property.

- Petroleum surface staining was observed on the ground surface adjacent to several of the pad-mounted transformers located to the east and west of the main building.

- Petroleum surface staining was observed on the ground surface adjacent to the ignition fuel pump house.

- Petroleum surface staining was observed on the ground surface beneath the 10,000-gallon diesel AST located south of the main building.

4.6 On-Site Wastewater System

Building and assessment records indicate the subject property has been occupied by a coal fired power plant facility from approximately 1923 until the present. In July 1977, ComEd was issued IEPA Permit #1977-EB-3699 for the construction of miscellaneous wastewater treatment facilities including clay-lined wastewater treatment settling basins, a synthetically lined coal pile drainage basin, and a synthetically-lined fly/bottom ash settling basin system. Prior to this time, unlined slag basins were in use at the station. It is unknown if the historic use of unlined basins has had an impact on the subsurface at the subject property.

4.7 Railroad

A railroad has abutted and been located on the subject property since at least 1923 according to aerial photographs, Sanborn Fire Insurance maps, and interviews with site personnel. It is unknown if the presence of the railroad and rail spur has had an impact on the subject property from fuels, oils, and/or solvents. ENSR observed areas of pervasive staining along the railroad tracks near the train car "thaw" house, "drive house", and "dump" house.

4.8 Spill History

As previously indicated, there have been several petroleum hydrocarbon spills on site, based on a review of the Station's oil and hazardous material incident files and Spill Prevention Control and Countermeasures Plan. The majority of the spills did not impact soil and/or groundwater quality. Rather, they discharged directly to the cooling water intake and/or discharge canals. A summary of the spill/release incidents at Waukegan Station is provided below.

Waukegan Station's NPDES permit file contained several incident reports relating to spills that occurred on site between 1978 and 1997, and that resulted in a condition that was either in violation of their NPDES (cooling water discharge) permit or that required notification to emergency response agencies (e.g., the Coast Guard). In all cases, the incidents involved petroleum hydrocarbons that leaked from the Station's equipment directly or indirectly (e.g., through a discharge pipe) to the cooling water canals. Based on the descriptions of the cleanup actions taken by ComEd in response to the incidents, it does not appear as though soil and/or groundwater quality was impacted by these spills/releases. We note that several of the spills were caused by leaks from the plant's oil coolers, including a large spill (600 gallons) that occurred in 1993.

The only record of a spill/release that impacted soil quality on site was the release of jet fuel that occurred during the early 1990s. According to Ms. Jenni Cawein, the release was caused from a leak in an underground pipe associated with the large aboveground storage tank. Ms. Cawein also indicated that the release was not required to be reported to the Illinois Emergency Management Agency (IEMA) and groundwater was not sampled to determine whether that media had been impacted. However, approximately 500 to 1,000 cubic yards of contaminated soil were excavated from the impacted area and treated on-site. The area served as a bioremediation project site during the spring and summer of 1994. Both *in situ* and *ex situ* treatments were conducted over an approximately 6-8-month time period. Sample results indicated a 50-90 percent reduction in total petroleum hydrocarbons (TPH) concentrations in the areas impacted by the leak.

4.9 Adjacent Property

According to Sanborn Fire Insurance maps, aerial photographs, and interviews with site personnel, the north adjacent property has been occupied by an asbestos manufacturing company since the 1920s. The west adjacent properties have been occupied since the 1920s by the Waukegan Station's main electrical switch yard, as well as a tannery and radiator manufacturing facility. According to ComEd documentation, there has been PCB-containing fluid releases from transformers and capacitors, as well as, releases from underground storage tanks containing petroleum products. Furthermore, the tannery and radiator facilities are no longer in operation, but also have left behind soil and groundwater contamination. An arsenic, lead, mercury, and chromium contaminated groundwater plume has been identified on the former tannery site, which extends easterly onto the subject property. The former radiator manufacturing facility has also left behind petroleum-contaminated soil and groundwater from leaking underground storage tanks, which may also be affecting the subject property.

4.10 Environmental Database Review

ENSR reviewed a variety of federal and state governmental databases using Environmental Data Resources (EDR) of Southport, Connecticut. The following federal and state contamination-related databases were searched for the subject property and surrounding area; the various search distances used are also noted:

TABLE 4-4
Databases Searched and Radii

Database Acronym	Description	Search Distance[1] (miles)
Federal Databases		
NPL[2]	Existing and proposed Superfund sites on the National Priorities List	1.0
CERCLIS[2]	Abandoned, uncontrolled or inactive hazardous waste sites reported to the U.S. EPA, which have been or are scheduled to be investigated by the U.S. EPA for potential nomination to the NPL.	0.5
RCRIS-TSD[2]	Reported sites that treat, store and/or dispose of hazardous waste and subject to the federal RCRA regulations.	0.5
RCRIS-LQG/SQG[2]	Reported large-quantity generators and small quantity generators of hazardous waste.	0.25
ERNS[2]	Sites reporting spills to the U.S. EPA and/or the U.S. Coast Guard under various federal regulations	Target property
FINDS	Facility Index System indicates the presence of a site on another federal database.	Target property
PADS	PCB Activity Database System identifies generators, transporters, commercial storers and/or brokers and disposers of PCBs who are required and have notified the EPA of such activities.	Target property
RAATS	RCRA Administrative Tracking System contains records based on enforcement actions issued under RCRA pertaining to major violators and includes administrative and civil actions brought by the EPA.	Target property
TRIS	Toxic Chemical Release Inventory System identified facilities who have reported releases of listed toxic chemicals to the air, water, and land in reportable quantities under SARA Title III Section 313.	Target property

TABLE 4-4
Databases Searched and Radii

Database Acronym	Description	Search Distance[1] (miles)
TSCA	Toxic Substances Control Act identified manufacturers and importers of chemical substances by plant site in 1986. No updates of the list have been made by EPA.	Target property
HMIRS	Hazardous Materials Information Reporting System contains hazardous material spill incidents reported to the Federal DOT.	Target property
NPL Liens	List of liens placed against real property in order for the EPA to recover remedial action expenditures or when the property owner receives notification of potential liability.	Target property
CORRACTS	Corrective Action Report identifies hazardous waste handlers with RCRA corrective action activity.	1.0
ROD	Records of Decision mandating a permanent remedy for a Superfund Site	1.0
MLTS	Material Licensing Tracking System, maintained by the Nuclear Regulatory Commission, contains a list of sites that possess or use radioactive materials and are subject to NRC licensing.	Target property
Delisted NPL	Sites removed from the NPL	Target property
Coal Gas	Former manufactured coal gas sites	1.0
	Illinois Databases	
SWHS[2]	State hazardous waste sites	1.0
UST[2]	Sites which have reported underground storage tanks.	0.5
LUST[2]	Sites which have reported leaking underground storage tanks.	0.5
SWF/LF[2]	List of permitted solid waste disposal facilities	0.5

1. The radial search distances used equal or exceed those recommended by ASTM for assessing the environmental condition of commercial real estate.
2. Databases which are required to be searched by ASTM.

4.10.1 Subject Property

The subject property was listed on the following databases: FINDS, ERNS, RCRIS-LQG, and LUST. The federal FINDS database only indicates the facility's presence on other databases and the ERNS indicate that the facility had a release of oil and/or hazardous substances on the subject property.

The RCRIS-LQG database indicates the facility is a large quantity generator of hazardous waste and is identified with IEPA #ILD000803635. However, ENSR reviewed an internal letter of comments attached to the 1993 Hazardous Waste Generation Report submitted to the IEPA dated February 25, 1994. This letter stated a new program was initiated to replace hazardous waste generating solvent in parts washing units with a non-hazardous type. As a result of successful waste minimization efforts, the IEPA was notified updating the Waukegan Station's generator status from hazardous to non-hazardous. Contact with the ComEd Compliance Specialist, Ms. Cawein, also indicated the Waukegan Station generated hazardous waste in the form of used parts washer solvent prior to 1994. Since 1994, the Waukegan Station only uses non-hazardous parts cleaner supplied and disposed of by Solvent Systems of Hampshire, Illinois.

The LUST database indicates the facility reported a petroleum release from an underground storage tank (IEPA LUST Incident #901211). According to Mr. Steve Jones, Environmental Protection Specialist with the IEPA Leaking Underground Storage Tank Division, the incident was identified on May 4, 1990 and remains an open case. However, ENSR reviewed a letter to the IEPA from ComEd dated May 22, 1990, which stated that a release from an underground storage tank was not the case, rather, it was an oil release from piping connected to a turbine oil reservoir. The reservoir, which is located entirely within the main building, ruptured an oil line releasing oil into a basement floor drain. The floor drain is routed to a sump that empties into the discharge flume. The release of oil resulted in an NPDES non-compliance violation.

4.10.2 Surrounding Land Uses

According to the EDR database report, several sites were identified within the specified search radius and are summarized in Table 4-2.

TABLE 4-2
EDR Database Summary

Site	Database	Distance	Direction	Location Relative to Inferred Hydraulic Gradient at Site
ComEd (Former Greiss Pfleger Tannery 1251 Sand Street Waukegan, Illinois	CERCLIS, FINDS, RCRIS-LQG	Adjacent	West	Upgradient

TABLE 4-2

EDR Database Summary

Site	Database	Distance	Direction	Location Relative to Inferred Hydraulic Gradient at Site
Manville Sales Corporation Greenwood Avenue & Sand Street Waukegan, Illinois	CERCLIS, RCRIS-SQG, FINDS, NPL, TRIS, SHWS	Adjacent	North	Cross-gradient
Thermal Ceramics, Inc. 120 E. Greenwood Avenue Waukegan, Illinois	FINDS, RCRIS-SQG	1/8-1/4 mile	Northwest	Upgradient
Waukegan Tar Pits JCT of Pershing & Dehringer Road Waukegan, Illinois	CERCLIS, FINDS, SHWS, RCRIS-LQG	1/2-1 mile	Southwest	Cross-gradient
Outboard Marine Corporation 200 Seahorse Drive Waukegan, Illinois	CERCLIS, FINDS, NPL, RCRIS-LQG, TRIS, RCRIS-TSD, CORRACTS, CONSENT, ROD, LUST	1/2–1 mile	South	Cross-gradient
North Shore Gas Company Sand & Dehringer Road Waukegan, Illinois	Coal Gas	1/2–1 mile	Southwest	Cross-gradient

The inferred groundwater flow direction in the subject property vicinity is toward Lake Michigan, which is located adjacent to the east of the subject property. Based on distance, inferred hydraulic gradient, and/or regulatory status, the last four above listed sites are unlikely to impact the subject property. However, as indicated in Section 4.9, the first two listed sites, Manville Sales Corporation and the former Pfleger Tannery have impacted the subject property, and are further discussed below.

- ComEd (Former Greiss Pfleger Tannery), located at 1251 Sand Street in Waukegan, Illinois is listed on the CERCLIS, FINDS, and RCRIS-LQG databases. The site is located adjacent west of the subject property. According to the EDR database report, the site is not listed on the NPL. However, interviews with ComEd personnel revealed that soil and groundwater contamination is prevalent at this location, which extends onto the subject property.

- Manville Sales Corporation, located at Greenwood Avenue and Sand Street in Waukegan, Illinois is listed on the CERCLIS, RCRIS-SQG, FINDS, NPL, TRIS, and SHWS databases. The site is located approximately less than 1/8 mile north of the subject property. According to the EDR database report, the site has been issued compliance violations, is listed on the final NPL, and is identified as an asbestos disposal facility. According to ComEd personnel, the Waukegan Station has not manufactured asbestos products, however the presence of the transite has been identified in the dredge spoils and believes these materials are from an off-site source. No closure date is reported on the EDR report. Based on the above information, this site is likely to have impacted the subject property.

5.0 SUMMARY OF FINDINGS

ENSR performed a Phase I Environmental Assessment in conformance with the scope and limitations of the ASTM practice E-1527-97 at the Commonwealth Edison Waukegan Station located at 10 Greenwood Avenue, Waukegan, Illinois. Any exceptions to or deletions from this practice are described in this report. This practice has revealed evidence of the following recognized environmental conditions associated with the subject property:

- Underground Storage Tanks: According to Mr. Dave Raudio, Construction Specialist, and available information, the facility has removed and/or abandoned-in-place three USTs used to store ignition oil and gasoline. According to Ms. Cawein, there are currently no active USTs located on the subject property. Two 12,000-gallon ignition fuel USTs were installed in 1931 and retired in place in 1986. A 500-gallon gasoline UST was installed in 1931 and removed in 1990. An internal memorandum in ComEd's files indicates that soil samples were collected from the walls of the tank pit following the removal of the 500-gallon gasoline UST. The samples were analyzed for benzene, toluene, ethylbenzene, and xylene (BTEX). None of those compounds was detected in the soil samples. A 5,000-gallon oil/water separator is also located at the subject property, but the dates of installation was unable to be provided by ComEd personnel, Waukegan Fire Department, or the OSFM. Although, no visual evidence (i.e., fill pipes) were observed during the ENSR site visit, no analytical results or clean closure documents were available for review. It is unknown if subsurface petroleum contamination exists.

- Aboveground Storage Tanks: Many of the ASTs and chemical storage areas were not equipped with secondary containment structures and petroleum staining was observed on the concrete floors within the main building and several of the outlying structures. Areas of petroleum staining were also observed on exterior paved, gravel, and soil covered surfaces adjacent to the main building and outlying structures. However, surface run-off from these areas is directed toward the east and/or west wastewater basins, which is discharged under the provisions of the NPDES permit.

- Polychorinated Biphenyls (PCBs): There are numerous liquid-cooled transformers on the site. According to Mr. Dave Rubner, ComEd PCB Specialist, a fluid exchange process to remove PCB containing dielectric fluid from transformers at all of the ComEd stations was conducted during the 1980s. Since the completion of the fluid exchange process, all transformers at the Waukegan Station are currently PCB free (i.e. below 50 ppm) and are considered to have extremely low potential for leachback to levels in excess of 50 ppm. Based on these statistics, ComEd does not intend to perform any additional testing of the transformers at the Waukegan Station. However, ENSR observed evidence of mislabeling (i.e. multiple labels on a single transformer listing different PCB concentrations) and oil staining around many of the pad-mounted electrical transformers located along the east and west sides of the main building. Although no permitting requirements currently apply to the use of equipment containing or potentially containing PCB coolants, equipment containing more than 50 ppm PCBs must be marked with the appropriate warning labels (40 CFR 761.45, PCB).

- Asbestos: According to Mr. Raudio, the spray-on material located on and within the train car "thaw" house has been tested and found to contain asbestos. This material, as well as, pipe insulation, boiler insulation, floor tile, ceiling tile, and any other materials not identified as asbestos free, should be treated as ACM. An additional asbestos issue was also identified at the Waukegan Station during ENSR's investigation. Asbestos in the form of transite brake shoes was observed in the dredge spoils and along the lakefront of the subject property. According to ComEd personnel, the Waukegan Station has not manufactured asbestos products and the presence of the transite brake shoes is likely from an off-site source. Estimated quantities and removal costs associated with the cleanup of the transite could not be provided at this time.

- Areas of Petroleum Surface Staining: Several areas of surface staining were observed on interior concrete and on exterior paved, gravel, and soil covered areas. Many of the aboveground storage tanks, transformers, and chemical storage areas were not equipped with secondary containment structures and petroleum staining was observed adjacent to these areas. However, surface run-off from these areas is directed toward the east and/or west wastewater basins, which is discharged under the provisions of the NPDES permit.

- On-Site Wastewater and Fly/Bottom Ash Disposal Systems: Building and assessment records indicate the subject property has been occupied by a coal fired power plant facility from approximately 1923 until the present. In July 1977, ComEd was issued IEPA Permit #1977-EB-3699 for the construction of miscellaneous wastewater treatment facilities including clay-lined wastewater treatment settling basins, a synthetically lined coal pile drainage basin, and a synthetically-lined fly/bottom ash settling basin system. Prior to this time, unlined slag basins were in use at the station. It is unknown if the use of the unlined basins may have impacted the subsurface at the subject property.

- Railroad: A railroad has abutted and been located on the subject property since at least 1923. The presence of the railroad and rail spur may have had an impact on the subject property from fuels, oils, and/or solvents. ENSR observed areas of pervasive staining along the railroad tracks near the train car "thaw" house, "drive house", and "dump" house.

- On-Site Spills/Releases: Based on a review of Waukegan Station's incident files, there have been several spills/releases on site. However, only one appears to have adversely affected on-site soil quality. According to Ms. Jenni Cawein, the release was caused from a leak in an underground pipe associated with the large aboveground storage tank. Ms. Cawein also indicated that the release was not required to be reported to the Illinois Emergency Management Agency (IEMA) and groundwater was not sampled to determine whether that media had been impacted. However, approximately 500 to 1,000 cubic yards of contaminated soil were excavated from the impacted area and treated on-site. The area served as a bioremediation project site during the spring and summer of 1994. Both *in situ* and *ex situ* treatments were conducted over an approximately 6-8-month time period. Sample results indicated a 50-90 percent reduction in total petroleum hydrocarbons (TPH) concentrations in the areas impacted by the leak.

- Adjacent Properties: The north adjacent property has been occupied by an asbestos manufacturing company since the 1920s. The west adjacent properties have been occupied since the 1920s by the Waukegan Station's main electrical switch yard, as well as a tannery and radiator manufacturing facility. According to ComEd documentation, there has been PCB-containing fluid releases from transformers and capacitors, as well as, releases from underground storage tanks containing petroleum products. Furthermore, the tannery and radiator facilities are no longer in operation, but also have left behind soil and groundwater contamination. An arsenic, lead, mercury, and chromium contaminated groundwater plume has been identified on the former tannery site, which extends easterly onto the subject property. The former radiator manufacturing facility has also left behind petroleum-contaminated soil and groundwater from leaking underground storage tanks, which may also be affecting the subject property.

6.0 REFERENCES

6.1 Persons Interviewed or Contacted

Mr. Dave Raudio, Construction Specialist, Commonwealth Edison, 10 Greenwood Avenue, Waukegan, Illinois; (847) 662-6201.

Ms. Jenni Cawein, Compliance Specialist, Commonwealth Edison, 10 Greenwood Avenue, Waukegan, Illinois; (847) 662-6201.

Mr. Christopher Lux, Site Construction Specialist, Commonwealth Edison, 10 Greenwood Avenue, Waukegan, Illinois; (847) 662-6201.

Mr. Dave Rubner, PCB Specialist, Commonwealth Edison, 10 South Dearborn Street, Chicago, Illinois; (312) 394-4461.

Mr. Steve Jones, Environmental Protection Specialist, Illinois Environmental Protection Agency Leaking Underground Storage Tank Division, Springfield, Illinois; (217) 782-6762.

6.2 Documents and Reports Reviewed

City of Waukegan Building Department Records, 18 North County Street, Waukegan, Illinois.

City of Waukegan Assessment Department Records, 18 North County Street, Waukegan, Illinois.

Aerial Photographs of subject property and surrounding properties dated 1939, 1959, 1964, 1975, 1985, 1990, and 1995 reviewed the City of Waukegan Graphics Department, 18 North County Street, Waukegan, Illinois.

Polk's 1948 through 1993 City Directories reviewed at the City of Waukegan Public Library, 128 North County Street, Waukegan, Illinois.

Ecology and Environment, Inc. of Chicago, Illinois, Screening Site Inspection Report , prepared for Pfleger Greiss, Waukegan, Illinois, dated March 13, 1990.

NPDES Permit #IL0002259, issued August 9, 1995, expiration August 1, 2000.

Illinois Generator Non-Hazardous Special Waste Report dated January 1, 1996.

Illinois Generator Non-Hazardous Special Waste Report dated January 1, 1997.

Illinois Generator Non-Hazardous Special Waste Report dated January 1, 1998.

Spill Prevention and Countermeasures Plan (SPCC) for Waukegan Generating Station, dated November 11, 1994.

Metcalf & Eddy of Chicago, Illinois, Report of Outstanding Environmental Liabilities at The Winston Property, 184 Dahringer Road, Waukegan, Illinois, dated May 18, 1998.

LUST Correspondence Letter between Comed and IEPA, dated May 22, 1990, regarding the misrepresentation of an oil spill as a LUST incident.

EDR Radius Map with Geocheck®, Comed Waukegan Station, 10 Greenwood Avenue, Waukegan, Illinois, dated August 18, 1998.

EDR Sanborn™ Map Report, ComEd Waukegan Station, 10 Greenwood Avenue, Waukegan, Illinois, dated August 18, 1998.

U.S.G.S. 7.5-minute Topographical Quadrangle Map, Zion, Illinois, dated 1960, photorevised 1972 and 1980.

Letter from Commonwealth Edison to the Waukegan Fire Marshal, dated February 26, 1998, regarding 1997 Tier II Emergency and Hazardous Chemical Inventory Form for Commonwealth Edison Waukegan Station, 10 Greenwood Avenue, Waukegan, Illinois.

7.0 SIGNATURES AND QUALITY CONTROL REVIEW

BY: Dennis P. O'Neil / for
Jeffrey D. Menter

TITLE: Senior Staff Specialist

DATE: 10/5/98

QUALITY CONTROL REVIEW

BY: Mark J. Knight / for
Aaron Gesin

TITLE: Program Manager

DATE: 10/5/98

7.0 SIGNATURES AND QUALITY CONTROL REVIEW

BY: ______________________
Jeffrey D. Menter

TITLE: Senior Staff Specialist

DATE: 10/2/98

QUALITY CONTROL REVIEW

BY: ______________________
Aaron Gesin

TITLE: Program Manager

DATE: 10/2/98

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RESPONSE TO MOTION FOR PARTIAL SUMMARY JUDGMENT

EXHIBIT 13

REMEDIAL INVESTIGATION REPORT FOR THE GRIESS-PFLEGER TANNERY, RELEVANT PAGES

REMEDIAL INVESTIGATION REPORT - PHASE I
FOR THE
FORMER GRIESS-PFLEGER TANNERY SITE
WAUKEGAN, ILLINOIS

VOLUME 1 OF 3

PREPARED FOR
COMMONWEALTH EDISON COMPANY

PREPARED BY

METCALF & EDDY, INC
ONE PIERCE PLACE, SUITE 1500 W
ITASCA, ILLINOIS

MARCH 1994

SECTION 2.0
SITE BACKGROUND

2.1 SITE DESCRIPTION

On October 15, 1973, Commonwealth Edison Company (CECo) purchased the 38-acre site from Beggs & Cobbs, Inc. of Boston, Massachusetts. This property is located adjacent to CECo's 240-acre Power Generation facility. The former tannery is located at the northeast corner of Sand (Pershing) and Dahringer Road in Lake County, Waukegan, Illinois. More specifically, the site is located in the northwest quarter of the southwest quarter of Section 15, Township 45 North, Range 12 East of the Third Principal Meridian in Lake County. Refer to Figure 2-1 for the site location.

2.2 SITE HISTORY

The Griess-Pfleger Tannery was built in 1917 and operated as a leather tanning facility from 1918 through 1973. Aerial photographs, Figures 2-2, 2-3, 2-4, and 2-5, illustrate the progression of the former tanning facility during the years 1939, 1959, 1964, and 1970, respectively. Shortly after the facility closed, a lacquer dust fire, which occurred on November 16, 1973, gutted several of the main structures. This fire was the last of several which had occurred throughout the tanning facility's operational history.

According to the Tannery Council of America, two tanning methods exist: chrome tanning and vegetable tanning. Past analytical data suggest that chromium tanning processes were utilized by the Griess-Pfleger Tannery. Chrome tanning consists of nine steps. Chemicals involved in the tannery process include: sodium sulfate, lime, diethylamine, sulfhydrate, cyanide salts, enzymes, ammonium sulfate or ammonium hydrate, sulfuric acid, sodium chloride, chrome liquor, sodium thiosulfate, and borax. The tanning process produced wastes from these chemicals in the form of gaseous reaction products, wastewater, sludge, and solid wastes.

In addition to impacts attributed to the tannery process, it is believed that a portion of the site may have been used as a dump site by third parties.

On December 2, 1988, Commonwealth Edison received notification from Ecology and Environment, a Field Investigation Team (FIT) contractor for the U.S. EPA, that the former tannery site was being considered as a candidate for placement on the National Priorities List (NPL). Subsequently, a preliminary site investigation was conducted on January 5, 1989 by FIT. Analytical data from the FIT investigation indicated elevated levels of chromium and lead in soil.

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

RESPONSE TO MOTION FOR PARTIAL SUMMARY JUDGMENT

EXHIBIT 14

REMEDIAL OBJECTIVES REPORT FOR THE GRIESS-PFLEGER TANNERY, RELEVANT PAGES

Remediation Objectives Report

Former Griess-Pfleger Tannery Site
Waukegan, Illinois

Prepared by:

The RETEC Group, Inc.
8605 West Bryn Mawr Avenue
Chicago, IL 60631

RETEC Project Number: CEDI4-15159-000

Prepared Under Contract to:

Commonwealth Edison Company on Behalf of
Commonwealth Edison and Beggs and Cobb Corporation

Prepared by:

Jenny K. Phillips

Jenny K. Phillips, Toxicologist

Reviewed by:

David Meiri

David Meiri, Ph.D., CGWP Senior Program Manager

August 8, 2002

T:\COMED\tannery\Final ROR Report

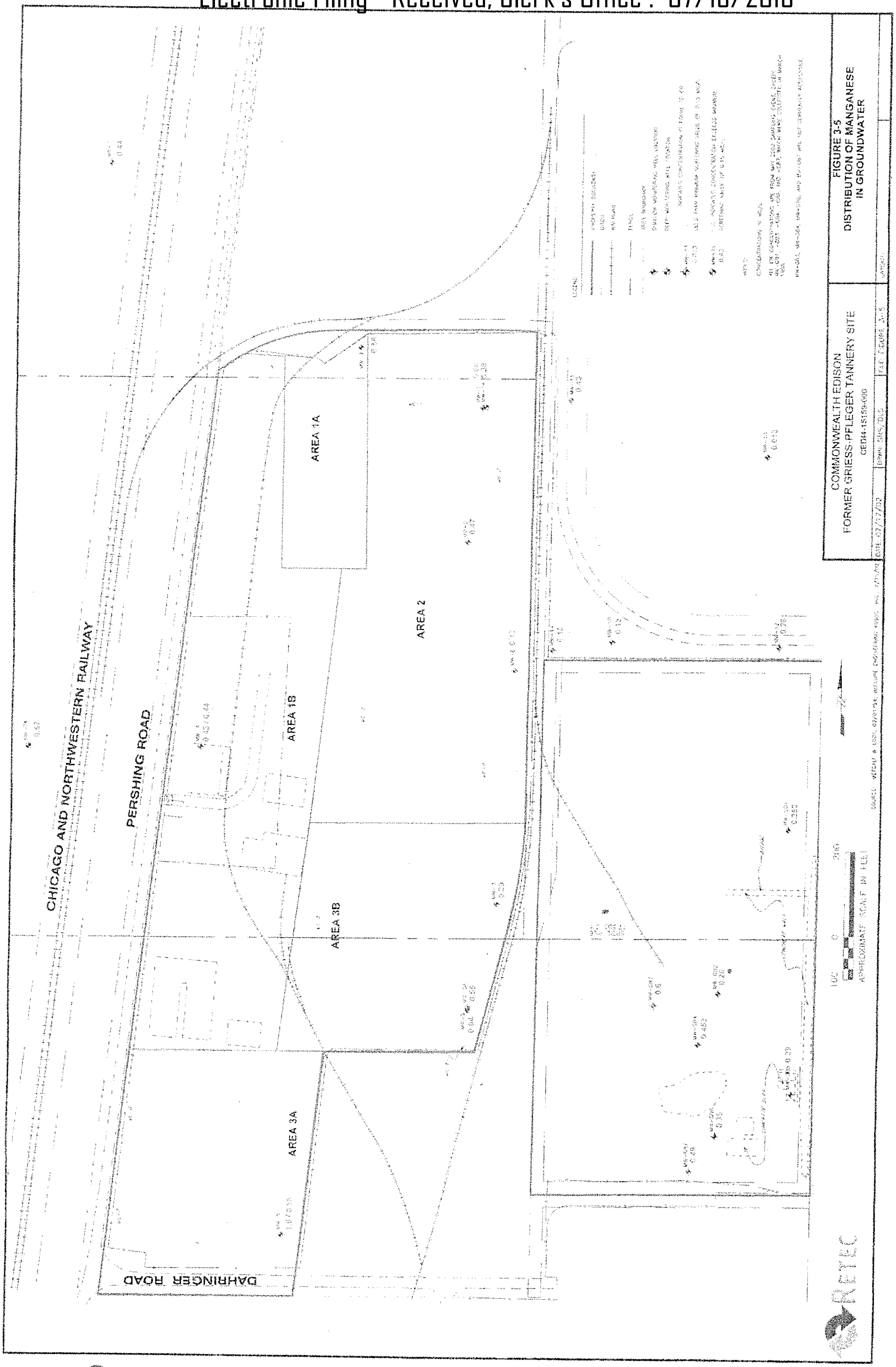
CHICAGO AND NORTHWESTERN RAILWAY
PERSHING ROAD
AREA 1A
AREA 1B
AREA 2
AREA 3A
AREA 3B
DAHRINGER ROAD
APPROXIMATE SCALE IN FEET
FIGURE 3-5
DISTRIBUTION OF MANGANESE
IN GROUNDWATER
COMMONWEALTH EDISON
FORMER GRIESS-PFLEGER TANNERY SITE
RETEC

Table 22

Summary of Groundwater Data (Continued)

	Sample Name / Date / Sample Type / Site / CAS No.	MW-5A 05/13/02 Investigation Tan	MW-6 05/10/02 Investigation Tan	MW-7 05/14/02 Investigation Background	MW-7A 05/14/02 Investigation Background	MW-8 05/13/02 Investigation Tan	MW-9 05/10/02 Investigation Tan
Total Metals (mg/L)							
Antimony	7440360	0.0036	<0.003	<0.003	<0.003	0.0035	<0.003
Arsenic	7440382	< 0.010	< 0.010	< 0.010	< 0.010	0.95	0.014
Barium	7440393	--	--	--	--	--	--
Calcium	7440702	210	240	440	140	180	170
Chromium	18540299	--	--	--	--	--	--
Iron	15438310	1.4	< 0.050	0.51	4.7	2.4	3.4
Lead	7439921	--	--	--	--	--	--
Magnesium	7439954	100	42	29	46	70	39
Manganese	7439965	0.55	1.0	0.44	0.67	0.13	0.58
Mercury	7439976	--	--	--	--	--	--
Selenium	7782492	--	--	--	--	--	--
Silver	7440224	--	--	--	--	--	--
Thallium	7440280	--	--	--	--	--	--
Zinc	7440666	--	--	--	--	--	--
Water Quality Parameter (mg/L)							
Solids, Total Dissolved (TDS)		1700	1500	2000	1100	1100	1500

Table 22

Summary of Groundwater Data (Continued)

	Sample Name Date Sample Type Site CAS No.	MW-10 05/09/02 Investigation Tan	MW-11 05/09/02 Investigation Tan	MW-12 05/09/02 Investigation Tan	MW-13 05/09/02 Investigation Tan	MW-14 05/09/02 Investigation Tan
Total Metals (mg/L)						
Antimony	7440360	<0.003	<0.003	<0.003	<0.003	<0.003
Arsenic	7440382	0.45	0.73	0.023	< 0.010	0.39
Barium	7440393	--	--	--	--	--
Calcium	7440702	110	210	330	55	160
Chromium	18540299	--	--	--	--	--
Iron	15438310	5.3	2.4	4.6	0.083	2.1
Lead	7439921	--	--	--	--	--
Magnesium	7439954	23	63	17	3.7	58
Manganese	7439965	0.18	0.43	0.26	0.013	0.15
Mercury	7439976	--	--	--	--	--
Selenium	7782492	--	--	--	--	--
Silver	7440224	--	--	--	--	--
Thallium	7440280	--	--	--	--	--
Zinc	7440666	--	--	--	--	--
Water Quality Parameter (mg/L)						
Solids, Total Dissolved (TDS)		560	1100	1600	200	870

Table 22

Summary of Groundwater Data (Continued)

	Sample Name Date Sample Type Site CAS No.	MW-101 (MW-4 dup) 05/10/02 Investigation Tan	MW-102 (MW-6 dup) 05/10/02 Investigation Tan	MW-GB2 05/10/02 Investigation GB	MW-GB5 05/10/02 Investigation GB
Total Metals (mg/L)					
Antimony	7440360	<0.003	<0.003	<0.003	<0.003
Arsenic	7440382	< 0.010	< 0.010	< 0.010	0.0085B
Barium	7440393	--	--	--	--
Calcium	7440702	140	230	92	110
Chromium	18540299	--	--	--	--
Iron	15438310	5.3	< 0.050	2.4	2.5
Lead	7439921	--	--	--	--
Magnesium	7439954	30	40	37	32
Manganese	7439965	0.44	0.98	0.26	0.29
Mercury	7439976	--	--	--	--
Selenium	7782492	--	--	--	--
Silver	7440224	--	--	--	--
Thallium	7440280	--	--	--	--
Zinc	7440666	--	--	--	--
Water Quality Parameter (mg/L)					
Solids, Total Dissolved (TDS)		860	1100	570	640

Table 22

Summary of Groundwater Data

Sample Name Date Sample Type Site	CAS No.	MW-GB1 Mar-98 Investigation GB	MW-GB2 Mar-98 Investigation GB	MW-GB3 Mar-98 Investigation GB	MW-GB4 Mar-98 Investigation GB	MW-GB5 Mar-98 Investigation GB
Total Metals (mg/L)						
Antimony	7440360	< 0.067	< 0.067	< 0.067	< 0.067	< 0.067
Arsenic	7440382	0.008	< 0.002	< 0.002	0.003	< 0.002
Barium	7440393	0.075	< 0.056	0.16	0.121	0.17
Calcium	7440702	NA	NA	NA	NA	NA
Chromium	18540299	< 0.011	< 0.011	< 0.011	< 0.011	< 0.011
Iron	15438310	1.88	14.8	8.3	2.88	4.9
Lead	7439921	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
Magnesium	7439954	NA	NA	NA	NA	NA
Manganese	7439965	0.353	0.414	0.6	0.452	0.3
Mercury	7439976	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Selenium	7782492	0.037	< 0.003	< 0.003	< 0.003	< 0.003
Silver	7440224	0.097	< 0.011	< 0.011	< 0.011	< 0.011
Thallium	7440280	0.004	< 0.002	< 0.002	< 0.002	< 0.002
Zinc	7440666	< 0.022	< 0.022	0.058	0.091	< 0.022
Water Quality Parameter (mg/L)						
Solids, Total Dissolved (TDS)		NA	NA	NA	NA	NA

Table 22

Summary of Groundwater Data (Continued)

Sample Name / Date / Sample Type / Site	CAS No.	MW-GB6 Mar-98 Investigation GB	MW-GB7 Mar-98 Investigation GB	MW-1 Oct-97 Investigation Tan	MW-1A Oct-97 Investigation Tan	MW-2 Oct-97 Investigation Tan
Total Metals (mg/L)						
Antimony	7440360	< 0.067	< 0.067	0.029	< 0.028	0.038
Arsenic	7440382	< 0.002	< 0.002	1.3	< 0.002	0.069
Barium	7440393	0.073	0.11	< 0.056	< 0.056	0.066
Calcium	7440702	NA	NA	NA	NA	NA
Chromium	18540299	< 0.011	< 0.011	< 0.011	0.02	< 0.011
Iron	15438310	8.5	7.8	1.3	0.092	2
Lead	7439921	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
Magnesium	7439954	NA	NA	NA	NA	NA
Manganese	7439965	0.35	0.49	0.38	0.99	0.28
Mercury	7439976	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Selenium	7782492	< 0.003	< 0.003	< 0.0033	< 0.0033	< 0.0033
Silver	7440224	< 0.011	< 0.011	< 0.011	< 0.011	< 0.011
Thallium	7440280	< 0.002	< 0.002	< 0.0022	< 0.0022	< 0.0022
Zinc	7440666	< 0.022	< 0.022	0.048	< 0.022	< 0.022
Water Quality Parameter (mg/L)						
Solids, Total Dissolved (TDS)		NA	NA	NA	NA	NA

Table 22

Summary of Groundwater Data (Continued)

Sample Name / Date / Sample Type / Site	CAS No.	MW-3 Oct-97 Investigation Tan	MW-4 Oct-97 Investigation Tan	MW-5 Oct-97 Investigation Tan	MW-5A Oct-97 Investigation Tan	MW-6 Oct-97 Investigation Tan
Total Metals (mg/L)						
Antimony	7440360	0.033	0.049	0.036	0.035	0.053
Arsenic	7440382	< 0.002	0.0044	0.0038	0.0032	< 0.002
Barium	7440393	< 0.056	0.097	< 0.056	0.1	< 0.056
Calcium	7440702	NA	NA	NA	NA	NA
Chromium	18540299	0.011	< 0.011	< 0.011	< 0.011	0.013
Iron	15438310	9.3	7.4	15	11	0.14
Lead	7439921	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
Magnesium	7439954	NA	NA	NA	NA	NA
Manganese	7439965	0.24	0.31	0.78	0.41	3.5
Mercury	7439976	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Selenium	7782492	< 0.0033	< 0.0033	< 0.0033	< 0.0033	< 0.0033
Silver	7440224	< 0.011	< 0.011	< 0.011	< 0.011	< 0.011
Thallium	7440280	< 0.0022	< 0.0022	< 0.0022	< 0.0022	< 0.0022
Zinc	7440666	0.059	0.16	0.1	0.024	0.46
Water Quality Parameter (mg/L)						
Solids, Total Dissolved (TDS)		NA	NA	NA	NA	NA

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Table 22

Summary of Groundwater Data (Continued)

Sample Name Date Sample Type Site	CAS No.	MW-7 Oct-97 Investigation Background	MW-7A Oct-97 Investigation Background	MW-8 Oct-97 Investigation Tan	MW-9 Oct-97 Investigation Tan	MW-10 Oct-97 Investigation Tan
Total Metals (mg/L)						
Antimony	7440360	< 0.028	< 0.028	< 0.028	0.039	< 0.028
Arsenic	7440382	0.076	0.0033	0.67	0.032	0.17
Barium	7440393	0.072	0.16	< 0.056	0.088	0.065
Calcium	7440702	NA	NA	NA	NA	NA
Chromium	18540299	< 0.011	0.026	< 0.011	0.012	< 0.011
Iron	15438310	5.4	5.9	3.3	6	3.3
Lead	7439921	0.0041	< 0.003	< 0.003	< 0.003	< 0.003
Magnesium	7439954	NA	NA	NA	NA	NA
Manganese	7439965	0.45	1.1	0.11	0.26	0.085
Mercury	7439976	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Selenium	7782492	0.0068	< 0.0033	< 0.0033	< 0.0033	< 0.0033
Silver	7440224	0.056	< 0.011	< 0.011	< 0.011	< 0.011
Thallium	7440280	< 0.0022	0.0029	< 0.0022	0.0022	< 0.0022
Zinc	7440666	0.032	0.096	< 0.022	0.068	< 0.022
Water Quality Parameter (mg/L)						
Solids, Total Dissolved (TDS)		NA	NA	NA	NA	NA

Table 22

Summary of Groundwater Data (Continued)

Sample Name / Date / Sample Type / Site / CAS No.		MW-11 Oct-97 Investigation Tan	MW-12 Oct-97 Investigation Tan	MW-13 Oct-97 Investigation Tan	MW-1T Nov-96 Investigation Tan	MW-1AT Nov-96 Investigation Tan
Total Metals (mg/L)						
Antimony	7440360	0.029	< 0.028	0.044		
Arsenic	7440382	0.22	0.0025	< 0.002	1.39	< 0.003 J
Barium	7440393	< 0.056	< 0.056	< 0.056	0.0378	0.021
Calcium	7440702	NA	NA	NA	NA	NA
Chromium	18540299	< 0.011	< 0.011	< 0.011	0.033	0.0059
Iron	15438310	0.73	1.4	0.42		
Lead	7439921	< 0.003	< 0.003	< 0.003	0.0018	0.0013
Magnesium	7439954	NA	NA	NA	NA	NA
Manganese	7439965	0.14	0.27	0.19		
Mercury	7439976	0.0002	< 0.0002	< 0.0002	< 0.00003	< 0.00003
Selenium	7782492	0.0034	< 0.0033	< 0.0033	< 0.0014	< 0.0014
Silver	7440224	< 0.011	< 0.011	< 0.011	< 0.0007	< 0.0007
Thallium	7440280	< 0.0022	0.0025	< 0.0022		
Zinc	7440666	< 0.022	0.16	0.032		
Water Quality Parameter (mg/L)						
Solids, Total Dissolved (TDS)		NA	NA	NA	NA	NA

Table 22

Summary of Groundwater Data (Continued)

Sample Name Date Sample Type Site	CAS No.	MW-2T Nov-96 Investigation Tan	MW-3T Nov-96 Investigation Tan	MW-4T Nov-96 Investigation Tan	MW-5T Nov-96 Investigation Tan	MW-5AT Nov-96 Investigation Tan
Total Metals (mg/L)						
Antimony	7440360					
Arsenic	7440382	0.0658	< 0.0025 J	< 0.0028 J	< 0.0025 J	< 0.0025 J
Barium	7440393	0.1	0.0627	0.0993	0.0303	0.112
Calcium	7440702	NA	NA	NA	NA	NA
Chromium	18540299	0.0139	0.0504	0.0024	0.02	0.0054
Iron	15438310					
Lead	7439921	< 0.001	0.0016	< 0.001	0.0011	< 0.001
Magnesium	7439954	NA	NA	NA	NA	NA
Manganese	7439965					
Mercury	7439976	< 0.00005	0.00004	< 0.00004	< 0.00003	< 0.00003
Selenium	7782492	0.0019	< 0.0014	< 0.0014	< 0.0023	< 0.0042
Silver	7440224	< 0.0007	< 0.0007	< 0.0007	0.0007	< 0.0007
Thallium	7440280					
Zinc	7440666					
Water Quality Parameter (mg/L)						
Solids, Total Dissolved (TDS)		NA	NA	NA	NA	NA

Table 22

Summary of Groundwater Data (Continued)

Sample Name Date Sample Type Site CAS No.		MW-6T Nov-96 Investigation Tan	MW-7T Nov-96 Investigation Background	MW-7AT Nov-96 Investigation Background	MW-8T Nov-96 Investigation Tan	MW-9T Nov-96 Investigation Tan
Total Metals (mg/L)						
Antimony	7440360					
Arsenic	7440382	< 0.0025 J	< 0.0025 J	< 0.0025 J	0.513	0.0487
Barium	7440393	0.0446	0.0545	0.209	0.035	0.11
Calcium	7440702	NA	NA	NA	NA	NA
Chromium	18540299	0.0044	0.0015	0.0019	0.0242	0.006
Iron	15438310					
Lead	7439921	< 0.001	< 0.001	0.0016	< 0.001	< 0.001
Magnesium	7439954	NA	NA	NA	NA	NA
Manganese	7439965					
Mercury	7439976	< 0.00005	< 0.00003	< 0.00003	< 0.00004	< 0.00004
Selenium	7782492	< 0.0014	< 0.0018	< 0.0014	< 0.0014	< 0.0014
Silver	7440224	< 0.0007	< 0.0007	< 0.0007	< 0.0007	< 0.0007
Thallium	7440280					
Zinc	7440666					
Water Quality Parameter (mg/L)						
Solids, Total Dissolved (TDS)		NA	NA	NA	NA	NA

Table 22

Summary of Groundwater Data (Continued)

Sample Name / Date / Sample Type / Site / CAS No.		MW-10T Nov-96 Investigation Tan	MW-11T Nov-96 Investigation Tan	MW-12T Nov-96 Investigation Tan	MW-13T Nov-96 Investigation Tan	MW-14D Investigation Tan	MW-14T Investigation Tan
Total Metals (mg/L)							
Antimony	7440360						
Arsenic	7440382	0.278	1.28	< 0.0025 J	< 0.0025 J	0.25	0.34
Barium	7440393	0.0574	0.0293	0.0261	0.0122	0.22	0.13
Calcium	7440702	NA	NA	NA	NA	NA	NA
Chromium	18540299	0.0028	0.0041	< 0.0006	0.00067		
Iron	15438310					1.4	1.4
Lead	7439921	< 0.001	< 0.001	0.0016	< 0.001		
Magnesium	7439954	NA	NA	NA	NA	NA	NA
Manganese	7439965					0.31	0.33
Mercury	7439976	< 0.00003	< 0.00003	< 0.00003	< 0.00003		
Selenium	7782492	< 0.0024	< 0.0031	< 0.0055	< 0.0017		
Silver	7440224	< 0.0007	< 0.0007	< 0.0007	< 0.0007		
Thallium	7440280						
Zinc	7440666					0.12	0.081
Water Quality Parameter (mg/L)							
Solids, Total Dissolved (TDS)		NA	NA	NA	NA	NA	NA