Chapter 7

Prepared for:
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St. Louis, MO

Hutsonville Power Station

Pond D Closure – Human Health and Ecological Risk Assessment

AECOM, Inc.
April 2009
Document No.: 10418-003

AECOM

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List of Acronyms

AI	Adequate Intake
AWQC	Ambient Water Quality Criteria
bgs	below ground surface
CADD	Chronic Average Daily Dose
CAS	Chemical Abstracts Service
COPC	Constituent of Potential Concern
CSM	Conceptual Site Model
CTE	Central Tendency Exposure
EAR	Estimated Average Requirement
EFH	Exposure Factors Handbook
EPC	Exposure Point Concentration
ERA	Ecological Risk Assessment
ERAGS	Ecological Risk Assessment Guidance for Superfund
HHRA	Human Health Risk Assessment
HI	Hazard Index
HQ	Hazard Quotient
IEPA	Illinois Environmental Protection Agency
IRIS	Integrated Risk Information System
kg	kilogram
LOAEL	Lowest Observed Adverse Effect Level
MCL	Maximum Contaminant Level
mL	milliliters
NHANES	National Health and Nutrition Examination Survey
NOAEL	No Observed Adverse Effect Level
OSWER	Office of Solid Waste and Emergency Response
RfD	Reference Dose
RME	Reasonable Maximum Exposure
RO	Remediation Objective
SERA	Screening Level Ecological Risk Assessment
SL	Screening Level
SMCL	Secondary Maximum Contaminant Level
SMDP	Scientific/Management Decision Point
TACO	Tiered Approach to Corrective Action Objectives
USEPA	U.S. Environmental Protection Agency
WQS	Water Quality Standard

Executive Summary

This report presents a human health risk assessment (HHRA) and an ecological risk assessment (ERA) in support of the closure of Pond D, a former coal ash impoundment, at the Ameren Energy Generating Company's Hutsonville Power Station (Station). Ameren is requesting that the Illinois Pollution Control Board (Board) adopt a site-specific regulation for the closure of Pond D. The closure, detailed more fully in the Pond D Closure Alternatives Report (NRT, 2009a), includes capping of Pond D with a geo-synthetic membrane, and installing a groundwater collection trench along the southern Station property boundary.

The purpose of the HHRA and ERA presented in this report is to confirm that the closure plan/activities for Pond D are protective of human health and the environment under current and reasonably foreseeable future conditions and land use. Illinois regulations do not require the performance of a risk assessment in evaluating the proper closure of surface impoundments such as Pond D. The risk assessments have been conducted consistent with state and federal guidance for site remediations, and based on a site-specific conceptual site model (CSM), presented below. The results of the risk assessment are then presented.

The risk assessments have been conducted based on the current environmental and land use conditions associated with Pond D, in the absence of additional closure activities (e.g., capping, trench installation). The results determined that current conditions are protective of human health and the environment under current and reasonably foreseeable future conditions and land use. Therefore, as the proposed closure activities will result in groundwater meeting Illinois Class I groundwater quality standards at the Station property boundary in the future (NRT, 2009b), the closure plan/activities for Pond D are also protective of human health and the environment.

Conceptual Site Model (CSM)

Setting. The Hutsonville Power Station is located on approximately 205 acres in Crawford County, Illinois on the west bank of the Wabash River between the towns of Hutsonville and York (SW1/4, Section 17, Township 8N, Range 11W). **Figure 2-1** presents the location and environs of the Station. In 1968 the company constructed Pond D as an unlined water pollution treatment facility for coal combustion wastes and related waste generated at the Station. Pond D was taken out of service in 2000, and dewatered shortly thereafter. Pond D is located on the western bank of the Wabash River, and is bounded to the south by agricultural land. The land use for the Station is classified industrial, and the agricultural land to the south of Pond D is classified agricultural. These land uses are expected to continue for the reasonably foreseeable future. The closest residence is approximately one-half mile from the Station.

Geology/hydrogeology. There are two water bearing units of interest in the vicinity of Pond D (NRT, 2009a).

- The upper migration zone
- The deep alluvial aquifer

A confining layer is present that restricts vertical migration of groundwater between the upper migration zone and deep alluvial aquifer. Groundwater flow direction in both the upper migration zone and the deep alluvial aquifer is eastward, toward the Wabash River.

Sources. As an unlined former coal ash impoundment, with ash present below the water table, constituents may leach from Pond D and impact groundwater. Boron and sulfate are constituents that can leach from coal ash and are mobile in groundwater, and are common indicators of coal ash impacts to groundwater. Groundwater monitoring of Pond D has indicated that boron and sulfate are present at some locations in the upper migration zone at concentrations above Illinois Class I Groundwater Quality Standards. The locations of these results suggest the potential for off-site migration in the upper migration zone, south of Pond D. While boron and sulfate have been detected at an elevated level in one well in the deep alluvial aquifer compared to other deep alluvial aquifer wells, the concentrations are below the Illinois Class I Groundwater Quality Standard.

Groundwater use. The upper migration zone is not used for potable or irrigation water supplies at or downgradient of the Station. This zone does not yield sufficient quantities of water to constitute a productive aquifer for power plant operational uses or agricultural irrigation purposes. Only the deep alluvial aquifer at depth in the Wabash River bedrock valley has sufficient thickness and hydraulic conductivity to yield adequate groundwater supplies for power plant and agricultural irrigation purposes.

There are six supply wells within ½ mile of the Station, as shown in **Appendix H**. All are finished in the deep alluvial aquifer. Two wells are located directly east of Pond D and are used by the Station for potable and production water (plant extraction wells EW-1 and EW-2). Four wells are located south and/or west of Pond D and are used for irrigation water. The nearest public water supply is in Hutsonville, which draws water from the deep alluvial aquifer near the Wabash River approximately a mile to the south of the Station (see **Appendix H**). As the only off-site groundwater impacts are limited to the upper migration zone, groundwater from Pond D is not expected to impact the Hutsonville supply well (NRT, 2009a).

As noted, the upper migration zone does not yield sufficient quantities of water to constitute a productive aquifer for power plant or irrigation purposes; however, this aquifer is capable of supporting residential water use. While no potable wells exist within the upper migration zone within the area that may be impacted by Pond D (NRT, 2009a; **Appendix H**), the landowner adjacent to the southern border of the Station, and downgradient of Pond D, has agreed to groundwater use restrictions to ensure that no small-scale domestic supplies are withdrawn from this aquifer within the impacted area (see **Appendix B**).

Potential receptors and exposure pathways. Based on the presence of coal ash-related constituents in the upper migration zone and the deep alluvial aquifer, potential exposures to these media are addressed in the risk assessments, as described below.

Human health risk assessment (HHRA)

The HHRA evaluated potential exposure to constituents present in groundwater associated with Pond D to determine whether the closure plan/activities for Pond D are protective of human health under current and reasonably foreseeable future conditions and land use.

The HHRA evaluates potential human health effects using the four step paradigm as identified by the USEPA (USEPA, 1989). The steps are:

- Hazard Identification
- Dose-Response Assessment
- Exposure Assessment
- Risk Characterization

Constituents of potential concern (COPCs) were identified for quantitative evaluation in the risk assessment based on a comparison of the maximum detected constituent concentrations in each water-bearing zone to conservative drinking water screening levels. Boron and manganese were identified as COPCs in the upper migration zone; no COPCs were identified in the deep alluvial aquifer. Dose-response values available from current USEPA sources were used in the evaluation.

Exposure scenarios considered for evaluation in the HHRA included direct exposure to constituents in groundwater either by use as drinking water or by direct contact with groundwater exposed in an excavation trench under a construction/utility worker scenario. As groundwater discharges to the Wabash River, recreational users of the river were also evaluated.

The HHRA was conducted based on the assumption that upper migration zone groundwater in the area is not used as a drinking water source and that a use restriction will prevent such use in the future. The deep alluvial aquifer on-site is used for plant potable and production water; groundwater immediately downgradient of Pond D is not currently used as an off-site drinking water source, though it could be used in the future in the unlikely event that the agricultural land use would change. However, no COPCs were identified in the deep alluvial aquifer based on the use of conservative drinking water screening levels. Therefore, a drinking water pathway was not quantitatively included in the HHRA.

The water table can occur at 3 to 33 feet below ground surface (bgs). It is assumed that a future construction/utility worker may be required to work in excavations up to a depth of 15 feet bgs. Therefore, a future construction/utility worker was evaluated for direct exposure to COPCs in groundwater in the upper migration zone via incidental ingestion and dermal contact during excavation.

Surface water concentrations in the Wabash River were estimated from the maximum detected concentrations of constituents in groundwater in both the deep alluvial aquifer and the upper migration zone. Three recreational receptors were evaluated for potential exposure to COPCs that may have migrated to the Wabash River. A recreational child and a recreational teenager were evaluated for potential exposure to COPCs in surface water while swimming via incidental ingestion and dermal contact. A recreational fisher (adult) was evaluated for potential exposure to COPCs in surface water while wading via incidental ingestion and dermal contact and for potential exposure to COPCs via ingestion of fish caught in the river.

The results of the HHRA indicate that predicted risks are orders of magnitude below regulatory target risk levels and, therefore, no adverse health effects are expected for any of the receptors evaluated based on the assumptions of the HHRA.

Ecological risk assessment (ERA)

The screening level ERA evaluated potential exposure by ecological receptors to constituents present in groundwater associated with Pond D to determine whether the closure plan/activities for Pond D are protective of the environment under current and reasonably foreseeable future conditions and land use.

The screening level ERA is organized into the three following major sections suggested by EPA's Framework for Ecological Risk Assessment (USEPA, 1992); these are:

- Problem Formulation
- Risk Analysis
- Risk Characterization

Exposure scenarios considered for evaluation in the ERA included use of the deep alluvial aquifer for irrigation, and as groundwater discharges to the Wabash River, aquatic receptors in the river were also evaluated.

To evaluate the use of groundwater as a source of irrigation water, which is used as a supplement to rainwater, the average constituent concentrations in the deep alluvial aquifer were compared to ecological risk based screening levels and short term agricultural water quality levels. Based on this comparison, it is not expected that groundwater used for irrigation will adversely impact crops.

A screening level ERA was conducted to determine whether exposure to constituents in groundwater discharging to the Wabash River posed a risk to ecological receptors. Surface water concentrations in the Wabash River were estimated from the maximum detected concentrations of constituents in groundwater in both the deep alluvial aquifer and the upper migration zone. The maximum estimated surface water concentrations were then compared to Illinois Water Quality Standards (WQS) and federal Ambient Water Quality Criteria (AWQC) derived to be protective of aquatic life. Estimated concentrations of the detected constituents were well below the screening levels indicating that groundwater discharging into the Wabash River is unlikely to pose a risk to aquatic receptors in the river in the vicinity of the Station.

The results of the ERA indicate no potential for ecological risks associated with the Pond D closure plan/activities, and no further ecological evaluation is warranted.

Summary

The human health and ecological risk assessments presented in this report have demonstrated that the current environmental conditions associated with Pond D are protective of human health and the environment under current and reasonably foreseeable future conditions and land use. Closure plan/activities for Pond D are expected to result in groundwater meeting Illinois Class I groundwater quality standards at the Station property boundary in the future (NRT, 2009b). Therefore, the closure plan/activities for Pond D are also protective of human health and the environment.

1.0 Introduction

This report presents a human health risk assessment (HHRA) and an ecological risk assessment (ERA) in support of the closure of Pond D, a former coal ash impoundment, at the Ameren Energy Generating Company's Hutsonville Power Station (Station). Ameren is requesting that the Illinois Pollution Control Board (Board) adopt a site-specific regulation regulating the closure of Pond D. The closure, detailed more fully in NRT, 2009a, includes capping of Pond D with a geo-synthetic membrane, and installing a groundwater collection trench along the southern Station property boundary.

1.1 Purpose

The purpose of the HHRA and ERA presented in this report is to determine if the closure plan/activities for Pond D are protective of human health and the environment under current and reasonably foreseeable future conditions and land use. This is accomplished by evaluating potential human health and ecological effects of potential exposures to constituents detected in samples of groundwater from the upper migration zone and the deep alluvial aquifer associated with Pond D (see Section 2).

1.2 Human health risk assessment (HHRA)

The HHRA was conducted to be consistent with United States Environmental Protection Agency (USEPA) guidance for conducting a risk assessment (see Section 4) as well as the Illinois Environmental Protection Agency (IEPA) Tiered Approach to Corrective Action Objectives (TACO) (IEPA, 2007). The HHRA has been conducted in accordance with the four-step paradigm for human health risk assessments developed by USEPA (USEPA, 1989); these steps are:

- Data Evaluation and Hazard Identification
- Toxicity Assessment
- Exposure Assessment
- Risk Characterization

1.3 Ecological risk assessment (ERA)

The ERA was conducted to be consistent with USEPA guidance for conducting a risk assessment. The ERA is organized into the three following major sections suggested by EPA's Framework for Ecological Risk Assessment (USEPA, 1992); these sections are:

- Problem Formulation
- Risk Analysis
- Risk Characterization

1.4 Report organization

The information presented in each section of the report follows.

- Section 2.0 – Conceptual Site Model. This section discusses the study area and its environs, describes source areas, potential migration pathways, and potentially impacted media.
- Section 3.0 – Data Evaluation. This section presents a summary of the data for use in the HHRA and ERA.

- Section 4.0 – Human Health Risk Assessment. This section presents the HHRA methods and results.
- Section 5.0 – Ecological Risk Assessment. This section presents the ERA methods and results.
- Section 6.0 – Conclusions. This section summarizes the conclusions of the HHRA and ERA.
- Section 7.0 – References. This section presents the references used in the text.

Tables and figures are provided after Section 7. Note that table and figure numbers are based on the appropriate section.

2.0 Conceptual site model

This section presents the conceptual site model (CSM) for Pond D. A CSM describes the system in which a site is located, and includes information about the setting, land use, geology and hydrogeology, potential sources, groundwater monitoring and modeling, and groundwater use. CSMs specific to the HHRA and the ERA are also provided that present potential receptors, and potential pathways to receptors.

The conceptual model is the foundation for the development of the risk assessments.

2.1 Setting

The Hutsonville Power Station is located in Crawford County, Illinois on the west bank of the Wabash River between the towns of Hutsonville and York (SW1/4, Section 17, Township 8N, Range 11W), on approximately 205 acres. **Figure 2-1** presents the location and environs of the Station. The Station consists of a coal-fired electrical generating plant and a wastewater disposal system for management of coal-combustion wastes, including fly ash. The coal-fired power plant has operated since the 1940's. The wastewater disposal system consists of five surface impoundments, denominated Pond A, Pond B, Pond C, Pond D, and the bottom ash pond. The impoundments accept only coal combustion waste (fly ash and bottom ash) and low-volume waste from the Hutsonville facility.

In 1968 Pond D was constructed as an unlined water pollution treatment facility for coal combustion and related wastes generated at the Station. Pond D has an area of approximately 22 acres, is located on the west bank of the Wabash River, and is as close as one hundred (100) feet to the river. Pond D no longer receives coal combustion by-products, and sluice waters from the power station are no longer routed through the impoundment. Ameren estimates that during its 30 years of active operation, Pond D accumulated approximately 950,000 cubic yards of ash and approximately 280,000 cubic yards lies below the water table.

The land use for the Station is classified as industrial. The Wabash River forms its eastern border while farmland comprises the southern and western borders. The northern border is undeveloped wooded land. The closest residence is approximately one-half mile from the Station.

2.2 Site geology and hydrogeology

There are two water bearing units of interest in the vicinity of Pond D (NRT, 2009a).

- The "upper migration zone," which is unconfined with the depth to water ranging from 3 to 20 feet below ground surface, depending on location.
- The "deep alluvial aquifer," which is confined, with depth to the top of this aquifer ranging from 22 to 24 feet on the plant property.

A confining layer is present that restricts vertical migration of groundwater between the upper migration zone and deep alluvial aquifer. Groundwater flow direction in both the upper migration zone and the deep alluvial aquifer is eastward, toward the Wabash River.

2.3 Potential sources

As an unlined former (now dewatered) coal ash impoundment, with ash present below the water table, constituents may leach from Pond D and impact groundwater. Boron and sulfate are constituents that can leach from coal ash and are mobile in groundwater. Groundwater monitoring of Pond D has indicated that boron and sulfate are present at some locations in groundwater at concentrations above Illinois Class I Groundwater Quality Standards, as discussed in more detail below and in Section 3.

2.4 Groundwater monitoring and modeling

Ameren has maintained a monitoring well network at the Station and has sampled wells periodically since 1984. Monitoring wells associated with Pond D are shown on **Figure 2-2**. Pond D is underlain by two water bearing units (the upper migration zone and the deep alluvial aquifer) that are separated by materials that have low hydraulic conductivity (shale bedrock or silts and clays). Wells installed to monitor groundwater quality associated with Pond D (see Section 3) have indicated that elevated concentrations of boron and sulfate (two common indicators of coal ash impacts) are present in Pond D monitoring wells screened in the upper migration zone (NRT, 1999).

Groundwater samples from wells MW6 and MW11R, which are screened in the upper migration zone near the south property boundary, show elevated boron and sulfate concentrations, suggesting the potential for off-site migration. Ameren investigated the extent of off-site impact by obtaining direct-push samples approximately 1,300 feet in the actively farmed agricultural field immediately south of the property line and determined that the upper migration zone was not impacted at these locations (NRT, 1999). To further delineate the extent of offsite impacts, Ameren used a calibrated numerical groundwater flow and transport model which calculated the extent of such impacts in the upper migration zone to be approximately 500 feet from the Station's southern property line (NRT, 2009b). As suggested by the groundwater modeling conducted by NRT, the past dewatering, together with the future capping of the unlined Pond D, and the installation of a groundwater collection trench, will result in groundwater meeting Class I groundwater standards in the future at the property boundary.

Groundwater in the deep alluvial aquifer has also been monitored. The results indicate highly localized, low-level (i.e., lower than Class I standards) coal ash impacts at MW14. The efficacy of the confining layer to limit migration is supported by these concentration data because, as explained by NRT (2009a), the concentrations are much lower than in the upper migration zone, despite the fact that Pond D was fist placed in service more than 40 years ago.

2.5 Groundwater use

The upper migration zone currently is not used at or downgradient of the Station. This zone does not yield sufficient quantities of water to constitute a productive aquifer for power plant operational uses or agricultural irrigation purposes. Only the deep alluvial aquifer at depth in the Wabash River bedrock valley has sufficient thickness and hydraulic conductivity to yield adequate groundwater supplies for power plant and agricultural irrigation purposes.

There are six supply wells within ½ mile of the Station, as shown in **Appendix H**. All are finished in the deep alluvial aquifer. Two wells are located directly east of Pond D and are used by the Station for plant water (plant extraction wells EW-1 and EW-2). Four wells are located south of Pond D and are used by the adjacent landowners for irrigation water.

The nearest public water supply is in Hutsonville, which draws water from the deep alluvial aquifer near the Wabash River approximately a mile to the south of the Station (**Appendix H**). Since groundwater flow is toward the east (NRT, 2009a), there is no reason to expect that groundwater from Pond D can impact the Hutsonville supply well. **Appendix A** presents the Consumer Confidence Report (CCR) for the Hutsonville water supply. As can be seen, none of the constituents monitored exceed drinking water quality standards.

As noted, the upper migration zone does not yield sufficient quantities of water to constitute a productive aquifer for power plant or irrigation purposes; however, this aquifer is capable of supporting residential water use. While no potable wells exist within the upper migration zone within the area that may be impacted by Pond D (NRT, 2009a; **Appendix H**), the landowner adjacent to the southern border of the Station, and downgradient of Pond D, has agreed to groundwater use restrictions to ensure that no small-scale domestic supplies are withdrawn from this aquifer within the impacted area (see **Appendix B**).

2.6 HHRA CSM

To guide identification of appropriate exposure pathways and receptors for evaluation in the HHRA, a CSM for human health was developed. The purpose of the CSM is to identify source areas, potential migration pathways of constituents from source areas to environmental media where exposure can occur, and to identify potential human receptors.

The first step in developing the human health CSM is the characterization of the setting of the site and surrounding area. Current and potential future site uses and potential receptors (i.e., residential, recreational, or industrial receptors who may contact the impacted environmental media of interest) are then identified. Potential exposure scenarios identifying appropriate environmental media and exposure pathways for current and potential future site uses and receptors are then developed. Those potential exposure pathways for which constituents are present at concentrations above conservative screening levels are identified. Those pathways that are determined to be potentially complete are evaluated quantitatively in the risk assessment.

For the Pond D closure activities, Pond D is the source area, and groundwater (both the upper migration zone and the deep alluvial aquifer) is the environmental medium of interest.

The property south of Pond D is classified as agricultural and the land is actively farmed, and is served by municipal water (**Appendix H**). The deep alluvial aquifer is used as a source of potable and production water for the Station. In addition, the City of Hutsonville municipal water supply well, located approximately a mile south of the Station, is screened in the deep alluvial aquifer, although is not expected to be impacted by Pond D. Therefore, a drinking water pathway will be evaluated for the deep alluvial aquifer. Irrigation wells are present within a ½ mile radius of the Station, therefore, the potential use of the deep alluvial aquifer will be also be evaluated as a source of irrigation water; this evaluation will be conducted in the ERA (Section 5).

Groundwater impacts have been demonstrated in the upper migration zone, and these impacts are expected to extend a limited distance off site, south of the property boundary. Although the upper migration zone cannot sustain pumping required by a production or irrigation well, a groundwater use restriction has been obtained to prevent domestic use of the upper migration zone on the property immediately south of Pond D (see **Appendix B**). Therefore, potable uses of the upper migration zone are not evaluated in the HHRA. Constituents associated with coal ash impoundments are not volatile, therefore, migration of vapors to indoor or outdoor air is not a complete pathway. Shallow groundwater in the upper migration zone may potentially be exposed during future construction or utility work if excavation occurs to the depth at or below the water table; excavation is generally assumed to occur to a depth of about 15 feet below ground surface (bgs) and groundwater is generally not assumed to be potentially exposed below that level. Water levels have ranged from about 3 feet to about 20 feet bgs. Therefore, a future construction worker scenario (incidental ingestion and dermal contact with groundwater) is evaluated in the HHRA.

Groundwater may discharge into the Wabash River. Therefore, a current and future recreational scenario including swimming (incidental ingestion and dermal contact with surface water) and fishing (ingestion of fish tissue and incidental ingestion and dermal contact with surface water while wading) is evaluated in the HHRA. For the swimming pathway, both a young child and a teenager are evaluated; an adult is evaluated for the fishing scenario.

Therefore, the receptors evaluated in the HHRA in Section 4 are:

- Recreational swimmer in the Wabash River
- Recreational fisher in the Wabash River
- Construction/utility worker who may excavate into the upper migration zone
- Drinking water use of the deep alluvial aquifer (residential and industrial use)

Figures and tables summarizing the HHRA CSM are presented in Section 4.

2.7 ERA CSM

The objectives of the ecological CSM are to identify the ecologically important exposure and migration pathways, and to specify exposure scenarios that are evaluated in the ERA. As noted above, for the Pond D closure activities, groundwater is the environmental medium of interest. Potential exposure to constituents in the deep alluvial aquifer by agricultural crops could occur via use of the deep alluvial aquifer as a source of irrigation water. In addition, groundwater discharges to the Wabash River, and aquatic receptors in the river could be exposed to constituents related to Pond D.

Therefore, the ERA will focus on the evaluation of:

- The agricultural plant community via groundwater (deep alluvial aquifer) use as irrigation water
- Wabash River aquatic community via discharge of groundwater to the Wabash River

Figures and tables summarizing the ERA CSM are presented in Section 5.

3.0 Data evaluation

A number of groundwater monitoring wells are present at the Hutsonville Power Station. Some of these wells have been monitored since 1984 for a variety of purposes. Several downgradient wells at the Station were installed for the purpose of monitoring Pond D. Five of the wells are screened in the deep alluvial aquifer, as follows:

- MW7D
- MW14
- MW115S
- MW115D
- MW121

Four wells are screened in the upper migration zone, as follows:

- MW6
- MW7
- MW8
- MW11R

The following three wells represent naturally occurring constituent concentrations in the upper migration zone (this is provided for informational purposes only; data from these wells have not been included quantitatively in the risk assessments):

- MW1
- MW10

Therefore, the HHRA and the ERA have been conducted based on monitoring well data collected from the wells listed above. **Figure 2-2** presents the locations of the wells in relationship to Pond D and other site features. To provide a dataset representative of current conditions while taking into account the potential for seasonal and temporal variation, monitoring well data collected between 2002 and 2008 have been included. Specifically, data collected during monitoring rounds between and including January 14, 2002 and October 21, 2008 have been included in the risk assessments.

The analytical suite for the groundwater monitoring at the Station is consistent with the state Operating Permit (2005-EO-3689). Analytical data are available for the following constituents for the above listed wells between 2002 and 2008:

- Alkalinity
- Boron
- Calcium
- Magnesium
- Manganese
- Sulfate

Appendix C presents the monitoring well data for the downgradient wells for the applicable date range. Data for a number of field parameters have also been collected, such as hardness, temperature, and oxygen. These data are not applicable to the risk assessments. However, the data may be used in a qualitative manner or to provide site-specific information for the risk assessments. Therefore, **Appendix C** presents the field parameter data as well as the chemistry data.

Table 3-1 presents a summary of the available data for each well. A total of 52 samples from five wells are available from the deep alluvial aquifer, and a total of 58 samples from four wells are available from the upper migration zone. Fewer samples are available for magnesium in the upper migration zone (6 samples) and the deep alluvial aquifer (2 samples). As will be discussed later, magnesium (along with calcium) is an essential nutrient and is not quantitatively evaluated in either the HHRA or ERA, so the availability of data does not impact the risk assessments.

Summary statistics were calculated for the above described data set for use in the HHRA and the ERA. Summary statistics were calculated separately for the deep alluvial aquifer and the upper migration zone. Summary statistics are presented in **Table 3-2** and include the following statistics:

- Frequency of Detection: The frequency of detection is reported as a ratio based on the number of samples reported as detected for a specific constituent and the total number of samples analyzed. As indicated in **Table 3-2**, all results for the applicable constituents and date range were reported as detected.

- Maximum Detected Concentration: This is the maximum detected concentration for each constituent/area/medium combination.

- Minimum Detected Concentration: This is the minimum detected concentration for each constituent/area/medium combination.

- Mean Detected Concentration: This is the arithmetic mean concentration for each constituent in each aquifer.

4.0 Human health risk assessment

An HHRA has been conducted in support of closure activities at Pond D. The HHRA has been conducted based on current and reasonably foreseeable site conditions to determine whether constituents potentially related to Pond D and present in groundwater may pose unacceptable risks to human health.

The HHRA has been conducted to be consistent with 35 Illinois Administrative Code Part 742 TACO program (IEPA, 2007), and in accordance with guidance contained in the following USEPA documents and Office of Solid Waste and Emergency Response (OSWER) directives:

- Risk Assessment Guidance for Superfund: Volume 1 - Human Health Evaluation Manual (Part A) (USEPA, 1989).
- Human Health Evaluation Manual Supplemental Guidance: Standard Default Exposure Factors. OSWER Directive 9285.6-03, March 25, 1991. (USEPA, 1991a);
- Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions. OSWER 9655.0-30. April, 1991. (USEPA, 1991b);
- Exposure Factors Handbook (EFH), Volumes I, II, and II; August 1997. (EPA/600/P-95/002Fa, b, c) (USEPA, 1997a);
- Risk Assessment Guidance for Superfund: Volume 1 - Human Health Evaluation Manual (Part E) (USEPA, 2004a).

The HHRA evaluates potential human health effects using the four step paradigm as identified by the USEPA (USEPA, 1989). The steps are:

- Hazard Identification
- Dose-Response Assessment
- Exposure Assessment
- Risk Characterization

Each step of the risk assessment is described in detail below.

4.1 Hazard identification

The purpose of the hazard identification process is two-fold: 1) to evaluate the nature and extent of release of constituents present in downgradient groundwater; and 2) to select a subset of constituents identified as Constituents of Potential Concern (COPCs) for quantitative evaluation in the risk assessment. This step of the risk assessment involves compiling and summarizing the data relevant to the risk assessment, and selecting COPCs based on available screening values.

COPCs are a subset of the complete set of constituents detected in groundwater that are carried through the quantitative risk assessment process. Selection of COPCs focuses the analysis on the most likely risk "drivers." As stated in USEPA guidance (USEPA, 1993):

> "Most risk assessments are dominated by a few compounds and a few routes of exposure. Inclusion of all detected compounds at a site in the risk assessment has minimal influence on the total risk. Moreover,

quantitative risk calculations using data from environmental media that may contain compounds present at concentrations too low to adversely affect public health have no effect on the overall risk estimate for the site. The use of a toxicity screen allows the risk assessment to focus on the compounds and media that may make significant contributions to overall risk."

Therefore, COPCs were identified by comparing constituent-specific analytical data for groundwater to appropriate screening levels and conducting a quantitative risk assessment for those constituents detected in groundwater in excess of the screening levels described below. Several factors are typically considered in identifying COPCs, including background, frequency of detection, essential nutrient status, and comparison to available screening levels. The frequency of detection for each constituent is 100%. Essential nutrient status and the comparison to screening levels are described below.

4.1.1 Essential nutrients

Calcium and magnesium are defined as essential nutrients (USEPA, 1989). According to USEPA (1989) essential nutrients do not need to be evaluated in a quantitative HHRA when they are present at low concentrations (i.e., only slightly elevated above background levels) and toxic only at very high doses. Screening values are not available for calcium or magnesium from any of the sources described below (USEPA, 2006a; USEPA, 2008; IEPA, 2002; IEPA, 2007). Additionally, dose-response values are not available with which to quantitatively evaluate potential health risks associated with these constituents (see Section 4.2). A weight-of-evidence approach therefore is used to evaluate calcium and magnesium.

The National Health and Nutrition Examination Survey (NHANES) conducted a study in 2001 to 2002 to evaluate the adequacy of American diets with respect to a number of nutrients, including the two essential nutrients of interest here (Moshfegh, et al., 2005). The report presents the following findings.

The NHANES study compared dietary amounts of magnesium to the Estimated Average Requirement (EAR). According to the report (Moshfegh, et al., 2005):

"The EAR is the average daily nutrient intake level estimated to meet the requirement of half of the healthy individuals in a particular life stage and gender group. It is used to estimate the prevalence of inadequate intakes in a population group."

The study estimates that 56% of American diets are inadequate in magnesium (Moshfegh, et al., 2005).

For calcium, an Adequate Intake (AI) has been established. According to the report (Moshfegh, et al., 2005):

"The AI for a nutrient is the recommended average daily intake level that is assumed to be adequate. It is important to note that, unlike an EAR, an AI cannot be used to estimate the prevalence of inadequacy in a population. Further, the percentages of the population above the AI may underestimate the true percentage with adequate intakes."

The study indicates that just over 1 in 4 Americans met the AI for calcium, with females being less likely to meet the AI; 30% had intakes greater than the AI. Less than 3% had intakes greater than the tolerable upper limit (Moshfegh, et al., 2005).

Based on the above information, it is unlikely that calcium or magnesium concentrations in groundwater could present a health risk. Therefore, these nutrients are not quantitatively evaluated in the HHRA.

4.1.2 Comparison to Applicable Standards and/or Screening Levels

A risk-based screen was performed to identify COPCs in downgradient groundwater. The methods and screening level sources are described below. For each constituent, the maximum detected downgradient groundwater concentration between 2002 and 2008 is compared to the screening levels.

There are a number of sources of USEPA and IEPA risk-based and regulatory standards and/or screening levels for groundwater that may be applicable to the Pond D closure. **Table 4-1** presents the comparison of maximum detected concentrations in groundwater to each of the screening levels, as described below.

1. The USEPA Regional Screening Levels (SLs) (USEPA, 2008) are risk-based concentrations in tap water (residential drinking water) corresponding to a cancer risk level of $1x10^{-6}$ or a hazard index of one for noncancer effects. SLs for tap water assume daily water ingestion by an adult. SLs are not intended to represent "de facto" cleanup standards but rather are screening levels that help determine whether further evaluation is necessary for a particular constituent at a particular location (USEPA, 2008).

   No potential carcinogens are included on the Pond D analyte list. SLs are available for boron and manganese. Because the SLs are based on a hazard index of one, an adjustment is often necessary to account for the cumulative effects for constituents with the same target endpoint. However, boron's target endpoint is developmental effects while manganese's target endpoint is the central nervous system (see **Table 4-3**). Therefore, no adjustment of the SLs is necessary. Maximum detected concentrations of boron and manganese in the upper migration zone are above SLs. The maximum detected concentration of manganese in the deep alluvial aquifer is above the SL, while the maximum detected concentration of boron in the deep alluvial aquifer is below the SL.

   SLs are not available for calcium or magnesium, as they are essential nutrients, nor for alkalinity or sulfate, which are discussed below.

2. USEPA Maximum Contaminant Levels (MCLs) (USEPA, 2006a) are regulatory standards set by the USEPA for select constituents. Primary MCLs are not available for any of the constituents on the Pond D analyte list. Secondary MCLs (SMCLs) are available for manganese and sulfate. SMCLs are not health-based; they are based on aesthetic (odor, taste, color, foaming), cosmetic (skin or tooth discoloration) or technical (corrosivity, staining, scaling, sedimentation) effects, as described on the following web-page: http://www.epa.gov/safewater/consumer/2ndstandards.html.

   As indicated on the above-referenced web-page, the SMCL of 50 ug/L for manganese is based on a black to brown color; black staining, and a bitter metallic taste. The maximum detected concentrations of manganese in both the upper migration zone and the deep alluvial aquifer are above the SMCL.

   The SMCL of 250,000 ug/L for sulfate is based on a salty taste. The maximum detected concentration of sulfate in the deep alluvial aquifer is below the SMCL, while the maximum detected concentration in the upper migration zone is above the SMCL.

3. Illinois Class I Groundwater Quality Standards (IEPA, 2002) are regulatory standards set by the state for select constituents. Class I groundwater quality standards are available for boron, manganese, and sulfate. The maximum detected concentrations of boron and sulfate in the deep alluvial aquifer are below the Class I standards and are above the Class I groundwater quality standards in the upper migration zone. The maximum detected concentration of manganese in both the deep alluvial aquifer and the upper migration zone is above the Class I standard.

4. Illinois TACO Class I Groundwater Remediation Objectives (ROs) (IEPA, 2007) are a combination of regulatory (IEPA, 2002) values, where available, and risk-based values. For the analytes considered here, the Class I ROs are the same as the Class I groundwater standards and the results of the screening evaluation are therefore the same.

There are no available screening values or standards for the human health effects of alkalinity, and there are no dose-response values available. Therefore, alkalinity is not quantitatively evaluated in the HHRA.

Upper migration zone

As noted in the CSM, the upper migration zone does not yield sufficient quantities of water to constitute a productive aquifer for power plant operational uses or agricultural irrigation purposes. The upper migration zone could be used as a source of domestic potable water; however, a groundwater use restriction has been obtained for the off-site area of this aquifer (downgradient and to the south of the Station) that is impacted by Pond D (**Appendix B**). Therefore, the drinking water pathway is not quantitatively evaluated in the HHRA for the upper migration zone. However, a construction worker could directly contact this groundwater in an excavation trench. Based on the results of the screening discussed above and presented in **Table 4-1**, boron and manganese are selected as COPCs for the upper migration zone for the HHRA because maximum detected concentrations exceed SLs, SMCLs, and/or Illinois Class I groundwater quality standards. These constituents will be quantitatively evaluated for the construction worker scenario.

While the maximum detected concentration of sulfate in the upper migration zone exceeds the SMCL, the Illinois Class I Groundwater Quality Standard, and the Illinois TACO Groundwater RO, there are no dose-response values (see Section 4.2) with which to quantitatively evaluate sulfate. As noted above, the SMCL for sulfate is based on taste. In addition, USEPA (2006) also provides a health advisory level for sulfate of 500,000 ug/L based on transient laxative effects that may occur above this concentration. The effect is considered transient in that adults tend to adapt to the levels in water in 1 to 2 weeks (USEPA, 2003a). Based on these mild and transient effects, and the lack of a dose-response value, sulfate is not quantitatively evaluated in the HHRA.

Deep alluvial aquifer

For the deep alluvial aquifer, boron concentrations are below the SLs, SMCLs, and Illinois Class I Groundwater Quality Standards (see **Table 4-1**). While manganese concentrations are above these screening levels, the concentrations of manganese in the deep alluvial aquifer are naturally occurring and are therefore not evaluated for off-site receptors (see **Appendix D**). In addition, the constituent data for the Station's extraction wells, which are screened in the deep alluvial aquifer, were compared to the screening levels identified above (**Table 4-2**). While the maximum detected manganese concentration is above the SMCL, the Illinois Class I Groundwater Quality Standard and the Illinois TACO Class I Groundwater RO, it is not above the purely risk-based tapwater SL; therefore, the manganese does not pose a risk to Hutsonville Power Station workers who may be using plant water as a source of drinking water while at work, nor to residential receptors who may use the deep alluvial aquifer in the vicinity of the Station as a source of drinking water in the future. Therefore, the drinking water pathway is not quantitatively evaluated in the HHRA for the deep alluvial aquifer. Use of the deep alluvial aquifer as a source of irrigation water is evaluated in the ERA (Section 5).

4.2 Dose-response assessment

The purpose of the dose-response assessment is to identify the types of adverse health effects a constituent may potentially cause, and to define the relationship between the dose of a constituent and the likelihood or magnitude of an adverse effect (response) (USEPA, 1989). Adverse effects are classified by USEPA as potentially carcinogenic or noncarcinogenic (i.e., potential effects other than cancer). Dose-response relationships are defined by USEPA for oral exposure and for exposure by inhalation. Oral toxicity values are also used to assess dermal exposures, with appropriate adjustments, because USEPA has not yet developed values for this route of exposure. Combining the results of the toxicity assessment with information on the magnitude of potential human exposure provides an estimate of potential risk. The COPCs identified here are not potentially carcinogenic, and no inhalation pathways are relevant to the groundwater exposure pathways described in Section 4.4. Therefore, the dose-response assessment is focused on oral and dermal noncarcinogenic effects.

Numerical toxicity values are generally obtained from USEPA databases/sources. The dose-response relationship is often determined from laboratory studies conducted under controlled conditions with laboratory animals. These laboratory studies are controlled to minimize responses due to confounding variables, and are conducted at relatively high dose levels to ensure that responses can be observed using as few animals as possible in the experiments. Mathematical models or uncertainty factors are used to extrapolate the relatively high doses administered to animals to predict potential human responses at dose levels far below those tested in animals. Humans are typically exposed to constituents in the environment at levels much lower than those tested in animals. These low doses may be detoxified or rendered inactive by the myriad of protective mechanisms that are present in humans (Ames et al., 1987) and that may not function at the high dose levels used in animal experiments. Therefore, the results of these animal studies may only be of limited use in accurately predicting a dose-response relationship in humans. However, to be protective of human health, USEPA incorporates many conservative assumptions and safety factors when deriving numerical toxicity criteria from laboratory studies, as discussed below.

The sources of the dose-response values are discussed followed by a discussion of USEPA's approach for developing noncarcinogenic toxicity values.

4.2.1 Sources of toxicity values

The USEPA's guidance regarding the hierarchy of sources of human health dose-response values in risk assessment was followed (USEPA, 2003b). Sources of the published dose-response values in this risk assessment include USEPA's Integrated Risk Information System (IRIS) (USEPA, 2009).

The primary (Tier 1) USEPA source of dose-response values is IRIS, an on-line computer database of toxicological information (USEPA, 2009). The IRIS database is updated monthly to provide the most current USEPA verified dose-response values. A dose-response value is "Work Group-Verified" if all available information on the value has been examined by an Agency Work Group, the value has been calculated using current Work Group methodology, a unanimous consensus has been reached on the value by the Work Group, and the value appears on IRIS. Dose-response values are available for both boron and manganese from IRIS. Therefore, Tier 2 and Tier 3 sources were not needed.

4.2.2 Noncarcinogenic toxicity assessment

Constituents with known or potential noncarcinogenic effects are assumed to have a dose below which no adverse effect occurs or, conversely, above which an adverse effect may be seen. This dose is called the threshold dose. A conservative estimate of the true threshold dose is called a No Observed Adverse Effect Level (NOAEL). The lowest dose at which an adverse effect has been observed is called a Lowest Observed Adverse Effect Level (LOAEL). By applying uncertainty factors to the NOAEL or the LOAEL, Reference Doses (RfDs) for chronic exposure to constituents with noncarcinogenic effects have been developed by USEPA (2009).

In regulatory toxicity assessment, USEPA assumes that humans are as sensitive, or more sensitive, to the toxic effects of a constituent as the most sensitive species used in the laboratory studies. Moreover, the RfD is developed based on the most sensitive or critical adverse health effect observed in the study population, with the assumption that if the most critical effect is prevented, then all other potential toxic effects are prevented. Uncertainty factors are applied to the NOAEL (or LOAEL, when a NOAEL is unavailable) for this critical effect to account for uncertainties associated with the dose-response relationship. These include using an animal study to derive a human toxicity value, extrapolating from a LOAEL to a NOAEL, extrapolating from a subchronic (partial lifetime) to a chronic lifetime exposure, and evaluating sensitive subpopulations. Generally, a 10-fold factor is used to account for each of these uncertainties; thus, the total uncertainty factor can range from 10 to 10,000. In addition, an uncertainty factor or a modifying factor of up to 10 can be used to account for inadequacies in the database or other uncertainties.

The RfD for boron includes an uncertainty factor of 66, based on inter-species and inter-individual toxicokinetic and toxicodynamic effects.

No uncertainty factors were applied to the manganese RfD, which was derived based on a human dietary study. However, a modifying factor of three has been applied for non-dietary exposures (incidental ingestion and dermal contact with groundwater and surface water), in accordance with USEPA (2009). Furthermore, the average dietary manganese content of the US diet (5 mg/day) was subtracted from the critical dose of 10 mg/day when assessing exposure to non-dietary manganese, per USEPA (2008). The unmodified RfD was used for potential dietary (fish tissue) exposures.

An RfD provides reasonable certainty that no noncarcinogenic health effects are expected to occur even if daily exposures were to occur at the RfD level for a lifetime. RfDs and exposure doses are expressed in units of milligrams of a constituent per kilogram of body weight per day (mg/kg-day). The lower the RfD value, the lower is the assumed threshold for effects, and the greater the assumed toxicity.

In identifying the appropriate RfD, the duration of exposure was considered. Chronic dose-response values apply to exposures lasting greater than seven years, while subchronic dose-response values apply to exposures lasting fewer than seven years (USEPA, 1989). Therefore, for evaluation of the future construction worker (described in Section 4.4) whose exposure is assumed to last one year, subchronic dose-response values are applicable. However, subchronic RfDs are not available for boron or manganese. Therefore, chronic RfDs have been used to evaluate subchronic as well as chronic exposures.

Table 4-3 summarizes the chronic toxicity information for COPCs with potential noncarcinogenic effects for the oral route of exposure. For each COPC, the chemical abstracts service number (CAS number), the dose-response value (RfD), and the reference for the toxicity value are presented. In addition, the USEPA confidence level in the value, the uncertainty factor, the modifying factor, the study animal, study method, target organ and critical effect upon which the toxicity value is based are also presented for each COPC, where available. The confidence level is provided where available, and is based on the confidence in the study and the extent of toxicity information available for that constituent.

4.3 Exposure Assessment

The purpose of the exposure assessment is to predict the magnitude and frequency of potential human exposure to each of the COPC retained for quantitative evaluation in the HHRA. The first step in the exposure assessment process is the characterization of the setting of the site and surrounding area. Current and potential future site uses and potential receptors (i.e., people who may contact the impacted environmental media of interest) are then identified. Potential exposure scenarios identifying appropriate environmental media and exposure pathways for current and potential future site uses and receptors are then developed. Those potential exposure pathways for which COPCs are identified and are judged to be complete are evaluated quantitatively in the risk assessment. This information is used to develop or update the CSM for Pond D.

To estimate the potential risk to human health that may be posed by the presence of COPCs in groundwater associated with Pond D, it is first necessary to estimate the potential exposure dose of each COPC for each receptor. The exposure dose is estimated for each constituent via each exposure route/pathway by which the receptor is assumed to be exposed. Reasonable maximum exposure (RME) scenarios and central tendency exposure (CTE) scenarios based on appropriate USEPA guidance are both evaluated in the quantitative risk assessment. Exposure dose equations combine the estimates of constituent concentration in the environmental medium of interest with assumptions regarding the type and magnitude of each receptor's potential exposure to provide a numerical estimate of the exposure dose. The exposure dose is defined as the amount of COPC taken into the receptor and is expressed in units of milligrams of COPC per kilogram of body weight per day (mg/kg-day). The exposure doses are combined with the toxicity values to estimate potential risks and hazards for each receptor.

This section contains four subsections. Section 4.3.1 presents the human health CSM for Pond D and identifies the potential exposure scenarios and receptors. Section 4.3.2 presents methods for quantifying potential exposures. Section 4.3.3 presents the receptor-specific exposure parameters. Section 4.3.4 identifies exposure point concentrations (EPCs).

4.3.1 Human Health Conceptual Site Model

The CSM for human health was discussed in Section 2.6. The human health CSM is presented in **Figure 4-1**. Receptors and pathways are summarized in **Table 4-4**, and below:

- Recreational swimmers in the Wabash River
- Recreational fisher in the Wabash River
- Construction/utility worker who may excavate into the upper migration zone
- Drinking water use of the deep alluvial aquifer (note – no COPCs were identified for this scenario, so it is not quantitatively evaluated in the HHRA)

4.3.2 Quantification of potential exposures

To estimate the potential risk to human health that may be posed by the presence of COPCs in groundwater, surface water, and fish tissue, it is first necessary to estimate the potential exposure dose of each COPC. The exposure dose is estimated for each constituent via each exposure pathway by which the receptor is assumed to be exposed. Exposure dose equations combine the estimates of constituent concentration in the environmental medium of interest with assumptions regarding the type and magnitude of each receptor's potential exposure to provide a numerical estimate of the exposure dose. The exposure dose is defined as the amount of COPC taken into the receptor and is expressed in units of milligrams of COPC per kilogram of body weight per day (mg/kg-day).

The Chronic Average Daily Dose (CADD) is used to estimate a receptor's potential intake from exposure to a COPC with noncarcinogenic effects. According to USEPA (1989), the CADD should be calculated by averaging the dose over the period of time for which the receptor is assumed to be exposed. Therefore, the averaging period is the same as the exposure duration.

The standardized equations for estimating a receptor's average daily dose are presented below, followed by descriptions of receptor-specific exposure parameters and constituent-specific parameters.

CADD Following Ingestion of Water (mg/kg-day):

$$CADD = \frac{CW \times IR \times EF \times ED}{BW \times AT}$$

where:

CADD	=	Chronic Average Daily Dose (mg/kg-day)
CW	=	Water Concentration (mg/L)
IR	=	Water Ingestion Rate (L/day)
EF	=	Exposure Frequency (days/year)
ED	=	Exposure Duration (year)
BW	=	Body Weight (kg)
AT	=	Averaging Time (days)

CADD Following Dermal Contact with Water (mg/kg-day):

$$CADD = \frac{DA_{event} \times EV \times EF \times ED \times SA}{BW \times AT}$$

where:

CADD	=	Chronic Average Daily Dose (dermally absorbed dose) (mg/kg-day)
DA_{event}	=	Absorbed Dose per Event (mg/cm^2-event)
SA	=	Surface Area (cm^2)
EV	=	Event Frequency (events/day)
EF	=	Exposure Frequency (days/year)
ED	=	Exposure Duration (years)
BW	=	Body Weight (kg)
AT	=	Averaging Time (years)

The calculation of the dose absorbed per unit area per event (DA_{event}) is as follows for inorganics:

$$DA_{event} = CW \times PC \times ET \times CF$$

where:

DA_{event}	=	Absorbed Dose per Event (mg/cm^2-event)
CW	=	Concentration in Water (mg/L)
PC	=	Permeability Constant (cm/hr)
ET	=	Exposure Time (hr/event)
CF	=	Conversion factor (L/1000 cm^3)

The permeability constant values (**Table 4-5**) were derived from USEPA (2004a) Exhibit 3-1.

CADD Following Fish Consumption (mg/kg-day):

$$CADD = \frac{CF \times IR \times EF \times ED}{AT \times BW}$$

where:

CADD	=	Chronic Average Daily Dose (mg/kg-day)
CF	=	Concentration in Fish Tissue (mg/kg-wet weight)
IR	=	Ingestion Rate (kg/day)
EF	=	Exposure Frequency (days/year)
ED	=	Exposure Duration (years)
AT	=	Averaging Time (days)
BW	=	Body Weight (kg)

4.3.3 Receptor-specific exposure parameters

The following subsections present the parameters that were used to evaluate each of the potential receptors in the HHRA. Both RME and CTE scenarios were evaluated for each receptor. Receptor-specific exposure parameters are presented below. Pathways to be evaluated are presented in **Figure 4-1** and in **Table 4-4**. Exposure parameters for both RME and CTE scenarios and are presented in **Table 4-6 through Table 4-9**.

Future Construction Worker

Exposure assumptions for the construction/utility worker under the RME and CTE scenarios are shown in **Table 4-6**. Construction work is assumed to occur to a depth of about 15 feet bgs and includes utility maintenance work. Exposure could occur via incidental ingestion and dermal contact with COPCs in groundwater.

The construction worker is assumed to contact groundwater 30 days per year for one year under the RME scenario and 15 days per year for one year under the CTE scenario. The surface area of the hands, forearms, and face are assumed to be exposed for dermal contact. The construction worker is assumed to incidentally ingest 5 milliliters (mL) of water while working and is assumed to weigh 70 kilograms (kg) (USEPA, 1991a).

Current and Future Recreational Child

Exposure assumptions for the recreational swimming child under the RME and CTE scenarios are shown in **Table 4-7**. Recreational swimming may take place in the Wabash River. As constituents in groundwater may migrate to surface water, COPCs may be present in surface water. Therefore, a recreational child has the potential to be exposed to COPCs present in surface water. The recreational child is evaluated for potential exposure to COPCs in surface water via incidental ingestion and dermal contact while swimming in the Wabash River.

The recreational child is assumed to be 0 to 6 years of age. Given the size of the river, the likelihood of a child this young swimming in the river is remote; the pathway is included as a conservative measure. Fish ingestion is not expected to be a significant pathway for young children (aged 0 to 6). Data show that roughly 50% of children aged 0 to 9 years of age ingest little to no fish (USEPA, 1997a). Roughly 97% of children aged 0 to 9 years ingest less than 20 grams of fish per day (USEPA, 1997a). These statistics are for total fish consumption (freshwater, saltwater, and shellfish). Young and older children consume less than 3 grams of freshwater finfish per day based on the data in Table 10-6 of the EFH (USEPA, 1997a). USEPA Region I also concluded that this pathway is unlikely to occur with any degree of frequency for young children in the Wells G and H Superfund site HHRA (USEPA, 2004b).

The recreational child is assumed to swim in the Wabash River 26 days per year for 2 hours per day under the RME scenario and 13 days per year for 1 hour per day under the CTE scenario. The full body surface area is assumed to be available for dermal contact. The child is assumed to ingest 50 mL of water while swimming (USEPA, 1989) and is assumed to weigh 15 kg (USEPA, 1991a).

Current and Future Recreational Teenager

Exposure assumptions for the recreational swimming teenager under the RME and CTE scenarios are shown in **Table 4-8**. Recreational swimming may take place in the Wabash River. As constituents in groundwater may migrate to surface water, COPCs may be present in surface water. Therefore, a recreational teenager has the potential to be exposed to COPCs present in surface water. The recreational teenager is evaluated for potential exposure to COPCs in surface water via incidental ingestion and dermal contact while swimming in the Wabash River. The recreational teenager is assumed to be 7 to 18 years of age. As discussed above, fish ingestion is not expected to be a significant pathway for children.

The recreational teenager is assumed to swim in the Wabash River 26 days per year for 2 hours per day under the RME scenario and 13 days per year for 1 hour per day under the CTE scenario. The full body surface area is assumed to be available for dermal contact. The teenager is assumed to ingest 50 mL of water while swimming (USEPA, 1989) and is assumed to weigh 47 kg (USEPA, 1997a).

Current and Future Recreational Fisher

Exposure assumptions for the recreational fisher under the RME and CTE scenarios are shown in **Table 4-9**. Recreational fishing may take place in the Wabash River. As constituents in groundwater may migrate to surface water, COPCs may be present in surface water and fish tissue. Therefore, the recreational fisher is evaluated for potential exposure to COPCs through ingestion of fish and incidental ingestion and dermal contact with surface water.

The recreational fisher is assumed to go fishing in the Wabash River 22 days per year for 30 years under the RME scenario and 3 days per year for 9 years under the CTE scenario. The fisher is assumed to ingest 129 grams of fish for each day of fishing (USEPA, 1997a). [Note that for the exposure calculation, the fish ingestion rate is expressed on a grams per day basis, averaged over 365 days per year; see **Table 4-9**.] The surface area of the hands, forearms, lower legs, and feet are assumed to be exposed for dermal contact. The fisher is assumed to ingest 5 mL of water while wading and is assumed to weigh 70 kg (USEPA, 1991a).

4.3.4 Exposure point concentrations

Exposure points are located where potential receptors may contact COPCs at or from the site. The concentration of COPCs in the environmental medium that receptors may contact must be estimated in order to determine the magnitude of potential exposure. The estimation of EPCs in media evaluated for the HHRA is discussed below for groundwater, surface water, and fish tissue.

Groundwater EPCs

Maximum detected concentrations of COPCs in downgradient groundwater (2002-2008) are selected as EPCs for groundwater, as presented in **Table 4-10**. Note that the maximum detected concentrations of both boron and manganese occurred in the upper migration zone. The use of the maximum detected concentration is conservative; USEPA defines the EPC as the 95% upper confidence limit on the arithmetic mean concentration (USEPA, 2002) for the RME scenario and the arithmetic mean concentration for the CTE scenario.

Surface Water EPCs

Surface water EPCs were estimated based on the maximum detected concentration in groundwater and a conservative dilution factor of 0.00048, described in detail in **Appendix E**. Surface water EPCs were derived as follows:

Surface Water EPC (mg/L) = Groundwater EPC (mg/L) x Dilution Factor (0.00048)

Surface water EPCs are presented in **Table 4-10**. Note that the derived surface water concentrations are below all screening levels presented in **Table 4-1** for drinking water and discussed in Section 4.1.2. While the surface water pathway could therefore be eliminated as a medium of concern, the pathway was retained in the HHRA in order to provide a more complete analysis of potential hazards associated with COPCs.

Fish Tissue EPCs

Fish tissue EPCs were estimated based on the estimated surface water EPC and water-to-fish uptake factors. An uptake factor of 1 mg constituent /kg fish per mg constituent/L water was used for boron, based on studies by Thompson, et al., (1976) which found no evidence of active boron bioaccumulation in sockeye salmon or Pacific oyster. Tissue concentrations were approximated by water concentrations. An uptake factor of 400 mg constituent /kg fish per mg constituent/L water was used for manganese (WSRC, 1999). Food chain multipliers of 1 for inorganics for trophic levels one and two were obtained from USEPA (1995). **Table 4-10** presents the uptake factors and the estimated fish tissue EPCs. The full equation for derivation of the fish tissue EPCs is presented in **Table 4-10** and reduces to:

Fish tissue EPC (mg/kg) = Surface Water EPC (mg/L) x Uptake Factor [(mg constituent/kg fish)/(mg constituent/L water)]

It should be noted that the fish tissue EPCs are well below screening levels for boron and manganese calculated using the USEPA website (http://epa-prgs.oml.gov/cgi-bin/chemicals/csl_search) based on a hazard quotient of 0.1 (27 mg/kg boron, 18.9 mg/kg manganese). While the fish tissue pathway could therefore be eliminated as a medium of concern, the pathway was retained in the HHRA in order to provide a more complete analysis of potential hazards associated with COPCs.

4.4 Risk characterization

The potential risk to human health associated with potential exposure to COPCs in environmental media associated with Pond D at the Hutsonville Power Station is evaluated in this step of the risk assessment process. Risk characterization is the process in which the dose-response information (Section 4.2) is integrated with quantitative estimates of human exposure derived in the Exposure Assessment (Section 4.3). The result is a quantitative estimate of the likelihood that humans will experience any adverse health effects given the exposure assumptions made. Two general types of health risk are characterized for each potential exposure pathway considered: potential carcinogenic risk and potential noncarcinogenic hazard. The COPCs evaluated in this HHRA are noncarcinogens. Noncarcinogenic hazard is evaluated by averaging exposure over the total exposure period.

The approach to noncarcinogenic risk characterization is presented in Section 4.4.1. The risk characterization results are presented in Section 4.4.2. The risk calculation spreadsheets are presented in **Appendix F**.

4.4.1 Noncarcinogenic risk characterization methods

The assumption in current regulatory risk assessment is that noncarcinogens have a threshold below which no adverse effects are expected. The estimate of that threshold is the reference dose. Therefore, the potential for exposure to a constituent to result in adverse noncarcinogenic health effects is estimated for each receptor by comparing the CADD for each COPC with the RfD for that COPC. The resulting ratio, which is unitless, is known as the Hazard Quotient (HQ) for that constituent. The HQ is calculated using the following equation:

$$HQ = \frac{CADD\ (mg/kg\text{-}day)}{RfD\ (mg/kg\text{-}day)}$$

The target HQ is defined as an HQ of less than or equal to one (USEPA, 1989, 1991b). When the HQ is less than or equal to 1, the RfD has not been exceeded, and no adverse noncarcinogenic effects are expected. If the HQ is greater than 1, there may be a potential for adverse noncarcinogenic health effects to occur; however, the magnitude of the HQ cannot be directly equated to a probability or effect level.

The total Hazard Index (HI) is calculated for each exposure pathway by summing the HQs for each individual constituent. The total HI is calculated for each potential receptor by summing the HIs for each pathway associated with the receptor. Where the total HI is greater than 1 for any receptor, a more detailed evaluation of potential noncarcinogenic effects based on specific health or target endpoints (e.g., liver effects, neurotoxicity) is performed (USEPA, 1989). The target HI is 1 on a per target endpoint basis. The target endpoints for boron (developmental) and manganese (central nervous system) are different and thus summing the HQs provides a conservative estimate of the HI.

A summary of all HIs for each receptor is presented in this section and compared to the USEPA's target HI of 1. The tables summarizing the HI show both the total HI; however, as noted above, the HQs for boron and manganese may be viewed separately because the target endpoints are different.

4.4.2 Risk characterization results

The results of the risk characterization are presented below by receptor.

Future Construction Worker

The construction worker is assumed to be potentially exposed to COPCs in groundwater via incidental ingestion and dermal contact during future construction or utility work in areas downgradient of Pond D. **Table 4-11** presents the HI for the construction worker under both the RME and CTE scenarios. The HI of 0.02 (RME) and 0.01 (CTE) are well below the acceptable hazard index of one. Therefore, no potentially adverse health effects for the construction worker are anticipated, based on the assumptions in this HHRA.

Current and Future Recreational Child

The recreational child is assumed to be potentially exposed to COPCs in surface water in the Wabash River via incidental ingestion and dermal contact while swimming. **Table 4-11** presents the HI for the recreational child under both the RME and CTE scenarios. The HI of 0.0002 (RME) and 0.00005 (CTE) are well below the acceptable hazard index of one. Therefore, no potentially adverse health effects for the recreational child are anticipated, based on the assumptions in this HHRA.

Current and Future Recreational Teenager

The recreational teenager is assumed to be potentially exposed to COPCs in surface water in the Wabash River via incidental ingestion and dermal contact while swimming. **Table 4-11** presents the HI for the recreational teenager under both the RME and CTE scenarios. The HI of 0.0001 (RME) and 0.00003 (CTE) are well below the acceptable hazard index of one. Therefore, no potentially adverse health effects for the recreational teenager are anticipated, based on the assumptions in this HHRA.

Current and Future Recreational Fisher

The recreational fisher is assumed to be potentially exposed to COPCs in fish tissue caught in the Wabash River via ingestion and in surface water in the Wabash River via incidental ingestion and dermal contact while wading. **Table 4-11** presents the HI for the recreational fisher under both the RME and CTE scenarios. The HI of 0.0008 (RME) and 0.00009 (CTE) are well below the acceptable hazard index of one. Therefore, no potentially adverse health effects for the recreational fisher are anticipated, based on the assumptions in this HHRA.

HHRA summary

Table 4-12 presents a summary of the total HI for each of the receptors evaluated in this HHRA. The HHRA evaluated construction and recreational receptors potentially exposed to groundwater downgradient of Pond D, and to surface water and fish tissue in the Wabash River that could be impacted by downgradient groundwater containing COPCs from Pond D. As indicated in **Table 4-12**, the results of the HHRA indicate that potential hazards associated with these pathways under the assumptions of this HHRA are negligible. Moreover, comparison of the constituent concentrations in the deep alluvial aquifer to drinking water-based screening levels indicates that use of that aquifer for drinking water purposes does not pose a threat to human health.

4.4.3 Evaluation of the Selection of Constituents of Potential Concern

In the Hazard Identification step, information on constituents detected at the site is combined with criteria quantifying their potential toxicity to obtain a subset of constituents for quantitative evaluation in the risk assessment, the COPCs. The goal is to include in the quantitative portion of the risk assessment those constituents that are the most toxic, prevalent, environmentally-persistent, and mobile. The selection of the COPCs forms the basis of the quantitative risk assessment.

The analyte list for downgradient groundwater has been focused on those constituents that are monitored and are related to Pond D, and the two constituents on that list having dose-response values for human health (boron and manganese) were included in the HHRA. The Pond D analyte list is consistent with the parameters required in the station's State Operating Permit (boron, sulfate, pH, total dissolved solids, temperature, specific conductance, groundwater elevation and monitoring well depth). Boron and sulfate are considered to be indicator constituents for the effects of coal ash leachate on groundwater due to their mobility and concentration.

However, to provide a more comprehensive evaluation of the adequacy of the analyte list for risk assessment purposes, data were obtained from a database of field leachate concentrations for a long analytical suite for samples from impoundments that received coal ash derived from bituminous coal (EPRI, 2006), similar to the Hutsonville Station. **Appendix G** presents the risk evaluation of these data. It was assumed that the maximum leachate concentrations from the database could be present in the upper migration zone; this is a conservative assumption as leachate would mix with and be diluted by groundwater in an environmental situation. The maximum leachate concentration data were compared to screening levels derived according to the methods presented in Section 4.1.2. The COPCs identified were evaluated for the construction worker scenario, which is the only potential receptor that may contact COPCs in the upper migration zone directly. Target "threshold" concentrations were then calculated, i.e., concentrations below which the constituents would not pose a risk to the construction worker receptor. As can be seen from the results in **Table G-9** of **Appendix G**, the maximum leachate concentrations from the EPRI database are all well below the calculated threshold concentrations for the construction worker. In addition, the threshold concentrations are orders of magnitude higher than would be expected to be present in groundwater as a result of leaching from an ash impoundment.

In addition, an evaluation of the groundwater discharge to surface water scenario is presented in **Appendix G**. It was again assumed that the maximum leachate concentrations from the EPRI (2006) database could be present in the upper migration zone; this is a conservative assumption as leachate would mix with and be diluted by groundwater in an environmental situation. The conservative dilution factor for groundwater discharge to surface water (**Appendix E**) was applied to predict surface water concentrations in the Wabash River. As shown in **Table G-10** of **Appendix G**, all predicted surface water concentrations are below the federal and state drinking water standards. Therefore, the focus of this HHRA on the Pond D analyte list is reasonable.

5.0 Ecological risk assessment

A Screening Level ERA (SERA) has been conducted in support of closure activities at Pond D. The purpose of the SERA is to evaluate potential adverse environmental effects on ecological receptors due to exposure to site-related COPCs in groundwater potentially discharging to the Wabash River. A SERA is considered the first tier of the ecological risk assessment process. Where the results of the SERA indicate sufficient potential ecological risk, further ecological risk assessment may be warranted. This approach is consistent with the eight-step process delineated for ecological risk assessment by USEPA Ecological Risk Assessment Guidance for Superfund (ERAGS) (USEPA, 1997b) and with USEPA Region 5 policy.

A major component of the SERA is an evaluation of whether potentially complete exposure pathways exist, linking constituents to potential ecological receptors. If such complete exposure pathways do not exist then there is no potential for ecological risk. Where complete exposure pathways exist, they are evaluated using measurement endpoints that rely on available data, using conservative assumptions and inferred generic assessment endpoints (e.g., protection of surface water receptors).

The SERA is organized into the three following major sections suggested by EPA's Framework for Ecological Risk Assessment (USEPA, 1992); these sections are Problem Formulation, Risk Analysis, and Risk Characterization. A brief description of the content and purpose of these sections are given below.

- Problem Formulation - In this phase, the objectives of the ERA are defined, and a plan for characterizing and analyzing risks is determined. Available information regarding stressors and specific sites is integrated. Products generated through problem formulation include assessment endpoints and conceptual site models.
- Risk Analysis - Risk analysis is directed by the problem formulation. During this phase of work, data are evaluated to characterize potential ecological exposures and effects.
- Risk Characterization - During risk characterization, exposure and stressor response profiles are integrated through risk estimation.

Based on the results of the completed SERA, a scientific/management decision point (SMDP) will be reached where a conclusion will be made either that (1) the available data indicate the potential for ecological risk and further investigation is warranted, (2) the available data indicate no potential for ecological risk and no further evaluation is warranted, or (3) there are data gaps that must be addressed before the presence or absence of risk can be concluded (e.g., additional sampling or analysis).

5.1 Problem formulation

Problem formulation is the initial systematic planning phase of the ecological risk assessment process. It provides the basis for the approach and methodology to be used as well as defining the specific scope and objectives of the risk evaluation.

The problem formulation phase of the SERA includes the following:

- Definition of risk assessment objectives;
- Site characterization and definition of the geographic area to be considered;
- Selection of specific ecological receptors and exposure pathways;
- Selection of assessment and measurement endpoints;

- Selection of COPC; and
- Development of the CSM.

5.1.1 Definition of risk assessment objectives

The purpose of the risk assessment is to evaluate the extent to which constituents released from Pond D may pose a threat to the environment.

5.1.2 Site characterization and definition of the geographic area to be considered

The site characterization is provided in Section 2. The geographic are to be considered in the SERA includes the Wabash River and local agricultural fields irrigated with groundwater from the deep alluvial aquifer.

5.1.3 Selection of specific ecological receptors and exposure pathways

Ecological receptors are the components of ecosystems (i.e., species or sensitive habitats) that are or may be adversely affected by a chemical, physical, or biological stressor. Receptors can be any part of an ecological system, including species, populations, communities, and the ecosystem itself. The SERA focuses on the pathways for which (1) chemical exposures are the highest and most likely to occur, and (2) there are adequate data pertaining to the receptors, exposure pathways, and toxicity for completion of risk analyses.

Aquatic community receptors may be directly exposed to surface water in the Wabash River. Surface water concentrations of constituents are calculated by applying to groundwater a dilution factor calculated based on a site-specific groundwater model (see **Appendix E**).

The deep alluvial aquifer is used as a source of irrigation water; therefore, the agricultural plant community will be evaluated for this medium.

5.1.4 Selection of assessment and measurement endpoints

For each of the ecological receptors/exposure pathways identified, assessment and measurement endpoints are identified for evaluation in the ERA.

According to the USEPA (1998), assessment endpoints are formal expressions of the actual environmental value to be protected. They usually describe potential adverse effects to long-term persistence, abundance, or reproduction of populations of key species or key habitats.

Measurement endpoints are the physical, chemical, or biological aspects of the ecological system that are measured to approximate or representative assessment endpoints. Measurement endpoints are often stressor-specific and are used to evaluate the assessment endpoint with respect to potential ecological risks.

The assessment and measurement endpoints for this evaluation are presented below.

Assessment Endpoint 1: The assessment endpoint is the sustainability of aquatic communities in the Wabash River in the vicinity of Pond D typical of comparable Illinois rivers with similar morphology and hydrology.

- Measurement Endpoint 1-1: Comparison of predicted surface water constituent concentrations to surface water screening values for the protection of aquatic life. Predicted surface water concentrations in excess of surface water screening values will be considered indicative of a potential for ecological risk.

Assessment Endpoint 2: The assessment endpoint is the sustainability of agricultural crops irrigated by groundwater from the deep alluvial aquifer in the vicinity of Pond D typical of comparable Illinois agricultural fields.

- Measurement Endpoint 2-1: Comparison of groundwater constituent concentrations to water quality values derived to be protective of plant life and agricultural crops. Groundwater concentrations in excess of water quality values will be considered indicative of a potential for ecological risk.

Although ecological food chains exist within the Wabash River, the constituents monitored for Pond D are not bioaccumulative constituents (USEPA, 1995). Therefore, vertebrate wildlife food chain exposure pathways are not believed to represent a significant potentially complete ecological exposure pathway, and are not proposed for further SERA evaluation. The chemical stressors are inorganic constituents related to former operations at Pond D. The potential effects associated with exposure to these COPCs are related to direct toxicity, rather than indirect (e.g., food chain) effects.

5.1.5 Selection of COPCs

COPCs represent the constituents detected in the environmental media that could present a potential risk for ecological receptors. Constituents with maximum concentrations less than their respective constituent-specific risk-based screening level were not retained as COPCs; constituents with maximum concentrations in excess of the screening level s were retained as COPCs. If no screening level was available, the constituent was selected as a COPC.

5.1.6 Conceptual site model

The end product of the problem formulation step is the development of an ecological CSM. The CSM summarizes the current knowledge of the site and ecological resources potentially at risk. The CSM is a set of working hypotheses regarding how ecological receptors at the Station may be exposed to site-related constituents. The CSM helps to describe the origin, fate, transport, exposure pathways, and receptors of interest. **Figure 5-1** presents the ecological CSM. The objectives of this CSM are to identify the ecologically important exposure and migration pathways, and to specify exposure scenarios that are evaluated in the SERA.

Based on the CSM presented in Section 2, the SERA focuses on the evaluation of:

- Wabash River aquatic community via discharge of groundwater to the river
- The agricultural plant community via groundwater (deep alluvial aquifer) use as irrigation water

5.2 Risk analysis

The risk analysis addresses the two identified assessment endpoints: Aquatic receptors in the Wabash River, and agricultural crops grown with irrigation water derived from the deep alluvial aquifer.

5.2.1 Aquatic assessment endpoint

Ecological receptors in the Wabash River may potentially be exposed to constituents in groundwater discharging to the surface water.

Since aquatic receptors are not directly exposed to groundwater, surface water concentrations were estimated from the groundwater data and the surface water concentrations were compared to risk-based surface water screening values. As described in Section 4.3.4, surface water concentrations were estimated based on the maximum detected concentration in groundwater and a conservative dilution factor of 0.00048, described in detail in **Appendix E**.

The following sources were used to identify appropriate surface water screening levels:

- Illinois Water Quality Standards (WQS) (IEPA, 2008); and
- Federal Ambient Water Quality Criteria (AWQC) (USEPA, 2006b).

Freshwater chronic screening levels for the protection of aquatic life were selected to evaluate the estimated surface water concentrations. These screening levels are based on conservative endpoints and sensitive ecological effects data and are designed to be used in the preliminary evaluation of constituent concentrations. These screening levels should not be used as remediation levels.

Table 5-1 presents the comparison of the estimated maximum surface water concentrations to the Illinois WQS and the federal AWQC. Illinois WQS are available for boron, sulfate, and manganese and federal AWQC are available for alkalinity. Screening levels are not available for calcium and magnesium. However, as discussed in Section 4.2, these constituents are essential nutrients and were eliminated from quantitative evaluation in the HHRA and ERA.

As indicated in **Table 5-1**, none of the estimated maximum surface water concentrations are above the available Illinois WQS or the federal AWQC. Therefore, no ecological COPCs have been identified for the groundwater discharge to surface water pathway.

5.2.2 Agricultural crop assessment endpoint

Agricultural crops may potentially be exposed to constituents in groundwater used as irrigation water. The potential use of groundwater as an irrigation source was evaluated by comparing groundwater data from the deep alluvial aquifer against recommended irrigation water quality values and ecologically-based screening levels.

The following sources were used to identify appropriate water quality values for irrigation water:

- Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Terrestrial Plants (Efroymson, et al., 1997); and
- Handbook of Wastewater Reclamation and Reuse (Rowe and Abdel-Magid, 1995).

Table 5-2 presents the comparison of the maximum and average groundwater concentrations against ecological risk based screening levels developed based on laboratory experiments with plants exposed to constituents in solution (Efroymson, et al., 1997) and irrigation water quality values recommended by Rowe and Abdel-Magid (1995). Screening levels were only available for boron and manganese. As indicated in Section 4.2, calcium and magnesium are essential nutrients and were eliminated from quantitative evaluation in the HHRA and ERA. The sulfate ion has plant fertility benefits and rarely results in plant toxicity, except at very high concentrations where high sulfate can interfere with uptake of other nutrients (CSU, 2007).

As indicated in **Table 5-2**, all concentrations of boron and manganese are below the short term use irrigation water quality values. Only the maximum concentration of boron is above the ecological risk based screening level and the maximum long term use irrigation water quality level. Both the average and maximum concentrations of manganese are above the long term use irrigation water quality level.

Both average and maximum concentrations were considered in order to evaluate a range of possible exposures. Since irrigation water would potentially be applied to crops over a long duration (i.e., several weeks or months during the growing season), the maximum concentration is expected to be an over-estimate of the actual exposure. The average concentration is more likely to represent plant exposure to constituents in groundwater over time. Under the average exposure scenario, manganese is the only constituent with a concentration above the long term use irrigation water quality value. As noted in **Appendix D**, manganese in the deep alluvial aquifer is considered to be naturally occurring, and not related to Pond D.

The Efroymson, et al. (1997) values are designed to be conservative screening levels that may not accurately represent the irrigation water exposure scenario since seedlings are grown in solution for relatively short periods of time (up to 32 days). The irrigation water quality values represent recommended limits for constituents in water used for irrigation of a wide variety of crops for both short and long term use (Rowe and Abdel-Magid, 1995).

The long term irrigation water quality value was derived "for waters continuously used on all soils" to be protective of a wide variety of crops under a variety of soil and climate conditions. The short term value was derived "for use up to 20 years on fine textured soils of pH 6.0 to 8.5." Rainfall on crops in the vicinity of the Station is likely to limit the need for irrigation water during some weeks of the growing season, so continuous use of groundwater as the sole water source for crops is unlikely. The average amount of irrigation water used on corn for silage and land in vegetables in Illinois is 0.7 acre-feet (US Census Bureau, 1994). According to the National Weather Service Forecast website (http://www.crh.noaa.gov/ilx/climate/spinormon.php), rainfall during the April to October growing season averages approximately 23.6 inches, the equivalent of 1.97 acre-feet. Therefore, the majority of the water needs of the crops would be met by rainfall, and irrigation is only expected to be needed during times of low rainfall. The inflow of rainwater will also serve to flush constituents out of the soil and avoid build up of constituents in the fields. Therefore, the short term use irrigation water quality value is likely to be more applicable to the groundwater evaluation. As noted above, and in **Table 5-2**, the constituent concentrations in the deep alluvial aquifer are below the short term levels.

Table 5-3 presents the sample by sample results for boron for the wells screened in the deep alluvial aquifer. As can be seen, all concentrations of boron in MW7D, MW115D, MW115S, and MW121 are below all of the screening values presented in **Table 5-2**. MW14 is the only well with concentrations above the screening values, and the boron concentrations in this well have been below 1 mg/L since 2005.

5.3 Risk characterization

The purpose of the ecological risk characterization is to summarize the results of the risk analysis phase of work and provide interpretation of the ecological significance of the findings. Potential risks to both aquatic/benthic receptors and agricultural crops were assessed.

<u>Assessment Endpoint 1: The sustainability of aquatic communities in the Wabash River</u>

The measurement endpoint used to evaluate potential risks to freshwater aquatic receptors in the Wabash River due to exposure to COPCs in groundwater was the comparison of estimated surface water concentrations to screening values designed to be protective of aquatic receptors. This evaluation was also assumed to be protective of benthic invertebrates exposed to constituents in sediment porewater.

The results of the screening presented in **Table 5-1** indicate that groundwater discharging into the Wabash River is unlikely to pose a risk to aquatic receptors in the river in the vicinity of the Station. The maximum estimated surface water concentrations of alkalinity, boron, manganese, and sulfate derived from groundwater in both the upper migration zone and the deep alluvial aquifer associated with Pond D are well below the available Illinois WQS and the federal AWQC.

Based on this evaluation, the available data indicate no potential for ecological risks within the Wabash River due to exposure to constituents discharged from groundwater and no further ecological evaluation is warranted.

Assessment Endpoint 2: The sustainability of agricultural crops irrigated by the deep alluvial aquifer

The measurement endpoint used to evaluate potential risks to agricultural crops due to exposure to COPCs in groundwater used for irrigation was the comparison of groundwater concentrations to screening levels designed to be protective of plants. The results of the screening presented in **Table 5-2** indicate that adverse effects on agricultural crops are unlikely due to exposure to COPCs in groundwater used for irrigation purposes in the vicinity of the Station. All concentrations of boron and manganese are below the short term use irrigation water quality levels. Based on the amount of rainfall that occurs during the growing season, the short term irrigation water quality values are more appropriate to evaluate the data than the long term irrigation water quality value derived for more continuous irrigation water use.

Average, not maximum, groundwater concentrations are also expected to be more representative of irrigation water exposure over the course of the growing season. The average concentrations of boron and manganese are below screening levels, with one exception (the average manganese concentration exceeds the long term irrigation water quality value). However, it has been shown that manganese in the deep alluvial aquifer is naturally occurring.

Both boron and manganese are essential to plant growth at low levels, but can be toxic at higher concentrations. Plant toxicity symptoms include burning of leave edges, necrosis of leaves and root browning (Efroymson, et al., 1997). However, agricultural crops have a range of tolerances for exposure to constituents such as boron and manganese. For example, although some fruit crops like blackberries are very sensitive to boron exposure (growth reductions observed at <0.5 mg/L), corn is moderately tolerant of boron (no adverse effects on yield up to 4 mg/L), and asparagus is tolerant of boron concentrations up to 15 mg/L (Maas, 1990). Soil and climate conditions will also impact whether a constituent in irrigation water adversely impacts crops. Based on the results of the evaluation of the average groundwater concentrations to ecological risk based screening levels and short term agricultural water quality levels, it is not expected that groundwater used for irrigation will adversely impact crops.

Evaluation of the analyte list

As noted in the HHRA (Section 4.4.3), the analyte list for downgradient groundwater has been focused on those constituents that are monitored and are related to Pond D. To provide a more comprehensive evaluation of the adequacy of the analyte list for risk assessment purposes, data were obtained from a database of field leachate concentrations for a long analytical suite for samples from impoundments that received coal ash derived from bituminous coal (EPRI, 2006), similar to the Hutsonville Station. **Appendix G** presents the risk evaluation of these data. It was assumed that the maximum leachate concentrations from the database could be present in the upper migration zone; this is a conservative assumption as leachate would mix with and be diluted by groundwater in an environmental situation. The groundwater to surface water dilution factor (**Appendix E**) was applied to the maximum leachate concentration data to provide predicted surface water concentrations for the Wabash River. All predicted surface water concentrations are below the state and federal ecological-based water quality standards, as shown in **Table G-11** of **Appendix G**.

ERA Summary

Based on the results of the ERA, the available data indicate no potential for ecological risks within the Wabash River due to exposure to constituents discharged from groundwater and no further ecological evaluation is warranted. Based on the results of the evaluation of the average groundwater concentrations to ecological risk based screening levels and short term agricultural water quality levels, it is not expected that groundwater used for irrigation will adversely impact crops.

6.0 Conclusions

This report has presented a baseline HHRA and a SERA for the Hutsonville Power Station Pond D closure plan/activities.

The HHRA was conducted based on the assumption that upper migration zone groundwater in the area is not used as a drinking water source and that a use restriction will prevent such use in the future. In addition, deep alluvial aquifer groundwater immediately downgradient of Pond D is not currently used as an off-site drinking water source, although the deep alluvial aquifer is used on-site for plant potable and production water. No COPCs were identified in the deep alluvial aquifer based on the use of conservative drinking water screening levels. Therefore, a drinking water pathway was not quantitatively included in the HHRA. A future construction worker was evaluated for direct exposure to groundwater via incidental ingestion and dermal contact during excavation. Surface water concentrations in the Wabash River were estimated from the maximum detected groundwater concentrations in the deep alluvial aquifer and the upper migration zone. Three recreational receptors were evaluated for potential exposure to COPCs that may have migrated to the Wabash River. A recreational child and a recreational teenager were evaluated for potential exposure to COPCs in surface water while swimming via incidental ingestion and dermal contact. A recreational fisher (adult) was evaluated for potential exposure to COPCs surface water while wading via incidental ingestion and dermal contact and for potential exposure to fish caught in the river via ingestion. The results of the HHRA indicate that predicted risks are orders of magnitude below regulatory target risk levels and, therefore, no adverse health effects are expected for any of the receptors evaluated based on the assumptions of the HHRA.

The SERA was conducted to determine whether exposure to constituents in groundwater discharging to the Wabash River posed a risk to ecological receptors. Surface water concentrations were estimated from the maximum detected groundwater concentrations in the deep alluvial aquifer and the upper migration zone. The maximum estimated surface water concentrations were then compared to Illinois WQS and federal AWQC derived to be protective of aquatic life. Estimated concentrations of the detected constituents were well below the screening levels indicating that groundwater discharging into the Wabash River is unlikely to pose a risk to aquatic receptors in the river in the vicinity of the Station. Based on the results of the evaluation of the average deep alluvial aquifer concentrations to ecological risk based screening levels and short term agricultural water quality levels, it is not expected that groundwater used for irrigation will adversely impact crops. The available data indicate no potential for ecological risks and no further ecological evaluation is warranted.

Therefore, the human health and ecological risk assessments presented in this report have demonstrated that the closure plan/activities for Pond D are protective of human health and the environment under current and reasonably foreseeable future conditions and land use.

7.0 References

CSU. 2007. Irrigation Water Quality Criteria. No. 0.506. Colorado State University March 2007.

Efroymson, R.A., M.E. Will, G.W. Suter II and A.C. Wooten. 1997a. Toxicological Benchmarks for Screening Potential Contaminants of Concem for Effects on Terrestrial Plants: 1997 Revision, Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, TN, ES/ER/TM-85/R3.

EPRI. 2006. Characterization of Field Leachates at Coal Combustion Product Management Sites. Technical Report 1012578. Electric Power Research Institute.

IEPA. 2002. Title 35 Environmental Protection. Subtitle F Public Water Supplies. Chapter I Pollution Control Board. Part 620 Groundwater Quality. Subpart A General. 620.410 Groundwater Quality Standards for Class I: Potable Resource Groundwater. February 5, 2002.

IEPA. 2007. Tiered Approach to Corrective Action Objectives. Title 35, Subtitle G, Chapter I, Subchapter J, Part 742. As amended February 23, 2007. Illinois Environmental Protection Agency.

IEPA. 2008. Title 35 Environmental Protection. Subtitle C Water Pollution. Chapter I Pollution Control Board. Part 302 Water Quality Standards. Subpart B General Use Water Quality Standards. 302.208 Numeric Standards for Chemical Constituents. September 8, 2008.

Maas, E.V. 1990. Crop salt tolerance. In: Agricultural Salinity Assessment and Management Manual. K.K. Tanji (ed.). ASCE, New York. pp. 262-304.

Moshfegh, A., J. Goldman, and L. Cleveland. 2005. What We Eat in America, NHANES 2001-2002: Usual Nutrient Intakes from Food Compared to Dietary Reference Intakes. U.S. Department of Agriculture, Agricultural Research Service.

NRT. 1999. Hydrogeologic Assessment Final Report, Hutsonville Power Station, Crawford County, Illinois. Prepared for Ameren Services by Natural Resources Technology, Inc. August 19, 1999.

NRT. 2009a. Pond D Closure Alternatives Report. Hutsonvelle Power Station, Crawford County, Illinois. Prepared for Ameren Services by Natural Resources Technology, Inc. April, 2009.

NRT. 2009b. Groundwater Modeling of Hutsonville Pond D. Technical memorandum prepared for Ameren Services by Natural Resources Technology, Inc. April, 2009.

Rowe, D.R. and I.M. Abdel-Magid. 1995. Handbook of Wastewater Reclamation and Reuse. CRC Press, Inc. 550pp.

Thompson, J.A.J., J.C. Davis, and R.E. Drew. 1976. Toxicity, uptake, and survey studies of boron in the marine environment. Water Res. 10:869-875.

US Census Bureau. 1994. Farm and Ranch Irrigation Survey. Table 23 Estimated Quantity of Water Applied and Method of Distribution by Selected Crops: 1994 and 1988. http://www.census.gov/prod/1/agr/92fris/table23.pdf

USEPA. 1989. Risk Assessment Guidance for Superfund: Volume I. Human Health Evaluation Manual (Part A). Interim Final. Office of Emergency and Remedial Response. U.S. Environmental Protection Agency, Washington, D.C. EPA 540/1-89/002.

USEPA. 1991a. Human Health Exposure Manual, Supplemental Guidance; Standard Default Exposure Factors. OSWER Directive No. 9285.6-03. U.S. Environmental Protection Agency, Washington, D.C.

USEPA. 1991b. Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions. OSWER Directive #9355.0-30. April.

USEPA. 1992. Framework for Ecological Risk Assessment. Risk Assessment Forum. EPA/630/R-92/001. February.

USEPA. 1993. Selecting Exposure Routes and Contaminants of Concern by Risk-Based Screening. EPA/903/R-93-001. United States Environmental Protection Agency, Region III. Hazardous Waste Management Division. Office of Superfund Programs.

USEPA. 1995. Great Lakes Water Quality Initiative Technical Support Document for the Procedure to Determine Bioaccumulation Factors. EPA-820-B-95-005. Office of Water, Washington, D.C. March.

USEPA. 1997a. Exposure Factors Handbook, Volumes I, II and III. EPA/600/P-95/002Fa, b, and c. Office of Research and Development. U.S. Environmental Protection Agency, Washington, D.C.

USEPA. 1997b. Ecological Risk Assessment Guidance for Superfund, Process for Designing and Conducting Ecological Risk Assessments (Interim Final). Office of Solid Waste and Emergency Response. EPA 540/R-97/006. June.

USEPA. 1998. Guidelines for Ecological Risk Assessment. Risk Assessment Forum. EPA/630/R-95/002F. April.

USEPA. 2002. Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites. OSWER Directive 9285.6-10. December 2002.

USEPA. 2003a. Drinking Water Advisory: Consumer Acceptability Advice and Health Effects Analysis on Sulfate. Office of Water. EPA 822-R-03-007. February 2003.

USEPA. 2003b. Human Health Toxicity Values in Superfund Risk Assessments. Office of Superfund Remediation and Technology Innovation. OSWER Directive 9285.7-53. December 5, 2003.

USEPA. 2004a. Risk Assessment Guidance for Superfund. Volume I. Human Health Evaluation Manual. Part E, Supplemental Guidance for Dermal Risk Assessment. Final. EPA/540/R/99/005. OSWER 9285.7-02EP. July 2004.

USEPA. 2004b. Baseline Human Health and Ecological Risk Assessment Report. Wells G&H Superfund Site. Aberjona River Study. Operable Unit 3. Woburn, Massachusetts. September 2004. [URL: http://www.epa.gov/ne/superfund/sites/wellsgh/213053.pdf]

USEPA. 2006a. 2006 Edition of the Drinking Water Standards and Health Advisories. August 2006. Office of Water.

USEPA. 2006b. National Recommended Water Quality Criteria. Office of Water, Office of Science and Technology. 2006.

USEPA. 2008. Regional Screening Level Table. September 2008. URL: [http://www.epa.gov/region09/superfund/prg/index.html].

USEPA. 2009. Integrated Risk Information System (IRIS). Environmental Criteria and Assessment Office. U.S. Environmental Protection Agency, Cincinnati, OH. [URL:http://cfpub.epa.gov/ncea/iris/index.cfm].

WSRC. 1999. Bioaccumulation and Bioconcentration Screening Protocol. Environmental Restoration Division Regulatory Document Handbook ERD-AG-003. Savannah River Site. Aiken, SC. Westinghouse Savannah River Company.

Tables

TABLE 3-1
SUMMARY OF AVAILABLE DATA FOR DOWNGRADIENT WELLS
HUTSONVILLE POWER STATION
AMEREN ENERGY GENERATING COMPANY
POND D CLOSURE RISK ASSESSSMENT

			Analytical Summary (b)					
Groundwater-Bearing Unit	**Well**	**Available Date Range (a)**	**Alkalinity, Total**	**Boron, Total**	**Calcium, Total**	**Magnesium, Total**	**Manganese, Total**	**Sulfate, Total**
Deep Alluvial Aquifer	MW7D	1/15/02 -- 10/8/2008	14	14	14	1	14	14
Deep Alluvial Aquifer	MW14	1/14/02 -- 10/21/2008	16	16	16		16	16
Deep Alluvial Aquifer	MW115D	4/11/05 -- 9/16/2008	3	3	3		3	3
Deep Alluvial Aquifer	MW115S	4/11/05 -- 10/8/2008	4	4	4		4	4
Deep Alluvial Aquifer	MW121	1/15/02 -- 10/8/2008	15	15	15	1	15	15
		Total number of samples:	52	52	52	2	52	52
Upper Migration Zone	MW6	1/14/02 -- 6/23/2008	14	14	14	1	14	14
Upper Migration Zone	MW7	1/15/02 -- 10/8/2008	14	14	14		14	14
Upper Migration Zone	MW8	1/15/02 -- 10/8/2008	15	15	15	4	15	15
Upper Migration Zone	MW11R	1/14/02 -- 9/8/2008	15	15	15	1	15	15
		Total number of samples:	58	58	58	6	58	58

Notes:
(a) - Data collected between 1/14/2002 and 10/21/2008 are included. The dates listed represent the first and last date within that range with monitoring data for each well.
(b) - Numbers represent the total number of samples analyzed for each constituent in each well over the listed date range.

TABLE 3-2
SUMMARY STATISTICS FOR DOWNGRADIENT WELLS - UPPER MIGRATION ZONE AND DEEP ALLUVIAL AQUIFER
HUTSONVILLE POWER STATION
AMEREN ENERGY GENERATING COMPANY
POND D CLOSURE RISK ASSESSSMENT

Constituent	Units	FOD (a)	Minimum Detection (a)	Mean (a)	Maximum Detection (a)	Location of Maximum
Deep Alluvial Aquifer						
Alkalinity, Total	ug/L	52 : 52	150000	293798	500000	MW14
Boron, Total	ug/L	52 : 52	20	335	1500	MW14
Calcium, Total	ug/L	52 : 52	50000	102135	180000	MW14
Magnesium, Total	ug/L	2 : 2	20000	21000	22000	MW007D
Manganese, Total	ug/L	52 : 52	8.3	800	3300	MW115S
Sulfate, Total	ug/L	52 : 52	14000	85596	230000	MW14
Upper Migration Zone						
Alkalinity, Total	ug/L	58 : 58	57000	292034	490000	MW7
Boron, Total	ug/L	58 : 58	500	8866	18000	MW8, MW11R
Calcium, Total	ug/L	58 : 58	130000	221897	390000	MW8
Magnesium, Total	ug/L	6 : 6	25000	58500	82000	MW8
Sulfate, Total	ug/L	58 : 58	160000	521552	960000	MW8
Manganese, Total	ug/L	58 : 58	4.2	1179	4700	MW8

Notes:
FOD - Frequency of Detection - Number of detected results: Total number of samples.
ug/L - micrograms per liter.
(a) Summary statistics were calculated based on groundwater data collected from downgradient wells between 1/14/2002 and 10/21/2008.
Results reported after duplicate results were averaged.

TABLE 4-1
COMPARISON OF MAXIMUM DETECTED CONCENTRATIONS IN DOWNGRADIENT WELLS TO HUMAN HEALTH SCREENING LEVELS
HUTSONVILLE POWER STATION
AMEREN ENERGY GENERATING COMPANY
HUMAN HEALTH RISK ASSESSMENT - POND D CLOSURE

Constituent	Units	FOD (a)	Minimum Detection (a)	Mean (a)	Maximum Detection (a)	Location of Maximum	Tapwater SL (b)	Is Maximum Detection >SL?	MCL (c)	Is Maximum Detection >MCL?	Illinois Class I Groundwater Quality Standard (d)	Is Maximum Detection >Class I?	Illinois TACO Class I Groundwater Remediation Objective (e)	Is Maximum Detection >Remediation Objective?
Deep Alluvial Aquifer														
Alkalinity, Total	ug/L	52 : 52	150000	293798	500000	MW14	NA	--	NA	--	NA	--	NA	--
Boron, Total	ug/L	52 : 52	20	335	1500	MW14	7300	No	NA	--	2000	No	2000	No
Calcium, Total	ug/L	52 : 52	50000	102135	180000	MW14	NA	--	NA	--	NA	--	NA	--
Magnesium, Total	ug/L	2 : 2	20000	21000	22000	MW007D	NA	--	NA	--	NA	--	NA	--
Manganese, Total	ug/L	52 : 52	8.3	800	3300	MW115S	880	Yes	50 SMCL	Yes	150	Yes	150	Yes
Sulfate, Total	ug/L	52 : 52	14000	85596	230000	MW14	NA	--	250000 SMCL	No	400000	No	400000	No
Upper Migration Zone														
Alkalinity, Total	ug/L	58 : 58	57000	292034	490000	MW7	NA	--	NA	--	NA	--	NA	--
Boron, Total	ug/L	58 : 58	500	8866	18000	MW8, MW11R	7300	Yes	NA	--	2000	Yes	2000	Yes
Calcium, Total	ug/L	58 : 58	130000	221897	390000	MW8	NA	--	NA	--	NA	--	NA	--
Magnesium, Total	ug/L	6 : 6	25000	58500	82000	MW8	NA	--	NA	--	NA	--	NA	--
Manganese, Total	ug/L	58 : 58	4.2	1179	4700	MW8	880	Yes	50 SMCL	Yes	150	Yes	150	Yes
Sulfate, Total	ug/L	58 : 58	160000	521552	960000	MW8	NA	--	250000 SMCL	Yes	400000	Yes	400000	Yes

Notes:
-- No value available.
FOD - Frequency of Detection - Number of detected results: Total number of samples
MCL - Maximum Contaminant Level
SL - Screening Level
SMCL - Secondary Maximum Contaminant Level
TACO - Tiered Approach to Corrective Action Objectives.
ug/L - micrograms per liter.
USEPA - United States Environmental Protection Agency
(a) Summary statistics were calculated based on groundwater data collected from downgradient wells between 1/14/2002 and 10/21/2008.
(b) USEPA. 2008. USEPA Regional Screening Levels (September 12, 2008). Values for tapwater. SLs for constituents on this table are based on a noncancer endpoint and a hazard quotient of one.
(c) USEPA. 2006a. USEPA Maximum Contaminant Level. 2006 Edition of the Drinking Water Standards and Health Advisories.
(d) IEPA. 2002. Title 35 Environmental Protection. Subtitle F Public Water Supplies. Chapter I Pollution Control Board. Part 620 Groundwater Quality. Subpart A General. 620.410 Groundwater Quality Standards for Class I: Potable Resource Groundwater. February 5, 2002.
(e) IEPA. 2007. Title 35 Environmental Protection. Subchapter F. Risk Based Cleanup Objectives. Part 742. Tiered Approach to Corrective Action Objectives (TACO). Feb. 23 2007. Appendix B, Table E. Tier 1 values for Class 1 groundwater.

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TABLE 4-2
COMPARISON OF MAXIMUM DETECTED CONCENTRATIONS IN EXTRACTION WELLS TO HUMAN HEALTH SCREENING LEVELS
HUTSONVILLE POWER STATION
AMEREN ENERGY GENERATING COMPANY
HUMAN HEALTH RISK ASSESSMENT - POND D CLOSURE

Constituent	Units	Maximum Detection (a)	Location of Maximum	Tapwater SL (b)	Is Maximum Detection >SL?	MCL (c)		Is Maximum Detection >MCL?	Illinois Class I Groundwater Quality Standard (d)	Is Maximum Detection >Class I?	Illinois TACO Class I Groundwater Remediation Objective (e)	Is Maximum Detection >Remediation Objective?
Deep Alluvial Aquifer												
Alkalinity, Total	ug/L	289000	EW-1	NA	--	NA		--	NA	--	NA	--
Boron, Total	ug/L	130	EW-2	7300	No	NA		--	2000	No	2000	No
Calcium, Total	ug/L	108000	EW-1	NA	--	NA		--	NA	--	NA	--
Manganese, Total	ug/L	590	EW-2	880	No	50	SMCL	Yes	150	Yes	150	Yes
Sulfate, Total	ug/L	60000	EW-1, EW-2	NA	--	250000	SMCL	No	400000	No	400000	No

Notes:
-- No value available.
FOD - Frequency of Detection - Number of detected results: Total number of samples.
MCL - Maximum Contaminant Level.
SL - Screening Level.
SMCL - Secondary Maximum Contaminant Level.
TACO - Tiered Approach to Corrective Action Objectives.
ug/L - micrograms per liter.
USEPA - United States Environmental Protection Agency.
(a) Maximum detected concentrations from EW-1 and EW-2.
(b) USEPA. 2008. USEPA Regional Screening Levels (September 12, 2008). Values for tapwater. SLs for constituents on this table are based on a noncancer endpoint and a hazard quotient of one.
(c) USEPA. 2006a. USEPA Maximum Contaminant Level. 2006 Edition of the Drinking Water Standards and Health Advisories.
(d) IEPA. 2002. Title 35 Environmental Protection. Subtitle F Public Water Supplies. Chapter I Pollution Control Board. Part 620 Groundwater Quality. Subpart A General. 620.410 Groundwater Quality Standards for Class I: Potable Resource Groundwater. February 5, 2002.
(e) IEPA. 2007. Title 35 Environmental Protection. Subchapter F. Risk Based Cleanup Objectives. Part 742. Tiered Approach to Corrective Action Objectives (TACO). Feb. 23 2007. Appendix B, Table E. Tier 1 values for Class 1 groundwater.

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TABLE 4-3
DOSE-RESPONSE INFORMATION FOR COPC WITH POTENTIAL NONCARCINOGENIC EFFECTS FROM CHRONIC EXPOSURE THROUGH THE ORAL ROUTE
HUTSONVILLE POWER STATION
AMEREN ENERGY GENERATING COMPANY
POND D CLOSURE RISK ASSESSSMENT

Constituent	CAS Number	Oral RfD (mg/kg-day)		Fraction Absorbed ABS_{GI} (a)	Dermal RfD (b) (mg/kg-day)	Reference (Last Verified)	USEPA Confidence Level	Uncertainty Factor	Modifying Factor	Target Organ/ Critical Effect at LOAEL	Study Animal	Study Method
Boron	7440-42-8	2.00E-01		--	2.00E-01	IRIS (3/09)	HIGH	66	1	Decreased fetal weight (developmental)	RAT	ORAL: DIET
Manganese	7439-96-5	2.40E-02	(c)	4.00E-02	9.60E-04	IRIS (3/09)	HIGH	1	3	CNS Effects (Other Effect: Impairment of Neurobehavioral Function)	HUMAN	ORAL
Manganese	7439-96-5	1.40E-01	(d)	4.00E-02	5.60E-03	IRIS (3/09)	HIGH	1	1	CNS Effects (Other Effect: Impairment of Neurobehavioral Function)	HUMAN	ORAL

Notes:
"--" - No adjustment necessary.
CAS - Chemical Abstracts Service.
CNS - Central Nervous System.
COPC - Constituent of Potential Concern.
IRIS - Integrated Risk Information System, an on-line computer database of toxicological information (USEPA, 2009).
LOAEL - Lowest Observed Adverse Effect Level.
RfD - Reference Dose.
USEPA - United States Environmental Protection Agency.
(a) USEPA. 2004a. Risk Assessment Guidance for Superfund. Volume 1, Part E, Supplemental Guidance for Dermal Risk Assessment. Exhibit 4-1. Where USEPA, 2004 does not recommend adjustments, no value is listed.
(b) Oral RfD multiplied by ABS_{GI}. Where no adjustment is recommended by USEPA, 2004a, Dermal RfD = Oral RfD.
(c) When assessing exposure to manganese in drinking water, IRIS (USEPA, 2009) recommends applying a modifying factor of 3 to the oral RfD of 0.14 mg/kg-day. The USEPA Regional Screening Level User's Guide (USEPA, 2008) also indicates that the average dietary manganese content of the US diet (5 mg/day) be subtracted from the critical dose of 10 mg/day when assessing exposure to non-dietary manganese.
Therefore, the RfD is (10 mg/day - 5 mg/day)/Modifying Factor (3) = 1.67 mg/day / 70 kg = 0.024 mg/kg-day.
(d) When assessing exposure to manganese in the diet (i.e., fish tissue) the RfD presented in IRIS (USEPA, 2009) is used without modification.

TABLE 4-4
POTENTIAL RECEPTORS, EXPOSURE MEDIA AND EXPOSURE PATHWAYS
HUTSONVILLE POWER STATION
AMEREN ENERGY GENERATING COMPANY
POND D CLOSURE RISK ASSESSSMENT

Receptor	Medium	Pathway	
Recreational Child			
	Wabash River Surface Water	Incidental Ingestion Dermal Contact	
Recreational Teen			
	Wabash River Surface Water	Incidental Ingestion Dermal Contact	
Recreational Fisher			
	Wabash River Surface Water	Incidental Ingestion Dermal Contact	
	Fish Tissue	Ingestion	
Construction/Utility Worker			
	Groundwater - Upper Migration Zone	Dermal Contact Incidental Ingestion	
Hutsonville Power Station Worker			
	Groundwater - Deep Alluvial Aquifer	Ingestion	No constituents of potential concern were identified for this pathway.
Future Downgradient Off-Site Resident			
	Groundwater - Deep Alluvial Aquifer	Ingestion	No constituents of potential concern were identified for this pathway.

TABLE 4-5
DERMAL PERMEABILITY CONSTANTS FOR GROUNDWATER AND SURFACE WATER
HUTSONVILLE POWER STATION
AMEREN ENERGY GENERATING COMPANY
POND D CLOSURE RISK ASSESSSMENT

Constituent	Dermal Permeability Constant (cm/hr)	
Boron	1.00E-03	(a)
Manganese	1.00E-03	(a)

Notes:
cm/hr - centimeter per hour.
(a) USEPA. 2004a. Risk Assessment Guidance for Superfund.
Volume 1, Part E, Supplemental Guidance for Dermal Risk Assessment.
Exhibit 3-1. (Inorganics)

TABLE 4-6
SUMMARY OF POTENTIAL EXPOSURE ASSUMPTIONS - FUTURE CONSTRUCTION WORKER
HUTSONVILLE POWER STATION
AMEREN ENERGY GENERATING COMPANY
POND D CLOSURE RISK ASSESSSMENT

	RME		CTE	
Parameter	**Construction Worker**		**Construction Worker**	
Parameters Used in the Groundwater Incidental Ingestion/Dermal Contact Pathway				
Exposure Time (hr/day)	1	(a)	1	(a)
Exposure Frequency (days/year)	30	(b)	15	(c)
Exposure Duration (yr)	1	(d)	1	(d)
Water Ingestion Rate (l/event)	0.005	(e)	0.005	(e)
Skin Contacting Medium (cm^2)	3300	(f,g)	3300	(f,g)
Body Weight (kg)	70	(h)	70	(h)

Notes:
CTE - Central Tendency Exposure.
RME - Reasonable Maximum Exposure.
(a) - Assumes that contact with water occurs only for a fraction of an 8-hour work day.
(b) - Exposure frequency is equivalent to 5 days per week for 6 weeks.
(c) - Exposure frequency is equivalent to 5 days per week for 3 weeks.
(d) - Construction activities are assumed to occur within a 1 year period.
(e) - USEPA. 1989. Risk Assessment Guidance for Superfund, Volume I. Value is one-tenth that assumed to occur during a swimming event.
(f) - USEPA. 1997a. Exposure Factors Handbook (EFH). Represents 50th percentile values for males and females based on hands, forearms, and face listed in EFH Tables 6-2 and 6-3.
(g) - USEPA. 2004a. Risk Assessment Guidance for Superfund, Supplemental Guidance for Dermal Risk Assessment. Exhibit 3-5.
(h) - USEPA. 1991a. Standard Default Exposure Factors.

TABLE 4-7
SUMMARY OF POTENTIAL EXPOSURE ASSUMPTIONS - CURRENT AND FUTURE RECREATIONAL SWIMMING CHILD
HUTSONVILLE POWER STATION
AMEREN ENERGY GENERATING COMPANY
POND D CLOSURE RISK ASSESSSMENT

Parameter	RME Child (0 to 6 yrs)		CTE Child (0 to 6 yrs)	
Parameters Used in the Wabash River Swimming Pathway				
Exposure Time (hr/event)	2	(a)	1	(a)
Exposure Frequency (days/year)	26	(b)	13	(c)
Exposure Duration (yr)	6	(d)	2	(e)
Water Ingestion Rate (l/event)	0.05	(f)	0.05	(f)
Skin Contacting Medium (cm^2)	6560	(g)	6560	(g)
Body Weight (kg)	15	(d)	15	(d)

Notes:
CTE - Central Tendency Exposure.
RME - Reasonable Maximum Exposure.
(a) - Best professional judgement.
(b) - One day per week for six months.
(c) - One day per week for three months.
(d) - USEPA. 1991a. Standard Default Exposure Factors.
(e) - USEPA. 1997a. Exposure Factors Handbook. Recommended average for time residing in a household, Table 1-2. (9 years total, assuming 7 years as an adult and 2 as a child - assumes that the 2 years as a child can occur anywhere between the ages of 0 to 6. Therefore, exposure factors for a 0 to 6 year old child are employed).
(f) - USEPA. 1989. Risk Assessment Guidance for Superfund, Volume I.
(g) - USEPA. 1997a. Exposure Factors Handbook. Average 50th percentile surface area for males and females age 0-6 of whole body.

TABLE 4-8
SUMMARY OF POTENTIAL EXPOSURE ASSUMPTIONS - CURRENT AND FUTURE RECREATIONAL SWIMMING TEENAGER
HUTSONVILLE POWER STATION
AMEREN ENERGY GENERATING COMPANY
POND D CLOSURE RISK ASSESSSMENT

Parameter	RME		CTE	
	Teen (7 to 18 yrs)		Teen (7 to 18 yrs)	
Parameters Used in the Wabash River Swimming Pathway				
Exposure Time (hr/event)	2	(a)	1	(a)
Exposure Frequency (days/year)	26	(b)	13	(c)
Exposure Duration (yr)	11	(d)	11	(d)
Water Ingestion Rate (l/event)	0.05	(e)	0.05	(e)
Skin Contacting Medium (cm^2)	13535	(f)	13535	(f)
Body Weight (kg)	47	(g)	47	(g)

Notes:
CTE - Central Tendency Exposure.
RME - Reasonable Maximum Exposure.
(a) - Best professional judgement.
(b) - One day per week for six months.
(c) - One day per week for three months.
(d) - Recreational teenager is assumed to range in age from 7 to 18. Therefore, total exposure duration is 11 years.
(e) - USEPA. 1989. Risk Assessment Guidance for Superfund, Volume I.
(f) - USEPA. 1997a. Exposure Factors Handbook. Average 50th percentile surface area for males and females aged 7 to 18 of whole body.
(g) - USEPA. 1997a. Exposure Factors Handbook. Body weight is the average of males and females aged 7 to 18 listed in EFH Table 7-3

TABLE 4-9
SUMMARY OF POTENTIAL EXPOSURE ASSUMPTIONS - CURRENT AND FUTURE RECREATIONAL FISHEF
HUTSONVILLE POWER STATION
AMEREN ENERGY GENERATING COMPANY
POND D CLOSURE RISK ASSESSSMENT

Parameter	RME Recreational Fisher		CTE Recreational Fisher	
Parameters Used in the Fish Ingestion Pathway				
Exposure Frequency (days/year)	365	(a)	365	(a)
Exposure Duration (yr)	30	(b)	9	(c)
Fish Ingestion Rate (kg/day)	0.008	(d)	0.001	(e)
Body Weight (kg)	70	(b)	70	(b)
Parameters Used in the Surface Water Pathway - Wading				
Exposure Time (hr/day)	1	(f)	1	(f)
Exposure Frequency (days/year)	22	(h)	3	(i)
Exposure Duration (yr)	30	(b)	9	(c)
Water Ingestion Rate (l/event)	0.005	(j)	0.005	(j)
Skin Contacting Medium (cm^2)	5669	(g)	5669	(g)
Body Weight (kg)	70	(b)	70	(b)

Notes:
CTE - Central Tendency Exposure.
RME - Reasonable Maximum Exposure.
(a) - Fish ingestion rates are based on 365 days per year.
(b) - USEPA. 1991a. Standard Default Exposure Factors.
(c) - USEPA. 1997a. Exposure Factors Handbook. Recommended average for time residing in a household. EFH Table 1-2.
(d) - USEPA. 1997a. Exposure Factors Handbook. 8 g/day is equivalent to approximately 22 fish meals of 129 g each per year.
(e) - 1 g/day is equivalent to approximately three 129 g fish meals per year (equivalent to one fish meal per month in the three summer months).
(f) - Assumed duration of wading event.
(g) - USEPA. 1997a. Exposure Factors Handbook. Represents 50th percentile values for adult males and females based on hands, forearms, lower legs, and feet.
(h) - One day per week for 5 months.
(i) - One day per month during the three summer months.
(j) - USEPA. 1989. Risk Assessment Guidance for Superfund, Volume I. Value is one-tenth that assumed to occur during a swimming event.

TABLE 4-10
EXPOSURE POINT CONCENTRATIONS
HUTSONVILLE POWER STATION
AMEREN SERVICES
POND D CLOSURE RISK ASSESSSMENT

Constituent	Groundwater Maximum Detection (mg/L)	Dilution Ratio (a)	Surface Water (b) (mg/L)	Water-to-Fish Uptake Factor [(mg constituent/kg fish ww)/ (mg constituent/L water)]	Estimated Maximum Fish Tissue Concentration (e) (mg/kg ww)
Upper Migration Zone					
Boron, Total	18	0.00048	0.00864	1 (c)	0.00864
Manganese, Total	4.7	0.00048	0.002256	400 (d)	0.9024

Notes:
FCM_{TL2} - Food Chain Multiplier Trophic Level 2.
FCM_{TL3} - Food Chain Multiplier Trophic Level 3.
(a) Derived in Appendix E.
(b) The estimated surface water concentration is equal to the maximum detected groundwater concentration multiplied by the dilution ratio.
(c) Studies by Thompson et al., (1976) found no evidence of active boron bioaccumulation in sockey salmon or Pacific oyster. Tissue levels approximated water levels.
(d) Surface water to fish bioconcentration factors described in *Bioaccumulation and Bioconcentration Screening Protocol* developed for the Savannah River Site (WSRC, 1999).
(e) Tissue concentration calculated by:
Concentration in fish (mg constituent/kg fish ww) = Concentration in water (mg constituent /L water)
x Uptake Factor ((mg constituent/kg fish ww)/(mg constituent/L water)) x FCM_{TL2} x FCM_{TL3}
Where FCM_{TL2} and FCM_{TL3} = 1 for all inorganic constituents (USEPA, 1995).

TABLE 4-11
SUMMARY OF POTENTIAL HAZARD INDICES
HUTSONVILLE POWER STATION
AMEREN ENERGY GENERATING COMPANY
POND D CLOSURE RISK ASSESSSMENT

	Future Construction Worker			
	Reasonable Maximum Exposure		Central Tendancy Exposure	
	Potential Noncarcinogenic Hazard		Potential Noncarcinogenic Hazard	
Constituent	Groundwater Ingestion/Dermal Contact	Total	Groundwater Ingestion/Dermal Contact	Total
Boron	0.001	0.001	0.0004	0.0004
Manganese	0.02	0.02	0.01	0.01
Total Hazard Index:	**0.02**	**0.02**	**0.01**	**0.01**

	Current and Future Recreational Child			
	Reasonable Maximum Exposure		Central Tendancy Exposure	
	Potential Noncarcinogenic Hazard		Potential Noncarcinogenic Hazard	
Constituent	Surface Water Ingestion/Dermal Contact	Total	Surface Water Ingestion/Dermal Contact	Total
Boron	0.00001	0.00001	0.000006	0.000006
Manganese	0.0002	0.0002	0.00005	0.00005
Total Hazard Index:	**0.0002**	**0.0002**	**0.00005**	**0.00005**

	Current and Future Recreational Teenager			
	Reasonable Maximum Exposure		Central Tendancy Exposure	
	Potential Noncarcinogenic Hazard		Potential Noncarcinogenic Hazard	
Constituent	Surface Water Ingestion/Dermal Contact	Total	Surface Water Ingestion/Dermal Contact	Total
Boron	0.000005	0.000005	0.000002	0.000002
Manganese	0.0001	0.0001	0.00003	0.00003
Total Hazard Index:	**0.0001**	**0.0001**	**0.00003**	**0.00003**

	Current and Future Recreational Fisher					
	Reasonable Maximum Exposure			Central Tendancy Exposure		
	Potential Noncarcinogenic Hazard			Potential Noncarcinogenic Hazard		
Constituent	Surface Water Ingestion/Dermal Contact	Fish Ingestion	Total	Surface Water Ingestion/Dermal Contact	Fish Ingestion	Total
Boron	0.0000004	0.000005	0.000005	0.00000005	0.0000006	0.0000007
Manganese	0.00001	0.0007	0.0007	0.000002	0.00009	0.00009
Total Hazard Index:	**0.00001**	**0.0007**	**0.0008**	**0.000002**	**0.00009**	**0.00009**

TABLE 4-12
TOTAL POTENTIAL HAZARD INDICES
HUTSONVILLE POWER STATION
AMEREN ENERGY GENERATING COMPANY
POND D CLOSURE RISK ASSESSSMENT

	Total Potential Hazard Index	
	RME	CTE
Future Construction Worker		
Ingestion and Dermal Contact with Groundwater HI:	0.02	0.01
Total Hazard Index:	**0.02**	**0.01**
Current and Future Recreational Child		
Ingestion and Dermal Contact with Surface Water HI:	0.0002	0.00005
Total Hazard Index:	**0.0002**	**0.00005**
Current and Future Recreational Teenager		
Ingestion and Dermal Contact with Surface Water HI:	0.0001	0.00003
Total Hazard Index:	**0.0001**	**0.00003**
Current and Future Recreational Fisher		
Ingestion of Fish Tissue HI:	0.0007	0.00009
Ingestion and Dermal Contact with Surface Water HI:	0.00001	0.000002
Total Hazard Index:	**0.0008**	**0.00009**

Notes:
CTE - Central Tendancy Exposure.
HI - Hazard Index.
RME - Reasonable Maximum Exposure.

TABLE 5-1
COMPARISON OF ESTIMATED SURFACE WATER CONCENTRATIONS TO ECOLOGICAL SCREENING LEVELS FOR SURFACE WATER
HUTSONVILLE POWER STATION
AMEREN ENERGY GENERATING COMPANY
POND D CLOSURE RISK ASSESSMENT

Constituent	Units	FOD (a)	Groundwater Minimum Detection (a)	Groundwater Mean (a)	Groundwater Maximum Detection (a)	Location of Maximum	Dilution Factor (b)	Estimated Surface Water Concentration (c)	Illinois Surface Water Standard (d)	Is Estimated Surface Water Concentration >Surface Water Standard?	Federal AWQC (e)	Is Maximum Detection >AWQC?
Deep Alluvial Aquifer												
Alkalinity, Total	ug/L	52 : 52	150000	293798	500000	MW14	0.00048	240	--	--	20000	No
Boron, Total	ug/L	52 : 52	20	335	1500	MW14	0.00048	0.72	1000	No	--	--
Calcium, Total	ug/L	52 : 52	50000	102135	180000	MW14	0.00048	86	--	--	--	--
Magnesium, Total	ug/L	2 : 2	20000	21000	22000	MW007D	0.00048	11	--	--	--	--
Manganese, Total	ug/L	52 : 52	8.3	800	3300	MW115S	0.00048	1.58	1000	No	--	--
Sulfate, Total	ug/L	52 : 52	14000	85596	230000	MW14	0.00048	110	1164200	No	--	--
Upper Migration Zone												
Alkalinity, Total	ug/L	58 : 58	57000	292034	490000	MW7	0.00048	235	--	--	20000	No
Boron, Total	ug/L	58 : 58	500	8866	18000	MW8, MW11R	0.00048	8.64	1000	No	--	--
Calcium, Total	ug/L	58 : 58	130000	221897	390000	MW8	0.00048	187	--	--	--	--
Magnesium, Total	ug/L	6 : 6	25000	58500	82000	MW8	0.00048	39.4	--	--	--	--
Manganese, Total	ug/L	58 : 58	4.2	1179	4700	MW8	0.00048	2.26	1000	No	--	--
Sulfate, Total	ug/L	58 : 58	160000	521552	960000	MW8	0.00048	461	1164200	No	--	--

Notes:
-- No value available.
AWQC - Aquatic Water Quality Criteria.
FOD - Frequency of Detection - Number of detected results: Total number of samples.
ug/L - micrograms per liter.
USEPA - United States Environmental Protection Agency.
(a) Summary statistics were calculated based on groundwater data collected from downgradient wells between 1/14/2002 and 10/21/2008.
(b) Derived in Appendix E.
(c) The estimated surface water concentration is equal to the maximum detected groundwater concentration multiplied by the dilution factor.
(d) IEPA. 2008. Title 35 Environmental Protection. Subtitle C Water Pollution. Chapter I Pollution Control Board. Part 302 Water Quality Standards. Subpart B General Use Water Quality Standards. 302.208 Numeric Standards for Chemical Constituents: September 8, 2008. Sulfate value calculated assuming a water hardness of 100 mg/L and chloride of 50 mg/L.
(e) USEPA. 2006b. National Recommended Water Quality Criteria. Available at http://www.epa.gov/waterscience/criteria/wqcriteria.html. Values selected are freshwater chronic AWQC for the protection of aquatic life.

TABLE 5-2
COMPARISON OF CONCENTRATIONS IN DOWNGRADIENT WELLS TO IRRIGATION SCREENING LEVELS
HUTSONVILLE POWER STATION
AMEREN ENERGY GENERATING COMPANY
POND D CLOSURE RISK ASSESSMENT

							Ecological Risk-Based Screening Levels			Agricultural Irrigation-Based Screening Levels					
Constituent	Units	FOD (a)	Minimum Detection (a)	Mean (a)	Maximum Detection (a)	Location of Maximum	Phytotoxicity Screening Value (b)	Is Mean >SL?	Is Maximum Detection >SL?	Long Term Use SL (c)	Is Mean >Long Term SL?	Is Maximum Detection >Long Term SL?	Short Term Use SL (c)	Is Mean >Short Term SL?	Is Maximum Detection >Short Term SL?
Deep Alluvial Aquifer															
Alkalinity, Total	ug/L	52 : 52	150000	293798	500000	MW14	NA	--	--	NA	--	--	NA	--	--
Boron, Total	ug/L	52 : 52	20	335	1500	MW14	1000	No	Yes	750	No	Yes	2000	No	No
Calcium, Total	ug/L	52 : 52	50000	102135	180000	MW14	NA	--	--	NA	--	--	NA	--	--
Magnesium, Total	ug/L	2 : 2	20000	21000	22000	MW007D	NA	--	--	NA	--	--	NA	--	--
Manganese, Total	ug/L	52 : 52	8.3	800	3300	MW115S	4000	No	No	200	Yes	Yes	10000	No	No
Sulfate, Total	ug/L	52 : 52	14000	85596	230000	MW14	NA	--	--	NA	--	--	NA	--	--

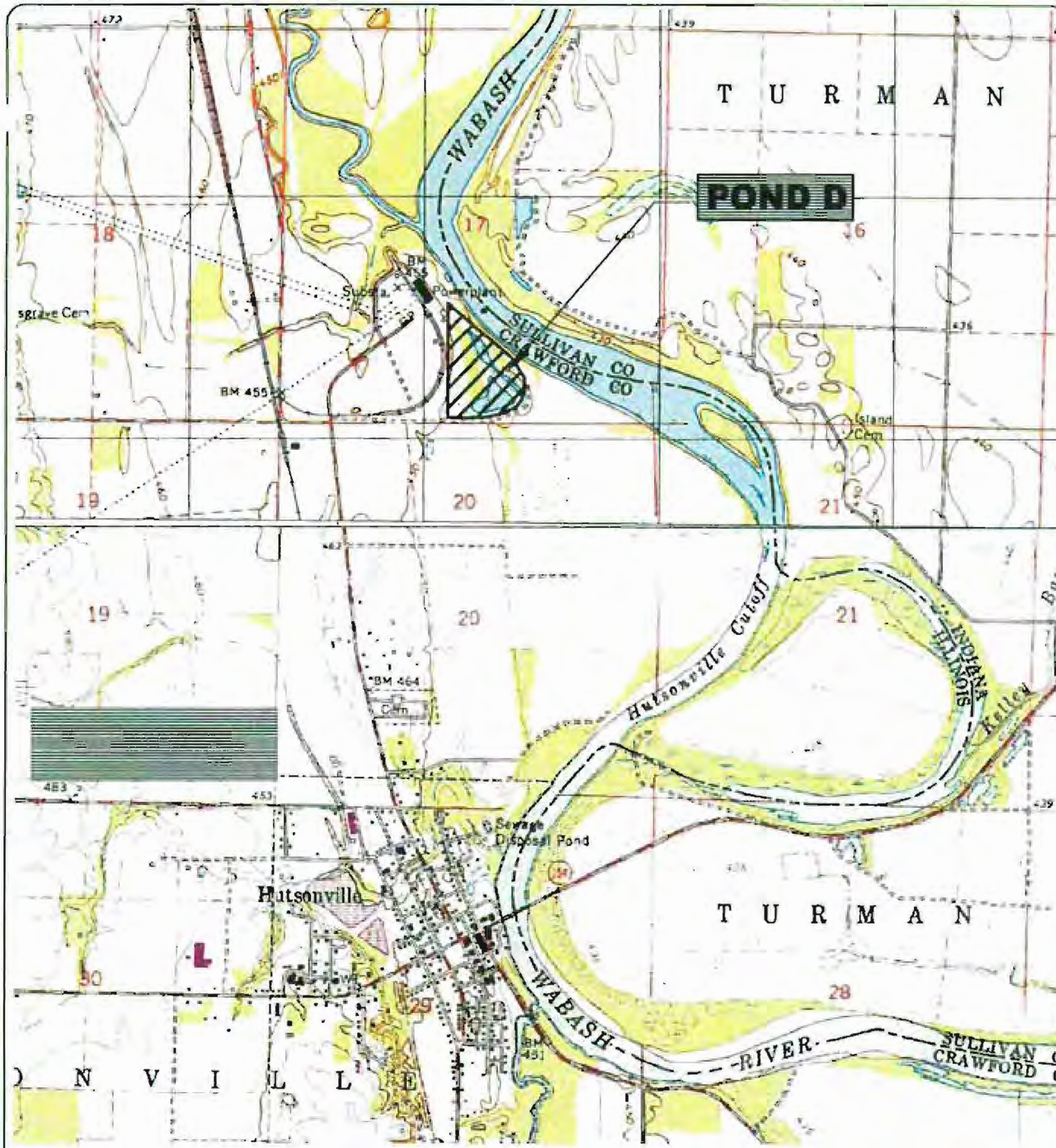
Notes:
-- No value available.
FOD - Frequency of Detection - Number of detected results: Total number of samples.
SL - Screening Level.
ug/L - micrograms per liter.
USEPA - United States Environmental Protection Agency.
(a) Summary statistics were calculated based on groundwater data collected from downgradient wells between 1/14/2002 and 10/21/2008.
(b) Efroymson, R.A., M.E. Will, G.W. Suter II and A.G. Wooten. 1997. Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Terrestrial Plants: 1997 Revision. Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, TN. ES/ER/TM-85/R3.
(c) Rowe and Abdel-Magid. 1995. Handbook of Wastewater Reclamation and Reuse. CRC Press, Inc. 550pp.

TSD 000391

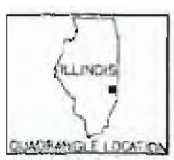
TABLE 5-3
BORON CONCENTRATIONS IN DOWNGRADIENT DEEP ALLUVIAL AQUIFER WELLS
HUTSONVILLE POWER STATION
AMEREN ENERGY GENERATING COMPANY
POND D CLOSURE RISK ASSESSMENT

Well	Sample Date	Boron (mg/L)
MW7D	1/15/2002	0.24
	9/18/2002	0.083
	12/19/2002	0.14
	3/19/2003	0.089
	6/2/2003	0.088
	8/11/2003	0.14
	10/13/2003	0.11
	2/23/2004	0.11
	4/19/2004	0.067
	8/2/2004	0.091
	10/4/2004	0.21
	3/15/2005	0.062
	6/29/2008	0.68
	10/8/2008	0.18
MW14	1/14/2002	1.4
	9/18/2002	0.19
	12/13/2002	0.57
	3/18/2003	0.73
	5/12/2003	1
	8/11/2003	0.4
	10/13/2003	0.63
	2/23/2004	1.4
	4/4/2004	1.5
	8/3/2004	1
	11/8/2004	1.1
	3/15/2005	0.88
	3/17/2008	0.48
	6/23/2008	0.91
	9/16/2008	0.37
	10/21/2008	0.54
MW115D	4/11/2005	0.022
	6/29/2008	0.1
	9/16/2008	0.054
MW115S	4/11/2005	0.02
	6/29/2008	0.083
	9/16/2008	0.065
	10/8/2008	0.11
MW121	1/15/2002	0.11
	9/19/2002	0.082
	12/19/2002	0.067
	3/17/2003	0.2
	6/17/2003	0.052
	8/11/2003	0.11
	10/13/2003	0.075
	2/23/2004	0.085
	4/19/2004	0.099
	8/2/2004	0.18
	10/4/2004	0.084
	3/16/2005	0.06
	6/29/2008	0.18
	7/21/2008	0.086
	10/8/2008	0.12

Figures



SOURCE: DIGITAL DOWNLOAD FROM
http://STORE.USGS.GOV
USGS 7.5 MINUTE QUADRANGLE,
WEST UNION IL, IN., HUTSONVILLE, IL
DATED: 1998, 2002



N

0 2000 4000

SCALE IN FEET

CONTOUR INTERVAL 10 FEET

NATURAL RESOURCE TECHNOLOGY

SITE LOCATION MAP

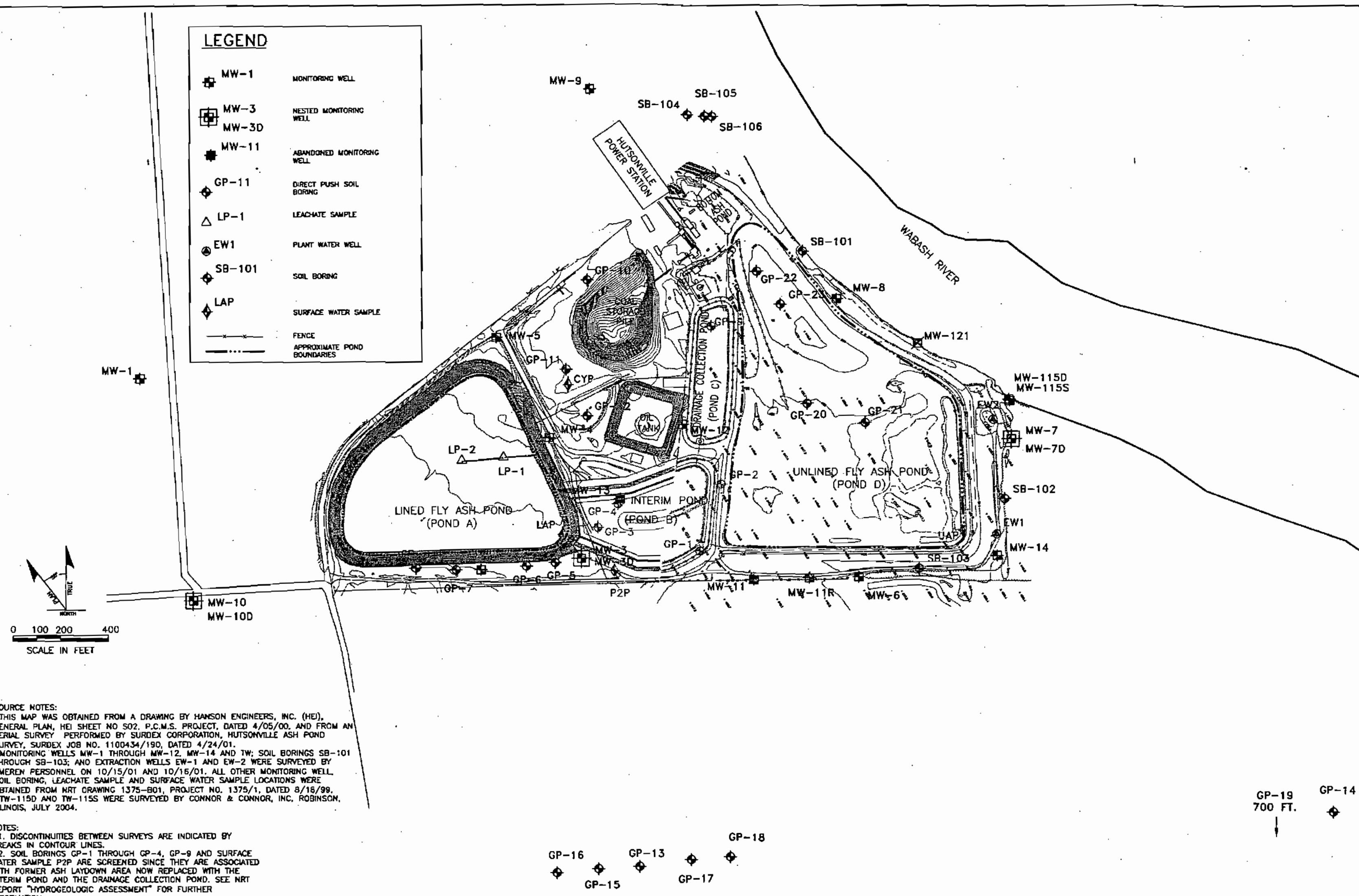
HUTSONVILLE POWER STATION
AMEREN ENERGY GENERATING
HUTSONVILLE, ILLINOIS

DRAWN BY: KNW 04/10/09 APP'D BY: BRH DATE:

PROJECT NO. 1954

DRAWING NO. 1954-A06

FIGURE NO. 2-1



SOURCE NOTES:
THIS MAP WAS OBTAINED FROM A DRAWING BY HANSON ENGINEERS, INC. (HEI), GENERAL PLAN, HEI SHEET NO S02, P.C.M.S. PROJECT, DATED 4/05/00, AND FROM AN AERIAL SURVEY PERFORMED BY SURDEX CORPORATION, HUTSONVILLE ASH POND SURVEY, SURDEX JOB NO. 1100434/190, DATED 4/24/01.
MONITORING WELLS MW-1 THROUGH MW-12, MW-14 AND TW; SOIL BORINGS SB-101 THROUGH SB-103; AND EXTRACTION WELLS EW-1 AND EW-2 WERE SURVEYED BY AMEREN PERSONNEL ON 10/15/01 AND 10/16/01. ALL OTHER MONITORING WELL, SOIL BORING, LEACHATE SAMPLE AND SURFACE WATER SAMPLE LOCATIONS WERE OBTAINED FROM NRT DRAWING 1375-B01, PROJECT NO. 1375/1, DATED 8/16/99.
TW-115D AND TW-115S WERE SURVEYED BY CONNOR & CONNOR, INC. ROBINSON, ILLINOIS, JULY 2004.

NOTES:
1. DISCONTINUITIES BETWEEN SURVEYS ARE INDICATED BY BREAKS IN CONTOUR LINES.
2. SOIL BORINGS GP-1 THROUGH GP-4, GP-9 AND SURFACE WATER SAMPLE P2P ARE SCREENED SINCE THEY ARE ASSOCIATED WITH FORMER ASH LAYDOWN AREA NOW REPLACED WITH THE INTERIM POND AND THE DRAINAGE COLLECTION POND. SEE NRT REPORT "HYDROGEOLOGIC ASSESSMENT" FOR FURTHER INFORMATION.

DRAWN BY: KNW	DATE: 04/03/09
CHECKED BY: KJB	DATE: 04/08/09
APPROVED BY:	DATE:
DRAWING NO: 1954-23-B23	
REFERENCE:	

SITE PLAN

POND D CLOSURE RISK ASSESSMENT
HUTSONVILLE POWER STATION
AMEREN SERVICES
HUTSONVILLE, ILLINOIS

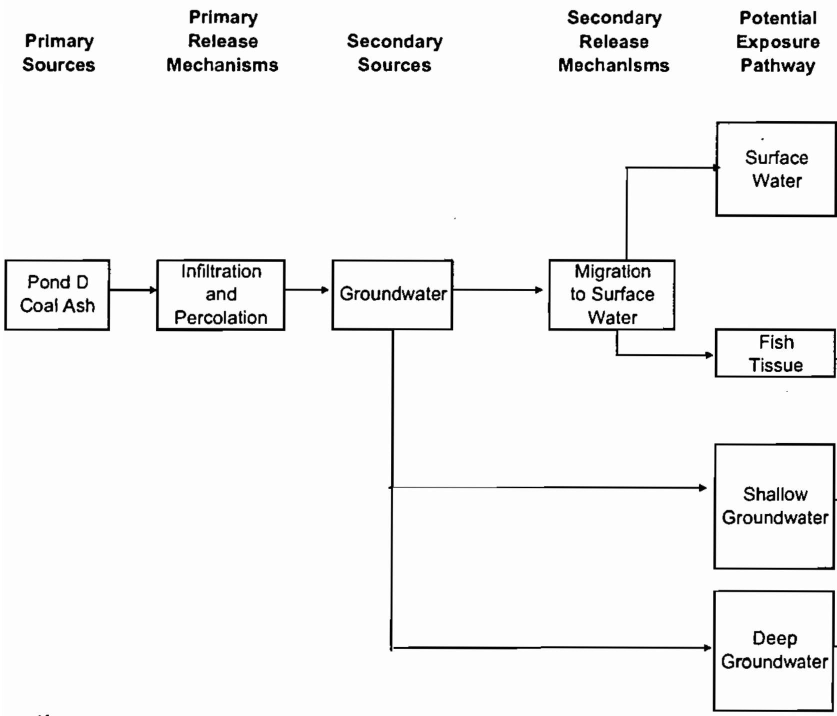
NATURAL RESOURCE TECHNOLOGY

PROJECT NO. 1954/2.3

FIGURE NO. 2-2

AECOM

Figure 4-1
Human Health Conceptual Site Model
Hutsonsville Power Station
Ameren Energy Generating Company
Pond D Closure Risk Assessment

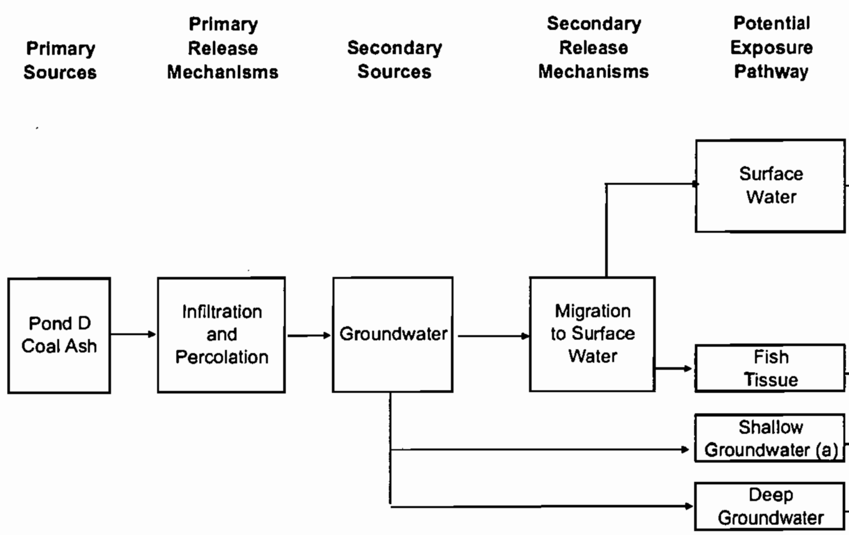


Potential Exposure Pathway	Potential Exposure Route	Future Construction Worker	Current/Future Recreational Swimmer - Child	Current/Future Recreational Swimmer - Teenager	Current/Future Recreational Angler - Adult	Current Station Worker / Future Resident
		Potential Receptors				
Surface Water	Incidental Ingestion	○	●	●	●	○
Surface Water	Dermal Contact	○	●	●	●	○
Surface Water	Ingestion as Drinking Water	○	○	○	○	○
Fish Tissue	Ingestion	○	○	○	●	○
Shallow Groundwater	Ingestion as Drinking Water (a)	○	○	○	○	○
Shallow Groundwater	Dermal Contact	●	○	○	○	○
Shallow Groundwater	Incidental Ingestion	●	○	○	○	○
Deep Groundwater	Ingestion as Drinking Water	○	○	○	○	●
Deep Groundwater	Dermal Contact	○	○	○	○	○
Deep Groundwater	Incidental Ingestion	○	○	○	○	○

Key:

- ● Pathway potentially complete, if constituents of potential concern (COPCs) are identified, further evaluation recommended.
- ○ Pathway evaluated and found incomplete.
- (a) Shallow groundwater cannot support sustained pumping needed for residential water use.

Figure 5-1
Ecological Conceptual Site Model
Hutsonsville Power Station
Ameren Energy Generating Company
Pond D Closure Risk Assessment



Potential Exposure Route	Potential Receptors: Aquatic Community	Potential Receptors: Higher Trophic Level Wildlife	Potential Receptors: Plant Community
Incidental Ingestion	--	○	--
Direct Contact	●	--	--
Ingestion as Drinking Water	--	○	--
Ingestion	--	--	--
None	--	--	--
Irrigation	--	--	●

Key:

● Pathway potentially complete, if constituents of potential concern (COPCs) are identified, further evaluation recommended.

○ Pathway evaluated and found incomplete.

-- Not applicable.

(a) Shallow groundwater cannot support sustained pumping needed for irrigation applications.

Appendix A

Consumer Confidence Report (CCR) for Hutsonville, IL

Consumer Confidence Report

Annual Drinking Water Quality Report

HUTSONVILLE

IL0330100

For more information regarding this report contact:

This report is intended to provide you with important information about your drinking water and the efforts made by the water system to provide safe drinking water.

The source of drinking water used by

HUTSONVILLE is Ground Water

Name ____________________

Phone ____________________

Annual Water Quality Report for the period of January 1 to December 31, 2008

Este informe contiene información muy importante sobre el agua que usted bebe. Tradúzcalo ó hable con alguien que lo entienda bien.

Source of Drinking Water

The sources of drinking water (both tap water and bottled water) include rivers, lakes, streams, ponds, reservoirs, springs, and wells. As water travels over the surface of the land or through the ground, it dissolves naturally-occurring minerals and, in some cases, radioactive material, and can pickup substances resulting from the presence of animals or from human activity.

Contaminants that may be present in source water include:

- Microbial contaminants, such as viruses and bacteria, which may come from sewage treatment plants, septic systems, agricultural livestock operations, and wildlife.
- Inorganic contaminants, such as salts and metals, which can be naturally-occurring or result from urban storm water runoff, industrial or domestic wastewater discharges, oil and gas production, mining, or farming.
- Pesticides and herbicides, which may come from a variety of sources such as agriculture, urban storm water runoff, and residential uses.
- Organic chemical contaminants, including **synthetic and volatile organic chemicals, which are** by-products of industrial processes and petroleum production, and can also come from gas stations, urban storm water runoff, and septic systems.
- Radioactive contaminants, which can be naturally -occurring or be the result of oil and gas production and mining activities.

Drinking water, including bottled water, may reasonably be expected to contain at least small amounts of some contaminants. The presence of contaminants does not necessarily indicate that water poses a health risk. More information about contaminants and potential health effects can be obtained by calling the EPAs Safe Drinking Water Hotline at (800) 426-4791.

In order to ensure that tap water is safe to drink, EPA prescribes regulations which limit the amount of certain contaminants in water provided by public water systems. FDA regulations establish limits for contaminants in bottled water which must provide the same protection for public health.

Some people may be more vulnerable to contaminants in drinking water than the general population. Immuno-compromised persons such as persons with cancer undergoing chemotherapy, persons who have undergone organ transplants, people with HIV/AIDS or other immune system disorders, some elderly and infants can be particularly at risk from **infections. These people should seek advice about drinking water from their health care providers.** EPA/CDC guidelines on appropriate means to lessen the risk of infection by Cryptosporidium and other microbial contaminants are available from the Safe Drinking Water Hotline (800-426-4791).

We want our valued customers to be informed about their water quality. If you would like to learn more, please feel welcome to attend any of our regularly scheduled meetings. The source water assessment for our supply has been completed by the Illinois EPA. If you would like a copy of this information, please stop by City Hall or call our water operator at ________________. To view a summary version of the completed Source Water Assessments, including: Importance of Source Water; Susceptibility to Contamination Determination; and documentation/recommendation of Source Water Protection Efforts, you may access the Illinois EPA website at http://www.epa.state.il.us/cgi-bin/wp/swap-fact-sheets.pl.

Consumer Confidence Report

Source Water Information

Source Water Name	Type of Water	Report Status	Location
WELL 3 (47811)	GW	________	IS SOUTH WELL OF 2 N OF BRIDGE

Source Water Assessment

To determine Hutsonville's susceptibility to groundwater contamination, the following documents were reviewed: a Well Site Survey, published in 1994 by the Illinois EPA, a report entitled "Water Supply Feasibility Study" prepared for the Village of Hutsonville by Daily and Associates Engineers, Inc., and a Source Water Protection Management Plan prepared by the Village of Hutsonville with assistance from Illinois Rural Water Association. During the survey of Hutsonville's source water protection area, Illinois EPA staff recorded no potential sources, routes, or possible problem sites within the 400 foot minimum setback zone of wells #3 and #4. Three potential sources or potential problem sites are located within the 1500 foot survey radius of both wells. Based on information provided by Hutsonville's water supply officials, the following facility, also indicated as a potential source in the site data table, has changed its status: the Old Ford Garage (map code 06027). At this site, the structure was razed and the tanks removed. The Illinois EPA considers the source water of this facility to be susceptible to contamination. This determination is based on a number of criteria including: monitoring conducted at the wells; monitoring conducted at the entry point to the distribution system; and the available hydrogeologic data on the wells.

Lead and Copper

Definitions:
Action Level: The concentration of a contaminant which, if exceeded, triggers treatment or other requirements which a water system must follow.
Action Level Goal (ALG): The level of a contaminant in drinking water below which there is no known or expected risk to health. ALGs allow for a margin of safety.

Lead and Copper	Date Sampled	MCLG	Action Level (AL)	90th Percentile	# Sites Over AL	Units	Violation	Likely Source of Contamination
Copper	09/29/2006	1.3	1.3	0	0	ppm	N	Erosion of natural deposits; Leaching from wood preservatives; Corrosion of household plumbing systems.
Lead	09/29/2006	0	15	0	0	ppb	N	Corrosion of household plumbing systems; Erosion of natural deposits.

Water Quality Test Results

Definitions:	The following tables contain scientific terms and measures, some of which may require explanation.
Maximum Contaminant Level or MCL:	The highest level of a contaminant that is allowed in drinking water. MCLs are set as close to the MCLGs as feasible using the best available treatment technology.
Maximum Contaminant Level Goal or MCLG:	The level of a contaminant in drinking water below which there is no known or expected risk to health. MCLGs allow for a margin of safety.
ppm:	milligrams per liter or parts per million - or one ounce in 7,350 gallons of water.
ppb:	micrograms per liter or parts per billion - or one ounce in 7,350,000 gallons of water.
na:	not applicable.
Avg:	Regulatory compliance with some MCLs are based on running annual average of monthly samples.
Maximum residual disinfectant level or MRDL:	The highest level of a disinfectant allowed in drinking water. There is convincing evidence that addition of a disinfectant is necessary for control of microbial contaminants.
Maximum residual disinfectant level goal or MRDLG:	The level of a drinking water disinfectant below which there is no known or expected risk to health. MRDLGs do not reflect the benefits of the use of disinfectants to control microbial contaminants.

Regulated Contaminants

Disinfectants and Disinfection By-Products	Collection Date	Highest Level Detected	Range of Levels Detected	MCLG	MCL	Units	Violation	Likely Source of Contamination
Chlorine		1.7	.07 - 1.7	MRDLG = 4	MRDL = 4	ppm	N	Water additive used to control microbes.
Haloacetic Acids (HAA5)*		8.8	8.8 - 8.8	No goal for the total	60	ppb	N	By-product of drinking water chlorination.

Not all sample results may have been used for calculating the Highest Level Detected because some results may be part of an evaluation to determine where compliance sampling should occur in the future

Total Trihalomethanes (TThm)*		18	18 - 18	No goal for the total	80	ppb	N	By-product of drinking water chlorination.

Not all sample results may have been used for calculating the Highest Level Detected because some results may be part of an evaluation to determine where compliance sampling should occur in the future

Inorganic Contaminants	Collection Date	Highest Level Detected	Range of Levels Detected	MCLG	MCL	Units	Violation	Likely Source of Contamination
Arsenic		.53	.53 - .53		10	ppb	N	Erosion of natural deposits; Runoff from orchards; Runoff from glass and electronics production wastes.
Barium		.03073	.03073 - .03073	2	2	ppm	N	Discharge of drilling wastes; Discharge from metal refineries; Erosion of natural deposits.
Fluoride		.266	.266 - .266	4	4.0	ppm	N	Erosion of natural deposits; Water additive which promotes strong teeth; Discharge from fertilizer and aluminum factories.
Nitrate [measured as Nitrogen]		2	2.15 - 2.15	10	10	ppm	N	Runoff from fertilizer use; Leaching from septic tanks, sewage; Erosion of natural deposits.
Sodium		23240	23240 - 23240			ppm	N	Erosion from naturally occuring deposits: Used in water softener regeneration.

Radioactive Contaminants	Collection Date	Highest Level Detected	Range of Levels Detected	MCLG	MCL	Units	Violation	Likely Source of Contamination
Combined Radium 226/228		1.35	1.35 - 1.35	0	5	pCi/L	N	Erosion of natural deposits.

Gross alpha excluding radon and uranium		1.3	1.3 - 1.3	0	15	pCi/L	N	Erosion of natural deposits.
Synthetic organic contaminants including pesticides and herbicides	Collection Date	Highest Level Detected	Range of Levels Detected	MCLG	MCL	Units	Violation	Likely Source of Contamination
Dibromochloropropane (DBCP)		.1199	0 - .1199	0	0	ppt	N	Runoff/leaching from soil fumigant used on soybeans, cotton, pineapples, and orchards.

Appendix B

Groundwater Use Restriction

Ameren Services

One Ameren Plaza
1901 Chouteau Avenue
PO Box 66149
St. Louis, MO 63166-6149

Letter of Agreement for
Restriction of Shallow Water Well Drilling

THIS LETTER OF AGREEMENT memorializes various discussions representatives from Ameren have had with you regarding groundwater contamination that extends onto your property located in Crawford County, Illinois, and near the City of Hutsonville ("Property"). AmerenEnergy Generating Company (AEG) owns and operates the Hutsonville Power Station located directly north of your property. AEG is seeking regulatory approval from state environmental officials to cap and close one of the coal ash ponds located on the plant property. Restricting the usage of shallow groundwater for certain purposes on portions of your property would facilitate such closure and the approval process.

Ameren

Such restriction would be accomplished by your agreement not to install wells within the first twenty-five (25) feet of the water table underlying the Property. Please find attached Exhibit A, a site photo/diagram depicting the area within which such groundwater use restriction would apply, as well as a legal description describing the cross-hatched restricted area. <u>Note there are no restrictions on the use of the Property (i.e., agricultural, commercial, industrial or residential) and current irrigation and farming practices are not impacted</u>.

The parties understand that if required by either the Illinois Environmental Protection Agency or the Illinois Pollution Control Board, this Letter of Agreement may be recorded within the chain of title for the Property with the Office of the Recorder of Deeds in Crawford County, Illinois. The parties agree that under no circumstances will this Letter of Agreement be recorded until such time as Ms. DeMent, or her estate, conveys or transfers title to such Property. This Letter of Agreement shall apply and benefit each party and their respective successors, assigns, future owners and the estate of any individual owner.

If the foregoing accurately sets forth our understanding, please indicate your agreement with the terms of this Letter of Agreement by signing where indicated below.

AGREED AND ACCEPTED THIS 14 DAY OF APRIL, 2009.

By: Margaret R. DeMent
Margaret R. DeMent, Owner

By: Dennis W. Weisenborn
Dennis W. Weisenborn
Vice President

STATE OF ILLINOIS

COUNTY OF Crawford } SS

I, the undersigned, a Notary Public, in and for said County and State aforesaid, DO HEREBY CERTIFY, that MARGARET. R. DEMENT, a single person, personally known to me to be the same person whose name is subscribed to the forgoing instrument, appeared before me this day in person and acknowledged that she signed, sealed and delivered the said instrument as her free and voluntary act, for the uses and purposes therein set forth.

GIVEN under my hand and Notarial Seal this 14 day of April, 2009.

"OFFICIAL SEAL"
William B Thompson
Notary Public, State of Illinois
My Commission Expires 1/26/2013

William B. Thompson
Notary Public

STATE OF MISSOURI

CITY OF ST. LOUIS } SS

On the 13TH day of APRIL, 2009, before me appeared Dennis W. Weisenborn, to me personally known, who being by me duly sworn, did say that he is a Vice President of AmerenEnergy Generating Company, and that such instrument was signed in behalf of said corporation by authority of its Board of Directors, and said Dennis W. Weisenborn acknowledged said instrument to be the free act and deed of said corporation.

My commission expires 10-27-2012

Steven M. Scholten - Notary Public
Notary Seal, State of
Missouri - St. Louis County
Commission #08550845
My Commission Expires 10/27/2012

Steven M. Scholten
Notary Public

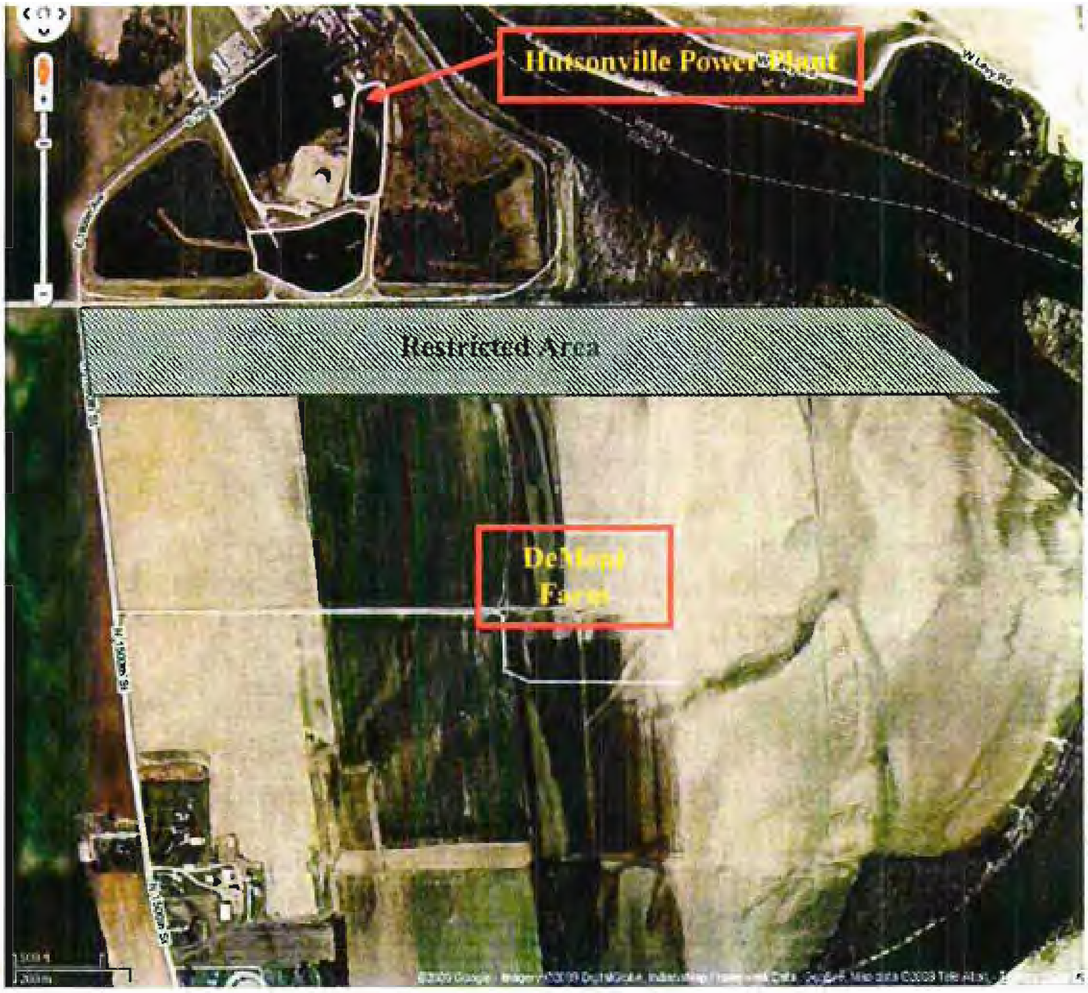


Exhibit A: Ariel View of DeMent Farm showing the 56.24 Acres m/l of Restricted Area

The area shown on the above photo located 500 feet South of the Hutsonville Generation Plant boundary, in the North Half of Section 20, Township 8 North, Range 11 West of the Second Principle Meridian, Crawford County, Illinois, lying East of Township Road 254A which extends in a Northwesterly direction across said Section 20 AND the area shown 500 feet South of the Hutsonville Generation Plant boundary, in the North Half of Section 21, Township 8 North, Range 11 West of the Second Principle Meridian, Crawford County, Illinois, lying West of the Wabash River.

Ameren
Real Estate

Appendix C

Downgradient Groundwater Data: 2002-2008

Appendix C
Analtyical Data Summary (2002-2008)
Hutsonville Power Station
Ameren Services
Pond D Closure Risk Assessment

Constituent	Aquifer: Well: Date:	Deep MW7D 1/15/2002	Deep MW7D 10/13/2003	Deep MW7D 10/22/2007	Deep MW7D 10/4/2004	Deep MW7D 10/8/2008	Deep MW7D 10/9/2006	Deep MW7D 12/19/2002	Deep MW7D 2/19/2007	Deep MW7D 2/23/2004	Deep MW7D 3/15/2005	Deep MW7D 3/19/2003	Deep MW7D 3/27/2006
Chemistry Parmeters													
Alkalinity, Total	ug/L	250000	220000		300000	240000		210000		260000	220000	170000	
Boron, Total	ug/L	240	110		210	180		140		110	62	89	
Calcium, Total	ug/L	88000	66000		85000	75000		67000		89000	61000	66000	
Magnesium, Total	ug/L												
Manganese, Total	ug/L	620	640		660	540		750		770	450	760	
Sulfate, Total	ug/L	58000	44000		36000	35000		31000		68000	42000	51000	
Field Parameters													
Hardness, Total	ug/L	360000	320000		330000	260000		320000		510000	240000	310000	
pH	std		7.5	7.3	7.5	7	6.9	7.38	7.2	7.4	7.53	7.3	6.8
Total Dissolved Solids	ug/L	420000	320000		420000	320000		320000		430000	280000	350000	
Temperature	^{o}C												17

Notes:
ug/L - micrograms per liter.

TSD 000410

Appendix C
Analtyical Data Summary (2002-2008)
Hutsonville Power Station
Ameren Services
Pond D Closure Risk Assessment

Constituent	Aquifer: / Well: / Date:	Deep MW7D 4/19/2004	Deep MW7D 6/2/2003	Deep MW7D 6/20/2007	Deep MW7D 6/26/2006	Deep MW7D 6/29/2008	Deep MW7D 7/1/2002	Deep MW7D 8/11/2003	Deep MW7D 8/2/2004	Deep MW7D 9/10/2007	Deep MW7D 9/15/2008	Deep MW7D 9/18/2002	Deep MW14 1/1/2008
Chemistry Parmeters													
Alkalinity, Total	ug/L	260000	200000			410000		240000	260000			200000	
Boron, Total	ug/L	67	88			680		140	91			83	
Calcium, Total	ug/L	85000	68000			130000		69000	81000			71000	
Magnesium, Total	ug/L											22000	
Manganese, Total	ug/L	830	680			1600		660	570			750	
Sulfate, Total	ug/L	61000	60000			75000		59000	47000			51000	
Field Parameters													
Hardness, Total	ug/L	420000	410000			490000	370000	270000	330000			270000	
pH	std	7.3	7.7	7.1	7.3	7		7.53	7	7.3	7	7.41	7
Total Dissolved Solids	ug/L	440000	390000			530000	420000	370000	360000			370000	
Temperature	°C				18								

Notes:
ug/L - micrograms per liter.

TSD 000411

Appendix C
Analtyical Data Summary (2002-2008)
Hutsonville Power Station
Ameren Services
Pond D Closure Risk Assessment

Constituent	Aquifer: Well: Date:	Deep MW14 1/14/2002	Deep MW14 10/13/2003	Deep MW14 10/21/2008	Deep MW14 10/25/2006	Deep MW14 11/12/2007	Deep MW14 11/8/2004	Deep MW14 12/13/2002	Deep MW14 2/23/2004	Deep MW14 2/27/2007	Deep MW14 3/13/2006	Deep MW14 3/15/2005	Deep MW14 3/17/2008	Deep MW14 3/18/2003
Chemistry Parmeters														
Alkalinity, Total	ug/L	410000	430000	450000			440000	400000	460000			450000	440000	390000
Boron, Total	ug/L	1400	630	540			1100	570	1400			880	480	730
Calcium, Total	ug/L	170000	170000	170000			170000	180000	180000			160000	160000	160000
Magnesium, Total	ug/L													
Manganese, Total	ug/L	380	510	570			510	500	430			350	500	510
Sulfate, Total	ug/L	230000	200000	140000			180000	210000	190000			220000	140000	120000
Field Parameters														
Hardness, Total	ug/L	680000	680000	560000			700000	700000	690000			620000	550000	630000
pH	std		7.3	6.7	6.6	6.7	6.9	6.92	6.8	6.8	6.8	6.92	6.6	7
Total Dissolved Solids	ug/L	780000	810000	670000			760000	740000	810000			780000	650000	570000
Temperature	^oC										14			

Notes:
ug/L - micrograms per liter.

TSD 000412

Appendix C
Analtyical Data Summary (2002-2008)
Hutsonville Power Station
Ameren Services
Pond D Closure Risk Assessment

Constituent	Aquifer: Well: Date:	Deep MW14 4/4/2004	Deep MW14 5/12/2003	Deep MW14 5/13/2007	Deep MW14 6/20/2006	Deep MW14 6/23/2008	Deep MW14 6/30/2002	Deep MW14 8/11/2003	Deep MW14 8/3/2004	Deep MW14 9/10/2007	Deep MW14 9/16/2008	Deep MW14 9/18/2002	Deep MW115D 10/14/2008	Deep MW115D 10/22/2007
Chemistry Parmeters														
Alkalinity, Total	ug/L	450000	480000			460000		430000	500000		430000	430000		
Boron, Total	ug/L	1500	1000			910		400	1000		370	190		
Calcium, Total	ug/L	170000	180000			180000		160000	180000		150000	180000		
Magnesium, Total	ug/L													
Manganese, Total	ug/L	400	480			560		410	450		480	530		
Sulfate, Total	ug/L	190000	230000			170000		180000	200000		120000	230000		
Field Parameters														
Hardness, Total	ug/L	740000	700000			600000	740000	640000	660000		520000	640000		
pH	std	6.9	7	6.7	7.5	7.1		7.345	6.9	7.2	6.7	7	7	7.2
Total Dissolved Solids	ug/L	780000	830000			690000	900000	740000	810000		650000	790000		
Temperature	^{o}C				22									

Notes:
ug/L - micrograms per liter.

TSD 000413

Appendix C
Analtyical Data Summary (2002-2008)
Hutsonville Power Station
Ameren Services
Pond D Closure Risk Assessment

Constituent	Aquifer: / Well: / Date:	Deep MW115D 10/9/2006	Deep MW115D 2/19/2007	Deep MW115D 4/11/2005	Deep MW115D 6/20/2007	Deep MW115D 6/26/2006	Deep MW115D 6/29/2008	Deep MW115D 9/12/2007	Deep MW115D 9/16/2008	Deep MW115S 10/22/2007	Deep MW115S 10/8/2008	Deep MW115S 10/9/2006	Deep MW115S 2/19/2007	Deep MW115S 4/11/2005
Chemistry Parmeters														
Alkalinity, Total	ug/L			220000			160000		220000		210000			260000
Boron, Total	ug/L			22			100		54		110			20
Calcium, Total	ug/L			59000			57000		68000		67000			75000
Magnesium, Total	ug/L													
Manganese, Total	ug/L			730			8.3		760		1200			200
Sulfate, Total	ug/L			55000			34000		38000		43000			46000
Field Parameters														
Hardness, Total	ug/L			300000			210000		240000		230000			340000
pH	std	7.4	7.2	7.41	7.4	7.4	7.2	7.1	7.2	7.5	7.1	7.1	6.7	7.5
Total Dissolved Solids	ug/L			320000			240000		330000		310000			340000
Temperature	^oC					20								

Notes:
ug/L - micrograms per liter.

TSD 000414

Appendix C
Analtyical Data Summary (2002-2008)
Hutsonville Power Station
Ameren Services
Pond D Closure Risk Assessment

Constituent	Aquifer: Well: Date:	Deep MW115S 6/20/2007	Deep MW115S 6/26/2006	Deep MW115S 6/29/2008	Deep MW115S 9/12/2007	Deep MW115S 9/16/2008	Deep MW121 1/15/2002	Deep MW121 10/13/2003	Deep MW121 10/22/2007	Deep MW121 10/4/2004	Deep MW121 10/4/2006	Deep MW121 10/8/2008	Deep MW121 12/19/2002	Deep MW121 2/12/2007
Chemistry Parmeters														
Alkalinity, Total	ug/L			170000		280000	220000	200000		280000		200000	230000	
Boron, Total	ug/L			83		65	110	75		84		120	67	
Calcium, Total	ug/L			57000		75000	70000	56000		77000		58000	78000	
Magnesium, Total	ug/L													
Manganese, Total	ug/L			610		3300	2000	760		1400		680	1200	
Sulfate, Total	ug/L			31000		14000	34000	30000		23000		18000	38000	
Field Parameters														
Hardness, Total	ug/L			220000		260000	320000	230000		350000		210000	360000	
pH	std	7	7.16	7.3	7.3	7.2		7.5	7	7.4	7.2	6.8	7.31	7.28
Total Dissolved Solids	ug/L			250000		350000	340000	280000		350000		260000	340000	
Temperature	^{o}C		17											

Notes:
ug/L - micrograms per liter.

TSD 000415

Appendix C
Analtyical Data Summary (2002-2008)
Hutsonville Power Station
Ameren Services
Pond D Closure Risk Assessment

Constituent	Aquifer: Well: Date:	Deep MW121 2/23/2004	Deep MW121 3/16/2005	Deep MW121 3/17/2003	Deep MW121 3/27/2006	Deep MW121 4/19/2004	Deep MW121 5/13/2007	Deep MW121 6/17/2003	Deep MW121 6/19/2006	Deep MW121 6/29/2008	Deep MW121 7/10/2006	Deep MW121 7/21/2008	Deep MW121 7/9/2007	Deep MW121 8/11/2003
Chemistry Parmeters														
Alkalinity, Total	ug/L	290000	187500	200000		260000		210000		150000		160000		220000
Boron, Total	ug/L	85	60	200		99		52		180		86		110
Calcium, Total	ug/L	86000	57000	83000		72000		74000		51000		50000		71000
Magnesium, Total	ug/L													
Manganese, Total	ug/L	2100	640	930		1200		820		640		680		1100
Sulfate, Total	ug/L	27000	34000	65000		19000		62000		33000		23000		52000
Field Parameters														
Hardness, Total	ug/L	410000	250000	300000		420000		290000		170000		160000		300000
pH	std	7.3	7.44	7.3	7	7.3	7.2	7.6	7.35	7	7.58	6.8	7.4	7.484
Total Dissolved Solids	ug/L	470000	250000	340000		340000		370000		210000		230000		310000
Temperature	^{o}C				14				15		17			

Notes:
ug/L - micrograms per liter.

TSD 000416

Appendix C
Analtyical Data Summary (2002-2008)
Hutsonville Power Station
Ameren Services
Pond D Closure Risk Assessment

Constituent	Aquifer: Well: Date:	Deep MW121 8/2/2004	Deep MW121 9/19/2002	Upper MW6 1/1/2008	Upper MW6 1/14/2002	Upper MW6 1/4/2005	Upper MW6 10/13/2003	Upper MW6 10/14/2008	Upper MW6 10/25/2006	Upper MW6 11/12/2007	Upper MW6 11/8/2004	Upper MW6 12/13/2002	Upper MW6 2/23/2004	Upper MW6 2/27/2007
Chemistry Parmeters														
Alkalinity, Total	ug/L	260000	200000		220000	240000	240000				180000	250000	240000	
Boron, Total	ug/L	180	82		15000	15000	15000				14000	16000	14000	
Calcium, Total	ug/L	72000	77000		130000	140000	140000				140000	130000	150000	
Magnesium, Total	ug/L		20000											
Manganese, Total	ug/L	1400	1400		1400	970	290				590	1300	880	
Sulfate, Total	ug/L	24000	40000		270000	380000	300000				380000	240000	310000	
Field Parameters														
Hardness, Total	ug/L	420000	270000		510000	700000	550000				610000	490000	700000	
pH	std	7.4	7.43	7		7.2	6.9	6.7	6.5	6.8	6.7	6.91	7.4	6.5
Total Dissolved Solids	ug/L	350000	340000		740000	890000	770000				900000	640000	790000	
Temperature	^{o}C													

Notes:
ug/L - micrograms per liter.

TSD 000417

Appendix C
Analtyical Data Summary (2002-2008)
Hutsonville Power Station
Ameren Services
Pond D Closure Risk Assessment

Constituent	Aquifer: Well: Date:	Upper MW6 3/11/2008	Upper MW6 3/13/2006	Upper MW6 3/18/2003	Upper MW6 4/4/2004	Upper MW6 5/12/2003	Upper MW6 6/20/2006	Upper MW6 6/20/2007	Upper MW6 6/23/2008	Upper MW6 6/30/2002	Upper MW6 7/11/2007	Upper MW6 7/12/2004	Upper MW6 8/4/2003	Upper MW6 8/7/2006	Upper MW6 9/15/2008
Chemistry Parmeters															
Alkalinity, Total	ug/L	190000		160000	280000	230000			240000			270000	190000		
Boron, Total	ug/L	15000		11000	11000	8200			16000			12000	13000		
Calcium, Total	ug/L	190000		170000	140000	150000			200000			160000	150000		
Magnesium, Total	ug/L														
Manganese, Total	ug/L	83		7	890	4.2			420			1700	80		
Sulfate, Total	ug/L	460000		450000	310000	360000			510000			360000	330000		
Field Parameters															
Hardness, Total	ug/L	610000		590000	590000	540000			710000	13000		700000	500000		
pH	std	6.2	6.8	6.7	6.9	7	6.84	6.6	6.8		6.9		7	6.7	6.7
Total Dissolved Solids	ug/L	930000		880000	810000	880000			980000	710000		900000	780000		
Temperature	^oC		12				17							20	

Notes:
ug/L - micrograms per liter.

TSD 000418

Appendix C
Analtyical Data Summary (2002-2008)
Hutsonville Power Station
Ameren Services
Pond D Closure Risk Assessment

Constituent	Aquifer: Well: Date:	Upper MW6 9/19/2002	Upper MW7 1/1/2008	Upper MW7 1/15/2002	Upper MW7 10/13/2003	Upper MW7 10/22/2007	Upper MW7 10/4/2004	Upper MW7 10/8/2008	Upper MW7 10/9/2006	Upper MW7 12/19/2002	Upper MW7 2/19/2007	Upper MW7 2/23/2004	Upper MW7 3/15/2005	Upper MW7 3/19/2003
Chemistry Parmeters														
Alkalinity, Total	ug/L	240000		380000	440000		490000	440000		420000		430000	430000	280000
Boron, Total	ug/L	15000		2300	2200		2600	1700		2500		2100	1400	500
Calcium, Total	ug/L	130000		150000	180000		210000	200000		180000		190000	150000	130000
Magnesium, Total	ug/L	32000												
Manganese, Total	ug/L	3600		100	120		120	78		220		22	12	20
Sulfate, Total	ug/L	200000		220000	240000		300000	280000		250000		280000	220000	160000
Field Parameters														
Hardness, Total	ug/L	460000		630000	710000		720000	670000		700000		760000	580000	450000
pH	std	7	7		7	7.1	6.9	6.7	6.7	6.91	6.7	6.9	7.05	7
Total Dissolved Solids	ug/L	690000		770000	820000		1000000	860000		790000		880000	730000	570000
Temperature	^{o}C													

Notes:
ug/L - micrograms per liter.

TSD 000419

Appendix C
Analtyical Data Summary (2002-2008)
Hutsonville Power Station
Ameren Services
Pond D Closure Risk Assessment

Constituent	Aquifer: Well: Date:	Upper MW7 3/27/2006	Upper MW7 4/19/2004	Upper MW7 6/2/2003	Upper MW7 6/20/2007	Upper MW7 6/26/2006	Upper MW7 6/29/2008	Upper MW7 7/1/2002	Upper MW7 8/11/2003	Upper MW7 8/2/2004	Upper MW7 9/10/2007	Upper MW7 9/15/2008	Upper MW7 9/18/2002	Upper MW8 1/1/2008	Upper MW8 1/15/2002
Chemistry Parmeters															
Alkalinity, Total	ug/L		420000	380000			440000		490000	460000			370000		360000
Boron, Total	ug/L		2000	1800			1700		2100	2000			2200		14000
Calcium, Total	ug/L		180000	150000			190000		170000	200000			180000		330000
Magnesium, Total	ug/L														
Manganese, Total	ug/L		51	24			95		18	160			52		3200
Sulfate, Total	ug/L		310000	220000			250000		220000	310000			240000		790000
Field Parameters															
Hardness, Total	ug/L		840000	650000			650000	590000	540000	780000			650000		1200000
pH	std	6.4	6.8	7.3	6.6	6.68	6.9		7.02	6.8	7	6.8	6.89	7	
Total Dissolved Solids	ug/L		970000	790000			800000	720000	790000	950000			760000		1800000
Temperature	^oC	15				17									

Notes:
ug/L - micrograms per liter.

TSD 000420

Appendix C
Analtyical Data Summary (2002-2008)
Hutsonville Power Station
Ameren Services
Pond D Closure Risk Assessment

	Aquifer:	Upper	Upper	Upper	Upper	Upper	Upper	Upper	Upper	Upper	Upper	Upper	Upper	Upper
	Well:	MW8	MW8	MW8	MW8	MW8	MW8	MW8	MW8	MW8	MW8	MW8	MW8	MW8
Constituent	Date:	10/13/2003	10/22/2007	10/4/2004	10/4/2006	10/8/2008	12/19/2002	2/12/2007	2/23/2004	3/16/2005	3/17/2003	3/27/2006	4/19/2004	5/13/2007
Chemistry Parmeters														
Alkalinity, Total	ug/L	350000		220000		350000	220000		360000	400000	300000		340000	
Boron, Total	ug/L	13000		11000		14000	11000		13000	13000	12000		12000	
Calcium, Total	ug/L	370000		200000		310000	320000		340000	310000	390000		310000	
Magnesium, Total	ug/L						74000				82000			
Manganese, Total	ug/L	2200		1300		2400	3600		4700	2200	2900		2300	
Sulfate, Total	ug/L	930000		620000		740000	740000		820000	940000	960000		870000	
Field Parameters														
Hardness, Total	ug/L	1300000		760000		1000000	1100000		1500000	1100000	1300000		1200000	
pH	std	7.1	7	6.9	6.9	6.3	6.97	6.9	7	7.44	7	6.9	7	6.8
Total Dissolved Solids	ug/L	1800000		1200000		1400000	1600000		1800000	1600000	1700000		1800000	
Temperature	^{o}C											13		

Notes:
ug/L - micrograms per liter.

Appendix C
Analtyical Data Summary (2002-2008)
Hutsonville Power Station
Ameren Services
Pond D Closure Risk Assessment

Constituent	Aquifer: Well: Date:	Upper MW8 6/18/2003	Upper MW8 6/19/2006	Upper MW8 6/29/2008	Upper MW8 7/1/2002	Upper MW8 7/10/2006	Upper MW8 7/21/2008	Upper MW8 7/9/2007	Upper MW8 8/11/2003	Upper MW8 8/2/2004	Upper MW8 9/19/2002	Upper MW11R 6/23/2008	Upper MW11R 1/1/2008	Upper MW11R 1/14/2002	Upper MW11R 1/4/2005
Chemistry Parmeters															
Alkalinity, Total	ug/L	360000		370000			360000		420000	280000	330000	210000		57000	140000
Boron, Total	ug/L	12000		18000			16000		14000	11000	10000	15000		3700	4300
Calcium, Total	ug/L	360000		320000			330000		360000	300000	320000	260000		240000	290000
Magnesium, Total	ug/L	68000									70000				
Manganese, Total	ug/L	2500		3000			2500		2500	2100	3800	910		2800	850
Sulfate, Total	ug/L	940000		770000			750000		960000	800000	790000	590000		730000	680000
Field Parameters															
Hardness, Total	ug/L	1179000		1100000	18000		990000		1200000	1200000	1100000	820000		840000	880000
pH	std	7.4	6.85	6.7		6.9	6.8	7	7.093	6.9	6.92		7		6.7
Total Dissolved Solids	ug/L	1800000		1500000	1400000		1600000		1800000	1500000	1300000	1200000		1300000	1300000
Temperature	^{o}C		17			18									

Notes:
ug/L - micrograms per liter.

TSD 000422

Appendix C
Analtyical Data Summary (2002-2008)
Hutsonville Power Station
Ameren Services
Pond D Closure Risk Assessment

Constituent	Aquifer: Well: Date:	Upper MW11R 10/13/2003	Upper MW11R 10/14/2008	Upper MW11R 10/25/2006	Upper MW11R 11/12/2007	Upper MW11R 11/8/2004	Upper MW11R 12/13/2002	Upper MW11R 2/23/2004	Upper MW11R 2/27/2007	Upper MW11R 3/11/2008	Upper MW11R 3/12/2008	Upper MW11R 3/13/2006	Upper MW11R 3/18/2003	Upper MW11R 4/4/2004
Chemistry Parmeters														
Alkalinity, Total	ug/L	120000				220000	260000	61000		240000			210000	260000
Boron, Total	ug/L	2800				8000	7000	2800		18000			5600	4900
Calcium, Total	ug/L	220000				230000	250000	240000		240000			220000	240000
Magnesium, Total	ug/L													
Manganese, Total	ug/L	700				240	880	1200		370			380	270
Sulfate, Total	ug/L	650000				650000	690000	720000		580000			590000	650000
Field Parameters														
Hardness, Total	ug/L	780000				810000	950000	890000		690000			740000	970000
pH	std	6.7	7	6.8	6.9	6.8	7.09	6	6.1		6.9	6.3	7	6.8
Total Dissolved Solids	ug/L	1200000				1300000	1300000	1200000		1100000			1100000	1300000
Temperature	^{o}C											12		

Notes:
ug/L - micrograms per liter.

TSD 000423

Appendix C
Analtyical Data Summary (2002-2008)
Hutsonville Power Station
Ameren Services
Pond D Closure Risk Assessment

Constituent	Aquifer: Well: Date:	Upper MW11R 5/12/2003	Upper MW11R 6/20/2006	Upper MW11R 6/20/2007	Upper MW11R 6/23/2008	Upper MW11R 6/30/2002	Upper MW11R 7/11/2007	Upper MW11R 7/12/2004	Upper MW11R 8/4/2003	Upper MW11R 8/7/2006	Upper MW11R 9/15/2008	Upper MW11R 9/19/2002	Upper MW11R 9/8/2008
Chemistry Parmeters													
Alkalinity, Total	ug/L	280000						230000	120000			200000	270000
Boron, Total	ug/L	5800						5800	2600			6600	10000
Calcium, Total	ug/L	220000						260000	220000			150000	140000
Magnesium, Total	ug/L											25000	
Manganese, Total	ug/L	590						320	520			3400	450
Sulfate, Total	ug/L	590000						670000	650000			390000	640000
Field Parameters													
Hardness, Total	ug/L	480000				780000		940000	620000			480000	880000
pH	std	7.2	6.83	6.7	6.7		6.6		7.2	6.8	6.6	7.15	
Total Dissolved Solids	ug/L	1100000				1200000		1300000	1200000			850000	1300000
Temperature	^{o}C		18							20			

Notes:
ug/L - micrograms per liter.

TSD 000424

Appendix D

Manganese in the Deep Alluvial Aquifer

NATURAL
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TECHNICAL MEMORANDUM

www.naturalrt.com

Date: April 3, 2009

Subject: Naturally-Occurring Manganese Concentrations in the Deep Alluvial Aquifer at Hutsonville

From: Bruce Hensel

Evaluation of naturally occurring groundwater quality data in the deep alluvial aquifer at the Hutsonville Power Station is complicated by the fact that there are no upgradient locations to monitor this formation. Therefore, naturally occurring conditions must be established by a lack of coal ash indicator constituents: boron and sulfate in this case.

Box-whisker diagrams for boron and sulfate are provided in Figures 1 and 2 (an explanation of box-whisker diagrams is provided at the end of this technical memorandum). The box-whisker diagrams show the distribution of concentrations from 2002 through 2008. Both diagrams show that the concentrations of boron and sulfate are highest in MW14, although all concentrations are lower than the Class I groundwater quality standard. These data suggest that MW14 has been affected by migration of boron and sulfate from Pond D. Meanwhile MW115S, 115D, and 121 have low boron and sulfate concentrations, suggesting naturally occurring conditions exist at these wells.

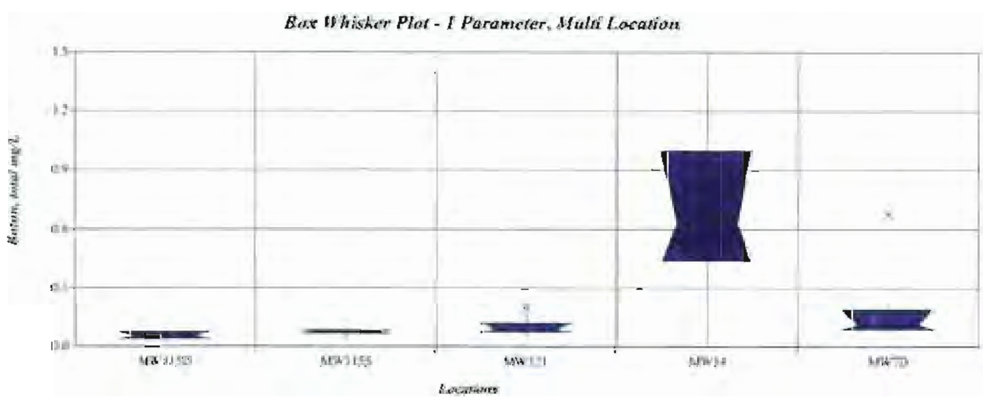


Figure 1. Boron concentrations in the deep alluvial aquifer at Hutsonville (2002-2008).

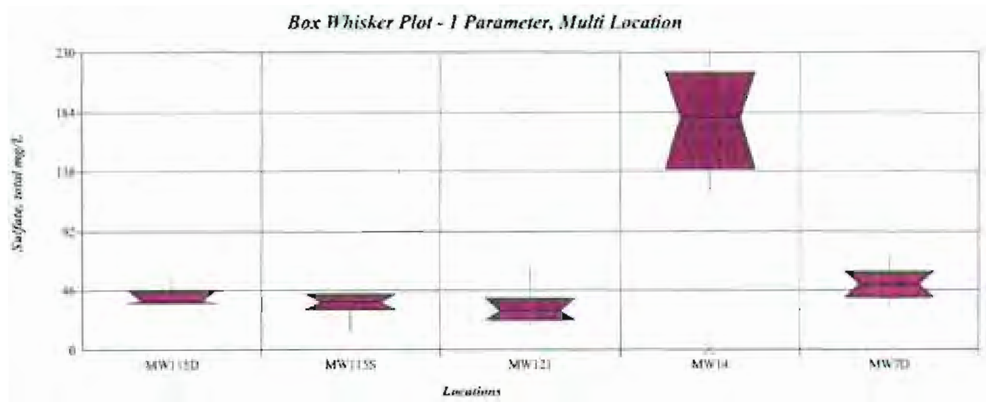


Figure 2. Sulfate concentrations in the deep alluvial aquifer at Hutsonville (2002-2008).

Figure 3 shows manganese concentrations over the same time period at the same monitoring wells. Manganese concentrations are opposite that of boron and sulfate, with highest concentrations in MW115S, MW115D, and MW121, and lowest concentrations in MW14. Considering that boron and sulfate are both more mobile than manganese—meaning manganese will not migrate in advance of boron and sulfate; these data indicate that the manganese present in the deep alluvial aquifer is not due to migration from Pond D, and instead reflects naturally occurring conditions.

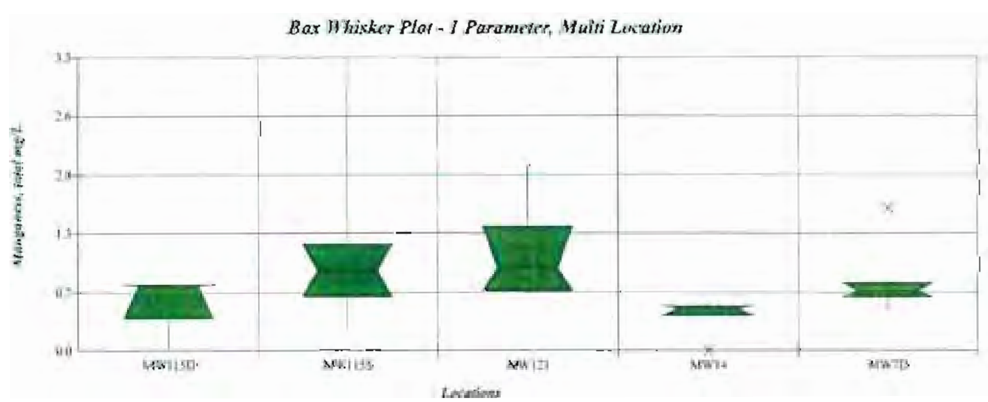
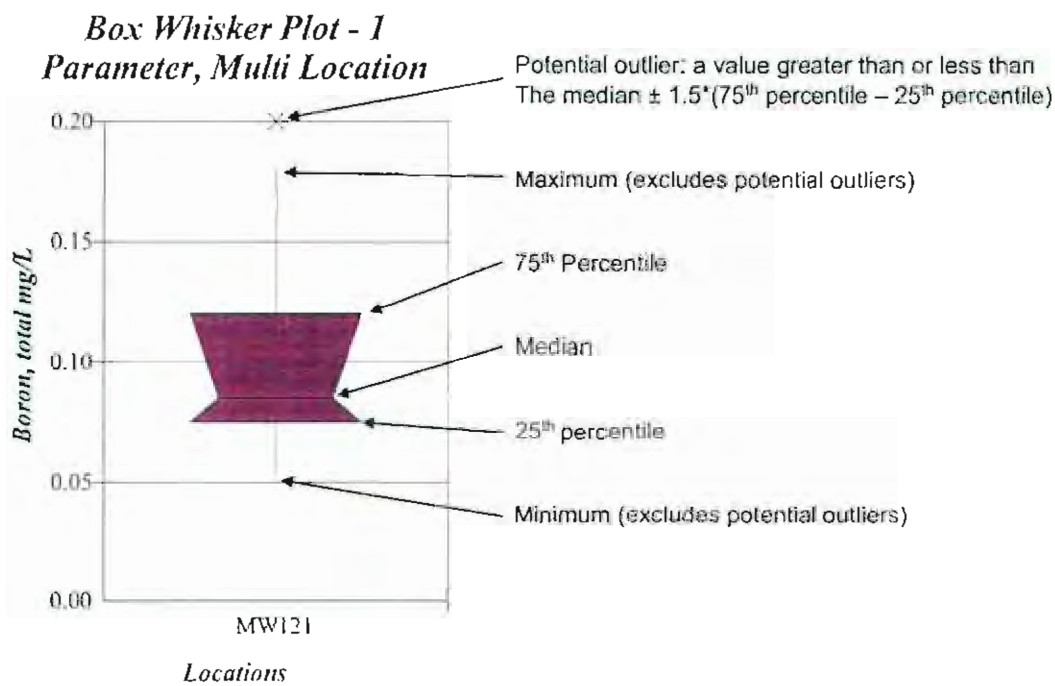


Figure 3. Manganese concentrations in the deep alluvial aquifer at Hutsonville (2002-2008).

This interpretation is consistent with research performed by the Electric Power Research Institute (2002). In this study, groundwater at three coal ash impoundments near rivers in Illinois was investigated, and it was found that naturally elevated concentrations could develop due to reducing redox conditions. Furthermore, naturally reducing conditions were found in groundwater beneath confining layers, similar to the deep alluvial aquifer at Hutsonville.

Explanation of Box-Whisker Diagrams:

Box-whisker diagrams are used in this technical memorandum to graphically illustrate the range of values collected for a dataset as depicted below:



Reference:

EPRI, 2002. *Manganese Occurrence Near Three Coal Ash Impoundments in Illinois.* Electric Power Research Institute Final Report 1005257.

Appendix E

Derivation of Dilution Factor for the Wabash River

NATURAL
RESOURCE
TECHNOLOGY

TECHNICAL MEMORANDUM

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Date: **April 3, 2009**

Subject: **Calculation of Mixing Ratio For Groundwater Discharge to the Wabash River From Hutsonville Power Station Pond D**

From: **Bruce Hensel**

A mixing ratio was developed that can be used to conservatively calculate the impact that dissolved inorganic constituents released to groundwater from Pond D may have on Wabash River water quality. This ratio is based on the relative volume of groundwater discharge to Wabash River discharge at low flow.

The Illinois State Water Survey (1988) published a 7-day, 10-year ($Q_{7,10}$) low flow value for the Wabash River at Hutsonville of 1,234 cfs. This value was developed at the city of Hutsonville, downstream from the power station; therefore, the station's NPDES-permitted discharge at outfall 002 was subtracted from the published value to obtain a Wabash River discharge value at the station.

Groundwater discharge to the Wabash River was estimated from the groundwater flow model developed for Pond D (described in NRT, 2009). The discharge rate was read from the MODFLOW mass balance output to the river cells. However, the entire reach of river cells was used; therefore, groundwater discharge to the river from model cells both upstream and downstream of Pond D is included in the groundwater discharge rate used in the calculation.

The resulting mixing ratio is 0.00048. This ratio can be multiplied by the concentration in a site monitoring well to conservatively estimate the concentration increase in the river after mixing. This estimate is conservative (meaning the calculated river concentration increase will be higher than the observed concentration increase) because:

- River discharge represents low flow conditions. Since river stage is in the denominator of the mixing ratio calculation, using a low river discharge increases the mixing ratio (relative to a high river discharge) and, therefore, increases the calculated concentration in the river.
- The groundwater discharge rate was obtained from the calibration model run, which included the period while Pond D was active. Simulated leakage from Pond D was

greater during this period than for current conditions, and as a result the volume of groundwater discharge to the river used in the model is higher than for the current condition.

- The groundwater discharge rate includes model cells upstream and downstream of the area affected by Pond D. As a result, the groundwater discharge rate used in the mixing ratio calculation is higher than the groundwater discharge rate for the area affected by Pond D. Since groundwater discharge is used in the numerator of the mixing ratio calculation, assumptions that increase the groundwater discharge rate increase the mixing ratio, which increases the calculated concentration in the river.

Mixing Ratio Calculation for Wabash River at Low Flow

7-day 10-year low flow at Hutsonville	**($Q_{7,10}$)**	1234	cfs	Source: Map 8; ISWS CR 441, 1988
Subtract Outfall 002 Discharge		2.6	cfs	Source: 2003 NPDES Permit
7-day 10-year low flow at Hutsonville Station	**($Q_{7,10}$)**	1231	cfs	
Model Calculated Discharge to River		5.84E+08	ft3	Source: NRT (2009), model run 5 (calibration).
	Model Period	9.78E+08	seconds	
	Q_{GW}	0.60	cfs	
Mixing Ratio (= Q_{GW} + $Q_{7,10}$)		4.8E-04		See Note 1

1 The mixing ratio calculation is conservative because:

a) The model-calculated discharge to the river is based on the entire model domain, which means that discuarge both upstream and downstream of the area affected by Pond D is included (increases Q_{GW}).

b) The model-calculated discharge to the river is based on all time steps in the calibration model (hut5), which includes the early time steps when Pond D was active, and the discharge from Pond D while active is greater than current conditions (increases Q_{GW}).

c) The river discharge is based on the 7-day, 10-year low flow; a lower mixing ratio can be expected during normal flow conditions.

2 References:

Illinois State Water Survey (ISWS), 1988. 7-Day 10-Year Low Flows of Streams in the Kankakee, Sangamon, Embarras, Little Wabash, and Southern Regions. Illinois State Water Survey Contract Report 441

NRT, 2009. Technical Memorandum: Groundwater Modeling of Hutsonville Pond D

Appendix F

Risk Calculation Spreadsheets

HUTSONVILLE POWER STATION
POND D CLOSURE RISK ASSESSSMENT
RME

Receptors Evaluated:	
Receptor 1:	Construction Worker - RME

EXPOSURE ASSUMPTIONS FOR CONSTRUCTION WORKER - RME DERMAL CONTACT WITH AND INCIDENTAL INGESTION OF GROUNDWATER		Assumed Value	Units	Calculated Value
Water Ingestion Rate	Construction Worker - RME	0.005	(l/day)	
Skin Exposed	Construction Worker - RME	3300	(cm^2)	
Body Weight	Construction Worker - RME	70	(kg)	
Exposure Time (dermal only)	Construction Worker - RME	1	(hr/day)	
Event Frequency (dermal only)	Construction Worker - RME	1	(event/day)	
Exposure Frequency	Construction Worker - RME	30	(days)/365 (days) =	8.22E-02
Exposure Duration	Construction Worker - RME	1	(yrs)/ 1(yrs) =	1.00E+00
Lifetime		70		
Unit Conversion Factor (dermal only)		0.001	(l/cm^3)	

HUTSONVILLE POWER STATION
POND D CLOSURE RISK ASSESSSMENT
NONCARCINOGENIC ASSESSMENT - HAZARD INDEX CALCULATION
FOR CONSTRUCTION WORKER - RME
DERMAL CONTACT WITH AND INCIDENTAL INGESTION
OF GROUNDWATER
RME

Constituent	Exposure Point Concentration In Groundwater (mg/l)	Oral Reference Dose (mg/kg-day)	Dermal Reference Dose (mg/kg-day)	Dermal Permeability Constant (cm/hr)	Exposure Time (hr)	DA event Dose Absorbed (mg/cm^2-event)	ADDing Construction Worker - RME (mg/kg-day)	Chronic Average Daily Dose-ing (mg/kg-day)	DAD Construction Worker - RME (mg/kg-day)	Chronic Average Daily Dose-derm (mg/kg-day)	Potential Hazard Quotient Ingestion	Potential Hazard Quotient Dermal Contact	Potential Hazard Quotient Total
Boron	1.80E+01	2.00E-01	2.00E-01	1.00E-03	1.00E+00	1.80E-05	1.06E-04	1.06E-04	6.97E-05	6.97E-05	5.28E-04	3.49E-04	8.77E-04
Manganese	4.70E+00	2.40E-02	9.60E-04	1.00E-03	1.00E+00	4.70E-06	2.76E-05	2.76E-05	1.82E-05	1.82E-05	1.15E-03	1.90E-02	2.01E-02
										Total:	1.68E-03	1.93E-02	2.10E-02

HUTSONVILLE POWER STATION
POND D CLOSURE RISK ASSESSSMENT
CTE

Receptors Evaluated:	
Receptor 1:	Construction Worker - CTE

EXPOSURE ASSUMPTIONS FOR CONSTRUCTION WORKER - CTE DERMAL CONTACT WITH AND INCIDENTAL INGESTION OF GROUNDWATER		Assumed Value	Units	Calculated Value
Water Ingestion Rate	Construction Worker - CTE	0.005	(l/day)	
Skin Exposed	Construction Worker - CTE	3300	(cm^2)	
Body Weight	Construction Worker - CTE	70	(kg)	
Exposure Time (dermal only)	Construction Worker - CTE	1	(hr/day)	
Event Frequency (dermal only)	Construction Worker - CTE	1	(event/day)	
Exposure Frequency	Construction Worker - CTE	15	(days)/ 365 (days) =	4.11E-02
Exposure Duration	Construction Worker - CTE	1	(yrs)/ 1(yrs) =	1.00E+00
Lifetime		70		
Unit Conversion Factor (dermal only)		0.001	(l/cm^3)	

HUTSONVILLE POWER STATION
POND D CLOSURE RISK ASSESSSMENT
NONCARCINOGENIC ASSESSMENT - HAZARD INDEX CALCULATION
FOR CONSTRUCTION WORKER - CTE
DERMAL CONTACT WITH AND INCIDENTAL INGESTION
OF GROUNDWATER
CTE

Constituent	Exposure Point Concentration In Groundwater (mg/l)	Oral Reference Dose (mg/kg-day)	Dermal Reference Dose (mg/kg-day)	Dermal Permeability Constant (cm/hr)	Exposure Time (hr)	DA event Dose Absorbed (mg/cm^2-event)	ADDing Construction Worker - CTE (mg/kg-day)	Chronic Average Daily Dose-ing (mg/kg-day)	DAD Construction Worker - CTE (mg/kg-day)	Chronic Average Daily Dose-derm (mg/kg-day)	Potential Hazard Quotient Ingestion	Potential Hazard Quotient Dermal Contact	Potential Hazard Quotient Total
Boron	1.80E+01	2.00E-01	2.00E-01	1.00E-03	1.00E+00	1.80E-05	5.28E-05	5.28E-05	3.49E-05	3.49E-05	2.64E-04	1.74E-04	4.39E-04
Manganese	4.70E+00	2.40E-02	9.60E-04	1.00E-03	1.00E+00	4.70E-06	1.38E-05	1.38E-05	9.11E-06	9.11E-06	5.75E-04	9.49E-03	1.01E-02
										Total:	8.39E-04	9.66E-03	1.05E-02

AECOM

HUTSONVILLE POWER STATION
POND D CLOSURE RISK ASSESSSMENT
RME

Receptors Evaluated:	
Receptor 1:	Recreational Swimming Child - RME

EXPOSURE ASSUMPTIONS FOR RECREATIONAL SWIMMING CHILD - RME DERMAL CONTACT WITH AND INCIDENTAL INGESTION OF SURFACE WATER		Assumed Value	Units	Calculated Value
Water Ingestion Rate	Recreational Swimming Child - RME	0.05	(l/day)	
Skin Exposed	Recreational Swimming Child - RME	6560	(cm^2)	
Body Weight	Recreational Swimming Child - RME	15	(kg)	
Exposure Time (dermal only)	Recreational Swimming Child - RME	2	(hr/day)	
Event Frequency (dermal only)	Recreational Swimming Child - RME	1	(event/day)	
Exposure Frequency	Recreational Swimming Child - RME	26	(days)/365 (days) =	7.12E-02
Exposure Duration	Recreational Swimming Child - RME	6	(yrs)/ 6(yrs) =	1.00E+00
Lifetime		70		
Unit Conversion Factor (dermal only)		0.001	(l/cm^3)	

HUTSONVILLE POWER STATION
POND D CLOSURE RISK ASSESSSMENT
NONCARCINOGENIC ASSESSMENT - HAZARD INDEX CALCULATION
FOR RECREATIONAL SWIMMING CHILD - RME
DERMAL CONTACT WITH AND INCIDENTAL INGESTION
OF SURFACE WATER
RME

Constituent	Exposure Point Concentration In Surface Water (mg/l)	Oral Reference Dose (mg/kg-day)	Dermal Reference Dose (mg/kg-day)	Dermal Permeability Constant (cm/hr)	Exposure Time (hr)	DA event Dose Absorbed (mg/cm^2-event)	ADDing Recreational Swimming Child - RME (mg/kg-day)	Chronic Average Daily Dose-ing (mg/kg-day)	DAD Recreational Swimming Child - RME (mg/kg-day)	Chronic Average Daily Dose-derm (mg/kg-day)	Potential Hazard Quotient Ingestion	Potential Hazard Quotient Dermal Contact	Potential Hazard Quotient Total
Boron	8.64E-03	2.00E-01	2.00E-01	1.00E-03	2.00E+00	1.73E-08	2.05E-06	2.05E-06	5.38E-07	5.38E-07	1.03E-05	2.69E-06	1.29E-05
Manganese	2.26E-03	2.40E-02	9.60E-04	1.00E-03	2.00E+00	4.51E-09	5.36E-07	5.36E-07	1.41E-07	1.41E-07	2.23E-05	1.46E-04	1.69E-04
										Total:	3.26E-05	1.49E-04	1.82E-04

HUTSONVILLE POWER STATION
POND D CLOSURE RISK ASSESSSMENT
CTE

Receptors Evaluated:	
Receptor 1:	Recreational Swimming Child - CTE

EXPOSURE ASSUMPTIONS FOR RECREATIONAL SWIMMING CHILD - CTE DERMAL CONTACT WITH AND INCIDENTAL INGESTION OF SURFACE WATER		Assumed Value	Units	Calculated Value
Water Ingestion Rate	Recreational Swimming Child - CTE	0.05	(l/day)	
Skin Exposed	Recreational Swimming Child - CTE	6560	(cm^2)	
Body Weight	Recreational Swimming Child - CTE	15	(kg)	
Exposure Time (dermal only)	Recreational Swimming Child - CTE	1	(hr/day)	
Event Frequency (dermal only)	Recreational Swimming Child - CTE	1	(event/day)	
Exposure Frequency	Recreational Swimming Child - CTE	13	(days)/365 (days) =	3.56E-02
Exposure Duration	Recreational Swimming Child - CTE	2	(yrs)/ 2(yrs) =	1.00E+00
Lifetime		70		
Unit Conversion Factor (dermal only)		0.001	(l/cm^3)	

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HUTSONVILLE POWER STATION
POND D CLOSURE RISK ASSESSSMENT
NONCARCINOGENIC ASSESSMENT - HAZARD INDEX CALCULATION
FOR RECREATIONAL SWIMMING CHILD - CTE
DERMAL CONTACT WITH AND INCIDENTAL INGESTION
OF SURFACE WATER
CTE

Constituent	Exposure Point Concentration In Surface Water (mg/l)	Oral Reference Dose (mg/kg-day)	Dermal Reference Dose (mg/kg-day)	Dermal Permeability Constant (cm/hr)	Exposure Time (hr)	DA event Dose Absorbed (mg/cm^2-event)	ADDing Recreational Swimming Child - CTE (mg/kg-day)	Chronic Average Daily Dose-ing (mg/kg-day)	DAD Recreational Swimming Child - CTE (mg/kg-day)	Chronic Average Daily Dose-derm (mg/kg-day)	Potential Hazard Quotient Ingestion	Potential Hazard Quotient Dermal Contact	Potential Hazard Quotient Total
Boron	8.64E-03	2.00E-01	2.00E-01	1.00E-03	1.00E+00	8.64E-09	1.03E-06	1.03E-06	1.35E-07	1.35E-07	5.13E-06	6.73E-07	5.80E-06
Manganese	2.26E-03	2.40E-02	9.60E-04	1.00E-03	1.00E+00	2.26E-09	2.68E-07	2.68E-07	3.51E-08	3.51E-08	1.12E-05	3.66E-05	4.78E-05
										Total:	1.63E-05	3.73E-05	5.36E-05

HUTSONVILLE POWER STATION
POND D CLOSURE RISK ASSESSSMENT
RME

Receptors Evaluated:	
Receptor 1:	Recreational Swimming Teen - RME

EXPOSURE ASSUMPTIONS FOR RECREATIONAL SWIMMING TEEN - RME DERMAL CONTACT WITH AND INCIDENTAL INGESTION OF SURFACE WATER		Assumed Value	Units	Calculated Value
Water Ingestion Rate	Recreational Swimming Teen - RME	0.05	(l/day)	
Skin Exposed	Recreational Swimming Teen - RME	13535	(cm^2)	
Body Weight	Recreational Swimming Teen - RME	47	(kg)	
Exposure Time (dermal only)	Recreational Swimming Teen - RME	2	(hr/day)	
Event Frequency (dermal only)	Recreational Swimming Teen - RME	1	(event/day)	
Exposure Frequency	Recreational Swimming Teen - RME	26	(days)/365 (days) =	7.12E-02
Exposure Duration	Recreational Swimming Teen - RME	11	(yrs)/ 11(yrs) =	1.00E+00
Lifetime		70		
Unit Conversion Factor (dermal only)		0.001	(l/cm^3)	

AECOM

HUTSONVILLE POWER STATION
POND D CLOSURE RISK ASSESSSMENT
NONCARCINOGENIC ASSESSMENT - HAZARD INDEX CALCULATION
FOR RECREATIONAL SWIMMING TEEN - RME
DERMAL CONTACT WITH AND INCIDENTAL INGESTION
OF SURFACE WATER
RME

Constituent	Exposure Point Concentration In Surface Water (mg/l)	Oral Reference Dose (mg/kg-day)	Dermal Reference Dose (mg/kg-day)	Dermal Permeability Constant (cm/hr)	Exposure Time (hr)	DA event Dose Absorbed (mg/cm^2-event)	ADDing Recreational Swimming Teen - RME (mg/kg-day)	Chronic Average Daily Dose-ing (mg/kg-day)	DAD Recreational Swimming Teen - RME (mg/kg-day)	Chronic Average Daily Dose-derm (mg/kg-day)	Potential Hazard Quotient Ingestion	Potential Hazard Quotient Dermal Contact	Potential Hazard Quotient Total
Boron	8.64E-03	2.00E-01	2.00E-01	1.00E-03	2.00E+00	1.73E-08	6.55E-07	6.55E-07	3.54E-07	3.54E-07	3.27E-06	1.77E-06	5.05E-06
Manganese	2.26E-03	2.40E-02	9.60E-04	1.00E-03	2.00E+00	4.51E-09	1.71E-07	1.71E-07	9.26E-08	9.26E-08	7.12E-06	9.64E-05	1.04E-04
										Total:	1.04E-05	9.82E-05	1.09E-04

TSD 000443

HUTSONVILLE POWER STATION
POND D CLOSURE RISK ASSESSSMENT
CTE

Receptors Evaluated:	
Receptor 1:	Recreational Swimming Teen - CTE

EXPOSURE ASSUMPTIONS FOR RECREATIONAL SWIMMING TEEN - CTE DERMAL CONTACT WITH AND INCIDENTAL INGESTION OF SURFACE WATER		Assumed Value	Units	Calculated Value
Water Ingestion Rate	Recreational Swimming Teen - CTE	0.05	(l/day)	
Skin Exposed	Recreational Swimming Teen - CTE	13535	(cm^2)	
Body Weight	Recreational Swimming Teen - CTE	47	(kg)	
Exposure Time (dermal only)	Recreational Swimming Teen - CTE	1	(hr/day)	
Event Frequency (dermal only)	Recreational Swimming Teen - CTE	1	(event/day)	
Exposure Frequency	Recreational Swimming Teen - CTE	13	(days)/365 (days) =	3.56E-02
Exposure Duration	Recreational Swimming Teen - CTE	11	(yrs)/ 11(yrs) =	1.00E+00
Lifetime		70		
Unit Conversion Factor (dermal only)		0.001	(l/cm^3)	

HUTSONVILLE POWER STATION
POND D CLOSURE RISK ASSESSSMENT
NONCARCINOGENIC ASSESSMENT - HAZARD INDEX CALCULATION
FOR RECREATIONAL SWIMMING TEEN - CTE
DERMAL CONTACT WITH AND INCIDENTAL INGESTION
OF SURFACE WATER
CTE

Constituent	Exposure Point Concentration In Surface Water (mg/l)	Oral Reference Dose (mg/kg-day)	Dermal Reference Dose (mg/kg-day)	Dermal Permeability Constant (cm/hr)	Exposure Time (hr)	DA event Dose Absorbed (mg/cm^2-event)	ADDing Recreational Swimming Teen - CTE (mg/kg-day)	Chronic Average Daily Dose-ing (mg/kg-day)	DAD Recreational Swimming Teen - CTE (mg/kg-day)	Chronic Average Daily Dose-derm (mg/kg-day)	Potential Hazard Quotient Ingestion	Potential Hazard Quotient Dermal Contact	Potential Hazard Quotient Total
Boron	8.64E-03	2.00E-01	2.00E-01	1.00E-03	1.00E+00	8.64E-09	3.27E-07	3.27E-07	8.86E-08	8.86E-08	1.64E-06	4.43E-07	2.08E-06
Manganese	2.26E-03	2.40E-02	9.60E-04	1.00E-03	1.00E+00	2.26E-09	8.55E-08	8.55E-08	2.31E-08	2.31E-08	3.56E-06	2.41E-05	2.77E-05
										Total:	5.20E-06	2.45E-05	2.97E-05

HUTSONVILLE POWER STATION
POND D CLOSURE RISK ASSESSSMENT
RME

Receptors Evaluated:	
Receptor 1:	Recreational Fisher - RME

EXPOSURE ASSUMPTIONS FOR RECREATIONAL FISHER - RME DERMAL CONTACT WITH AND INCIDENTAL INGESTION OF SURFACE WATER		Assumed Value	Units	Calculated Value
Water Ingestion Rate	Recreational Fisher - RME	0.005	(l/day)	
Skin Exposed	Recreational Fisher - RME	5669	(cm^2)	
Body Weight	Recreational Fisher - RME	70	(kg)	
Exposure Time (dermal only)	Recreational Fisher - RME	1	(hr/day)	
Event Frequency (dermal only)	Recreational Fisher - RME	1	(event/day)	
Exposure Frequency	Recreational Fisher - RME	22	(days)/ 365 (days) =	6.03E-02
Exposure Duration	Recreational Fisher - RME	30	(yrs)/ 30(yrs) =	1.00E+00
Lifetime		70		
Unit Conversion Factor (dermal only)		0.001	(l/cm^3)	

HUTSONVILLE POWER STATION
POND D CLOSURE RISK ASSESSSMENT
NONCARCINOGENIC ASSESSMENT - HAZARD INDEX CALCULATION
FOR RECREATIONAL FISHER - RME
DERMAL CONTACT WITH AND INCIDENTAL INGESTION
OF SURFACE WATER

Constituent	Exposure Point Concentration In Surface Water (mg/l)	Oral Reference Dose (mg/kg-day)	Dermal Reference Dose (mg/kg-day)	Dermal Permeability Constant (cm/hr)	Exposure Time (hr)	DA event Dose Absorbed (mg/cm^2-event)	ADDing Recreational Fisher - RME (mg/kg-day)	Chronic Average Daily Dose-ing (mg/kg-day)	DAD Recreational Fisher - RME (mg/kg-day)	Chronic Average Daily Dose-derm (mg/kg-day)	Potential Hazard Quotient Ingestion	Potential Hazard Quotient Dermal Contact	Potential Hazard Quotient Total
Boron	8.64E-03	2.00E-01	2.00E-01	1.00E-03	1.00E+00	8.64E-09	3.72E-08	3.72E-08	4.22E-08	4.22E-08	1.86E-07	2.11E-07	3.97E-07
Manganese	2.26E-03	2.40E-02	9.60E-04	1.00E-03	1.00E+00	2.26E-09	9.71E-09	9.71E-09	1.10E-08	1.10E-08	4.05E-07	1.15E-05	1.19E-05
										Total:	5.91E-07	1.17E-05	1.23E-05

TSD 000447

HUTSONVILLE POWER STATION
POND D CLOSURE RISK ASSESSSMENT
CTE

Receptors Evaluated:	
Receptor 1:	Recreational Fisher - CTE

EXPOSURE ASSUMPTIONS FOR RECREATIONAL FISHER - CTE DERMAL CONTACT WITH AND INCIDENTAL INGESTION OF SURFACE WATER		Assumed Value	Units	Calculated Value
Water Ingestion Rate	Recreational Fisher - CTE	0.005	(l/day)	
Skin Exposed	Recreational Fisher - CTE	5669	(cm^2)	
Body Weight	Recreational Fisher - CTE	70	(kg)	
Exposure Time (dermal only)	Recreational Fisher - CTE	1	(hr/day)	
Event Frequency (dermal only)	Recreational Fisher - CTE	1	(event/day)	
Exposure Frequency	Recreational Fisher - CTE	3	(days)/ 365 (days) =	8.22E-03
Exposure Duration	Recreational Fisher - CTE	9	(yrs)/ 9(yrs) =	1.00E+00
Lifetime		70		
Unit Conversion Factor (dermal only)		0.001	(l/cm^3)	

HUTSONVILLE POWER STATION
POND D CLOSURE RISK ASSESSSMENT
NONCARCINOGENIC ASSESSMENT - HAZARD INDEX CALCULATION
FOR RECREATIONAL FISHER - CTE
DERMAL CONTACT WITH AND INCIDENTAL INGESTION
OF SURFACE WATER
CTE

Constituent	Exposure Point Concentration In Surface Water (mg/l)	Oral Reference Dose (mg/kg-day)	Dermal Reference Dose (mg/kg-day)	Dermal Permeability Constant (cm/hr)	Exposure Time (hr)	DA event Dose Absorbed (mg/cm^2-event)	ADDing Recreational Fisher - CTE (mg/kg-day)	Chronic Average Daily Dose-ing (mg/kg-day)	DAD Recreational Fisher - CTE (mg/kg-day)	Chronic Average Daily Dose-derm (mg/kg-day)	Potential Hazard Quotient Ingestion	Potential Hazard Quotient Dermal Contact	Potential Hazard Quotient Total
Boron	8.64E-03	2.00E-01	2.00E-01	1.00E-03	1.00E+00	8.64E-09	5.07E-09	5.07E-09	5.75E-09	5.75E-09	2.54E-08	2.88E-08	5.41E-0ť
Manganese	2.26E-03	2.40E-02	9.60E-04	1.00E-03	1.00E+00	2.26E-09	1.32E-09	1.32E-09	1.50E-09	1.50E-09	5.52E-08	1.56E-06	1.62E-0(
										Total:	8.05E-08	1.59E-06	1.67E-0(

TSD 000449

HUTSONVILLE POWER STATION
POND D CLOSURE RISK ASSESSSMENT
RME

Receptors Evaluated:	
Receptor:	RME Recreational Fisher

ASSUMPTIONS FOR RECREATIONAL FISHER - RME INGESTION OF FISH		Assumed Value	Units	Calculated Value
Fish Ingestion Rate	RME Recreational Fisher	0.008	(kg fish/day)	
Body Weight	RME Recreational Fisher	70	(kg)	
Exposure Frequency	RME Recreational Fisher	365	(days)/ 365 (days) =	1.00E+00
Exposure Duration	RME Recreational Fisher	30	(yrs)/ 30 (yrs) =	1.00E+00
Lifetime		70	(years)	

HUTSONVILLE POWER STATION
POND D CLOSURE RISK ASSESSSMENT
POTENTIAL HAZARD INDEX
INGESTION OF FISH
RECREATIONAL FISHER - RME

Constituent	Fish Tissue Concentration (mg/kg)	Oral Reference Dose (mg/kg-day)	ADDing RME Recreational Fisher (mg/kg-day)	Lifetime Average Daily Dose (mg/kg-day)	Excess Lifetime Hazard Index
Boron	8.64E-03	2.00E-01	9.87E-07	9.87E-07	4.94E-06
Manganese	9.02E-01	1.40E-01	1.03E-04	1.03E-04	7.37E-04
				Total:	7.42E-04

HUTSONVILLE POWER STATION
POND D CLOSURE RISK ASSESSSMENT
CTE

Receptors Evaluated:	
Receptor:	CTE Recreational Fisher

ASSUMPTIONS FOR RECREATIONAL FISHER - CTE INGESTION OF FISH		Assumed Value	Units	Calculated Value
Fish Ingestion Rate	CTE Recreational Fisher	0.001	(kg fish/day)	
Body Weight	CTE Recreational Fisher	70	(kg)	
Exposure Frequency	CTE Recreational Fisher	365	(days)/ 365 (days) =	1.00E+00
Exposure Duration	CTE Recreational Fisher	9	(yrs)/ 9 (yrs) =	1.00E+00
Lifetime		70	(years)	

HUTSONVILLE POWER STATION
POND D CLOSURE RISK ASSESSSMENT
POTENTIAL HAZARD INDEX
INGESTION OF FISH
RECREATIONAL FISHER - CTE

Constituent	Fish Tissue Concentration (mg/kg)	Oral Reference Dose (mg/kg-day)	ADDing CTE Recreational Fisher (mg/kg-day)	Lifetime Average Daily Dose (mg/kg-day)	Excess Lifetime Hazard Index
Boron	8.64E-03	2.00E-01	1.23E-07	1.23E-07	6.17E-07
Manganese	9.02E-01	1.40E-01	1.29E-05	1.29E-05	9.21E-05
				Total:	9.27E-05

Appendix G

Leachate Data Evaluation

Appendix G

Leachate Data Evaluation

The risk assessments for Pond D focused on the constituents included in the monitoring program for Pond D. To provide a more comprehensive evaluation of the adequacy of the analyte list for risk assessment purposes, data were obtained from a database of field leachate concentrations for a long analytical suite for samples from impoundments that received coal ash derived from bituminous coal (EPRI, 2006), similar to the Hutsonville Station. This appendix presents the risk evaluation of these data.

For the purposes of this evaluation, it was assumed that the maximum leachate concentrations from the database could be present in the upper migration zone; this is a conservative assumption as leachate would mix with and be diluted by groundwater in an environmental situation.

Two scenarios were evaluated:

- Direct contact with constituents in the upper migration zone by a construction worker.
- Discharge of the leachate (assumed to be groundwater) to the Wabash River and comparison to human health and ecological screening levels for surface water.

Derivation of Leachate Threshold Concentrations for the Construction Worker Scenario

Threshold concentrations in leachate were derived for a construction worker exposure scenario for a comprehensive list of inorganics that may be present in fly ash leachate, as listed below:

- Aluminum
- Antimony
- Arsenic
- Barium
- Beryllium
- Boron
- Cadmium
- Chromium
- Cobalt
- Copper
- Iron
- Lead
- Lithium
- Manganese
- Mercury
- Molybdenum
- Nickel
- Selenium
- Silicon
- Silver
- Strontium
- Sulfate
- Thallium
- Uranium
- Vanadium
- Zinc

The threshold concentrations were derived assuming future construction worker contact with leachate. Incidental ingestion of leachate and dermal contact with leachate are the potential exposure pathways evaluated. Threshold concentrations are then compared to leachate concentrations from the Electric Power Research Institute (EPRI, 2006).

The threshold concentrations were developed using the same construction worker scenario and methods used in the risk assessment presented in Section 4.0 of this document, and in accordance with the four-step paradigm for human health risk assessments developed by the United States Environmental Protection Agency (USEPA) (1989); these steps are:

- Hazard Identification. Constituents potentially present in fly ash, as listed above, have been identified as the Constituents of Potential Concern (COPCs).
- Dose Response Assessment. The dose-response assessment evaluates the relationship between the magnitude of exposure (dose) and the potential for occurrence of specific health effects (response). Both potential carcinogenic and noncarcinogenic effects are considered. Quantitative dose-response values used in the derivation of threshold concentrations are presented.
- Exposure Assessment. The purpose of the exposure assessment is to provide a quantitative estimate of the magnitude and frequency of potential exposure to COPC by a construction worker.
- Risk Characterization. Risk characterization combines the results of the exposure assessment and the dose-response assessment to derive the threshold concentrations.

Each step is described briefly below, and is described more fully in the main text of this report.

Dose-Response Assessment

The purpose of the dose-response assessment is to identify the types of adverse health effects a constituent may potentially cause, and to define the relationship between the dose of a constituent and the likelihood or magnitude of an adverse effect (response). Adverse effects are characterized as potentially carcinogenic or noncarcinogenic (i.e., potential effects other than cancer). Dose-response relationships are defined for oral and inhalation exposure. Oral dose-response values, with appropriate adjustments, are also used to assess dermal exposures because values for this route of exposure have not yet been developed by USEPA. Combining the results of the toxicity assessment with information on the magnitude of potential human exposure allows for the estimation of potential risks and the calculation of concentrations in environmental media that are protective of human health.

Dose-response values were selected according to the United States Environmental Protection Agency (USEPA) hierarchy of sources (USEPA, 2003). Sources of dose-response values used in this risk assessment include the Integrated Risk Information System (IRIS) (USEPA, 2009), the Tier 1 source, Provisional Peer-Reviewed Toxicity Values (PPRTVs), a Tier 2 source, and the Health Effects Assessment Summary Tables (HEAST) (USEPA, 1997b), a Tier 3 source. PPRTV papers are available from the National Center for Environmental Assessment (NCEA) via a Superfund Remedial Project Manager request. Because this is not a Superfund site, access to these papers is not available and the USEPA Regional Screening Level Table (USEPA, 2008) is the only source of current PPRTVs. Therefore, reference doses for cobalt and lithium were obtained from USEPA (2008). However, USEPA (2008) does not provide information beyond the actual reference dose. Target endpoints for cobalt and lithium were identified based on other sources, as discussed below:

- A previous PPRTV oral reference dose for cobalt, dated January 15, 2002, was based on increased hemoglobin as a target endpoint. The Agency for Toxic Substances and Disease Registry (ATSDR) has based an intermediate Minimal Risk Level (MRL) for inhalation on hematological effects (ATSDR, 2007). Therefore, it is assumed that the current PPRTV is based on hematological effects.

- A review of the information presented on the Hazardous Substances Data Bank (HSDB) for lithium carbonate suggests that the target endpoint is neurological effects (http://toxnet.nlm.nih.gov/cgi-bin/sis/search/f?./temp/~0ocJZ9:2).

Table G-1 summarizes the dose-response information for potential noncarcinogenic effects from oral and dermal exposures. Because the construction worker exposure duration (one year) is less than 7 years, sub-chronic dose-response data are used where available, and chronic dose-response data are used where chronic dose-response data are not available. Table G-2 summarizes the dose-response information for the potentially carcinogenic effects.

Lead does not have dose-response values and is evaluated using an integrated exposure model (Bowers, 1994). Silicon and sulfate do not have dose-response values and are not evaluated further. Reference doses for cobalt and lithium were obtained from USEPA (2008).

Construction Worker Exposure Assessment

Exposure pathways included in the derivation of the threshold concentrations for the construction worker include incidental ingestion and dermal contact with leachate.

Exposure parameters for these pathways are presented in Table G-3. The exposure parameters are the same as those presented in Section 4.3.3 of the main text and were obtained from USEPA sources (USEPA, 1991a, USEPA, 1989, USEPA, 1997a, USEPA, 2004). Equations used to derive the threshold concentrations are presented below.

The calculation of dose follows USEPA (1989) guidance, as shown below. The Chronic Average Daily Dose (CADD) is calculated for noncarcinogenic effects and is averaged over the exposure duration, while the Lifetime Average Daily Dose (LADD) is calculated for potentially carcinogenic effects and is averaged over the receptor's assumed lifetime (70 years).

Average Daily Dose (Lifetime and Chronic) Following Ingestion of Water (mg/kg-day):

$$ADD = \frac{CW \times IR \times EF \times ED}{BW \times AT}$$

where:

ADD	=	Chronic or Lifetime Average Daily Dose (mg/kg-day)
CW	=	Water Concentration (mg/L)
IR	=	Water Ingestion Rate (L/day)
EF	=	Exposure Frequency (days/year)
ED	=	Exposure Duration (year)
BW	=	Body Weight (kg)
AT	=	Averaging Time (days)

Average Daily Dose (Lifetime and Chronic) Following Dermal Contact with Water (mg/kg-day):

$$ADD = \frac{DA_{event} \times EV \times EF \times ED \times SA}{BW \times AT}$$

where:

ADD	=	Chronic or Lifetime Average Daily Dose (dermally absorbed dose) (mg/kg-day)
DAevent	=	Absorbed Dose per Event (mg/cm^2-event)
SA	=	Surface Area (cm^2)
EV	=	Event Frequency (events/day)
EF	=	Exposure Frequency (days/year)
ED	=	Exposure Duration (years)
BW	=	Body Weight (kg)
AT	=	Averaging Time (years)

The calculation of the dose absorbed per unit area per event (DAevent) is as follows for inorganics:

$$DA_{event} = CW \times PC \times ET \times CF$$

where:

DAevent	=	Absorbed Dose per Event (mg/cm^2-event)
CW	=	Concentration in Water (mg/L)
PC	=	Permeability Constant (cm/hr)
ET	=	Exposure Time (hr/event)
CF	=	Conversion factor (L/1000 cm^3)

The permeability constants were obtained from USEPA (2004) Exhibit 3-1 and presented in Table G-4.

Because the goal of this evaluation is to derive threshold concentrations in leachate, ADDs were derived using a unit concentration of 1 milligram constituent per liter (L) of leachate (mg constituent/L leachate). Attachment G-1 presents the calculation of the dose via incidental ingestion and dermal contact per mg constituent/L leachate.

Risk Characterization / Threshold Concentration Derivation

The purpose of the risk characterization is to provide estimates of the potential risk to human health from exposure to COPC. To accomplish this objective, this section includes quantitative estimates of potential carcinogenic and noncarcinogenic risk for a construction worker who may potentially contact COPCs in leachate, per mg constituent/L leachate. These estimates are used to derive the threshold concentrations for COPCs in leachate.

The results of the exposure assessment are combined with the results of the dose-response assessment to derive quantitative estimates of risk, or the probability of adverse health effects following assumed potential exposure to COPC. The approach for estimating potential carcinogenic risk and noncarcinogenic hazard is described below, followed by the approach for deriving the threshold concentrations based on the predicted risk and/or hazard.

Carcinogenic Risk Characterization

The purpose of carcinogenic risk characterization is to estimate the upper-bound likelihood, over and above the background cancer rate, that a receptor will develop cancer in his or her lifetime as a result of exposure to a constituent in an environmental medium. The Excess Lifetime Cancer Risk (ELCR) is the likelihood over and above the background cancer rate that an individual will contract cancer in his or her lifetime. The risk value is expressed as a probability (e.g., 10^{-6}, or one in one million). For an ELCR of 10^{-6}, an individual would have a 1 in one million chance of developing cancer (over the background rate). The relationship between the ELCR and the estimated LADD of a constituent may be expressed as:

$$\text{ELCR} = 1\text{-}e^{-(\text{CSF x LADD})}$$

When the product of the cancer slope factor (CSF) and the LADD is much greater than 1, the ELCR approaches 1 (i.e., 100 percent probability). When the product is less than 0.01 (one chance in 100), the equation can be closely approximated by:

$$\text{ELCR} = \text{LADD (mg/kg-day) x CSF (mg/kg-day)}^{-1}$$

The product of the CSF and the LADD is unitless, and provides an upper-bound estimate of the potential carcinogenic risk associated with the potential construction worker contact with leachate per mg constituent/L leachate, as presented in Attachment G-1.

Noncarcinogenic Risk Characterization

The potential for exposure to a constituent to result in adverse noncarcinogenic health effects is estimated by comparing the Chronic Average Daily Dose (CADD) with the RfD. The resulting ratio, which is unitless, is known as the Hazard Quotient (HQ) for that constituent. The HQ is calculated using the following equation:

$$\text{HQ} = \frac{\text{CADD (mg/kg-day)}}{\text{RfD (mg/kg-day)}}$$

The total Hazard Index (HI) per mg constituent/L leachate is derived by summing the HQs for each pathway (ingestion, dermal), as presented in Attachment G-1.

Derivation of Threshold Concentrations

The threshold concentration is calculated to represent the concentration in water which would result in a calculated risk at a particular target level. The equation used to calculate the threshold concentrations is:

$$\text{Threshold concentrations (mg/L)} = \frac{\text{1 mg constituent/L leachate x Target Risk/HQ}}{\text{Unit Risk/HQ}}$$

The target risk levels used for the derivation of threshold concentrations are based on USEPA guidance. Specifically, USEPA provides the following guidance (USEPA, 1991b):

> "Where the cumulative carcinogenic site risk to an individual based on reasonable maximum exposure for both current and future land use is less than 10^{-4}, and the non-carcinogenic hazard quotient is less than 1, action generally is not warranted unless there are adverse environmental impacts." and,

> "The upper boundary of the risk range is not a discrete line at 1 x 10^{-4}, although EPA generally uses 1 x 10^{-4} in making risk management decisions. A specific risk estimate around 10^{-4} may be considered acceptable if justified based on site-specific conditions."

Therefore, a total target risk level of 10^{-4} is appropriate for development of threshold concentrations for potential carcinogens. However, to provide a range of threshold concentrations, target risk levels of 10^{-5} and 10^{-4} were used. Because only one potential carcinogen (arsenic) is included, the full target risk level is attributed to arsenic, as indicated in Table G-5. A hazard index of one per target organ (per USEPA, 1989) was used to develop the threshold concentrations for noncarcinogens. The target HI of one for each target organ was divided by the number of COPCs sharing the same target organ, as specified in Table G-6. The threshold concentration for lead was derived in Attachment G-2 and is presented in Table G-7. The final selected threshold concentration is the lower of the cancer and noncancer derived values, as presented in Table G-8.

Comparison of Threshold Concentrations to Leachate Concentrations

Threshold concentrations were compared to maximum detected leachate concentrations as presented in EPRI (2006) in Table G-9. Maximum detected concentrations are below the construction worker threshold concentrations. Therefore, potentially unacceptable risks are not expected to occur for a construction worker who may contact leachate from fly ash.

Evaluation of Leachate Discharge to the Wabash River

It was assumed that the maximum leachate concentrations from the EPRI (2006) database could be present in the upper migration zone; this is a conservative assumption as leachate would mix with and be diluted by groundwater in an environmental situation. The groundwater to surface water dilution factor (**Appendix E**) was applied to the maximum leachate concentration data to provide predicted surface water concentrations for the Wabash River.

As shown in Table G-10, all predicted surface water concentrations are below the state and federal drinking water standards. Although the predicted concentration for arsenic is above the SL for tapwater, this is a very conservative and unlikely scenario which assumes that all groundwater discharging to the river has the maximum detected leachate concentration of arsenic.

As shown in Table G-11, all predicted surface water concentrations are below the state and federal ecological-based water quality standards. Therefore, the focus of the risk assessments on the Pond D analyte list is reasonable, and is not likely to under-predict risks.

References

ATSDR. 2007. Minimal Risk Levels. Agency for Toxic Substances and Disease Registry. November 2007. http://www.atsdr.cdc.gov/mrls/index.html.

Bowers, T.S., B.D. Beck, and H.S. Karam. 1994. Assessing the relationship between environmental lead concentrations and adult blood lead levels. Risk Anal. 14(2): 183-189.

EPRI. 2006. Characterization of Field Leachates at Coal Combustion Product Management Sites. Technical Report 1012578. Electric Power Research Institute.

USEPA. 1989. Risk Assessment Guidance for Superfund: Volume I. Human Health Evaluation Manual (Part A). Interim Final. Office of Emergency and Remedial Response. U.S. Environmental Protection Agency, Washington, D.C. EPA 540/1-89/002.

USEPA. 1991a. Human Health Exposure Manual, Supplemental Guidance; Standard Default Exposure Factors. OSWER Directive No. 9285.6-03. U.S. Environmental Protection Agency, Washington, D.C.

USEPA. 1991b. Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions. OSWER Directive #9355.0-30. April.

USEPA. 1997a. Exposure Factors Handbook, Volumes I, II and III. EPA/600/P-95/002Fa, b, and c. Office of Research and Development. U.S. Environmental Protection Agency, Washington, D.C.

USEPA. 1997b. Health Effects Assessment Summary Tables (HEAST). EPA 540-R-94-020. Office of Research and Development. U.S. Environmental Protection Agency, Washington, D.C.

USEPA. 2003. Human Health Toxicity Values in Superfund Risk Assessments. Office of Superfund Remediation and Technology Innovation. OSWER Directive 9285.7-53. December 5, 2003.

USEPA. 2004. Risk Assessment Guidance for Superfund. Volume I. Human Health Evaluation Manual. Part E, Supplemental Guidance for Dermal Risk Assessment. Final. EPA/540/R/99/005. OSWER 9285.7-02EP. July 2004.

USEPA. 2008. Regional Screening Level Table. September 2008. URL: [http://www.epa.gov/region09/superfund/prg/index.html].

USEPA. 2009. Integrated Risk Information System (IRIS). Environmental Criteria and Assessment Office. U.S. Environmental Protection Agency, Cincinnati, OH. [URL:http://cfpub.epa.gov/ncea/iris/index.cfm].

TABLE G-1
DOSE-RESPONSE INFORMATION FOR COPC WITH POTENTIAL NONCARCINOGENIC EFFECTS FROM SUBCHRONIC EXPOSURE THROUGH THE ORAL ROUTE
HUTSONVILLE POWER STATION
AMEREN ENERGY GENERATING COMPANY
POND D CLOSURE RISK ASSESSSMENT

Constituent	CAS Number	Oral RfD (mg/kg-day)		Fraction Absorbed ABS_{GI} (a)	Dermal RfD (b) (mg/kg-day)	Reference (Last Verified)	USEPA Confidence Level	Uncertainty Factor	Modifying Factor	Target Organ/ Critical Effect at LOAEL	Study Animal	Study Method
Aluminum	7429-90-5	1.00E+00	(chr)	--	1.00E+00	PPRTV (2/7/07)	LOW	100	NA	Neurological Toxicity	MOUSE	ORAL: DIET
Antimony	7440-36-0	4.00E-04	(chr)	1.50E-01	6.00E-05	IRIS (3/09)	LOW	1000	1	Longevity, blood glucose, and cholesterol	RAT	ORAL
Arsenic	7440-38-2	3.00E-04	(chr)	--	3.00E-04	IRIS (3/09)	MEDIUM	3	1	Hyperpigmentation, Kertosis and Possible Vascular Complications	HUMAN	ORAL
Barium	7440-42-8	2.00E-01	(chr)	7.00E-02	1.40E-02	IRIS (3/09)	MEDIUM	300	1	Nephropathy	MOUSE	DRINKING WATER
Beryllium	7440-41-7	2.00E-03	(chr)	7.00E-03	1.40E-05	IRIS (3/09)	LOW/MEDIUM	300	1	Small intestinal lesions	DOG	ORAL:DIET
Boron	7440-42-8	2.00E-01	(chr)	--	2.00E-01	IRIS (3/09)	HIGH	66	1	Decreased fetal weight (developmental)	RAT	ORAL: DIET
Cadmium	7440-43-9	5.00E-04	(chr)	5.00E-02	2.50E-05	IRIS (3/09)	HIGH	10	1	Significant proteinuria	HUMAN	ORAL
Chromium	16065-83-1	1.50E+00	(chr)	1.30E-02	1.95E-02	IRIS (3/09)	LOW	100	10	No effects observed	Rat	ORAL: DIET
Cobalt	7440-48-4	3.00E-04	(chr)	--	3.00E-04	PPRTV (g)	NA	NA	NA	Blood effects (k)	NA	NA
Copper	7440-50-8	3.70E-02	(chr)	--	3.70E-02	HEAST (97) (i)	NA	NA	NA	Gastrointestinal irritation	HUMAN	ORAL
Iron	7439-89-8	7.00E-01	(chr)	--	7.00E-01	PPRTV (9/11/06)	NA	1.5	NA	Adverse Gastrointestinal Effects	HUMAN	ORAL:DIETARY SUPPLEMENTS
Lead	7439-92-1	(h)		--	(h)	NA	NA	NA	NA	NA	NA	NA
Lithium	7439-93-2	2.00E-03	(chr)	--	2.00E-03	PPRTV (g)	NA	NA	NA	Neurological (l)	NA	NA
Manganese	7439-96-5	2.40E-02	(c) (chr)	4.00E-02	9.60E-04	IRIS (3/09)	HIGH	1	3	CNS Effects (Other Effect: Impairment of Neurobehavioral Function)	HUMAN	ORAL
Mercury	7439-97-6	3.00E-03	(f,j)	7.00E-02	2.10E-04	IRIS (3/09)	HIGH	100 (f)	1	Autoimmune Effects	RAT	ORAL: DIET
Molybdenum	7439-98-7	5.00E-03	(chr)	--	5.00E-03	IRIS (3/09)	MEDIUM	30	1	Increased uric acid levels	HUMAN	ORAL: DIET
Nickel	7440-02-0	2.00E-02	(chr)	4.00E-02	8.00E-04	IRIS (3/09)	MEDIUM	300	1	Decreased Body and Organ Weights	RAT	ORAL
Selenium	7782-49-2	5.00E-03	(chr)	--	5.00E-03	IRIS (3/09)	HIGH	3	1	Clinical Selenosis	HUMAN	EPIDEMIOLOGICAL
Silver	7440-22-4	5.00E-03	(chr)	4.00E-02	2.00E-04	IRIS (3/09)	LOW	3	1	Argyria	HUMAN	INTRAVENOUS (THERAPEUTIC)
Stronium	7440-24-6	6.00E-01	(chr)	--	6.00E-01	IRIS (3/09)	MEDIUM	300	1	Rachic bone	RAT	ORAL
Thallium	7440-28-0	6.48E-04	(d,f)	--	6.48E-04	IRIS (3/09)	LOW	300 (f)	1	Increased Levels of SGOT and LDH	RAT	ORAL: SUBCHRONIC
Uranium	NA	3.00E-03	(chr)	--	3.00E-03	IRIS (3/09)	MEDIUM	1000	1	Initial body weight loss; moderate nephrotoxicity	RABBIT	ORAL:DIET
Vanadium	7440-62-2	5.04E-03	(e) (chr)	2.60E-02	1.31E-04	IRIS (3/09)	LOW	100	1	Decreased hair cystine	RAT	ORAL
Zinc	7440-66-6	3.00E-01	(chr)	--	3.00E-01	IRIS (3/09)	MEDIUM/ HIGH	3	1	Decrease in Erythrocyte Cu, Zn-Superoxide Dismutase (ESOD) Activity in Healthy Adult Male and Female Volunteers	HUMAN	ORAL

See notes on following page.

TABLE G-1
DOSE-RESPONSE INFORMATION FOR COPC WITH POTENTIAL NONCARCINOGENIC EFFECTS FROM SUBCHRONIC EXPOSURE THROUGH THE ORAL ROUTE
HUTSONVILLE POWER STATION
AMEREN ENERGY GENERATING COMPANY
POND D CLOSURE RISK ASSESSSMENT

Constituent	CAS Number	Oral RfD (mg/kg-day)	Fraction Absorbed ABS_{GI} (a)	Dermal RfD (b) (mg/kg-day)	Reference (Last Verified)	USEPA Confidence Level	Uncertainty Factor	Modifying Factor	Target Organ/ Critical Effect at LOAEL	Study Animal	Study Method

Notes:
Chronic values used where sub-chronic values are not available, denoted with "chr".
"--" - No adjustment necessary.
CAS - Chemical Abstracts Service.
HEAST - Health Effects Assessment Summary Tables (USEPA, 1997b).
IRIS - Integrated Risk Information System, an on-line computer database of toxicological information (USEPA, 2009).
LOAEL - Lowest Observed Adverse Effects Level.
NA - Not available.
PPRTV - Provisional Peer Reviewed Toxicity Value.
RfD - Reference Dose.
USEPA - United States Environmental Protection Agency.
(a) USEPA, 2004. Risk Assessment Guidance for Superfund. Volume 1, Part E, Supplemental Guidance for Dermal Risk Assessment. Exhibit 4-1. Where USEPA, 2004 does not recommend adjustments, no value is listed.
(b) Oral RfD multiplied by ABS_{GI}. Where no adjustment is recommended by USEPA, 2004, Dermal RfD = Oral RfD.
(c) When assessing exposure to manganese in soil or drinking water, IRIS (01/09) recommends applying a modifying factor of 3 to the oral RfD of 0.14 mg/kg-day. The USEPA Regional Screening Level User's Guide (USEPA, 2009) also indicates that the average dietary manganese content of the US diet (5 mg/day) be subtracted from the critical dose of 10 mg/day. Therefore, the RfD is (10 mg/day - 5 mg/day)/Modifying Factor (3) = 1.67 mg/day / 70 kg = 0.024 mg/kg-day.
(d) The oral RfD toxicity value for Thallium is derived from the IRIS oral RfD for Thallium Sulfate by factoring out the molecular weight (MW) of the sulfate ion. Thallium Sulfate (TL_2SO_4) has a molecular weight of 504.82. The two atoms of Thallium contribute 81% of the MW. Thallium Sulfate's oral RfD of 8E-5 mg/kg-day multiplied by 81% gives a Thallium oral RfD of 6.48E-5 mg/kg-day.
(e) The oral RfD toxicity value for Vanadium, is derived from the IRIS oral RfD for Vanadium Pentoxide by factoring out the molecular weight (MW) of the oxide ion. Vanadium Pentoxide (V_2O_5) has a molecular weight of 181.88. The two atoms of Vanadium contribute 56% of the MW. Vanadium Pentoxide's oral RfD of 9E-03 mg/kg-day multiplied by 56% gives a Vanadium oral RfD of 5.04E-03 mg/kg-day.
(f) Uncertainty factor of 10 for sub-chronic to chronic exposure removed to derive subchronic reference dose.
(g) As presented in the USEPA Regional Screening Level table dated September 12, 2008 (http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm). (USEPA, 2008).
(h) Lead is evaluated separately using the Bowers Model.
(i) Converted from drinking water standard: 1.3 mg/L x 2 L/day x 1/70 kg = 0.037 mg/kg-day. (See also USEPA, 2008a. Maximum Contaminant Levels (MCL)).
(j) Value for mercuric chloride.
(k) PPRTV issue paper not available. However, the previous PPRTV was based on increased hemoglobin (1/18/02) and the Agency for Toxic Disease Registry Minimal Risk Level (November 2007) is based on hematological effects. Therefore, it is assumed that the current PPRTV is based on blood effects.
(l) PPRTV issue paper not available. Neurological effects assumed based on summary for lithium carbonate presented on the Hazardous Substances Data Bank (HSDB). http://toxnet.nlm.nih.gov/cgi-bin/sis/search/f?./temp/~0ocJZ9:2

TSD 000463

TABLE G-2
DOSE-RESPONSE INFORMATION FOR COPC WITH POTENTIAL CARCINOGENIC EFFECTS THROUGH THE ORAL ROUTE
HUTSONVILLE POWER STATION
AMEREN ENERGY GENERATING COMPANY
POND D CLOSURE RISK ASSESSSMENT

Constituent	CAS Number	USEPA Carcinogen Class	Oral CSF $(mg/kg\text{-}day)^{-1}$	Fraction Absorbed ABS_{GI} (a)	Dermal CSF (b) $(mg/kg\text{-}day)^{-1}$	Reference (Last Verified)	Study Animal	Study Method
Aluminum	7429-90-5	NA	NA	–	NA	NA	NA	NA
Antimony	7440-36-0	NA	NA	(c)	NA	NA	NA	NA
Arsenic	7440-38-2	A	1.50E+00	–	1.50E+00	IRIS (3/09)	HUMAN	DRINKING WATER: HUMAN
Barium	7440-42-8	D	NA	(c)	NA	NA	NA	NA
Beryllium	7440-41-7	ND	NA	(c)	NA	IRIS (3/09)	NA	NA
Boron	7440-42-8	ND	NA	–	NA	IRIS (3/09)	NA	NA
Cadmium	7440-43-9	NA	NA	(c)	NA	IRIS (3/09)	NA	NA
Chromium	16065-83-1	D	NA	(c)	NA	NA	NA	NA
Cobalt	7440-48-4	NA	NA	–	NA	NA	NA	NA
Copper	7440-50-8	D	NA	–	NA	IRIS (3/09)	NA	NA
Iron	7439-89-6	NA	NA	–	NA	NA	NA	NA
Lead	7439-92-1	NA	(d)	–	NA	NA	NA	NA
Lithium	7439-93-2	NA	NA	–	NA	NA	NA	NA
Manganese	7439-96-5	D	NA	(c)	NA	IRIS (3/09)	NA	NA
Mercury	7439-97-6	D	NA	(c)	NA	NA	NA	NA
Molybdenum	7439-98-7	NA	NA	–	NA	NA	NA	NA
Nickel	7440-02-0	NA	NA	(c)	NA	NA	NA	NA
Selenium	7782-49-2	D	NA	–	NA	IRIS (3/09)	NA	NA
Silver	7440-22-4	D	NA	(c)	NA	NA	NA	NA
Stronium	7440-24-6	NA	NA	–	NA	NA	NA	NA
Thallium	7440-28-0	D	NA	–	NA	IRIS (3/09)	NA	NA
Uranium	NA	NA	NA	–	NA	NA	NA	NA
Vanadium	7440-62-2	NA	NA	(c)	NA	NA	NA	NA
Zinc	7440-66-6	D	NA	–	NA	IRIS (3/09)	NA	NA

Notes:
"–" - No adjustment necessary.
A - Human carcinogen.
CAS - Chemical Abstracts Service.
COPC - Constituent of Potential Concern.
CSF - Cancer Slope Factor.
D - Not classifiable as to human carcinogenicity.
IRIS - Integrated Risk Information System, an online computer database of toxicological information (USEPA, 2009).
NA - Not available.
ND - Data are inadequate for an assessment of human carcinogenic potential.
USEPA - United States Environmental Protection Agency.
(a) USEPA, 2004. Risk Assessment Guidance for Superfund. Volume 1, Part E, Supplemental Guidance for Dermal Risk Assessment. Exhibit 4-1. Where USEPA, 2004 does not recommend adjustments, no value is listed.
(b) Oral CSF divided by ABS_{GI}. Where no adjustment is recommended, Dermal CSF = Oral CSF.
(c) No oral CSF available; therefore, fraction absorbed not applicable.
(d) Lead is evaluated separately using the Bowers model.

TABLE G-3
SUMMARY OF POTENTIAL EXPOSURE ASSUMPTIONS - FUTURE CONSTRUCTION WORKER
HUTSONVILLE POWER STATION
AMEREN ENERGY GENERATING COMPANY
POND D CLOSURE RISK ASSESSSMENT

Parameter	RME Construction Worker	
Parameters Used in the Groundwater Incidental Ingestion/Dermal Contact Pathway		
Exposure Time (hr/day)	1	(a)
Exposure Frequency (days/year)	30	(b)
Exposure Duration (yr)	1	(c)
Water Ingestion Rate (l/event)	0.005	(d)
Skin Contacting Medium (cm^2)	3300	(e,f)
Body Weight (kg)	70	(g)

Notes:
RME - Reasonable Maximum Exposure.
(a) - Assumes that contact with water occurs only for a fraction of an 8-hour work day.
(b) - Exposure frequency is equivalent to 5 days per week for 6 weeks.
(c) - Construction activities are assumed to occur within a 1 year period.
(d) - USEPA. 1989. Risk Assessment Guidance for Superfund, Volume I. Value is one-tenth that assumed to occur during a swimming event.
(e) - USEPA. 1997a. Exposure Factors Handbook (EFH). Represents 50th percentile values for males and females based on hands, forearms, and face listed in EFH Tables 6-2 and 6-3.
(f) - USEPA. 2004. Risk Assessment Guidance for Superfund, Supplemental Guidance for Dermal Risk Assessment. Exhibit 3-5.
(g) - USEPA. 1991a. Standard Default Exposure Factors.

TABLE G-4
DERMAL PERMEABILITY CONSTANTS FOR LEACHATE
HUTSONVILLE POWER STATION
AMEREN ENERGY GENERATING COMPANY
POND D CLOSURE RISK ASSESSSMENT

Constituent	Dermal Permeability Constant (cm/hr)	
Aluminum	1.00E-03	(a)
Antimony	1.00E-03	(a)
Arsenic	1.00E-03	(a)
Barium	1.00E-03	(a)
Beryllium	1.00E-03	(a)
Boron	1.00E-03	(a)
Cadmium	1.00E-03	(a)
Chromium	1.00E-03	(a)
Cobalt	4.00E-04	(a)
Copper	1.00E-03	(a)
Iron	1.00E-03	(a)
Lead	1.00E-04	(a)
Lithium	1.00E-03	(a)
Manganese	1.00E-03	(a)
Mercury	1.00E-03	(a)
Molybdenum	1.00E-03	(a)
Nickel	2.00E-04	(a)
Selenium	1.00E-03	(a)
Silver	6.00E-04	(a)
Stronium	1.00E-03	(a)
Thallium	1.00E-03	(a)
Uranium	1.00E-03	(a)
Vanadium	1.00E-03	(a)
Zinc	6.00E-04	(a)

Notes:
(a) USEPA, 2004. Risk Assessment Guidance for Superfund.
Volume 1, Part E, Supplemental Guidance for Dermal Risk Assessment.
Exhibit 3-1. (Inorganics)

TABLE G-5
THRESHOLD CONCENTRATIONS FOR CONSTRUCTION WORKER LEACHATE CONTACT - POTENTIALLY CARCINOGENIC EFFECTS
HUTSONVILLE POWER STATION
AMEREN ENERGY GENERATING COMPANY
POND D CLOSURE RISK ASSESSSMENT

Constituent	Potential Carcinogenic Risk Based on 1 mg/L Constituent in Leachate	Threshold Concentration (a)	
		10^{-5} Risk Level (mg/L)	10^{-4} Risk Level (mg/L)
Aluminum	NC	NC	NC
Antimony	NC	NC	NC
Arsenic	2.09E-07	48	479
Barium	NC	NC	NC
Beryllium	NC	NC	NC
Boron	NC	NC	NC
Cadmium	NC	NC	NC
Chromium	NC	NC	NC
Cobalt	NC	NC	NC
Copper	NC	NC	NC
Iron	NC	NC	NC
Lead	NC	NC	NC
Lithium	NC	NC	NC
Manganese	NC	NC	NC
Mercury	NC	NC	NC
Molybdenum	NC	NC	NC
Nickel	NC	NC	NC
Selenium	NC	NC	NC
Silver	NC	NC	NC
Stronium	NC	NC	NC
Thallium	NC	NC	NC
Uranium	NC	NC	NC
Vanadium	NC	NC	NC
Zinc	NC	NC	NC

Notes:
NC - Not calculated, no dose-response value available.
(a) Threshold concentration calculated using the following equation:

$$\text{Threshold Concentration} = \frac{\text{Target Carcinogenic Risk Level} * \text{1 mg/L constituent in leachate}}{\text{Carcinogenic Risk Based on 1 mg/L constituent in leachate}}$$

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TABLE G-6
THRESHOLD CONCENTRATIONS FOR CONSTRUCTION WORKER LEACHATE CONTACT - NONCARCINOGENIC EFFECTS
HUTSONVILLE POWER STATION
AMEREN ENERGY GENERATING COMPANY
POND D CLOSURE RISK ASSESSSMENT

Constituent	Hazard Quotient based on 1 mg/L Constituent in Groundwater	Target Endpoint	Target Hazard Quotient (b)	Threshold Concentration (a) (mg/L)
Aluminum	9.75E-06	Neurological	0.33	33,861
Antimony	7.93E-02	Longevity, blood effects	0.25	3.2
Arsenic	3.25E-02	Skin, Vascular	0.33	10
Barium	3.06E-04	Kidney	0.25	817
Beryllium	2.80E-01	Gastrointestinal	0.33	1.2
Boron	4.87E-05	Developmental	1	20,522
Cadmium	1.67E-01	Kidney	0.25	1.5
Chromium	2.03E-04	No effects observed	1	4,935
Cobalt	2.47E-02	Blood effects	0.25	10
Copper	2.63E-04	Gastrointestinal	0.33	1,253
Iron	1.39E-05	Gastrointestinal	0.33	23,703
Lead	NC	NA	(c)	25 (c)
Lithium	4.87E-03	Neurological	0.33	68
Manganese	4.28E-03	Nervous System	0.33	77
Mercury	2.04E-02	Immune effects	1	49
Molybdenum	1.95E-03	Kidney	0.25	128
Nickel	1.26E-03	Body weight	0.5	396
Selenium	1.95E-03	Skin, Nails, Hair, Behavioral	0.33	169
Silver	1.28E-02	Skin	0.33	26
Stronium	1.62E-05	Skeletal	1	61,566
Thallium	1.50E-02	Blood Effects	0.25	17
Uranium	3.25E-03	Body weight, Kidney	0.25	77
Vanadium	3.07E-02	Hair	0.5	16
Zinc	2.73E-05	Blood Effects	0.25	9,151

Notes:
HQ - Hazard Quotient.
(a) Threshold concentration calculated using the following equation:

$$\text{Threshold Concentration} = \frac{\text{Target HQ} * \text{1 mg/L constituent in leachate}}{\text{HQ based on 1 mg/L constituent in leachate}}$$

(b) Target HQ is one per target organ. In cases where the target endpoint is shared, the target HQ is divided by the number of constituents sharing the same endpoint. Where multiple endpoints are listed, the target HQ is based on the endpoint with the highest number of shared constituents.
(c) Threshold concentration for lead derived using Bowers Lead Model.

TABLE G-7
DERIVATION OF LEAD IN GROUNDWATER THRESHOLD CONCENTATION
CONSTRUCTION WORKER INGESTION
HUTSONVILLE POWER STATION
AMEREN ENERGY GENERATING COMPANY
POND D CLOSURE RISK ASSESSSMENT

Parameter	**Value**
Baseline Blood Lead Concentration (ug/dL) (a)	1.5
Biokinetic Slope Factor (ug/dL per ug/day)	0.4
Ingestion - Groundwater	
Water Absorption Factor (unitless)	0.2
Water Ingestion Rate (L/day)	0.005
Threshold Groundwater Concentration (ug/L) (b)	**25,000**
Exposure Frequency (days)	30
Averaging Time (days)	42
Uptake water (ug/day)	17.86
Calculated Blood Lead Concentration (ug/dl)	9
Target Blood Lead Level (c)	10

Notes:
(a) Baseline blood lead level listed for all populations and for mid-west populations. USEPA Adult Lead Model spreadsheet dated 5/19/2005.
(b) Concentration that results in a blood lead concentration of less than or equal to 10 ug/dL.
(c) Target Blood Lead Level as Defined by OSHA for Adult Workers:
1) Blood lead level of workers (male and female) intending to have children should remain below 30 ug/dL.
2) OSHA allows 40 ug/dL as a "permissible" blood lead level in lead-exposed workers, below which no further medical monitoring or workplace intervention is required.
3) The Centers for Disease Control has selected 10 ug/dl as the "level of concern" for young children. Bowers et al. (1994) suggest that while the CDC criteria for children were not developed for adults they may be useful as a screening technique for adults.
4) USEPA (2003) also recommends10 ug/dl as the target blood lead level.

TABLE G-8
THRESHOLD CONCENTRATIONS FOR CONSTRUCTION WORKER LEACHATE CONTACT - POTENTIALLY CARCINOGENIC EFFECTS
HUTSONVILLE POWER STATION
AMEREN ENERGY GENERATING COMPANY
POND D CLOSURE RISK ASSESSSMENT

Constituent	Threshold Concentration for Potentially Carcinogenic Effects (a)		Threshold Concentration for Noncarcinogenic Effects (b)	Selected Threshold Concentration (d)
	10^{-5} Risk Level (mg/L)	10^{-4} Risk Level (mg/L)	(mg/L)	(mg/L)
Aluminum	NC	NC	33,861	33,861
Antimony	NC	NC	3.2	3
Arsenic	48	479	10	10
Barium	NC	NC	817	817
Beryllium	NC	NC	1.2	1
Boron	NC	NC	20,522	20,522
Cadmium	NC	NC	1.5	1
Chromium	NC	NC	4,935	4,935
Cobalt	NC	NC	10	10
Copper	NC	NC	1,253	1,253
Iron	NC	NC	23,703	23,703
Lead	NC	NC	25 (c)	25
Lithium	NC	NC	68	68
Manganese	NC	NC	77	77
Mercury	NC	NC	49	49
Molybdenum	NC	NC	128	128
Nickel	NC	NC	396	396
Selenium	NC	NC	169	169
Silver	NC	NC	26	26
Stronium	NC	NC	61,566	61,566
Thallium	NC	NC	17	17
Uranium	NC	NC	77	77
Vanadium	NC	NC	16	16
Zinc	NC	NC	9,151	9,151

Notes:
NC - Not calculated, no dose-response value available.
(a) Derived in Table G-5.
(b) Derived in Table G-6.
(c) Derived in Table G-7 and Attachment G-2.
(d) Lower of cancer and noncancer calculated values.

TABLE G-9
COMPARISON OF MAXIMUM LEACHATE CONCENTRATIONS TO CONSTRUCTION WORKER THRESHOLD CONCENTRATIONS
HUTSONVILLE POWER STATION
AMEREN ENERGY GENERATING COMPANY
POND D CLOSURE RISK ASSESSSMENT

Constituent (a)	Median (a) (mg/L)	Maximum (a) (mg/L)	Threshold Concentration (b) (mg/L)	Is Maximum Detection >Threshold Concentration?
Leachate				
Aluminum	0.08	15.1	33,861	No
Antimony	0.006	0.059	3	No
Arsenic	0.06	1.4	10	No
Barium	0.14	0.5	817	No
Beryllium	<0.0004	0.009	1	No
Boron	1.1	112	20,522	No
Cadmium	0.001	0.02	1	No
Chromium	<0.0005	0.03	4,935	No
Cobalt	0.001	0.022	10	No
Copper	0.003	0.45	1,253	No
Iron	0.05	14.7	23,703	No
Lead	<0.000146	0.008	25	No
Lithium	0.2	1.1	68	No
Manganese	0.07	4.2	77	No
Mercury	0.000001	0.000005	49	No
Molybdenum	0.2	6.0	128	No
Nickel	0.007	0.07	396	No
Selenium	0.01	0.3	169	No
Silicon	4.7	18.5	(c)	--
Silver	<0.0002	0.002	26	No
Stronium	0.67	5.6	61,566	No
Sulfate	171	1830	(c)	--
Thallium	0.0007	0.018	17	No
Uranium	0.0007	0.06	77	No
Vanadium	0.04	0.75	16	No
Zinc	0.009	0.09	9,151	No

Notes:
(a) Maximum/median data from EPRI, 2006. All results are representative of dissolved concentrations, with the exception of sulfate, which is a total concentration.
(b) See Table G-8.
(c) No threshold concentration derived. Dose-response data are not available.

TABLE G-1u
COMPARISON OF SURFACE WATER CONCENTRATIONS PREDICTED FROM MAXIMUM LEACHATE CONCENTRATIONS TO HUMAN HEALTH SCREENING VALUES
HUTSONVILLE POWER STATION
AMEREN ENERGY GENERATING COMPANY
HUMAN HEALTH RISK ASSESSMENT - POND D CLOSURE

Constituent (a)	Units	Median (a)	Maximum (a)	Dilution Ratio (c)	Estimated Surface Water Concentration (h) (ug/L)	Tapwater SL (b)	Is Maximum Detection >SL?	MCL (d)	Is Maximum Detection >MCL?	Illinois Class I Groundwater Quality Standard (e)	Is Maximum Detection >Class I	Illinois TACO Class I Groundwater Remediation Objective (f)	Is Maximum Detection >Remediation Objective?
Leachate													
Aluminum	ug/L	80	15100	0.00048	7.2	37000	No	50-200	No	NA	--	NA	--
Antimony	ug/L	6.06	59	0.00048	0.028	15	No	6	No	6	No	6	No
Arsenic	ug/L	58	1380	0.00048	0.66	0.045	Yes	10	No	50	No	50	No
Barium	ug/L	141	545	0.00048	0.26	7300	No	2000	No	2000	No	2000	No
Beryllium	ug/L	<0.4	8.55	0.00048	0.0041	73	No	4	No	4	No	4	No
Boron	ug/L	1085	112000	0.00048	54	7300	No	NA	--	2000	No	2000	No
Cadmium	ug/L	1.17	21	0.00048	0.0102	18	No	5	No	5	No	5	No
Chromium	ug/L	<0.5	29	0.00048	0.014	55000	No	100	No	100	No	100	No
Cobalt	ug/L	1.48	22	0.00048	0.0103	11	No	NA	--	1000	No	1000	No
Copper	ug/L	3.00	452	0.00048	0.22	1500	No	1300 TTAL	No	650	No	650	No
Iron	ug/L	50	14700	0.00048	7.1	26000	No	300	No	5000	No	5000	No
Lead	ug/L	<0.146	7.98	0.00048	0.0038	NA	--	15 TTAL	No	7.5	No	7.5	No
Lithium	ug/L	213	1060	0.00048	0.51	73	No	NA	--	NA	--	NA	--
Manganese	ug/L	72	4170	0.00048	2.0	880	No	50 SMCL	No	150	No	150	No
Mercury	ug/L	0.0014	0.0052	0.00048	0.0000025	11 (g)	No	2	No	2	No	2	No
Molybdenum	ug/L	214	6030	0.00048	2.9	180	No	NA	--	NA	--	NA	--
Nickel	ug/L	7.08	72	0.00048	0.034	730	No	NA	--	100	No	100	No
Selenium	ug/L	13	283	0.00048	0.14	180	No	50	No	50	No	50	No
Silicon	ug/L	4715	18500	0.00048	8.9	NA	--	NA	--	NA	--	NA	--
Silver	ug/L	<0.2	2.00	0.00048	0.00096	180	No	100 SMCL	No	50	No	50	No
Stronium	ug/L	671	5610	0.00048	2.7	22000	No	NA	--	NA	--	NA	--
Sulfate	ug/L	171324	1830000	0.00048	878	NA	--	250000 SMCL	No	400000	No	400000	No
Thallium	ug/L	0.68	18	0.00048	0.0084	2.4	No	2	No	2	No	2	No
Uranium	ug/L	0.70	61	0.00048	0.029	110	No	30	No	NA	--	NA	--
Vanadium	ug/L	39	754	0.00048	0.36	180	No	NA	--	NA	--	NA	--
Zinc	ug/L	8.7	90	0.00048	0.043	11000	No	5000	No	5000	No	5000	No

Notes:
-- No value available.
MCL - Maximum Contaminant Level.
SL - Screening Level.
SMCL - Secondary Maximum Contaminant Level
TACO - Tiered Approach to Corrective Action Objectives
TTAL - Treatment Technology Action Level.
ug/L - micrograms per liter.
USEPA - United States Environmental Protection Agency.
(a) **Maximum/median data from EPRI, 2006.** All results are representative of dissolved concentrations, with the exception of sulfate, which is a total concentration.
(b) USEPA. 2008. USEPA Regional Screening Levels (September 12, 2008). Values for tapwater. SLs for constituents on this table are based on a noncancer endpoint and a hazard quotient of one. The SL for arsenic is based on potentially carcinogenic effects and a cancer risk level of 1E-6.
(c) Derived in Appendix B.
(d) USEPA. 2006. USEPA Maximum Contaminant Level. 2006 Edition of the Drinking Water Standards and Health Advisories.
(e) IEPA. 2002. Title 35 Environmental Protection. Subtitle F Public Water Supplies. Chapter I Pollution Control Board. Part 620 Groundwater Quality. Subpart A General. 620.410 Groundwater Quality Standards for Class I: Potable Resource Groundwater. February 5, 2002.
(f) IEPA. 2007. Title 35 Environmental Protection. Subchapter F: Risk Based Cleanup Objectives. Part 742 Tiered Approach to Corrective Action Objectives (TACO). Feb, 23 2007. Appendix B, Table E. Tier 1 values for Class 1 groundwater.
(g) SL for mercuric chloride.
(h) The estimated surface water concentration is equal to the maximum detected groundwater concentration multiplied by the dilution ratio.

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TABLE G

COMPARISON OF SURFACE WATER CONCENTRATIONS PREDICTED FROM MAXIMUM LEACHATE CONCENTRATIONS TO SURFACE WATER SCREENING VALUES
HUTSONVILLE POWER STATION
AMEREN ENERGY GENERATING COMPANY
HUMAN HEALTH RISK ASSESSMENT - POND D CLOSURE

Constituent (a)	Median (a) (ug/L)	Maximum (a) (ug/L)	Dilution Ratio (b)	Estimated Surface Water Concentration (c) (ug/L)	Illinois Water Quality Standards (d) (ug/L)	Is Maximum Detection > Water Quality Standard?	Federal AWQC for the Protection of Aquatic Life (e) (ug/L)	Is Maximum Detection > AWQC?
Leachate								
Aluminum	80	15100	0.00048	7.2	-	No	87	No
Antimony	6.06	59	0.00048	0.028	-	No	30	No
Arsenic	58	1380	0.00048	0.66	190 (g)	No	150	No
Barium	141	545	0.00048	0.26	5000 (f)	No	-	No
Beryllium	<0.4	8.55	0.00048	0.0041	-	No	0.66	No
Boron	1085	112000	0.00048	54	1000 (f)	No	-	No
Cadmium	1.17	21	0.00048	0.0102	10 (g,i)	No	0.25 (i)	No
Chromium	<0.5	29	0.00048	0.014	178 (g,h,i)	No	74 (i)	No
Cobalt	1.48	22	0.00048	0.0103	-	No	23	No
Copper	3.00	452	0.00048	0.22	11 (g,i)	No	9.0 (i)	No
Iron	50	14700	0.00048	7.1	1000 (f)	No	1000	No
Lead	<0.146	7.98	0.00048	0.0038	16 (g,i)	No	2.5 (i)	No
Lithium	213	1060	0.00048	0.51	-	No	-	No
Manganese	72	4170	0.00048	2.0	1000 (f)	No	-	No
Mercury	0.0014	0.0052	0.00048	0.0000025	1.1 (g)	No	0.77 (g)	No
Molybdenum	214	6030	0.00048	2.9	-	No	-	No
Nickel	7.08	72	0.00048	0.034	5 (g,i)	No	52 (i)	No
Selenium	13	283	0.00048	0.14	1000 (f)	No	5	No
Silicon	4715	18500	0.00048	8.9	-	No	-	No
Silver	<0.2	2.00	0.00048	0.00096	5000	No	0.36	No
Stronium	671	5610	0.00048	2.7	-	No	-	No
Sulfate	171324	1830000	0.00048	878	1164199 (f)	No	-	No
Thallium	0.68	18	0.00048	0.0084	-	No	12	No
Uranium	0.70	61	0.00048	0.029	-	No	-	No
Vanadium	39	754	0.00048	0.36	-	No	20	No
Zinc	8.7	90	0.00048	0.043	22 (g,i)	No	118 (i)	No

Notes:
– No value available.
AWQC - Ambient Water Quality Criteria
ug/L - micrograms per liter.
USEPA - United States Environmental Protection Agency.
(a) **Maximum/median data from EPRI, 2006.** All results are representative of dissolved concentrations, with the exception of sulfate, which is a total concentration.
(b) Derived in Appendix B.
(c) The estimated surface water concentration is equal to the maximum detected groundwater concentration multiplied by the dilution ratio.
(d) IPCB, 2009. Illinois Pollution Control Board (IPCB) Title 35, Environmental Protection, Part 302 Water Quality Standards
(e) USEPA, 2006. National Recommended Water Quality Criteria. Available at http://www.epa.gov/waterscience/criteria/wqcriteria.html
(f) IPCB Subpart B, Section 302.208 g),h) - Numeric Water Quality Standards.
(g) IPCB Subpart B, Section 302.208 e) - Numeric Water Quality Standards for the Protection of Aquatic Organisms.
(h) Value for trivalent chromium.
(i) Hardness dependent value.

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Appendix G

Attachment G-1: Unit Risk Calculation Spreadsheets

HUTSONVILLE POWER STATION
POND D CLOSURE RISK ASSESSSMENT
RME

Receptors Evaluated:	
Receptor 1:	Construction Worker - RME

CARCINOGENIC AND NONCARCINOGENIC
ASSUMPTIONS FOR FOR CONSTRUCTION WORKER - RME
DERMAL CONTACT WITH AND INCIDENTAL INGESTION OF GROUNDWATER

		Assumed Value	Units	Calculated Value
Water Ingestion Rate	Construction Worker - RME	0.005	(l/day)	
Skin Exposed	Construction Worker - RME	3300	(cm^2)	
Body Weight	Construction Worker - RME	70	(kg)	
Exposure Time (dermal only)	Construction Worker - RME	1	(hr/day)	
Event Frequency (dermal only)	Construction Worker - RME	1	(event/day)	
Exposure Frequency	Construction Worker - RME	30	(days)/365 (days) =	8.22E-02
Exposure Duration (cancer)	Construction Worker - RME	1	(yrs)/ 70(yrs) =	1.43E-02
Exposure Duration (noncancer)	Construction Worker - RME	1	(yrs)/ 1(yrs) =	1.00E+00
Lifetime		70		
Unit Conversion Factor (dermal only)		0.001	(l/cm^3)	

HUTSONVILLE POWER STATION
POND D CLOSURE RISK ASSESSSMENT
CARCINOGENIC ASSESSMENT - UNIT RISK CALCULATION
FOR CONSTRUCTION WORKER - RME
DERMAL CONTACT WITH AND INCIDENTAL INGESTION
OF GROUNDWATER

Constituent	Unit Concentration In Groundwater (mg/l)	Oral Cancer Slope Factor $(mg/kg\text{-}day)^{-1}$	Dermal Cancer Slope Factor $(mg/kg\text{-}day)^{-1}$	Dermal Permeability Constant (cm/hr)	Exposure Time (hr)	DA event Dose Absorbed (mg/cm^2-event)	ADDing Construction Worker - RME (mg/kg-day)	Lifetime Average Daily Dose - Ing. (mg/kg-day)	DAD Construction Worker - RME (mg/kg-day)	Lifetime Average Daily Dose - Derm. (mg/kg-day)	Excess Lifetime Cancer Risk Per Unit Concentration: Ingestion	Excess Lifetime Cancer Risk Per Unit Concentration: Dermal Contact	Excess Lifetime Cancer Risk Per Unit Concentration: Total
Aluminum	1.00E+00	NA	NA	1.00E-03	1.00E+00	1.00E-06	8.39E-08	8.39E-08	5.54E-08	5.54E-08	NA	NA	NC
Antimony	1.00E+00	NA	NA	1.00E-03	1.00E+00	1.00E-06	8.39E-08	8.39E-08	5.54E-08	5.54E-08	NA	NA	NC
Arsenic	1.00E+00	1.50E+00	1.50E+00	1.00E-03	1.00E+00	1.00E-06	8.39E-08	8.39E-08	5.54E-08	5.54E-08	1.26E-07	8.30E-08	2.09E-07
Barium	1.00E+00	NA	NA	1.00E-03	1.00E+00	1.00E-06	8.39E-08	8.39E-08	5.54E-08	5.54E-08	NA	NA	NC
Beryllium	1.00E+00	NA	NA	1.00E-03	1.00E+00	1.00E-06	8.39E-08	8.39E-08	5.54E-08	5.54E-08	NA	NA	NC
Boron	1.00E+00	NA	NA	1.00E-03	1.00E+00	1.00E-06	8.39E-08	8.39E-08	5.54E-08	5.54E-08	NA	NA	NC
Cadmium	1.00E+00	NA	NA	1.00E-03	1.00E+00	1.00E-06	8.39E-08	8.39E-08	5.54E-08	5.54E-08	NA	NA	NC
Chromium	1.00E+00	NA	NA	1.00E-03	1.00E+00	1.00E-06	8.39E-08	8.39E-08	5.54E-08	5.54E-08	NA	NA	NC
Cobalt	1.00E+00	NA	NA	4.00E-04	1.00E+00	4.00E-07	8.39E-08	8.39E-08	2.21E-08	2.21E-08	NA	NA	NC
Copper	1.00E+00	NA	NA	1.00E-03	1.00E+00	1.00E-06	8.39E-08	8.39E-08	5.54E-08	5.54E-08	NA	NA	NC
Iron	1.00E+00	NA	NA	1.00E-03	1.00E+00	1.00E-06	8.39E-08	8.39E-08	5.54E-08	5.54E-08	NA	NA	NC
Lead	1.00E+00	NA	NA	1.00E-04	1.00E+00	1.00E-07	8.39E-08	8.39E-08	5.54E-09	5.54E-09	NA	NA	NC
Lithium	1.00E+00	NA	NA	1.00E-03	1.00E+00	1.00E-06	8.39E-08	8.39E-08	5.54E-08	5.54E-08	NA	NA	NC
Manganese	1.00E+00	NA	NA	1.00E-03	1.00E+00	1.00E-06	8.39E-08	8.39E-08	5.54E-08	5.54E-08	NA	NA	NC
Mercury	1.00E+00	NA	NA	1.00E-03	1.00E+00	1.00E-06	8.39E-08	8.39E-08	5.54E-08	5.54E-08	NA	NA	NC
Molybdenum	1.00E+00	NA	NA	1.00E-03	1.00E+00	1.00E-06	8.39E-08	8.39E-08	5.54E-08	5.54E-08	NA	NA	NC
Nickel	1.00E+00	NA	NA	2.00E-04	1.00E+00	2.00E-07	8.39E-08	8.39E-08	1.11E-08	1.11E-08	NA	NA	NC
Selenium	1.00E+00	NA	NA	1.00E-03	1.00E+00	1.00E-06	8.39E-08	8.39E-08	5.54E-08	5.54E-08	NA	NA	NC
Silver	1.00E+00	NA	NA	6.00E-04	1.00E+00	6.00E-07	8.39E-08	8.39E-08	3.32E-08	3.32E-08	NA	NA	NC
Stronium	1.00E+00	NA	NA	1.00E-03	1.00E+00	1.00E-06	8.39E-08	8.39E-08	5.54E-08	5.54E-08	NA	NA	NC
Thallium	1.00E+00	NA	NA	1.00E-03	1.00E+00	1.00E-06	8.39E-08	8.39E-08	5.54E-08	5.54E-08	NA	NA	NC
Uranium	1.00E+00	NA	NA	1.00E-03	1.00E+00	1.00E-06	8.39E-08	8.39E-08	5.54E-08	5.54E-08	NA	NA	NC
Vanadium	1.00E+00	NA	NA	1.00E-03	1.00E+00	1.00E-06	8.39E-08	8.39E-08	5.54E-08	5.54E-08	NA	NA	NC
Zinc	1.00E+00	NA	NA	6.00E-04	1.00E+00	6.00E-07	8.39E-08	8.39E-08	3.32E-08	3.32E-08	NA	NA	NC

HUTSONVILLE POWER STATION
POND D CLOSURE RISK ASSESSSMENT
NONCARCINOGENIC ASSESSMENT - HAZARD INDEX CALCULATION
FOR CONSTRUCTION WORKER - RME
DERMAL CONTACT WITH AND INCIDENTAL INGESTION
OF GROUNDWATER

Constituent	Unit Concentration In Groundwater (mg/l)	Oral Reference Dose (mg/kg-day)	Dermal Reference Dose (mg/kg-day)	Dermal Permeability Constant (cm/hr)	Exposure Time (hr)	DA event Dose Absorbed (mg/cm^2-event)	ADDing Construction Worker - RME (mg/kg-day)	Chronic Average Daily Dose-ing (mg/kg-day)	DAD Construction Worker - RME (mg/kg-day)	Chronic Average Daily Dose-derm (mg/kg-day)	Potential Hazard Quotient Per Unit Concentration Ingestion	Dermal Contact	Total
Aluminum	1.00E+00	1.00E+00	1.00E+00	1.00E-03	1.00E+00	1.00E-06	5.87E-06	5.87E-06	3.87E-06	3.87E-06	5.87E-06	3.87E-06	9.75E-06
Antimony	1.00E+00	4.00E-04	6.00E-05	1.00E-03	1.00E+00	1.00E-06	5.87E-06	5.87E-06	3.87E-06	3.87E-06	1.47E-02	6.46E-02	7.93E-02
Arsenic	1.00E+00	3.00E-04	3.00E-04	1.00E-03	1.00E+00	1.00E-06	5.87E-06	5.87E-06	3.87E-06	3.87E-06	1.96E-02	1.29E-02	3.25E-02
Barium	1.00E+00	2.00E-01	1.40E-02	1.00E-03	1.00E+00	1.00E-06	5.87E-06	5.87E-06	3.87E-06	3.87E-06	2.94E-05	2.77E-04	3.06E-04
Beryllium	1.00E+00	2.00E-03	1.40E-05	1.00E-03	1.00E+00	1.00E-06	5.87E-06	5.87E-06	3.87E-06	3.87E-06	2.94E-03	2.77E-01	2.80E-01
Boron	1.00E+00	2.00E-01	2.00E-01	1.00E-03	1.00E+00	1.00E-06	5.87E-06	5.87E-06	3.87E-06	3.87E-06	2.94E-05	1.94E-05	4.87E-05
Cadmium	1.00E+00	5.00E-04	2.50E-05	1.00E-03	1.00E+00	1.00E-06	5.87E-06	5.87E-06	3.87E-06	3.87E-06	1.17E-02	1.55E-01	1.67E-01
Chromium	1.00E+00	1.50E+00	1.95E-02	1.00E-03	1.00E+00	1.00E-06	5.87E-06	5.87E-06	3.87E-06	3.87E-06	3.91E-06	1.99E-04	2.03E-04
Cobalt	1.00E+00	3.00E-04	3.00E-04	4.00E-04	1.00E+00	4.00E-07	5.87E-06	5.87E-06	1.55E-06	1.55E-06	1.96E-02	5.17E-03	2.47E-02
Copper	1.00E+00	3.70E-02	3.70E-02	1.00E-03	1.00E+00	1.00E-06	5.87E-06	5.87E-06	3.87E-06	3.87E-06	1.59E-04	1.05E-04	2.63E-04
Iron	1.00E+00	7.00E-01	7.00E-01	1.00E-03	1.00E+00	1.00E-06	5.87E-06	5.87E-06	3.87E-06	3.87E-06	8.39E-06	5.54E-06	1.39E-05
Lead	1.00E+00	NA	NA	1.00E-04	1.00E+00	1.00E-07	5.87E-06	5.87E-06	3.87E-07	3.87E-07	NA	NA	NC
Lithium	1.00E+00	2.00E-03	2.00E-03	1.00E-03	1.00E+00	1.00E-06	5.87E-06	5.87E-06	3.87E-06	3.87E-06	2.94E-03	1.94E-03	4.87E-03
Manganese	1.00E+00	2.40E-02	9.60E-04	1.00E-03	1.00E+00	1.00E-06	5.87E-06	5.87E-06	3.87E-06	3.87E-06	2.45E-04	4.04E-03	4.28E-03
Mercury	1.00E+00	3.00E-03	2.10E-04	1.00E-03	1.00E+00	1.00E-06	5.87E-06	5.87E-06	3.87E-06	3.87E-06	1.96E-03	1.85E-02	2.04E-02
Molybdenum	1.00E+00	5.00E-03	5.00E-03	1.00E-03	1.00E+00	1.00E-06	5.87E-06	5.87E-06	3.87E-06	3.87E-06	1.17E-03	7.75E-04	1.95E-03
Nickel	1.00E+00	2.00E-02	8.00E-04	2.00E-04	1.00E+00	2.00E-07	5.87E-06	5.87E-06	7.75E-07	7.75E-07	2.94E-04	9.69E-04	1.26E-03
Selenium	1.00E+00	5.00E-03	5.00E-03	1.00E-03	1.00E+00	1.00E-06	5.87E-06	5.87E-06	3.87E-06	3.87E-06	1.17E-03	7.75E-04	1.95E-03
Silver	1.00E+00	5.00E-03	2.00E-04	6.00E-04	1.00E+00	6.00E-07	5.87E-06	5.87E-06	2.32E-06	2.32E-06	1.17E-03	1.16E-02	1.28E-02
Stronium	1.00E+00	6.00E-01	6.00E-01	1.00E-03	1.00E+00	1.00E-06	5.87E-06	5.87E-06	3.87E-06	3.87E-06	9.78E-06	6.46E-06	1.62E-05
Thallium	1.00E+00	6.48E-04	6.48E-04	1.00E-03	1.00E+00	1.00E-06	5.87E-06	5.87E-06	3.87E-06	3.87E-06	9.06E-03	5.98E-03	1.50E-02
Uranium	1.00E+00	3.00E-03	3.00E-03	1.00E-03	1.00E+00	1.00E-06	5.87E-06	5.87E-06	3.87E-06	3.87E-06	1.96E-03	1.29E-03	3.25E-03
Vanadium	1.00E+00	5.04E-03	1.31E-04	1.00E-03	1.00E+00	1.00E-06	5.87E-06	5.87E-06	3.87E-06	3.87E-06	1.16E-03	2.96E-02	3.07E-02
Zinc	1.00E+00	3.00E-01	3.00E-01	6.00E-04	1.00E+00	6.00E-07	5.87E-06	5.87E-06	2.32E-06	2.32E-06	1.96E-05	7.75E-06	2.73E-05

Appendix G

Attachment G-2: Derivation of Lead Threshold Concentration

Appendix G

Attachment G-2 Derivation of Threshold Concentration for Lead

This attachment presents the derivation of the threshold concentration for lead for a construction worker potentially exposed to leachate via incidental ingestion. None of the models available for lead include the dermal contact pathway. The dermal contact exposure pathway is not expected to contribute significantly to the future construction worker, because of the limited body surface area in contact with leachate (i.e., hands and forearms), and the short duration of contact. In addition, the potential absorbed dermal dose from lead in leachate is expected to be negligible due to the low skin permeability constant of lead constituents in water (PC = $1x10^{-4}$ cm/hr, USEPA, 2004).

For many constituents associated with known or potential noncarcinogenic health effects, it has been demonstrated that there is a threshold for these effects. It is conventionally assumed for all such constituents that there is a dose below which no adverse effect occurs or, conversely, above which an adverse effect may be seen. For constituents with known or suspected carcinogenic effects, the underlying default assumption for regulatory risk assessment is that there is no threshold for effects. Thus, every dose, no matter how small, is assumed to pose some finite level of risk.

Because of the uncertainties in the dose-response relationship between exposure to lead and biological effects, it is unclear whether the noncarcinogenic effects of lead exhibit a threshold response. Therefore, a reference dose (RfD) for lead is not available. Although USEPA has classified lead as a B2 (probable human) carcinogen, no cancer slope factor (CSF) has been developed. Therefore, potential exposures to lead cannot be evaluated using the traditional methods of risk assessment. The sensitive receptor for the evaluation of lead is the young child. When evaluating an adult exposure scenario, the sensitive receptor is a woman of child-bearing age.

The Technical Review Workgroup (TRW), convened by USEPA to evaluate the risk assessment of lead, assumes that there is a baseline blood lead concentration in the adult population of the United States. The TRW selected baseline blood lead concentration represents the best estimate of a reasonable central tendency value for women of child-bearing age without previous excessive occupational exposures (USEPA, 2003). The TRW has developed potential baseline blood lead levels which are dependent on ethnic group and geographic location. The recommended range in the May 19, 2005 TRW lead model spreadsheet (USEPA, 2005) is 1.4 ug/dl to 2.0 ug/dl for the various ethnic and regional groups included in the model. The recommended value for Midwest populations is 1.5 ug/dl and is the value used in this risk assessment.

It is assumed that there is a relationship between uptake of lead into the body and blood lead levels. A numerical value, called a biokinetic slope factor (BKSF), was assigned to represent the relationship between uptake of lead into the body and blood levels. The TRW recommended BKSF of 0.4 ug Pb/dL blood per ug Pb absorbed/day (USEPA, 2003) is utilized in this risk assessment.

The absorption fraction (AF) is the fraction of lead ingested daily that is absorbed from the gastrointestinal tract. The TRW assumption that the absorption factor for soluble lead in water is 0.2 (USEPA, 2003), was utilized in this risk assessment.

The USEPA Adult Lead Methodology (2003) does not evaluate potential exposures to lead in water. However, a model for evaluating adult exposure to elevated levels of lead in multiple environmental media (air, soil, and water) is available from peer reviewed literature (Bowers et al., 1994). The model of Bowers et al., (1994) is based upon a biokinetic slope factor approach conceptually similar to that upon which the USEPA (2003) model is based. Therefore, the Bowers Model (Bowers et al.,

1994) is used to evaluate potential exposures to lead in leachate. The medium of interest here is leachate; therefore, potential exposures via air and soil are not evaluated.

The adult lead exposure model of Bowers et al. (1994) also assumes that there is a baseline blood lead level in the adult population of the United States. It is assumed that the baseline blood lead level reflects typical exposure arising primarily due to lead in the diet. It is assumed that there is a relationship between uptake of lead into the body and blood lead levels. The BKSF represents the relationship between uptake of lead into the body and blood levels.

The following equation was used to predict the average expected blood lead level for a hypothetical construction worker after exposure to leachate:

$$PbB\,(ug/dl) = PbB_{baseline}\,(ug/dl) + [BKSF\,\frac{(ug/dl)}{ug/day} * Uptake_{water}\,(ug/day)]$$

BKSF and $PbB_{baseline}$ were discussed above. The equation used to calculate uptake from leachate is presented below:

$$Uptake_{water}\,(ug/day) = \frac{AF_w\,(unitless) * IR_w\,(L/day) * C_w\,(ug/L) * EF\,(days)}{AT\,(days)}$$

Where:

AF_w = Water Absorption Factor (unitless)
IR_w = Water Ingestion Rate (L/day)
C_w = Water Concentration (ug/L)
EF = Exposure Frequency (days/year
AT = Averaging Time (days per year)

The water ingestion rate (0.005 L/day) and exposure frequency (30 days per year, 5 days per week for 6 weeks) are presented in Table G-3. The averaging time is 6 weeks (42 days). The water absorption factor of 0.2 was discussed above.

To derive a threshold concentration for lead in leachate, water concentrations were entered into the model such that the predicted blood lead concentration does not exceed 10 ug/dl.

References

Bowers, T.S., B.D. Beck, and H.S. Karam. 1994. Assessing the relationship between environmental lead concentrations and adult blood lead levels. Risk Anal. 14(2): 183-189.

USEPA. 2003. Recommendations of the Technical Review Workgroup for Lead for an Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil. EPA-540-R-03-001, OSWER Directive #9285.7-54. December 1996 (January 2003) -- The Adult Lead Methodology (ALM).

USEPA. 2004. Risk Assessment Guidance for Superfund. Volume I. Human Health Evaluation Manual. Part E, Supplemental Guidance for Dermal Risk Assessment. Final. EPA/540/R/99/005. OSWER 9285.7-02EP. July 2004.

USEPA. 2005. U.S. EPA Technical Review Workgroup for Lead, Adult Lead Committee. Spreadsheet for calculating blood lead concentrations. http://www.epa.gov/superfund/health/contaminants/lead/products.htm. Version Date 5/19/05.

Appendix H

Potable Well Search

NATURAL RESOURCE TECHNOLOGY

TECHNICAL MEMORANDUM

www.naturalrt.com

Date: April 10, 2009

Subject: Potable Well Search, Hutsonville Power Station Pond D

From: Bruce Hensel

On April 7, 2009, NRT searched for water supply well records within a 0.5-mile radius of Pond D using the Illinois State Geological Survey's (ISGS) online interactive map of well records[1]. Six wells were identified within a 0.5-mile radius of Pond D as shown on the figure and table below. On the figure, the Wabash River is shown in blue as the eastern boundary of the state, and the grid lines outline the map Sections, which are also numbered in the center of each Section. The City of Hutsonville is shown to the south by the brown shading at the southern end of Section 20, and the southeast portion of Pond D is shown as a small triangular shape near the center of the map. Wells are identified by blue dots, and the yellow numbers adjacent to wells indicate total borehole depths. A green line depicting the approximate 0.5-mile radius from Pond D is also shown on the figure. Because the Wabash River forms a hydrologic barrier in the area, the well survey was not conducted for areas east of the river (in Indiana).

- Wells 60, 61, and 64 (located in Section 20) are owned by Margaret Dement and are used for irrigation (field inspection verifies that there is no well in the position denoted by 64 on the ISGS map, the actual location is likely east of this point).
- Well number 66 (located in the north-central portion of Section 20) is also used for irrigation and is owned by Duane Wampler.
- Hutsonville Power Station Plant wells #1 and #2 are numbered 90 and 88 and located in the southeast corner of Section 17.

Based on the well log information, the two closest wells outside of the 0.5-mile radius are:

- Well 90 (located in Section 18, northwest of Pond D) is owned by Jim Allison, and is identified by the well log as a private water well.
- Well 73, a City of Hutsonville water supply well located in the southeast portion of Section 20; approximately one mile south of Pond D.

[1] Map and related well records from: http://ablation.isgs.uiuc.edu/website/ilwater/viewer.htm

In June 2005, the following landowners were identified near the power station property: J.P. Allison, J. Grimes, Slaughter, M. Kelly, and M. Dement. There are wells, outside the 0.5-mile radius, servicing three residences on the Allison property to the northwest, and the Grimes residence to the west. These wells are upgradient of both the Station and upgradient monitoring well MW10. There are no ISGS records for potable wells servicing residences on the Dement, Slaughter, and Kelly properties, nor were wellheads visible when the properties were field-checked by personnel from the Hutsonville Power Station in 2005. Furthermore, the buildings on these three parcels are more than 0.5-mile south of Pond D, and wells, if present, would be near the buildings and outside the 0.5-mile radius. Finally, the Dement residence is reportedly connected to the City of Hutsonville public water supply. This information suggests that the Dement, Slaughter, and Kelly properties do not have wells within 0.5 mile of Pond D.

Well Identification	Section T8N, R11W	Location to 0.5-mile Radius of Pond D	Owner Name	Borehole Depth (feet)	Screened Formation	Screen Depth (feet)	
						Top	Bottom
120332991300 Power Plant	17	Within Radius	C.I.P.S. Hutsonville Unit	90	Deep Alluvial	57*	87
120333386700 Power Plant	17	Within Radius	Central IL Public Serv. Co.	88	Deep Alluvial	31	61
120333519600 Irrigation	20	Within Radius	Dement, Margaret R.	64	Deep Alluvial	46*	61
120333666700 Irrigation	20	Within Radius	Wampler, Duane	66	Deep Alluvial	34	64
120333675600 Irrigation	20	Within Radius	DeMent, Margaret	60	Deep Alluvial	32	62*
120333689800 Irrigation	20	Within Radius	DeMent, Margaret	61	Deep Alluvial	40	60
120333440500 Municipal	20	Outside Radius	City of Hutsonville	73	Deep Alluvial	30*	60*
120333741100 Domestic	18	Outside Radius	Allison, Jim	90	Sandstone	30	90

*: Estimated value, information unclear on the ISGS log.

TSD 000483


3 N 11 W
Hutsonville
N
ISGS Map Service: ILWATER 12/15/08
0
0.4501 Miles

ILLINOIS STATE GEOLOGICAL SURVEY

Irrigation Well	Top	Bottom
dark clay	0	2
[illegible]nd & gravel	2	47
coarse sand	47	61
Total Depth		61

Casing: 16" PVC SCH 40 from -1' to 31'
16" PVC SAWED SCREEN from 31' to 61'

Screen: 30' of 16" diameter 32 slot

Grout: BENSEAL from 3 to 20.

Grout: GRAVEL PACK from 20 to 61.

Static level 9' below casing top which is 1' above GL

Location source: Location from permit

Permit Date: June 7, 2002 **Permit #:**

COMPANY Speth, James
FARM DeMent, Margaret
DATE DRILLED June 12, 2002 **NO.**
ELEVATION 0 **COUNTY NO.** 36898
LOCATION NE NE NW
LATITUDE 39.127799 **LONGITUDE** -87.658791
COUNTY Crawford **API** 120333689800 **20 - 8N - 11W**

TSD 000485

ILLINOIS STATE GEOLOGICAL SURVEY

Irrigation Well	Top	Bottom
topsoil	0	2
[illegible]y sand & gravel	2	22
coarse gray sand w/medium-large gravel	22	30
coarse gray sand with fine gravel	30	60
shale at	60	60
Total Depth		60

Casing: 12" SCH 40 PVC from 0' to 40'
Screen: 20' of 12" diameter .06 slot
Grout: BENTONITE from 0 to 30.
Water from sand & gravel at 20' to 60'.
Static level 23' below casing top which is 2' above GL
Pumping level 0' when pumping at 750 gpm for 0 hours

Address of well: same as above

Location source: Location from permit

Permit Date: January 19, 2000 **Permit #:**

COMPANY Hacker, Tim
FARM DeMent, Margaret
DATE DRILLED February 8, 2000 **NO.** 2
ELEVATION 0 **COUNTY NO.** 36756
LOCATION SE SE NW
LATITUDE 39.122411 **LONGITUDE** -87.658754
COUNTY **Crawford** **API** **120333675600** **20 - 8N - 11W**

ILLINOIS STATE GEOLOGICAL SURVEY

Irrigation Well	Top	Bottom
topsoil	0	3
silty dark clay	3	20
gray clay	20	25
coarse gray sand with fine-med gravel	25	66
gray clay at	66	66
Total Depth		66

Casing: 12" SCH 40 PVC from 0' to 32'
Screen: 3' of 12" diameter .06 slot
Grout: BENTONITE from 0 to 25.
Water from sand & gravel at 25' to 66'.
Static level 11' below casing top which is 1' above GL
Pumping level 0' when pumping at 1000 gpm for 0 hours

Additional location info: Lot: Subdivision: S of CIPS Power Plant

Address of well:
Hutsonville, IL

Location source: Location from permit

Permit Date: January 15, 1997 **Permit #:** 033-1-9

COMPANY Hacker, Tim
FARM Wampler, Duane
DATE DRILLED January 29, 1998 **NO.** 1
ELEVATION 0 **COUNTY NO.** 36667
LOCATION NE NE NW
LATITUDE 39.127799 **LONGITUDE** -87.658791
COUNTY Crawford **API** 120333666700 **20 - 8N - 11W**

TSD 000487

ILLINOIS STATE GEOLOGICAL SURVEY

Irrigation Well	Top	Bottom
SS #66941 (0'-65')	0	0
p soil	0	1
fine brown sand	1	13
coarse brown sand	13	45
gravel & sand	45	64
Total Depth		64

Casing: 16" PVC WC SCH 80 from 2' to 64'
Screen: 30' of 16" diameter .12 slot
Grout: BENTONITE from 0 to 0.
Water from sand & gravel at 0' to 0'.

Sample set # 66941 (0' - 65') Received: June 2, 1989

Location source: Location from permit

Permit Date: February 10, 1989 **Permit #:** 139628

COMPANY Erwin, Harold E.
FARM Dement, Margaret R.
DATE DRILLED March 24, 1989 **NO.**
ELEVATION 0 **COUNTY NO.** 35196
LOCATION NW NW NW
LATITUDE 39.12778 **LONGITUDE** -87.665637
COUNTY Crawford **API** 120333519600 **20 - 8N - 11W**

ILLINOIS STATE GEOLOGICAL SURVEY

Municipal Water Supply	Top	Bottom
fine dark brown sand	0	5
fine to medium sand	5	30
fine/med sand & gvl	30	73
Total Depth		73

Casing: 10" STEEL 40.48#/FT from -5' to 61'
Screen: 15' of 10" diameter .07999999821186066 slot
Grout: CEMENT from 0 to 20.
Size hole below casing: 24"

Water from Alluvial at 77' to 61'.
Static level 245' below casing top which is 5' above GL
Pumping level 35' when pumping at 400 gpm for 5 hours

Permanent pump installed at 50' on June 24, 1987, with a capacity of 300 gpm

Additional location info: Lot: #3C Subdivision: Jacob A. Parker

Location source: Location from permit

Permit Date: June 1, 1987 **Permit #:** 132217

COMPANY Peterson, Steven R.
FARM Hutsonville, City of
DATE DRILLED June 24, 1987 **NO.** 4
ELEVATION 0 **COUNTY NO.** 34405
LOCATION 557'S line, 1855'E line of section
LATITUDE 39.117019 **LONGITUDE** -87.654743
COUNTY Crawford **API** 120333440500 **20 - 8N - 11W**

TSD 000489

ILLINOIS STATE GEOLOGICAL SURVEY

Industrial Water Well	Top	Bottom
cinders, sand & clay	0	5
...ed to soft clay	5	22
soft gray clay	22	26
f-med s, gvl & bld	26	88
Total Depth		88

Casing: 26" .375 WALL from 0' to 57'
42" .375 WALL from -22' to 30'

Screen: 30' of 26" diameter .5 slot
Grout: CEMENT from 5 to 30.
Size hole below casing: 42"

Water from alluvial at 25' to 97'.
Static level 15' below casing top which is 0' above GL
Pumping level 22' when pumping at 826 gpm for 5 hours

Permanent pump installed at 60' on , with a capacity of 600 gpm

Driller's Log filed
Location source: Location from permit

Permit Date: August 26, 1983 **Permit #:** 109053

COMPANY Ruester, John T.
FARM Central Il Public Serv.Co.
DATE DRILLED October 28, 1983 **NO.** 4
ELEVATION 440GL **COUNTY NO.** 33867
LOCATION 350'S line, 150'W line of SE SW SE
LATITUDE 39.129677 **LONGITUDE** -87.654832
COUNTY **Crawford** **API** **120333386700** **17 - 8N - 11W**

TSD 000490

ILLINOIS STATE GEOLOGICAL SURVEY

Water Well	Top	Bottom
brown clay,very soft	0	20
gray clay very soft	20	25
crs sand & gravel w/bldr @ 40'(wtr brg)	25	54
gravel w/boulders very loose(wtr brg)	54	75
medium/fine sand very loose (wtr brg)	75	90
bedrock at	90	90
Total Depth		90

Casing: 42" from -1' to 30'
26" from -1' to 57'

Screen: 30' of 26" diameter 6 slot
Water from sand & gravel at 25' to 87'.
Static level 18' below casing top which is 2' above GL
Pumping level 24' when pumping at 825 gpm for 3 hours

Driller's Log filed
Sample set # 60350 (0' - 85') Received: June 1, 1976

Location source: Location from permit

Permit Date: May 18, 1976 **Permit #:** 47367

COMPANY owner
FARM C.I.P.S.-Hutsonville Unit
DATE DRILLED May 25, 1976 **NO.** 3
ELEVATION 440TM **COUNTY NO.** 29913
LOCATION 350'S line, 1630'E line of SE
LATITUDE 39.129678 **LONGITUDE** -87.654686
COUNTY **Crawford** **API** **120332991300** **17 - 8N - 11W**

ILLINOIS STATE GEOLOGICAL SURVEY

Private Water Well	Top	Bottom
sandy clay	0	5
sand & gravel	5	8
gray hardpan	8	15
gray sandstone	15	51
gry shale	51	64
coal	64	68
gray shale	68	90
Total Depth		90

Casing: 5" PVC SDR 21 from -2' to 90'

Grout: BENTONITE from 0 to 30.
Water from sandstone at 15' to 51'.
Static level 11' below casing top which is 2' above GL
Pumping level 85' when pumping at gpm for 5 hours
Permanent pump installed at 85' on December 24, 2007, with a capacity of 10 gpm

Address of well: same as above

Location source: Location from permit

Permit Date: December 17, 2007 **Permit #:** 033-7-0

COMPANY Van Gilder, Richard E.
FARM Allison, Jim
DATE DRILLED December 20, 2007 **NO.**
ELEVATION **COUNTY NO.** 37411
LOCATION NE NE SE
LATITUDE 39.135033 **LONGITUDE** -87.66725
COUNTY Crawford **API** 120333741100 **18 - 8N - 11W**