HYDROGEOLOGIC ASSESSMENT PLAN
WAUKEGAN GENERATING STATION
WAUKEGAN, ILLINOIS

SUBMITTED BY:
MIDWEST GENERATION, LLC
235 REMINGTON BLVD, SUITE A
BOLINGBROOK, IL 60440

SUBMITTED TO:
ILLINOIS ENVIRONMENTAL PROTECTION AGENCY
1021 N GRAND AVENUE EAST
SPRINGFIELD, IL 62702

PREPARED BY:
PATRICK ENGINEERING INC.
4970 VARSITY DRIVE
LISLE, ILLINOIS 60532

PATRICK PROJECT NO. 21053.026

JULY 2010

PATRICK ENGINEERING

EXHIBIT
615

MWG13-15_39462

TABLE OF CONTENTS

1.0 INTRODUCTION

1.1 Background

Pursuant to the request of the Illinois Environmental Protection Agency (Illinois EPA), this document presents the Hydrogeologic Assessment (HA) Plan for the on-site ash pond areas at the Midwest Generation, LLC (MWG) Waukegan Generating Station in Waukegan, Illinois. The purpose of the HA Plan is to characterize the subsurface hydrogeology and to evaluate the potential, if any, for contaminant migration from the on-site ash ponds. This HA Plan was developed as the result of numerous communications between MWG and the Illinois EPA, the most recent being a meeting held at Illinois EPA's offices in Springfield, Illinois on June 10, 2010. During that meeting, a conceptual approach for the completion of hydrogeologic assessments of MWG ash ponds at a number of sites (including Waukegan) was presented by MWG and was conceptually agreed to by the parties. MWG agreed to submit the substance of the proposed assessment plans in written form to the Illinois EPA in July 2010 for each of the relevant sites.

This HA Plan for the Waukegan facility describes the objectives of the assessment, the specific assessment work to be performed, and a description of the contents of the final report, which will provide the results of the assessment.

1.2 Site Location

The Waukegan facility (the Site) is located in Section 15, Township 45 North, Range 12 East, in the City of Waukegan, Lake County, Illinois. Figure 1 provides a Site Location Map.

Major features of the Site include a coal-fired power plant, coal piles, and two active ash ponds. The ponds are lined with a high-density polyethylene (HDPE); the total area of the two ash ponds is approximately 25 acres. Figure 2 shows the locations of the two ash ponds.

2.0 SCOPE OF WORK

2.1 Hydrogeologic Assessment Objectives

The Scope of Work for this HA has been developed based upon the objectives of the assessment program. The objectives were defined by the Illinois EPA in their original informational request. The objectives are as follows:

1. Identification of Potable Well Use within 2,500 Feet of the Ash Ponds;
2. Evaluation of the Potential for Contaminant Migration from the Ash Ponds; and
3. Characterization of Subsurface Hydrogeology

Each of these objectives is discussed in more detail below, along with the specific scope of work developed to achieve them.

2.2 Identification of Potable Well Use

MWG has completed the investigation of potable water well use within 2,500 feet of the Waukegan ash ponds. MWG submitted the results of this investigation to the Illinois EPA by letter dated July 15, 2009. The results of the potable water well investigation will be incorporated into the final HA Report.

2.3 Evaluation of Contaminant Migration Potential

The Illinois EPA has requested that an evaluation of the potential for contaminant migration from the ash ponds be performed in accordance with the groundwater non-degradation standard of Illinois Administrative Code (IAC) Part 620, Subpart C. Evaluation of the non-degradation standard will require the installation and sampling of monitoring wells located both upgradient and downgradient of the two ash ponds. The tasks necessary to complete this evaluation are described below.

2.3.1 Location and Installation of Groundwater Monitoring Wells

MWG will install five (5) groundwater monitoring wells spaced approximately 200 feet apart around the perimeter of the ash ponds. The well locations have been selected so that both upgradient and downgradient wells are represented. The spacing of the well locations at the Site along the downgradient edge of the ash ponds has been calculated so as to detect a groundwater plume emanating from a point source beneath the ash ponds. The site-specific calculations which form the basis for the well spacing are contained in Attachment A.

One of the monitoring wells will be upgradient of the ash ponds; the additional four wells will be downgradient of the ash ponds. Figure 3 shows the location of the proposed five monitoring wells. The well borings will be advanced using hollow-stem augers to an approximate depth of 20 feet below ground surface, so as to intersect with the groundwater table for a depth of approximately 10 feet. Soil lithology will be inspected and logged by an experienced geologist/engineer during the boring process. The final depth of the wells will be determined in the field by the geologist/engineer based upon the depth at which groundwater is encountered. Upon termination of each boring, a 2-inch diameter, PVC well will be installed in order to collect samples of the groundwater in the uppermost aquifer. The actual depth of the screened interval of each monitoring well will be determined in the field based on the field conditions encountered in order to ensure a representative groundwater sample can be obtained. The monitoring wells will be completed to approximately 3 feet above grade with PVC casing and covered with a stick-up, steel well protector with a locking cap.

2.3.2 Groundwater Sampling and Analytical Testing

MWG will measure the groundwater elevation in each of the five wells and collect pH and conductivity measurements using a portable meter. Groundwater samples will be collected from each of the wells with a peristaltic pump, using low-flow sampling techniques. The groundwater samples will be filtered in the field using a disposable, 0.45µm, in-line filter to allow for the analytical testing of dissolved compounds. The samples will be immediately placed on ice in a cooler and kept at a temperature of no higher than 4° F. The samples will be transported to TestAmerica, an Illinois-EPA accredited analytical laboratory, in accordance with chain-of-custody procedures that maintain the integrity of the samples.

The analytical laboratory will test groundwater samples from each of the wells for the compounds listed in Table 1. Proposed analytes include the inorganic compounds listed in IAC 620.410(a), excluding both radium and the poly-aromatic hydrocarbons (PAHs) listed in IAC 620.410(b).

2.4 Characterization of Subsurface Hydrogeology

The subsurface hydrogeology beneath the ash ponds will be characterized by determining Site lithology and the groundwater flow patterns in the vicinity of the ash ponds. The Site lithology will be determined during the installation of the groundwater monitoring wells. In order to determine the groundwater flow patterns, information concerning local hydraulic gradients and permeability will be collected, as described in more detail below.

2.4.1 Topographic and Water Elevation Surveys

A survey crew will measure both the top-of-casing and ground surface elevations of all installed monitoring wells and the groundwater elevations within each of the monitoring wells. The survey crew will concurrently measure the water elevation in each of the ash ponds and Lake Michigan. This data will be used to determine the hydrogeologic flow characteristics of the Site. The data will also be used to construct geologic cross-sections of the Site.

2.4.2 Hydraulic Testing of Selected Wells

All wells will be developed using either a down-hole or peristaltic pump or by hand bailing until at least three well volumes have been removed or the removed water appears clear. Three of the five wells will be selected for hydraulic conductivity testing using rising- and falling-head slug tests. Each slug test will be performed by inserting a 'slug' into the well, displacing the water in the well. A down-hole water level measuring and recording device will measure the rate at which the water level returns to its static level. The slug will then be removed from the well, lowering the water level in the well. The rate at which the water level recovers to its static level will be measured. This data will be used to calculate the hydraulic conductivity of the uppermost aquifer at the Site.

2.5 Final Assessment Report

A written report detailing the field methods employed and results of the hydrogeologic assessment will be prepared and submitted to the Illinois EPA. The report will include soil boring logs and monitoring well construction diagrams, geologic cross-sections, analytical data tables, hydraulic conductivity testing results, a potentiometric surface map, and a map detailing the locations of potable water wells within 2,500 feet of the ash ponds. The proposed Table of Contents for the final HA Report is as follows:

1. Introduction
2. Site Location and Regional Hydrogeology
3. Ash Pond Descriptions
4. Investigation Methodology
5. Investigation Results
    a. Results of Potable Water Use Investigation
    b. Groundwater Elevation Data
    c. Local Lithology
    d. Groundwater Analytical Results
    e. Permeability Testing Data
6. Findings and Conclusions of Hydrogeologic Assessment

3.0 SCHEDULE

This HA Plan is being submitted to the Illinois EPA for its review and approval. Implementation of the HA Plan will begin upon receipt of written approval by the Illinois EPA. It is anticipated that a final Assessment Report can be submitted to Illinois EPA within 6 weeks of completion of all field work specified in this HA Plan.

FIGURES AND TABLES

TABLE 1
PROPOSED SAMPLING AND ANALYSIS PLAN
Midwest Generation, LLC
Waukegan Generating Station
Waukegan, Illinois
July 2010

PARAMETER	NOTES
pH	Field Parameter
Specific Conductance	Field Parameter
Groundwater Depth	Field Parameter
Well Depth	Field Parameter
Boron[a]	Laboratory Parameter
Sulfate[b]	Laboratory Parameter
Iron[a]	Laboratory Parameter
Manganese[a]	Laboratory Parameter
Total Dissolved Solids[c]	Laboratory Parameter
Antimony[a]	Laboratory Parameter
Arsenic[a]	Laboratory Parameter
Barium[a]	Laboratory Parameter
Beryllium[a]	Laboratory Parameter
Cadmium[a]	Laboratory Parameter
Chloride[d]	Laboratory Parameter
Chromium[a]	Laboratory Parameter
Cobalt[a]	Laboratory Parameter
Copper[a]	Laboratory Parameter
Cyanide[a]	Laboratory Parameter
Fluoride[a]	Laboratory Parameter
Lead[a]	Laboratory Parameter
Mercury[e]	Laboratory Parameter
Nickel[a]	Laboratory Parameter
Nitrate as N[f]	Laboratory Parameter
Selenium[a]	Laboratory Parameter
Silver[a]	Laboratory Parameter
Thallium[a]	Laboratory Parameter
Zinc[a]	Laboratory Parameter

NOTES

[a] Dissolved metals analyzed by SW-846 Method 6020

[b] Dissolved sulfate analyzed by SW-846 Method 9038

[c] Total dissolved solids analyzed by SW-846 Method 2540C

[d] Dissolved chloride analyzed by SW-846 Method 9251

[e] Dissolved mercury analyzed by SW-846 Method 7470A

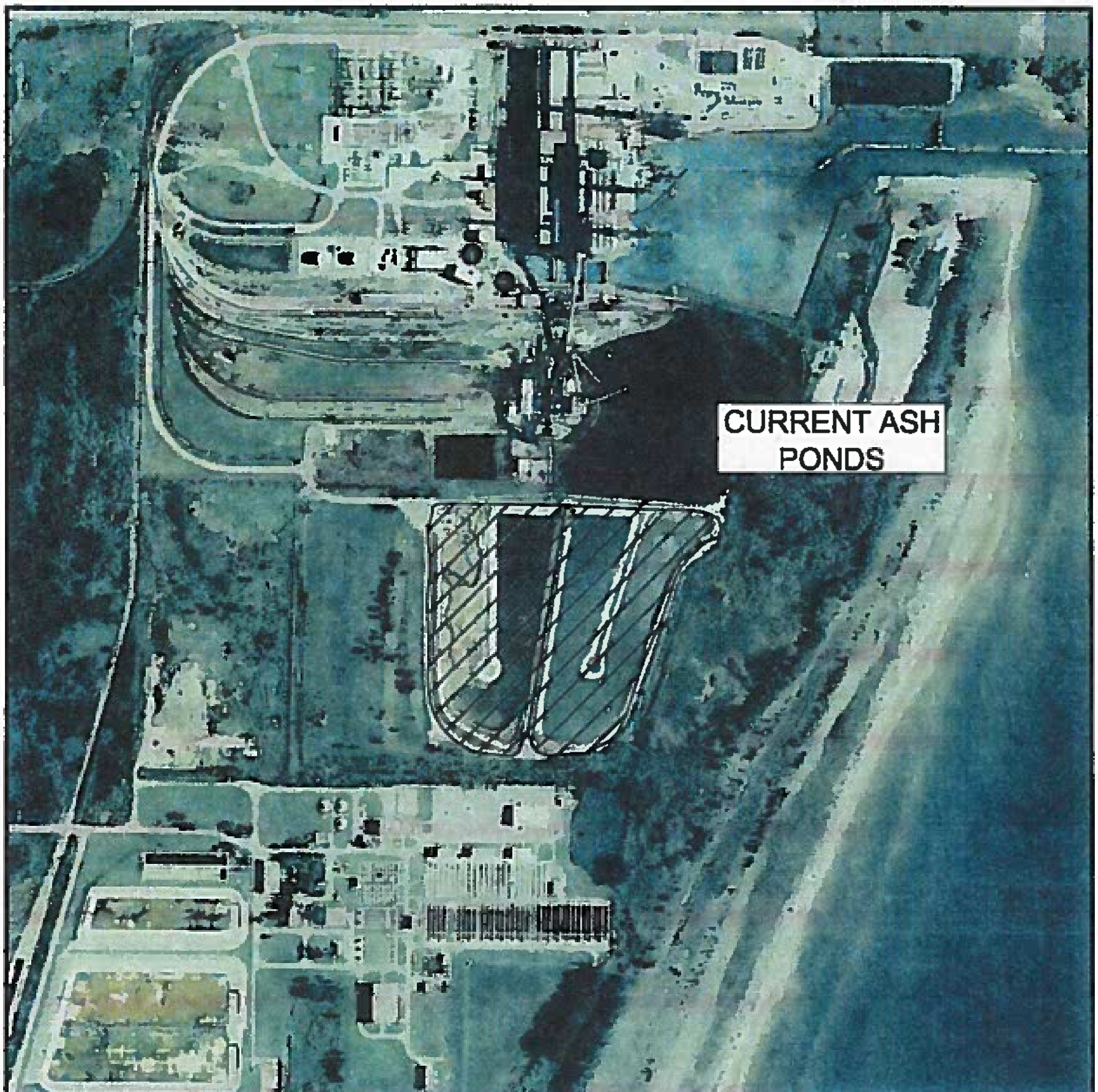
[f] Dissolved nitrate analyzed by SW-846 Method 4500 NO2 and NO3

NOTE
THIS DRAWING WAS PREPARED USING ILLINOIS' WAUKEGAN (1993) AND ZION (1993) 7.5 MINUTE-SERIES TOPOGRAPHIC QUADRANGLE MAP.

N

1" = 2,000'

Date: JULY 2010	FIGURE 1 SITE LOCATION MAP	PATRICK ENGINEERING INC.
Proj No.: 21053.026	WAUKEGAN STATION WAUKEGAN, ILLINOIS	4970 Varsity Drive Lisle, Illinois 60532-4101 TEL (630) 795-7200 FAX (630) 724-1681 PROFESSIONAL DESIGN FIRM LICENSE NO. 184-000409
App. By: RMF		



N

AERIAL IMAGE SOURCE:
LANDISCOR AERIAL INFORMATION INC., JULY 2008

1" = 600'

Date: JULY 2010	FIGURE 2 SITE VICINITY MAP	PATRICK ENGINEERING INC.
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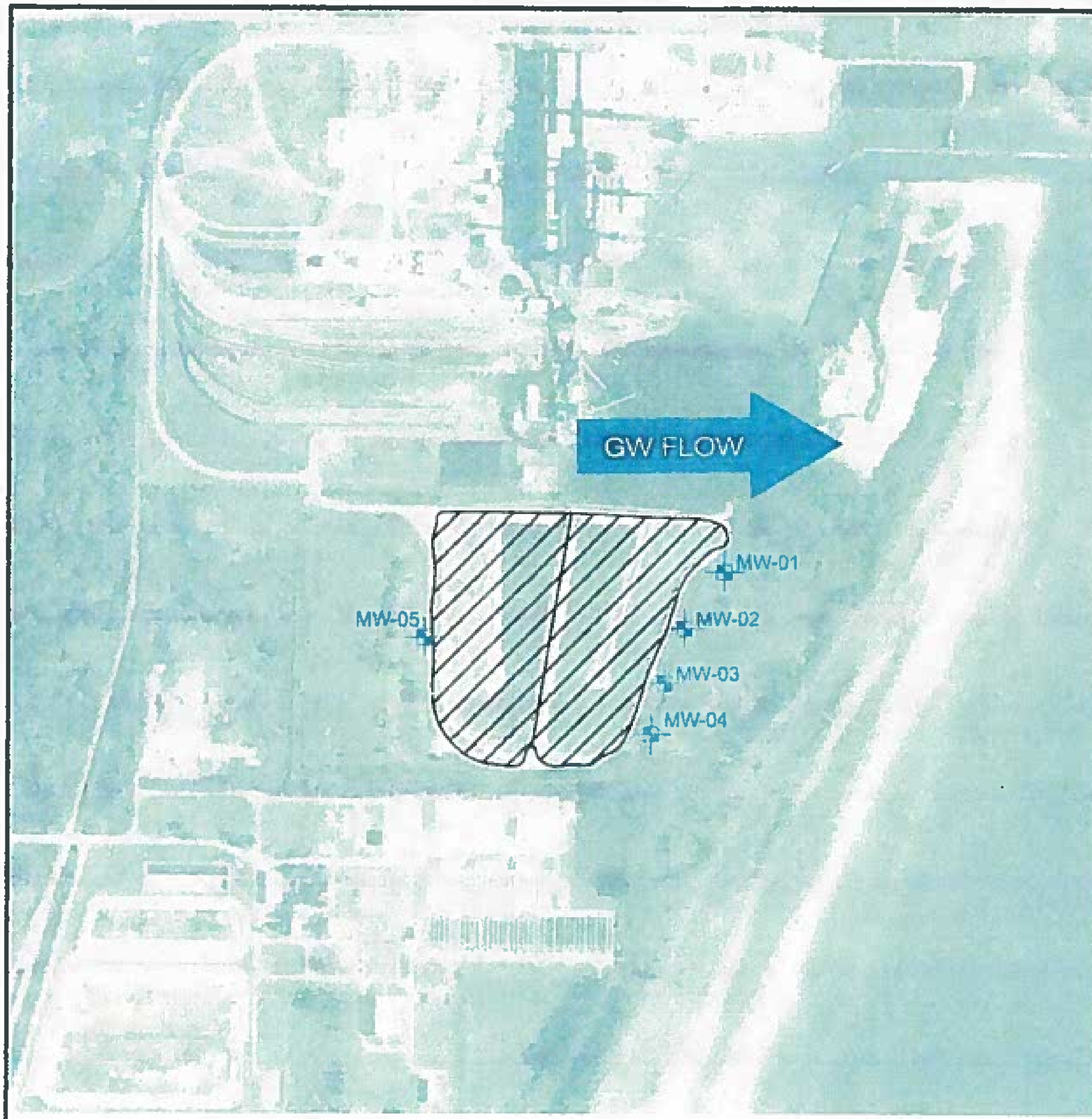

LEGEND

MW-01 Proposed Monitoring Well Location

AERIAL IMAGE SOURCE
LANDISCOR AERIAL INFORMATION INC., JULY 2008

N

1" = 600'

Date: JULY 2010	FIGURE 3 PROPOSED MONITORING WELL LOCATION PLAN	PATRICK ENGINEERING INC.
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App. By: RMF		

ATTCHEMENT A

WELL SPACING CALCULATIONS

ATTACHMENT A
WELL SPACING CALCULATIONS

Purpose of Calculation

An estimate of the of theoretical contaminant plume widths at the Site was calculated in order to determine the appropriate number and spacing of monitoring wells around the ash pond(s) for the initial hydrogeologic assessments. The objective of this calculation is to determine the approximately well spacing of the downgradient monitoring well network, located 25 feet downgradient edge of the ash pond(s) which would result in the likely detection of a groundwater plume emanating from a point-source beneath the ash pond(s).

Methodology

The width of a contaminant plume is dependent upon the transverse dispersitivity of the aquifer (the mechanical mixing of a solute perpendicular to the direction of flow due to diverging flow paths at the pore scale). The coefficient of transverse dispersion can be estimated using the average linear velocity and the transverse dispersivity (which is estimated based upon the length of the flow path). The distribution of contamination in an ideal plume will follow a normal distribution; therefore, 99.7% of the mass of contamination should be contained within three standard deviations away from the center of mass, where the standard deviation is a function of the coefficient of transverse dispersion. (Fetter, 1999)

The process of calculating the theoretical plume widths and well spacing is presented below:

1. Determine the Darcy velocity (q) of the aquifer:

   q = KI, where:

   K = hydraulic conductivity of aquifer (estimated from soil/rock type)
   I = hydraulic gradient (calculated from groundwater elevations in Phase II reports for each site)

2. Determine the average linear velocity (v) of the aquifer:

   v = q/n, where

   q = Darcy velocity (from above)
   n = effective porosity (estimated from soil/rock type)

3. Determine the transverse dispersivity (α_T) of the aquifer:

    $\alpha_T = \alpha_X/3$ (from 35 IAC Part 742, Appendix C, Table C) where:

    α_X = longitudinal dispersivity = 0.10 * X, where:

    X = distance along the centerline of the plume from the source (X was measured from the approximate center of the ash pond(s) to a point 25 feet downgradient from the downgradient edge of the ash pond(s).)

4. Determine the coefficient of transverse dispersion (D_T):

    $D_T = \alpha_T * v + D^*$, where:

    α_T = transverse dispersivity (from above)

    v = average linear velocity (from above)

    D^* = molecular diffusion (insignificant under most conditions, so not included in calculation, see Fetter, 1999)

5. Determine the standard deviation of the contaminant distribution normal to flow (σ_y):

    $\sigma_y = \sqrt{2D_T t}$, where:

    D_T = coefficient of transverse dispersion (from above)

    t = time for contaminant to travel from source to distance X = X/v

6. Determine the approximate well spacing:

    Spacing = $3\sigma_y$ (distance from center of plume to edge of plume normal to groundwater flow)

All of the equations are taken from *Contaminant Hydrogeology, 2nd Edition* by C.W. Fetter, 1999 except where noted. This methodology was discussed during a meeting held at Illinois EPA's offices in Springfield, Illinois on June 10, 2010. The methodology presented herein is an industry standard for determining monitoring well spacing.

Results

After applying the above equations using Site-specific input parameters (as shown in the following table), an approximate downgradient well spacing of 200 feet was found to be appropriate for a monitoring well network located 25 feet downgradient of the edge of the ash ponds.

Well Spacing Calculations Table

Calculations	Result	Units
q = KI	0.0043	ft/day
v = q/n	0.0142	ft/day
αT = αX/3	8.33	ft
DT = αT * v + D*	0.012	ft2/day
σy = √2DTt	64.55	ft
Approximate well spacing	200	ft

Variables	Value	Source
K (ft/day)	2.835	literature value for soil type
I (ft/ft)	0.0015	from Phase II groundwater elevations
n (unitless)	0.3	estimated from soil type
X (feet)	250	measured from center of ash pond
3σy	193.65	calculated