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**REPORT ON**

# HUMAN HEALTH AND ECOLOGICAL ASSESSMENT OF THE MERAMEC ENERGY CENTER

## AMEREN MISSOURI
## ST. LOUIS, MISSOURI

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# 1. Introduction

The Meramec Energy Center (MEC) is a 831 MW natural gas and coal-fueled steam electrical power generating facility located along the Mississippi River at the confluence of the Meramec River, in St. Louis County, Missouri. The facility began operations in 1953 and historically Ameren Missouri managed coal ash in a series of nine (9) on-site surface impoundments. The Company has commenced closure of certain impoundments and closure activities will continue over the next several years. The facility is scheduled to be retired in 2022 at which point the remaining active ash ponds will be closed. Figure 1 shows the location of the facility, and the location of the surface impoundments.

The U.S. Environmental Protection Agency (USEPA) issued a final rule for "Disposal of Coal Combustion Residuals from Electric Utilities" in 2015 (the CCR Rule). One of the requirements in the CCR Rule is that utilities monitor groundwater at coal ash management facilities, and that the data be reported publicly. Ameren Missouri is complying with the CCR Rule, and has posted the required information on their publicly-available website: *https://www.ameren.com/Environment/ccr-rule-compliance*.

This Haley & Aldrich report is a companion document to the recently published 2017 Annual Groundwater Monitoring Report prepared by Golder Associates Inc. ("Golder") to provide interested reviewers with the information needed to interpret and meaningfully understand the groundwater monitoring data. Beyond the specific monitoring requirements of the CCR Rule, Ameren Missouri has also voluntarily taken the additional steps to determine if there has been any off-site impact to surface water from the operation of the surface impoundments. In this report, Haley & Aldrich examines groundwater data reported under the CCR Rule, and the results of surface water samples collected from the Mississippi River and Meramec River, which border the Meramec Energy Center.

Ameren Missouri's comprehensive evaluation demonstrates that there are no adverse impacts resulting from coal ash management practices at the Meramec Energy Center on human health or the environment from either surface water or groundwater uses. In fact, as described in Sections 6 and 7, concentration levels of constituents detected in the groundwater would need to be multiple orders of magnitude higher before such a risk could exist. Details about the evaluation are provided below.

# 2. Approach

The analysis presented in this report was conducted by evaluating the environmental setting of the Meramec Energy Center, including its location and where ash management has occurred at the facility. Information on where groundwater is located at the facility, the rate(s) of groundwater flow, the direction(s) of groundwater flow, and where waterbodies may intercept groundwater flow was prepared by Golder, and is reviewed and summarized here.

A conceptual model was developed based on this physical setting information, and the model was used to identify what human populations could contact groundwater and/or surface water in the area of the facility. This information was also used to identify where ecological populations could come into contact with surface water. This conceptual model approach was used to identify where to collect surface water samples to allow evaluation of potential impact to the environment. Groundwater and surface water data are evaluated on a human health risk basis and an ecological risk basis.

Human health risk assessment is a process used to estimate the chance that contact with constituents in the environment may result in harm to people. Generally, there are four components to the process: (1) Hazard Identification, (2) Toxicity Assessment, (3) Exposure Assessment, and (4) Risk Characterization.

The USEPA develops "screening levels" of constituent concentrations in groundwater (and other media) that are considered to be protective of specific human exposures. These screening levels are referred to as "Risk-Based Screening Levels" or RSLs, and are published by USEPA and updated twice yearly[1]. In developing the screening levels, USEPA uses a specific target risk level (component 4) combined with an assumed exposure scenario (component 3) and toxicity information from USEPA (component 2) to derive an estimate of a concentration of a constituent in an environmental medium, for example groundwater, (component 1) that is protective of a person in that exposure scenario (for example, drinking water). Similarly, ecological screening levels for surface water are developed by Federal and State agencies to be protective of the wide range of potential aquatic ecological resources, or receptors.

Risk-based screening levels are designed to provide a conservative estimate of the concentration to which a receptor (human or ecological) can be exposed without experiencing adverse health effects. Due to the conservative methods used to derive risk-based screening levels, it can be assumed with reasonable certainty that concentrations below screening levels will not result in adverse health effects, and that no further evaluation is necessary. Concentrations above conservative risk-based screening levels do not necessarily indicate that a potential risk exists, but indicate that further evaluation may be warranted.

The surface water and groundwater data were evaluated using human health risk-based and ecological risk-based screening levels drawn from Federal and State sources. The screening levels are used to determine if the concentration levels of constituents could pose a risk to human health or the environment. The evaluation also considers whether constituents are present in groundwater and surface water above screening levels, and if so, if the results could be due to the ash management operations.

### Conceptual Site Model

A conceptual site model (CSM) is used to evaluate the potential for human or ecological exposure to constituents that may have been released to the environment. Some of the questions posed during the CSM evaluation include:

> What is the source? How can constituents be released from the source? What environmental media may be affected by constituent release? How and where do constituents travel within a medium? Is there a point where a receptor (human or ecological) could contact the constituents in the medium? Are the constituent concentrations high enough to potentially exert a toxic effect?

For the evaluation of the ash management operations at the Meramec Energy Center, the coal ash stored at surface impoundments on site is the potential source. Constituents present in the coal ash can be dissolved into infiltrating water (either from precipitation or from groundwater intrusion) and those constituents may then be present in shallow groundwater, also referred to as the alluvial aquifer. Constituents could move with groundwater as it flows, usually in a downgradient/downhill direction.

[1] USEPA Risk-Based Screening Levels (November 2017). http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm

The constituents derived from the coal ash could then be introduced to adjacent surface water bodies; here, that could be the Mississippi River and/or Meramec River. Figure 1 shows the facility location and layout, and identifies direction of groundwater flow and the adjacent surface water bodies. Thus, the environmental media of interest for this evaluation are:

- Groundwater on the facility;
- Mississippi River surface water;
- Meramec River surface water; and
- Creek/Drainage surface water along the northern boundary of the facility.

The direction of groundwater flow has been cataloged for many years at the Meramec Energy Center. The direction and rate of flow can vary with Mississippi and Meramec River stages but as Figure 1 shows, the direction of groundwater flow is mainly from the bluff area on the northern side to the southwest towards the Meramec River and to a lesser extent to the Mississippi River.

The facility is located in a metropolitan area and surrounded by bluffs. Its immediate neighbors include the Metropolitan Sewer District (MSD) wastewater treatment facility and a golf course owned by Ameren Missouri. There are no users of shallow groundwater that are present between the surface impoundments and the Mississippi River and Meramec River. According to a well survey database maintained by the Missouri Department of Natural Resources (MDNR), there are approximately eight (8) private wells and three (3) public wells recorded within a one-mile radius of the facility (see Figure 2). Five of the private wells are located between the Mississippi and Meramec Rivers and are upgradient of the facility. The three public wells and five of the private wells are located in a bluff area on the west side of the Meramec River and the Mississippi River.

American Water and the City of St. Louis provide drinking water to the majority of residents located within the metropolitan area. Water intake locations include the Mississippi River (Chain of Rocks), the Missouri River (Howard Bend), both upstream from the facility, and the Meramec River at a location approximately 5 miles upstream from the Meramec Energy Center. The Mississippi is a source of drinking water for the City of Chester, Illinois; the drinking water intake is located approximately 51.2 miles downstream from the facility.

The Mississippi and Meramec Rivers can be used for human recreation – wading, swimming, boating, fishing. The creek/drainage along the northern portion of the facility is small in size and would be limited mostly to wading.

Both rivers serve as habitat for aquatic species – fish, amphibians, etc.

A depiction of the conceptual site model is shown in Figure 3.

Based on this conceptual site model and the facility setting shown in Figure 1, samples have been collected from each of these environmental media – groundwater, Mississippi River, and Meramec River, as well as the creek/drainage along the northern portion of the facility. The samples have been analyzed for constituents that are commonly associated with coal ash, as discussed below. However, it is recognized by the USEPA that all of these constituents are naturally occurring and can be found in rocks, soils, water and sediments; thus, the challenge is to understand what the naturally occurring background levels are for these constituents. [See Attachment A for a more detailed discussion of the constituents present in coal ash and in our natural environment.] The CCR Rule requires sampling and analysis of upgradient and/or background groundwater just for this reason. The same reasoning applies to the surface water, thus, when sampling surface water for this evaluation, samples were collected

upstream to assess background conditions, and downstream to assess whether the facility may be having an impact on surface water quality. The sampling is detailed in the next section.

To answer the question, "Are the constituent concentrations high enough to potentially exert a toxic effect?" health risk-based screening levels from Federal and State sources are used for comparison to the data. To be conservative, all data are compared to risk-based drinking water screening level levels, even though the closest downgradient drinking water intake in the Mississippi River is 51.5 miles downstream near Chester, Illinois. The surface water data is compared to risk-based human recreational screening levels, and to ecological screening levels.

Thus, this conceptual site model has guided the sample collection, sample analysis, and the risk-based sample results evaluation that are provided in the following sections.

# 3. Sample Collection

### Alluvial Aquifer Groundwater

Ten (10) groundwater monitoring wells were installed to evaluate groundwater at the surface impoundments under the CCR Rule. Eight (8) monitoring wells were installed along the perimeter of the surface impoundments to assess groundwater conditions at the ash management area, and two (2) monitoring wells were installed north and east of the facility to assess background groundwater conditions. Figure 1 shows the locations and groundwater elevations of the monitoring wells. Each well is identified by a unique name. MW-1 through MW-8 are located around the perimeter of the surface impoundments, and BMW-1 and BMW-2 are the two background wells.

Each groundwater monitoring well was sampled nine (9) times in 2016 and 2017[2].

### Mississippi River

In September 2017, Golder collected surface water samples (not required by the CCR Rule for compliance) from twelve (12) locations in the Mississippi River. These locations are shown on Figure 4. At each sample location, shallow samples were collected near the surface of the river. Where the depth of water was greater than four (4) feet, a second sample was collected mid-depth in the river (referred to here as a deep sample).

To assess water conditions unaffected by facility operations, Golder sampled the Mississippi River at three (3) locations approximately 0.25 miles upstream of the facility (M-MIS-10S through -12S). Five (5) samples were collected to represent the following environments:

- Nearshore on the side closest to the Meramec Energy Center (M-MIS-10S), shallow depth;
- Midstream (M-MIS-12S/D), shallow depth, and deep depth; and
- Near midstream (M-MIS-11S/D), shallow depth, and deep depth.

Golder also sampled the Mississippi River at six (6) locations adjacent to the facility (M-MIS-4S through -9S). The data from these locations are used to assess whether there is potential impact by the facility to river water quality. Similar to the upstream location, ten (10) samples were collected to represent the following environments:

[2] The CCR Rule requires eight (8) rounds of sampling events to establish baseline conditions in each well. Under the CCR Rule, the ninth sampling round is defined as the "Detection" sampling round.

- Nearshore on the side closest to the Meramec Energy Center (M-MIS-4S and M-MIS-7S), shallow depth;
- Midstream (M-MIS-6S/D and M-MIS-9S/D), shallow depth, and deep depth; and
- Near midstream (M-MIS-5S/D and M-MIS-8S/D), shallow depth, and deep depth.

Three (3) locations are approximately 0.25 miles downstream of the facility (M-MIS-1S through -3S). The data from these locations are used to assess whether there is potential impact by the facility to river water quality. Similar to the upstream location, five (5) samples were collected to represent the following environments:

- Nearshore on the side closest to Meramec Energy Center (M-MIS-1S), shallow depth;
- Midstream (M-MIS-3S/D), shallow depth, and deep depth; and
- Near midstream (M-MIS-2S/D), shallow depth, and mid-depth.

Thus, a total of twenty (20) samples were collected from the Mississippi River.

### Meramec River

The western border of the Meramec Energy Center is adjacent to Meramec River. Golder collected surface water samples from nine (9) locations in the river in September 2017. These locations are shown on Figure 4.

Three (3) locations are upstream of the facility (M-MEC-7S to -9S), and represent water conditions unaffected by facility operations. Four (4) samples were collected to represent the following environments:

- Nearshore on the side closest to the Meramec Energy Center (M-MEC-7S), shallow depth;
- Midstream (M-MEC-9S/D), shallow depth, and deep depth; and
- Near midstream (M-MEC-8S), shallow depth (this location was not deep enough to collect a deep sample).

Six (6) sampling locations (in two groups) are adjacent to the facility. The data from these locations are used to assess whether there is potential impact by the facility to river water quality. Similar to the upstream location, nine (9) samples were collected to represent the following environments:

- Nearshore on the side closest to the Meramec Energy Center (M-MEC-4S and M-MEC-1S), shallow depth;
- Midstream (M-MEC-5S, and M-MEC-2S/D), shallow depth, and deep depth (location M-MEC-5 was not deep enough to collect a deep sample); and
- Near midstream (M-MEC-6S/D and M-MEC-3S/D), shallow depth, and deep depth.

Thus, a total of thirteen (13) surface water samples were collected from the Meramec River.

### Creek/Drainage

A creek/drainage bed runs along the northwestern boundary of Meramec Energy Center. Shallow surface water samples were collected from three (3) locations in the creek in September 2017. These locations are shown on Figure 4. One location is upstream of the facility (M-C-1), one location is adjacent (M-C-2), and one location is downstream of the facility (M-C-3), near the confluence with the

Meramec River. Thus, a total of three (3) surface water samples were collected from the creek/drainage area.

## 4. Sample Analysis

The CCR Rule identifies the constituents that are included for groundwater testing; these are:

| | | |
|---|---|---|
| Boron | Antimony | Lead |
| Calcium | Arsenic | Lithium |
| Chloride | Barium | Mercury |
| pH | Beryllium | Molybdenum |
| Sulfate | Cadmium | Selenium |
| Total Dissolved Solids (TDS) | Chromium | Thallium |
| Fluoride | Cobalt | Radium 226/228 |

The CCR Rule requires eight (8) rounds of groundwater sampling and analysis. However, nine (9) rounds of groundwater samples collected through June 2017 were analyzed for all constituents. The samples from an additional tenth round from November 2017 were analyzed for the constituents listed in the first column above (these are the Appendix III constituents under the CCR Rule – the remaining are referred to as Appendix IV constituents). The CCR Rule requires statistical methods be used to determine whether a statistically significant increase (SSI) above background exists for the first column constituents. If so, additional assessment monitoring could be required.

So as to create an appropriate dataset for comparison, the above parameters were also used for the surface water sample analysis except for pH and radium 226/228[3]. Two sets of analyses were conducted on the surface water samples. The samples were analyzed for the list above (referred to as the "total (unfiltered)" results), and then an aliquot of each sample was filtered to remove sediments/particulates and then analyzed (referred to as the "dissolved (filtered)" results). This is an important step for the analysis of surface water samples for two reasons:

- Surface water, especially in large rivers, can carry a large sediment load – the total (unfiltered results) include constituent concentrations that are associated with the sediment from upstream locations and not the water; and
- Some of the ecological screening levels used to evaluate the results apply only to dissolved (filtered) data.

The surface water samples were also analyzed for hardness, as some of the ecological screening levels are calculated based on site-specific hardness levels.

## 5. Risk-Based Screening Levels

A comprehensive set of risk-based screening levels have been compiled for this evaluation for the three types of potential exposures identified in the conceptual site model discussion above:

- Human health drinking water consumption;
- Human health recreational use of surface water; and
- Aquatic ecological receptors for surface water.

[3] As discussed in Section 6, radium-226/228 was not detected above risk-based screening levels in the CCR Rule monitoring wells.

Table 1 provides the human health drinking water and recreational screening levels available from the State of Missouri sources and from Federal sources. Table 2 provides the ecological screening levels.

### Drinking Water Screening Levels

The Missouri State drinking water supply levels are essentially the same as the Federal primary drinking water standards, also known as Maximum Contaminant Levels or MCLs. The Missouri State groundwater screening levels provide some additional screening levels not included on their list of drinking water screening levels.

In addition to the MCLs that are enforceable for municipal drinking water supplies, there are Federal secondary MCLs, or SMCLs, that are generally based on aesthetics (taste, color) and are not risk-based. The USEPA also provides risk-based screening levels (RSLs) for tapwater (drinking water).

The selected screening levels used to evaluate potential drinking water exposures are shown on Table 1. Missouri drinking water supply screening levels were used and supplemented with Federal MCLs, then the USEPA risk-based levels for tapwater (RSLs), and finally the Federal SMCLs.

It is important to note that the CCR Rule limits the evaluation of groundwater monitoring data of ash management areas to Federal MCLs or to a comparison with site-specific background. That comparison and evaluation is provided in the CCR Rule Groundwater Monitoring Report prepared by Golder, which this report supplements. The use of a more comprehensive set of screening levels in this evaluation provides a broader risk-based evaluation of the groundwater data than would be provided by the CCR Rule requirements.

### Recreational Screening Levels

Table 1 provides the State of Missouri human health recreational screening levels, based on fish consumption. The Federal Ambient Water Quality Criteria (AWQC) for consumption of organisms are also provided. Both sources were used to identify the screening levels used in this analysis, as listed on Table 1. The drinking water screening levels used to evaluate surface water are protective for other recreational uses of the river such as swimming, wading, and boating. Note that this evaluation of other uses of surface water are above and beyond the requirements of the CCR Rule.

### Ecological Screening Levels

The ecological risk-based screening levels for surface water are provided in Tables 2. As noted above, some of the screening levels are based on the hardness of the water. Therefore, Table 2 provides the screening levels for both the Mississippi River and the Meramec River as the hardness data for the two rivers are similar. Note that this ecological evaluation of surface water is above and beyond the requirements of the CCR Rule.

## 6. Results

The level of analysis and comparison to risk-based screening levels presented below is above and beyond the requirements of the CCR Rule. The analysis of the groundwater results required by the CCR Rule is presented in the 2017 Groundwater Monitoring Annual Report prepared by Golder: *https://www.ameren.com/Environment/managing-ccrs/ash-pond-closure*. This report serves to supplement that report by providing the risk-based analysis of groundwater and surface water, so that the groundwater results can be understood in their broader environmental context.

### Alluvial Aquifer Groundwater – CCR Rule Evaluation

Ameren Missouri has filed on its website reports and notification required by the federal CCR Rule, as noted above, and additional reports will be prepared and posted on Ameren's website per the CCR Rule. The statistical analysis of the data has indicated an SSI for samples collected from monitoring wells M-MW-1 through MW-8 (see Figure 1). Analytes exhibiting an SSI include boron, calcium, sulfate, and TDS.

The SSI values reflect a statistical evaluation that compares mathematically the results of the various rounds of samples to background water quality as required under the CCR rule. However, such values without further evaluation do not establish that there is an actual adverse impact to human health or the environment. The CSM process and screening analysis described in this report provides the relevant context for such groundwater monitoring results and whether the MEC poses a true risk to human health and the environment. As explained in the remaining sections of this report, based upon surface water sampling data and the application of risk assessment principles uniformly adopted by USEPA and state environmental regulators including the Missouri Department of Natural Resources (MDNR), no such risk exists.

### Alluvial Aquifer Groundwater – Risk-Based Evaluation

Groundwater data from all nine (9) rounds of groundwater monitoring were compared to the human health risk-based drinking water screening levels. Figure 1 shows that the monitoring wells are located at the edge of the surface impoundments and, therefore, provide worst-case groundwater results.

Table 3 compares the results of all sampling rounds to human health drinking water screening levels. Analytical results greater than the screening level are provided; analytical results below the risk-based drinking water screening levels are indicated by "<". The vast majority of the results are below the human health risk-based drinking water screening levels.

A limited number of parameters are above screening values for some, but not all, sampling events. MW-6 has the most results above the screening levels: these are for boron, sulfate, TDS, cobalt, lithium, and molybdenum. MW-7 also has a majority of results for boron, sulfate, TDS, lithium, and molybdenum above the screening levels. Note that shallow groundwater in the vicinity of the ash management areas is not used as a source of drinking water. The drinking water wells within the 1-mile radius of the facility are upgradient and, therefore, not impacted by facility operations.

The striking aspect of the analysis shown in Table 3 is how few results are above a conservative risk-based drinking water screening level for human health, given that the wells are located at the base of the ash management area, and the facility has been in operation for 65 years[4]. Even for the very few results that may be above screening values for some of the sampling events, including the SSI results identified under the CCR Rule, there is no complete drinking water exposure pathway to groundwater. Where there is no exposure, there is no risk.

### Mississippi River

The comparison to risk-based screening levels of the analytical results for the Mississippi River are presented in Tables 4 through 6.

[4] Out of the 1660 groundwater analyses conducted, only 242 results are above a drinking water screening level (see Table 3). Put another way, approximately 85% of the groundwater results for the CCR Rule monitoring wells located at the edge of the MEC impoundments are below drinking water screening levels.

- Table 4 – Comparison to drinking water screening levels – No results are above risk-based screening levels for drinking water.
- Table 5 – Comparison to human health recreational screening levels – Only total and dissolved concentrations of arsenic are above their screening levels. The arsenic results upstream and downstream are similar, thus, indicative of normal river conditions. In addition, groundwater samples on-site indicate that arsenic is either below screening levels or non-detected, thus, indicating that arsenic in the river is not attributable to the surface impoundments.
- Table 6 – Comparison to ecological screening levels – No results are above risk-based ecological screening levels, with the exception of a single result for selenium that was just slightly above the screening level. Selenium was not detected in on-site groundwater above drinking water screening levels thus indicated the selenium in the river is not likely attributable to the surface impoundments.

There are no analytical results for the Mississippi River that above drinking water screening levels. While arsenic concentrations in the river are slightly above the human health recreational screening levels, the concentrations are similar upstream and downstream indicating that the facility is not the source of the arsenic detected in the river. In fact, the concentrations of arsenic in all of the rivers sampled by Ameren for this evaluation (the Mississippi at Sioux, Meramec, and Rush Island; the Missouri River at Labadie and Sioux; and the Meramec River at Meramec) are all very similar with total results ranging from 0.0012 to 0.005 mg/L. This underscores the fact that arsenic is naturally occurring in our environment, as discussed in more detail in Attachment A.

Thus, the Mississippi River sampling results do not show evidence of impact of constituents derived from the MEC. This is important in that the absence of concentrations above risk-based screening levels means that there is not a significant pathway of exposure.

### Meramec River

The comparison to risk-based screening levels of the analytical results for Meramec River are presented in:

- Table 7 – Comparison to drinking water screening levels – All results are below the risk-based screening levels with the exception of lead. The total lead results upstream and downstream are similar and, thus, indicative of normal river conditions. All dissolved concentrations of lead are below the screening level, indicating that lead is associated with particulate in the river. In addition, groundwater samples on-site indicate that lead is either below screening levels or non-detected, thus, indicating that lead in the river is not attributable to the surface impoundments.
- Table 8 – Comparison to human health recreational screening levels – All results are below the risk-based screening levels with the exception of arsenic. The total and dissolved arsenic results upstream and downstream are similar and, thus, indicative of normal river conditions. In addition, groundwater samples on-site indicate that arsenic is either below screening levels or non-detected, thus, indicating that arsenic in the river is not likely attributable to the surface impoundments.
- Table 9 – Comparison to ecological screening levels – All results are below the risk-based screening levels with the exception of lead. The total lead results upstream and downstream are similar and, thus, likely represent normal river conditions. As noted above, groundwater samples on-site indicate that lead is either below screening levels or non-detected, thus, indicating that the lead in the river is not likely attributable to the surface impoundments.

Total lead concentrations are above drinking water and ecological screening levels in the Meramec River. However, the concentrations are similar upstream and downstream. Lead is not present above drinking water screening levels in site groundwater. Arsenic concentrations in the creek are slightly above the human health recreational screening levels, the concentrations are similar upstream and downstream. Arsenic is not present above drinking water screening levels in site groundwater.

Thus, the Meramec River sampling results do not show evidence of impact of constituents derived from the surface impoundments.

### Creek/Drainage

The comparison to risk-based screening levels of the analytical results for Creek/Drainage are presented in:

- Table 10 – Comparison to drinking water screening levels – All results are below risk-based screening levels for drinking water.
- Table 11 – Comparison to human health recreational screening levels – Only total concentrations of arsenic are above the screening level. The total arsenic results upstream and downstream are similar, thus indicative of represent normal creek conditions. In addition, groundwater samples on-site indicate that arsenic is either below screening levels or non-detected, thus, indicating that arsenic in the river is not likely attributable to the surface impoundments.
- Table 12 – Comparison to ecological screening levels – All results are below risk-based screening levels for ecological risk.

There are no analytical results for the creek/drainage that above drinking water screening levels. While arsenic concentrations in the creek/drainage are slightly above the human health recreational screening levels, arsenic is not present above drinking water screening levels in site groundwater, the concentrations are similar upstream and downstream and, thus, likely represent normal conditions and not attributable to the surface impoundments.

Thus, even this small water body immediately adjacent to the impoundments does not show evidence of risk to human health or the environment from ash management operations at the MEC. This is important in that the absence of concentrations above risk-based screening levels means that there is not a significant pathway of exposure.

### NPDES Outfall WET Testing Results

Two permitted outfalls under the National Pollutant Discharge Elimination System (NPDES) program are tested for toxicity on a periodic basis as required by the permit. WET (whole effluent toxicity) testing involves mixing Mississippi River water collected upstream with the effluent water from Outfall 003 and from Outfall 009 to simulate mixing of the effluent upon discharge to the river. The tests are conducted on a 10% effluent mixture. Tests are also conducted on the upstream Mississippi River water and on laboratory reconstituted control water. If the effluent treatment results are not statistically different from the control results, then the effluent is considered to have passed the WET test. Table 13 shows the results of the direct aquatic organism toxicity testing that is conducted using the outfall effluents

from 2013 through 2017[5]. The results indicate no evidence of aquatic toxicity of the outfall effluent. This is a direct biological measure demonstrating the lack of toxicity of the Outfall 003 and Outfall 009 effluent.

## 7. Derivation of Risk-Based Screening Levels for Groundwater

The results presented here demonstrate that the 65-year history of ash management activities at the surface impoundments have not had an adverse effect on human health or the environment. While some groundwater results are above drinking water screening levels, there is no pathway of exposure to the on-site groundwater (i.e., the shallow alluvial groundwater is not used as a source of drinking water). For those waters where a theoretical pathway of exposure exists (i.e., the Mississippi River, the Meramec River, and the adjacent creek-drainage area), there is no evidence of impact and all samples are either below screening levels or consistent with background.

Ameren's facilities are located on major river systems with a massive and rapid river flow. In this section, we have attempted to illustrate how the groundwater – which is a fraction of the volume and flow rate of the river – may interact with a surface body under an assumed set of criteria and conditions. (see Attachment B). Such an exercise in assumptions can help put in context whether a theoretical risk to public water supplies exists, particularly where, as here, actual surface water samples have been collected and evaluated.

However, impacts to groundwater does not mean that surface waters are impaired. The degree of interface between groundwater and surface waters is variable and complex and dependent upon a variety of factors including gradient and flow rate. It is possible, however, to determine the maximum concentration level that would need to be present on-site in groundwater and still be protective of the surface water environment, assuming gradient and flow rates are such that groundwater flows into the surface water. Groundwater and surface waters flow at very different rates and volumes. The Mississippi River is the largest river system in North America and as depicted on Table 14 and Attachment B, when compared to groundwater, its dilution factor is greater than 100,000.

It is possible to calculate a protective screening level for groundwater based upon the amount of dilution that occurs under the above assumption. This calculated risk-based screening level for groundwater can be used to determine whether an on-site groundwater concentration level is protective of the river. Stated differently, at what concentration level does groundwater entering the river system pose a human health or ecological risk?

Table 14 and Table 15 are summarized below and show the application of the dilution factor to calculate risk-based screening levels for the following parameters: boron, sulfate, TDS, cobalt, lithium, and molybdenum. These Table 3 constituents have one or more monitoring well concentrations above the drinking water screening levels. For each constituent, the human health drinking water and recreational screening levels are presented as well as the ecological screening level. The lowest of the three screening levels is then identified for surface water and the dilution factor applied to this lowest screening level. The resulting calculation indicates the concentration level that would have to be present in groundwater for there to be a corresponding ecological or human health risk to either Mississippi River or Meramec River bodies.

[5] Note that presently effluent is discharged only from Outfall 003.

This evaluation is not limited to only those constituents for which SSIs have been identified. The constituents listed here are those for which there is one or more groundwater result above a risk-based screening level[6].

**DERIVATION OF RISK-BASED SCREENING LEVELS FOR GROUNDWATER BASED ON THE MISSISSIPPI RIVER (see Table 14)**

| | **Estimated Dilution Factor for the Mississippi River** | 100,000 | | | |
|---|---|---|---|---|---|
| **Constituents** | **Lowest of the Human Health and Ecological Screening Levels (mg/L)** | **Groundwater Risk-Based Screening Level* (mg/L)** | **Maximum MEC Groundwater Concentration (mg/L)** | | **Ratio Between Groundwater Risk-Based Screening Level and the Maximum MEC Groundwater Concentration** |
| Boron** | 2 | 200000 | 30.3 | M-MW-7 | >6,000 |
| Sulfate** | 250 | 25000000 | 1250 | M-MW-7 | >20,000 |
| TDS** | 500 | 50000000 | 2320 | M-MW-7 | >21,000 |
| Cobalt | 0.006 | 600 | 0.0078 | M-MW-6 | >76,000 |
| Lithium | 0.04 | 4000 | 0.164 | M-MW-6 | >24,000 |
| Molybdenum | 0.1 | 10000 | 0.717 | M-MW-7 | >13,000 |

**CALCULATING RISK-BASED SCREENING LEVELS FOR GROUNDWATER BASED ON THE MERAMEC RIVER (see Table 15)**

| | **Estimated Dilution Factor for the Meramec River** | 700 | | | |
|---|---|---|---|---|---|
| **Constituents** | **Lowest of the Human Health and Ecological Screening Levels (mg/L)** | **Groundwater Risk-Based Screening Level* (mg/L)** | **Maximum MEC Groundwater Concentration (mg/L)** | | **Ratio Between Groundwater Target Level and the Maximum MEC Groundwater Concentration** |
| Boron** | 2 | 1400 | 30.3 | M-MW-7 | >40 |
| Sulfate** | 250 | 175000 | 1250 | M-MW-7 | >100 |
| TDS** | 500 | 350000 | 2320 | M-MW-7 | >100 |
| Cobalt | 0.006 | 4.2 | 0.0078 | M-MW-6 | >500 |
| Lithium | 0.04 | 28 | 0.164 | M-MW-6 | >100 |
| Molybdenum | 0.1 | 70 | 0.717 | M-MW-7 | >90 |

*** Where the Groundwater Risk-Based Screening Level = Screening Level x Dilution Factor.**

**** Constituents for which an SSI has been identified. Note that although an SSI was identified for boron, sulfate, and TDS, these constituents are not present in surface water at concentrations above the risk-based screening levels.**

[6] Note that under the CCR Rule, statistically significant levels of Appendix IV constituents are determined after Assessment Monitoring has been conducted.

The groundwater alternative risk-based screening levels are calculated in units of milligrams of constituent per liter of water (mg/L). One mg/L is equivalent to one million parts per million.[7]

The table identifies the maximum groundwater concentration of each constituent detected in the MEC monitoring wells. The comparison between the target levels and the maximum concentrations indicates that there is a wide margin of safety between the two values for both the Mississippi River and the Meramec River. This margin is shown in the last column of each table. To illustrate, concentration levels of boron and molybdenum would need to be more than 40 and 90 times higher, respectively, than currently measured levels before an adverse impact in the Meramec River could occur. Similarly, the concentration levels of boron and molybdenum would need to be more than 6,000 and 13,000 times higher, respectively, than currently measured levels before an adverse impact in the Mississippi River could occur.

This means that not only do the present concentrations of constituents in groundwater at the RCPA not pose a risk to human health or the environment, but even much higher concentrations would not be harmful.

## 8. Closure of the Surface Impoundments

Ameren Missouri has commenced the closure of inactive surface impoundments[8]. Closure of the CCR units will continue in series until the remaining surface impoundments are closed following the retirement of the facility in 2022. Closure is estimated to reduce the movement of CCR constituents from the surface impoundments discharge (or flux) of water into the alluvial aquifer groundwater by 90% or more. This reduction is the result of several factors: closure will cease the flow of water and ash to the surface impoundments, a cap will be installed that will limit infiltration of precipitation, and the closure plan includes stormwater run-on and run-off controls to route stormwater off of the capped area and away from the surface impoundments. It is likely that concentrations of constituents in groundwater at the surface impoundments will decrease post-closure.

## 9. Summary

This comprehensive evaluation demonstrates that there are no adverse impacts on human health from either surface water or groundwater uses resulting from coal ash management practices at the Meramec Energy Center.

## 10. Attachments

TABLES

1 HUMAN HEALTH SCREENING LEVELS

2 ECOLOGICAL SCREENING LEVELS

[7] A million parts per million is equivalent to 1 penny in $10,000 worth of pennies, 1 second in 11.5 days, or 1 inch in 15.8 miles.

[8] Importantly, the CCR Rule promulgated by USEPA in 2015 is both under appeal [Utility Solid Waste Activities, et al v. EPA, Docket No. 15-01219, DC Circuit Court of Appeals Sept 13, 2017, Letter from Pruitt to reconsider.] and is being reconsidered by the current Administration. Notwithstanding any proposed changes to the federal CCR Rule, Ameren Missouri intends to implement its closure plan and schedule.

FIGURES



ATTACHMENTS

# TABLES

**TABLE 1**
**HUMAN HEALTH SCREENING LEVELS**
**MERAMEC ENERGY CENTER, ST. LOUIS COUNTY, MO**
**AMEREN MISSOURI**

| | | | Missouri State Water Quality Screening Levels (mg/L) | | | Federal Water Quality Screening Levels (mg/L) | | | | Selected Screening Level (mg/L) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Constituent | Abbreviation | CASRN | Human Health Fish Consumption (a) | Drinking Water Supply (a) | Groundwater (a) | USEPA AWQC Human Health Consumption of Organism Only (b) | MCLs (c) | SMCLs (c) | November 2017 USEPA Tapwater RSLs (d) | Drinking Water (e) | Recreational Use (f) |
| Antimony | Sb | 7440-36-0 | 4.3 | 0.006 | 0.006 | 0.64 | 0.006 | NA | 0.0078 (m) | 0.006 | 4.3 |
| Arsenic | As | 7440-38-2 | NA | 0.05 | 0.05 | 0.00014 (i) | 0.01 | NA | 0.000052 | 0.05 | 0.00014 |
| Barium | Ba | 7440-39-3 | NA | 2 | 2 | NA | 2 | NA | 3.8 | 2 | NA |
| Beryllium | Be | 7440-41-7 | NA | 0.004 | 0.004 | NA | 0.004 | NA | 0.025 | 0.004 | NA |
| Boron | B | 7440-42-8 | NA | NA | 2 | NA | NA | NA | 4 | 4 (q) | NA |
| Cadmium | Cd | 7440-43-9 | NA | 0.005 | 0.005 | NA | 0.005 | NA | 0.0092 | 0.005 | NA |
| Calcium | Ca | 7440-70-2 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Chloride | Cl | 7647-14-5 | NA | 250 | NA | NA | NA | 250 | NA | 250 | NA |
| Chromium | Cr | 16065-83-1 (g) | NA | 0.1 | 0.1 | NA | 0.1 (j) | NA | 22 (n) | 0.1 | NA |
| Cobalt | Co | 7440-48-4 | NA | NA | 1 | NA | NA | NA | 0.006 | 0.006 | NA |
| Fluoride | Fl | 16984-48-8 | NA | 4 | 4 | NA | 4 | 2 | 0.8 | 4 | NA |
| Lead | Pb | 7439-92-1 | NA | 0.015 | 0.015 | NA | 0.015 (k) | NA | 0.015 | 0.015 | NA |
| Lithium | Li | 7439-93-2 | NA | NA | NA | NA | NA | NA | 0.04 | 0.04 | NA |
| Mercury | Hg | 7487-94-7 (h) | NA | 0.002 | 0.002 | NA | 0.002 (l) | NA | 0.0057 (o) | 0.002 | NA |
| Molybdenum | Mo | 7439-98-7 | NA | NA | NA | NA | NA | NA | 0.1 | 0.1 | NA |
| Radium 226/228 (pCi/L) | Ra 226/228 | RADIUM226228 | NA | NA | NA | NA | 5 | NA | NA | 5 | NA |
| Selenium | Se | 7782-49-2 | NA | 0.05 | 0.05 | 4.2 | 0.05 | NA | 0.1 | 0.05 | 4.2 |
| Sulfate | SO4 | 7757-82-6 | NA | 250 | NA | NA | NA | 250 | NA | 250 | NA |
| Thallium | Tl | 7440-28-0 | 0.0063 | 0.002 | 0.002 | 0.00047 | 0.002 | NA | 0.0002 (p) | 0.002 | 0.0063 |
| Total Dissolved Solids | TDS | TDS | NA | NA | NA | NA | NA | 500 | NA | 500 | NA |
| pH (std) | -- | PHFLD | NA | NA | NA | NA | NA | 6.5 - 8.5 | NA | 6.5 - 8.5 | NA |

Notes:

AWQC - Ambient Water Quality Criteria.
CASRN - Chemical Abstracts Service Registry Number.
HI - Hazard Index (noncancer child).
MCL - Maximum Contaminant Level.
mg/L - milligram per liter.
NA - not available.
pCi/L - picoCurie per liter.
RSL - Risk-based Screening Levels (USEPA).
TR - Target Risk (carcinogenic).
USEPA - United States Environmental Protection Agency.

(a) - 10 Missouri Code of State Regulations Division 20 Chapter 7 Table A. Updated January 29, 2014. Per 10 CSR 20-7.031(4)(B)(2), the criteria for Human Protection Fish Consumption apply to dissolved metals data. All other criteria apply to total concentrations.
http://www.sos.mo.gov/adrules/csr/current/10csr/10c20-7a.pdf
(b) - USEPA National Recommended Water Quality Criteria. USEPA Office of Water and Office of Science and Technology. Accessed November 2014.
https://www.epa.gov/wqc/national-recommended-water-quality-criteria-human-health-criteria-table
USEPA AWQC Human Health for the Consumption of Organism Only apply to total concentrations.
(c) - USEPA 2012 Edition of the Drinking Water Standards and Health Advisories. Spring 2012.
http://water.epa.gov/drink/contaminants/index.cfm
(d) - USEPA Risk-Based Screening Levels (November 2017). Values for tapwater. HI = 1.0, TR = 1E-06.
http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm
(e) - The hierachy for selecting the Human Health Screening Level for Drinking Water is: Missouri State Water Quality Criteria for Drinking Water Supply (a); Federal USEPA MCL for Drinking Water (c); Federal June 2017 USEPA Tapwater RSL (d); Federal USEPA SMCL for Drinking Water (c).
(f) - The hierachy for selecting the Human Health Screening Level for Recreational Use is: Missouri State Water Quality Criteria for Human Health Fish Consumption (a); Federal USEPA AWQC for Human Health Consumption of Organism Only (b).
(g) - CAS number for Trivalent Chromium.
(h) - CAS number for Mercuric Chloride.
(i) - Value applies to inorganic form of arsenic only.
(j) - Value for Total Chromium.
(k) - Lead Treatment Technology Action Level is 0.015 mg/L.
(l) - Value for Inorganic Mercury.
(m) - RSL for Antimony (metallic) used for Antimony.
(n) - RSL for Chromium (III), Insoluble Salts used for Chromium.
(o) - RSL for Mercuric Chloride used for Mercury.
(p) - RSL for Thallium (Soluble Salts) used for Thallium.
(q) - RSL selected for Boron as the Missouri State Water Quality Groundwater screening level is based on irrigation.

**TABLE 2**
**ECOLOGICAL SCREENING LEVELS**
**MERAMEC ENERGY CENTER, ST. LOUIS COUNTY, MO**
**AMEREN MISSOURI**

| | | Missouri State Water Quality Criteria (mg/L) | | | | | | Federal Water Quality Criteria (mg/L) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Site-Specific Protection of Aquatic Life Acute (a) | | Site-Specific Protection of Aquatic Life Chronic (a) | | Irrigation (a) | Livestock Wildlife Watering (a) | Site-Specific USEPA Aquatic Life AWQC Freshwater Acute (b) | | Site-Specific USEPA Aquatic Life AWQC Freshwater Chronic (b) | |
| **Constituent** | **CASRN** | **Total** | **Dissolved** | **Total** | **Dissolved** | **Total** | **Total** | **Total** | **Dissolved** | **Total** | **Dissolved** |
| Antimony (c) | 7440-36-0 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Arsenic | 7440-38-2 | NA | NA | NA | 0.02 | 0.1 | NA | 0.34 | 0.34 | 0.15 | 0.15 |
| Barium (c) | 7440-39-3 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Beryllium | 7440-41-7 | NA | NA | NA | 0.005 | 0.1 | NA | NA | NA | NA | NA |
| Boron | 7440-42-8 | NA | NA | NA | NA | 2 | NA | NA | NA | NA | NA |
| Cadmium | 7440-43-9 | 0.011 | 0.010 | 0.00049 | 0.0004 | NA | NA | 0.0042 (f) | 0.0038 (g) | 0.0015 (f) | 0.0013 (g) |
| Calcium (c) | 7440-70-2 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Chloride | 16887-00-6 | NA | NA | NA | NA | NA | NA | 860 | NA | 230 | NA |
| Chromium | 7440-47-3 | 3.5 | 1.1 | 0.17 | 0.14 | 0.1 (e) | NA | 3.5 (e,g) | 1.1 (e,h) | 0.17 (e,g) | 0.14 (e,h) |
| Cobalt | 7440-48-4 | NA | NA | NA | NA | NA | 1 | NA | NA | NA | NA |
| Fluoride | 16984-48-8 | NA | NA | NA | NA | NA | 4 | NA | NA | NA | NA |
| Lead | 7439-92-1 | 0.23 | 0.15 | 0.0089 | 0.0060 | NA | NA | 0.23 (f) | 0.15 (g) | 0.0089 (f) | 0.0060 (g) |
| Lithium (c) | 7439-93-2 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Mercury | 7439-97-6 | 0.0024 | 0.0024 | 0.0005 | 0.0005 | NA | NA | 0.0016 | 0.0014 | 0.00091 | 0.00077 |
| Molybdenum (c) | 7439-98-7 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Selenium | 7782-49-2 | NA | NA | NA | 0.005 | NA | NA | 0.013 (d) | 0.013 (d) | 0.005 (d) | 0.005 (d) |
| Sulfate | 14808-79-8 | NA | NA | 1608 (g,i) | NA | NA | NA | NA | NA | NA | NA |
| Thallium (c) | 7440-28-0 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Total Dissolved Solids (c) | TDS | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |

Notes:
AWQC - USEPA Ambient Water Quality Criteria.
CASRN - Chemical Abstracts Service Registry Number.
CMC - Criterion Maximum Concentration.
mg/L - milligram per liter.
NA - Not Available.
USEPA - United States Environmental Protection Agency.

(a) - 10 Missouri Code of State Regulations Division 20 Chapter 7 Table A. January 29, 2014.
http://www.sos.mo.gov/adrules/csr/current/10csr/10c20-7a.pdf. Total values provided.
Missouri State Protection of Aquatic Life Acute and Chronic values apply only to dissolved results (except mercury);
irrigation, livestock/wildlife watering, and mercury Aquatic Life Acute and Chronic values apply only to totals results.
(b) - USEPA National Recommended Water Quality Criteria. USEPA Office of Water and Office of Science and Technology. Accessed December 2014.
http://water.epa.gov/scitech/swguidance/standards/criteria/current/index.cfm
Total values provided. Values adjusted for site-specific hardness - see note (f).
USEPA provides AWQC for both total and dissolved results.
(c) - Water quality criteria from the presented sources are not available for this constituent.
(d) - The selenium value is based on the 1999 selenium criterion document for screening purposes.
Acute AWQC is equal to 1/[(f1/CMC1) + (f2/CMC2)] where f1 and f2 are the fractions of total selenium that are treated as selenite and selenate,
respectively, and CMC1 and CMC2 are 185.9 ug/L and 12.82 ug/L, respectively. Calculated assuming that all selenium is present as selenate,
a likely overly conservative assumption.
(e) - Value for trivalent chromium used.
(f) - Hardness dependent value for total metals. Site-specific total recoverable mean hardness value for Meramec River and Mississippi River of 224 mg/L as CaCO3 used.
(g) - Hardness dependent value for total metals adjusted for dissolved fraction. Site-specific total recoverable mean hardness value for the Meramec River and
Mississippi River of 224 mg/L as CaCO3 used.
(h) - Chloride dependent value (default chloride value of 25 mg/L is assumed) for Meramec River and Mississippi River.
When chloride is greater than or equal to 25 and less than or equal to 500 mg/L and hardness is between 100 and 500 mg/L,
sulfate limit in mg/L = [1276.7 + 5.508 (hardness) − 1.457 (chloride)] * 0.65.

**TABLE 3**
**SUMMARY OF MERAMEC SURFACE IMPOUNDMENT GROUNDWATER MONITORING RESULTS COMPARISON TO HUMAN HEALTH DRINKING WATER SCREENING LEVELS**
**MERAMEC ENERGY CENTER, ST. LOUIS COUNTY, MO**
**AMEREN MISSOURI**

| | | Human Health Drinking Water Screening (a) | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Constituent** | Boron | Calcium | Chloride | pH | Sulfate | TDS | Fluoride | Antimony | Arsenic | Barium | Beryllium | Cadmium | Chromium | Cobalt | Lead | Lithium | Mercury | Molybdenum | Selenium | Thallium | Radium-226/228 |
| | **HH DW SL** | 4 | NA | 250 | 6.5-8.5 | 250 | 500 | 4 | 0.006 | 0.05 | 2 | 0.004 | 0.005 | 0.1 | 0.006 | 0.015 | 0.04 | 0.002 | 0.1 | 0.05 | 0.002 | 5 |
| **Monitoring Well ID** | **Sampling Event Date** | mg/L | mg/L | mg/L | S.U. | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | pCi/L |
| M-BMW-1 (b) | May-16 | < | < | < | < | < | 832 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| | Jun-16 | < | < | < | < | < | 755 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| | Jul-16 | < | < | < | < | < | 772 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| | Sep-16 | < | < | < | < | < | 817 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| | Nov-16 | < | < | < | < | < | 751 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| | Jan-17 | < | < | < | < | < | 752 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| | Mar-17 | < | < | < | < | < | 728 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| | Jun-17 | < | < | < | < | < | 723 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| | Nov-17 | < | < | < | NA | < | 764 | < | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| M-BMW-2 (b) | Mar-16 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| | May-16 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| | Jul-16 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| | Sep-16 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| | Nov-16 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| | Jan-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| | Mar-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| | Jun-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| | Nov-17 | < | < | < | NA | < | < | < | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| M-MW-1 | Mar-16 | < | < | < | < | < | 611 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| | May-16 | < | < | < | < | < | 663 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| | Jul-16 | < | < | < | < | < | 675 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| | Sep-16 | < | < | < | < | < | 623 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| | Nov-16 | < | < | < | < | < | 609 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| | Jan-17 | < | < | < | < | < | 608 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| | Mar-17 | < | < | < | < | < | 632 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| | Jun-17 | < | < | < | < | < | 643 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| | Nov-17 | < | < | < | NA | < | 612 | < | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| M-MW-2 | Mar-16 | 4.53 | < | < | < | 313 | 716 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| | May-16 | 5.4 | < | < | < | 329 | 847 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| | Jul-16 | 4.06 | < | < | < | 299 | 811 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| | Sep-16 | 4.74 | < | < | < | 312 | 802 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| | Nov-16 | < | < | < | < | 290 | 756 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| | Jan-17 | 5.88 | < | < | < | 352 | 750 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| | Mar-17 | 6.6 | < | < | < | 399 | 850 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| | Jun-17 | 6.04 | < | < | < | 317 | 809 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| | Nov-17 | 5.08 | < | < | NA | 330 | < | < | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| M-MW-3 | Mar-16 | 5.61 | < | < | < | < | 682 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| | May-16 | 5.96 | < | < | < | 264 | 755 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| | Jul-16 | 8.28 | < | < | < | 309 | 872 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| | Sep-16 | 9.39 | < | < | < | 344 | 957 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| | Nov-16 | 8.41 | < | < | < | 348 | 854 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| | Jan-17 | 6.75 | < | < | < | < | 729 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| | Mar-17 | 6.8 | < | < | < | 315 | 832 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| | Jun-17 | 6.63 | < | < | < | 278 | 816 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| | Nov-17 | 6.66 | < | < | NA | 318 | 809 | < | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| M-MW-4 | Mar-16 | 8.98 | < | < | < | 370 | 918 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| | May-16 | 8.36 | < | < | < | 380 | 1030 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| | Jul-16 | 8.71 | < | < | < | 366 | 993 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| | Sep-16 | 8.54 | < | < | < | 378 | 995 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| | Nov-16 | 8.58 | < | < | < | 402 | 908 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| | Jan-17 | 8.66 | < | < | < | 403 | 925 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| | Mar-17 | 8.89 | < | < | < | 404 | 976 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| | Jun-17 | 9 | < | < | < | 378 | 964 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| | Nov-17 | 8.54 | < | < | NA | 404 | 928 | < | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| M-MW-5 | Mar-16 | 7.3 | < | < | < | 374 | 918 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| | May-16 | 6.9 | < | < | < | 355 | 940 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| | Jul-16 | 7.07 | < | < | < | 341 | 1030 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| | Sep-16 | 7.13 | < | < | < | 391 | 1050 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| | Nov-16 | 7.97 | < | < | < | 438 | 1010 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| | Jan-17 | 8.97 | < | < | < | 446 | 1000 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| | Mar-17 | 9.24 | < | < | < | 425 | 1060 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| | Jun-17 | 9.04 | < | < | < | 410 | 1090 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| | Nov-17 | 8.72 | < | < | NA | 426 | 1030 | < | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| M-MW-6 | Mar-16 | 18.8 | < | < | < | 580 | 1280 | < | < | < | < | < | < | < | < | < | < | 0.129 | < | 0.137 | < | < | < |
| | May-16 | 25.9 | < | < | < | 631 | 1310 | < | < | < | < | < | < | < | < | < | < | 0.164 | < | 0.124 | < | < | < |
| | Jul-16 | 14.7 | < | < | < | 555 | 1370 | < | < | < | < | < | < | < | < | < | < | 0.13 | < | 0.129 | < | < | < |
| | Sep-16 | 14.8 | < | < | < | 547 | < | < | < | < | < | < | < | < | < | < | < | 0.123 | < | 0.12 | < | < | < |
| | Nov-16 | 13.8 | < | < | < | 610 | 1290 | < | < | < | < | < | < | < | 0.0061 | < | 0.13 | < | 0.135 | < | < | < |
| | Jan-17 | 9.8 | < | < | < | 672 | 1500 | < | < | < | < | < | < | < | 0.0065 | < | 0.138 | < | 0.163 | < | < | < |
| | Mar-17 | 11.1 | < | < | < | 656 | 1510 | < | < | < | < | < | < | < | < | < | 0.14 | < | 0.157 | < | < | < |
| | Jun-17 | 10.9 | < | < | < | 504 | 1320 | < | < | < | < | < | < | < | 0.0078 | < | 0.129 | < | 0.147 | < | < | < |
| | Nov-17 | 8.6 | < | < | NA | 696 | 1590 | < | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |

**TABLE 3**
**SUMMARY OF MERAMEC SURFACE IMPOUNDMENT GROUNDWATER MONITORING RESULTS COMPARISON TO HUMAN HEALTH DRINKING WATER SCREENING LEVELS**
**MERAMEC ENERGY CENTER, ST. LOUIS COUNTY, MO**
**AMEREN MISSOURI**

| | | Human Health Drinking Water Screening (a) | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Constituent** | Boron | Calcium | Chloride | pH | Sulfate | TDS | Fluoride | Antimony | Arsenic | Barium | Beryllium | Cadmium | Chromium | Cobalt | Lead | Lithium | Mercury | Molybdenum | Selenium | Thallium | Radium-226/228 |
| | **HH DW SL** | 4 | NA | 250 | 6.5-8.5 | 250 | 500 | 4 | 0.006 | 0.05 | 2 | 0.004 | 0.005 | 0.1 | 0.006 | 0.015 | 0.04 | 0.002 | 0.1 | 0.05 | 0.002 | 5 |
| **Monitoring Well ID** | **Sampling Event Date** | mg/L | mg/L | mg/L | S.U. | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | pCi/L |
| M-MW-7 | Mar-16 | 21.5 | < | < | < | 911 | 1590 | < | < | < | < | < | < | < | < | < | < | < | 0.451 | < | < | < |
| | May-16 | 18.7 | < | < | < | 941 | 1660 | < | < | < | < | < | < | < | < | < | 0.0403 | < | 0.338 | < | < | < |
| | Jul-16 | 21.1 | < | < | < | 881 | 1780 | < | < | < | < | < | < | < | < | < | 0.0509 | < | 0.359 | < | < | < |
| | Sep-16 | 20.3 | < | < | < | 1000 | 1740 | < | < | < | < | < | < | < | < | < | 0.0436 | < | 0.351 | < | < | < |
| | Nov-16 | 21.4 | < | < | < | 756 | 1690 | < | < | < | < | < | < | < | < | < | 0.0583 | < | 0.331 | < | < | < |
| | Jan-17 | 30.3 | < | < | < | 999 | 2060 | < | < | < | < | < | < | < | < | < | 0.0711 | < | 0.297 | < | < | < |
| | Mar-17 | 25.5 | < | < | < | 1250 | 2220 | < | < | < | < | < | < | < | < | < | 0.0742 | < | 0.314 | < | < | < |
| | Jun-17 | 19.3 | < | < | < | 896 | 1630 | < | < | < | < | < | < | < | < | < | < | < | 0.717 | < | < | < |
| | Nov-17 | 25.6 | < | < | NA | 1220 | 2320 | < | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| M-MW-8 | Mar-16 | 9.94 | < | < | < | 469 | 875 | < | < | < | < | < | < | < | < | < | < | < | 0.229 | < | < | < |
| | May-16 | 9.56 | < | < | < | 449 | 959 | < | < | < | < | < | < | < | < | < | < | < | 0.204 | < | < | < |
| | Jul-16 | 9.05 | < | < | < | 437 | 985 | < | < | < | < | < | < | < | < | < | < | < | 0.215 | < | < | < |
| | Sep-16 | 8.64 | < | < | < | 455 | < | < | < | < | < | < | < | < | < | < | < | < | 0.211 | < | < | < |
| | Nov-16 | 8.89 | < | < | < | 478 | 881 | < | < | < | < | < | < | < | < | < | < | < | 0.212 | < | < | < |
| | Jan-17 | 8.91 | < | < | < | 448 | 886 | < | < | < | < | < | < | < | < | < | < | < | 0.207 | < | < | < |
| | Mar-17 | 9.39 | < | < | < | 456 | 908 | < | < | < | < | < | < | < | < | < | < | < | 0.213 | < | < | < |
| | Jun-17 | 8.39 | < | < | < | 407 | 957 | < | < | < | < | < | < | < | < | < | < | < | 0.19 | < | < | < |
| | Nov-17 | 7.6 | < | < | NA | 435 | 917 | < | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Summary Ratio of # Results above the SL : Total # Results | | 62:90 | 0:90 | 0:90 | 0:80 | 61:90 | 78:90 | 0:90 | 0:80 | 0:80 | 0:80 | 0:80 | 0:80 | 0:80 | 3:80 | 0:80 | 14:80 | 0:80 | 24:80 | 0:80 | 0:80 | 0:80 |

Notes:
< - less than the Human Health Drinking Water Screening Leve
DW - Drinking Water.
HH - Human Health.
MCL - Maximum Contaminant Level
mg/L - milligram per liter.
NA - Not Applicable/Not Analyzed
RSL - Risk-Based Screening Level
SL - Screening Level.
TDS - Total Dissolved Solids
USEPA - United States Environmental Protection Agency

(a) - Drinking Water Screening Levels selected in Table 1 following the following hierarch
Missouri State Water Quality Criteria for Drinking Water Supply
Federal USEPA MCL for Drinking Water.
Federal November 2017 USEPA Tapwater RSL.
Federal USEPA SMCL for Drinking Water.
(b) - Background wells

**TABLE 4**
**SUMMARY OF MISSISSIPPI RIVER SURFACE WATER TOTAL (UNFILTERED) AND DISSOLVED (FILTERED) RESULTS COMPARISON TO HUMAN HEALTH DRINKING WATER SCREENING LEVELS**
**MERAMEC ENERGY CENTER, ST. LOUIS COUNTY, MO**
**AMEREN MISSOURI**

| | | Human Health Drinking Water Screening (a) | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Constituent** | Boron | | Calcium | | Chloride | pH | Sulfate | TDS | Fluoride | Antimony | | Arsenic | | Barium | | Beryllium | | Cadmium | | Chromium | |
| | **Fraction** | Total | Dissolved | Total | Dissolved | Total | Total | Total | Total | Total | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Dissolved |
| **Sample Location** | **HH DW SL** | 4 | 4 | NA | NA | 250 | 6.5-8.5 | 250 | 500 | 4 | 0.006 | 0.006 | 0.05 | 0.05 | 2 | 2 | 0.004 | 0.004 | 0.005 | 0.005 | 0.1 | 0.1 |
| **ID** | **Sampling Event Date** | mg/L | mg/L | mg/L | mg/L | mg/L | S.U. | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L |
| **UPSTREAM** | | | | | | | | | | | | | | | | | | | | | | |
| M-MIS-10S | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| M-MIS-11D | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| M-MIS-11S | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| M-MIS-12D | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| M-MIS-12S | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| **ADJACENT** | | | | | | | | | | | | | | | | | | | | | | |
| M-MIS-4S | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| M-MIS-5D | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| M-MIS-5S | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| M-MIS-6D | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| M-MIS-6S | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| M-MIS-7S | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| M-MIS-8D | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| M-MIS-8S | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| M-MIS-9D | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| M-MIS-9S | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| **DOWNSTREAM** | | | | | | | | | | | | | | | | | | | | | | |
| M-MIS-1S | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| M-MIS-2D | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| M-MIS-2S | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| M-MIS-3D | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| M-MIS-3S | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |

Notes:
< - less than the Human Health Drinking Water Screening Level.
DW - Drinking Water.
HH - Human Health.
MCL - Maximum Contaminant Level.
mg/L - milligram per liter.
NA - Not Applicable/Not Analyzed.
pCi/L - picoCurie per liter.
RSL - Risk-Based Screening Level.
SL - Screening Level.
S.U. - Standard Units.
TDS - Total Dissolved Solids.
USEPA - United States Environmental Protection Agency.

(a) - Drinking Water Screening Levels selected in Table 1 following the following hierarchy:
Missouri State Water Quality Criteria for Drinking Water Supply.
Federal USEPA MCL for Drinking Water.
Federal November 2017 USEPA Tapwater RSL.
Federal USEPA SMCL for Drinking Water.

**TABLE 4**
**SUMMARY OF MISSISSIPPI RIVER SURFACE WATER TOTAL (UNFILTERED) AND DISSOLVED (FILTERED) RESULTS COMPARISON TO HUMAN HEALTH DRINKING WATER SCREENING LEVELS**
**MERAMEC ENERGY CENTER, ST. LOUIS COUNTY, MO**
**AMEREN MISSOURI**

| | | Human Health Drinking Water Screening (a) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Constituent** | Cobalt | | Lead | | Lithium | | Mercury | | Molybdenum | | Selenium | | Thallium | | Radium-226/228 | Hardness |
| | **Fraction** | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Total |
| **Sample Location** | **HH DW SL** | 0.006 | 0.006 | 0.015 | 0.015 | 0.04 | 0.04 | 0.002 | 0.002 | 0.1 | 0.1 | 0.05 | 0.05 | 0.002 | 0.002 | 5 | NA |
| **ID** | **Sampling Event Date** | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | pCi/L | mg/L |
| **UPSTREAM** | | | | | | | | | | | | | | | | | |
| M-MIS-10S | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MIS-11D | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MIS-11S | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MIS-12D | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MIS-12S | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| **ADJACENT** | | | | | | | | | | | | | | | | | |
| M-MIS-4S | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MIS-5D | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MIS-5S | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MIS-6D | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MIS-6S | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MIS-7S | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MIS-8D | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MIS-8S | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MIS-9D | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MIS-9S | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| **DOWNSTREAM** | | | | | | | | | | | | | | | | | |
| M-MIS-1S | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MIS-2D | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MIS-2S | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MIS-3D | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MIS-3S | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |

Notes:
< - less than the Human Health Drinking Water Screening Level.
DW - Drinking Water.
HH - Human Health.
MCL - Maximum Contaminant Level.
mg/L - milligram per liter.
NA - Not Applicable/Not Analyzed.
pCi/L - picoCurie per liter.
RSL - Risk-Based Screening Level.
SL - Screening Level.
S.U. - Standard Units.
TDS - Total Dissolved Solids.
USEPA - United States Environmental Protection Agency.

(a) - Drinking Water Screening Levels selected in Table 1 following the following hierarchy:
Missouri State Water Quality Criteria for Drinking Water Supply.
Federal USEPA MCL for Drinking Water.
Federal November 2017 USEPA Tapwater RSL.
Federal USEPA SMCL for Drinking Water.

**TABLE 5**
**SUMMARY OF MISSISSIPPI RIVER SURFACE WATER TOTAL (UNFILTERED) AND DISSOLVED (FILTERED) RESULTS COMPARISON TO HUMAN HEALTH RECREATIONAL USE SCREENING LEVELS**
**MERAMEC ENERGY CENTER, ST. LOUIS COUNTY, MO**
**AMEREN MISSOURI**

| | | Human Health Recreational Use Screening (a) | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Constituent** | Boron | | Calcium | | Chloride | pH | Sulfate | TDS | Fluoride | Antimony | | Arsenic | | Barium | | Beryllium | | Cadmium | | Chromium | |
| | **Fraction** | Total | Dissolved | Total | Dissolved | Total | Total | Total | Total | Total | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Dissolved |
| | **HH REC SL** | NA | NA | NA | NA | NA | 6.5-8.5 | NA | NA | NA | 4.3 | 4.3 | 0.00014 | 0.00014 | NA | NA | NA | NA | NA | NA | NA | NA |
| **Sample Location ID** | **Sampling Event Date** | mg/L | mg/L | mg/L | mg/L | mg/L | S.U. | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L |
| **UPSTREAM** | | | | | | | | | | | | | | | | | | | | | | |
| M-MIS-10S | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | 0.003 | 0.0028 | < | < | < | < | < | < | < | < |
| M-MIS-11D | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | 0.0028 | 0.0026 | < | < | < | < | < | < | < | < |
| M-MIS-11S | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | 0.003 | 0.0025 | < | < | < | < | < | < | < | < |
| M-MIS-12D | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | 0.0024 | 0.0019 | < | < | < | < | < | < | < | < |
| M-MIS-12S | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | 0.0022 | 0.0019 | < | < | < | < | < | < | < | < |
| **ADJACENT** | | | | | | | | | | | | | | | | | | | | | | |
| M-MIS-4S | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | 0.0032 | 0.0028 | < | < | < | < | < | < | < | < |
| M-MIS-5D | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | 0.0028 | 0.0024 | < | < | < | < | < | < | < | < |
| M-MIS-5S | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | 0.0027 | 0.0024 | < | < | < | < | < | < | < | < |
| M-MIS-6D | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | 0.0024 | 0.0019 | < | < | < | < | < | < | < | < |
| M-MIS-6S | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | 0.0023 | 0.002 | < | < | < | < | < | < | < | < |
| M-MIS-7S | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | 0.0035 | 0.0027 | < | < | < | < | < | < | < | < |
| M-MIS-8D | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | 0.0029 | 0.0024 | < | < | < | < | < | < | < | < |
| M-MIS-8S | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | 0.0027 | 0.0025 | < | < | < | < | < | < | < | < |
| M-MIS-9D | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | 0.0022 | 0.0018 | < | < | < | < | < | < | < | < |
| M-MIS-9S | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | 0.0022 | 0.0021 | < | < | < | < | < | < | < | < |
| **DOWNSTREAM** | | | | | | | | | | | | | | | | | | | | | | |
| M-MIS-1S | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | 0.0028 | 0.0024 | < | < | < | < | < | < | < | < |
| M-MIS-2D | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | 0.003 | 0.0025 | < | < | < | < | < | < | < | < |
| M-MIS-2S | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | 0.003 | 0.0024 | < | < | < | < | < | < | < | < |
| M-MIS-3D | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | 0.0024 | 0.0021 | < | < | < | < | < | < | < | < |
| M-MIS-3S | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | 0.0026 | 0.0021 | < | < | < | < | < | < | < | < |

Notes:
< - less than the Human Health Recreational Use Screening Level.
HH - Human Health.
mg/L - milligram per liter.
NA - Not Applicable/Not Analyzed.
pCi/L - picoCurie per liter.
REC - Recreational Use.
SL - Screening Level.
S.U. - Standard Units.
TDS - Total Dissolved Solids.
USEPA - United States Environmental Protection Agency.

(a) - Recreational Use Screening Levels selected in Table 1 following the following hierarchy:
Missouri State Water Quality Criteria for Human Health Fish Consumption.
USEPA Ambient Water Quality Criteria for Human Health Consumption of Organism Only.

**TABLE 5**
**SUMMARY OF MISSISSIPPI RIVER SURFACE WATER TOTAL (UNFILTERED) AND DISSOLVED (FILTERED) RESULTS COMPARISON TO HUMAN HEALTH RECREATIONAL USE SCREENING LEVELS**
**MERAMEC ENERGY CENTER, ST. LOUIS COUNTY, MO**
**AMEREN MISSOURI**

| | | Human Health Recreational Use Screening (a) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Constituent** | Cobalt | | Lead | | Lithium | | Mercury | | Molybdenum | | Selenium | | Thallium | | Radium-226/228 | Hardness |
| | **Fraction** | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Total |
| | **HH REC SL** | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 4.2 | 4.2 | 0.0063 | 0.0063 | NA | NA |
| **Sample Location ID** | **Sampling Event Date** | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | pCi/L | mg/L |
| **UPSTREAM** | | | | | | | | | | | | | | | | | |
| M-MIS-10S | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MIS-11D | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MIS-11S | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MIS-12D | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MIS-12S | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| **ADJACENT** | | | | | | | | | | | | | | | | | |
| M-MIS-4S | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MIS-5D | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MIS-5S | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MIS-6D | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MIS-6S | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MIS-7S | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MIS-8D | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MIS-8S | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MIS-9D | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MIS-9S | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| **DOWNSTREAM** | | | | | | | | | | | | | | | | | |
| M-MIS-1S | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MIS-2D | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MIS-2S | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MIS-3D | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MIS-3S | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |

Notes:
< - less than the Human Health Recreational Use Screening Level.
HH - Human Health.
mg/L - milligram per liter.
NA - Not Applicable/Not Analyzed.
pCi/L - picoCurie per liter.
REC - Recreational Use.
SL - Screening Level.
S.U. - Standard Units.
TDS - Total Dissolved Solids.
USEPA - United States Environmental Protection Agency.

(a) - Recreational Use Screening Levels selected in Table 1 following the following hierarchy:
Missouri State Water Quality Criteria for Human Health Fish Consumption.
USEPA Ambient Water Quality Criteria for Human Health Consumption of Organism Only.

**TABLE 6**
**SUMMARY OF MISSISSIPPI RIVER SURFACE WATER TOTAL (UNFILTERED) AND DISSOLVED (FILTERED) RESULTS COMPARISON TO ECOLOGICAL SCREENING LEVELS**
**MERAMEC ENERGY CENTER, ST. LOUIS COUNTY, MO**
**AMEREN MISSOURI**

| | | Ecological Screening (a) | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Constituent** | Boron | | Calcium | | Chloride | pH | Sulfate | TDS | Fluoride | Antimony | | Arsenic | | Barium | | Beryllium | | Cadmium | | Chromium | |
| | **Fraction** | Total | Dissolved | Total | Dissolved | Total | Total | Total | Total | Total | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Dissolved |
| **Sample** | **ECO SL** | 2 | 2 | NA | NA | 230 | 6.5-8.5 | 1608 | NA | 4 | NA | NA | 0.15 | 0.15 | NA | NA | 0.1 | 0.1 | 0.0015 | 0.0015 | 0.167 | 0.167 |
| **Location ID** | **Sampling Event Date** | mg/L | mg/L | mg/L | mg/L | mg/L | S.U | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L |
| **UPSTREAM** | | | | | | | | | | | | | | | | | | | | | | |
| M-MIS-10S | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| M-MIS-11D | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| M-MIS-11S | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| M-MIS-12D | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| M-MIS-12S | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| **ADJACENT** | | | | | | | | | | | | | | | | | | | | | | |
| M-MIS-4S | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| M-MIS-5D | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| M-MIS-5S | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| M-MIS-6D | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| M-MIS-6S | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| M-MIS-7S | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| M-MIS-8D | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| M-MIS-8S | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| M-MIS-9D | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| **DOWNSTREAM** | | | | | | | | | | | | | | | | | | | | | | |
| M-MIS-9S | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| M-MIS-1S | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| M-MIS-2D | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| M-MIS-2S | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| M-MIS-3D | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| M-MIS-3S | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |

Notes:
< - Less than the Ecological Screening Level.
ECO - Ecological.
mg/L - milligram per liter.
NA - Not Applicable/Not Analyzed.
pCi/L - picoCurie per liter.
SL - Screening Level.
S.U. - Standard Units.
TDS - Total Dissolved Solids.
USEPA - United States Environmental Protection Agency.

Qualifiers:
J - Value is estimated.

(a) - Ecological Screening Levels selected in Table 2 following the following hierarchy:
Missouri State Water Quality Criteria for the Protection of Aquatic Life (Chronic).
USEPA Aquatic Life Ambient Water Quality Criteria (Chronic).
Missouri State Water Quality Criteria for the Protection of Aquatic Life (Acute).
USEPA Aquatic Life Ambient Water Quality Criteria (Acute).
Missouri State Water Quality Criteria for Irrigation.
Missouri State Water Quality Criteria for Livestock Wildlife Watering.

**TABLE 6**
**SUMMARY OF MISSISSIPPI RIVER SURFACE WATER TOTAL (UNFILTERED) AND DISSOLVED (FILTERED) RESULTS COMPARISON TO ECOLOGICAL SCREENING LEVELS**
**MERAMEC ENERGY CENTER, ST. LOUIS COUNTY, MO**
**AMEREN MISSOURI**

| | | Ecological Screening (a) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Constituent** | Cobalt | | Lead | | Lithium | | Mercury | | Molybdenum | | Selenium | | Thallium | | Radium-226/228 | Hardness |
| | **Fraction** | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Total |
| **Sample** | **ECO SL** | 1 | 1 | 0.0089 | 0.0089 | NA | NA | 0.0005 | 0.0005 | NA | NA | 0.005 | 0.005 | NA | NA | NA | NA |
| **Location ID** | **Sampling Event Date** | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | pCi/L | mg/L |
| **UPSTREAM** | | | | | | | | | | | | | | | | | |
| M-MIS-10S | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MIS-11D | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MIS-11S | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MIS-12D | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MIS-12S | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| **ADJACENT** | | | | | | | | | | | | | | | | | |
| M-MIS-4S | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MIS-5D | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MIS-5S | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MIS-6D | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MIS-6S | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | 0.0051 J | < | < | NA | < |
| M-MIS-7S | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MIS-8D | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MIS-8S | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MIS-9D | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| **DOWNSTREAM** | | | | | | | | | | | | | | | | | |
| M-MIS-9S | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MIS-1S | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MIS-2D | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MIS-2S | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MIS-3D | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MIS-3S | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |

Notes:
< - Less than the Ecological Screening Level.
ECO - Ecological.
mg/L - milligram per liter.
NA - Not Applicable/Not Analyzed.
pCi/L - picoCurie per liter.
SL - Screening Level.
S.U. - Standard Units.
TDS - Total Dissolved Solids.
USEPA - United States Environmental Protection Agency.

Qualifiers:
J - Value is estimated.

(a) - Ecological Screening Levels selected in Table 2 following the following hierarchy:
Missouri State Water Quality Criteria for the Protection of Aquatic Life (Chronic).
USEPA Aquatic Life Ambient Water Quality Criteria (Chronic).
Missouri State Water Quality Criteria for the Protection of Aquatic Life (Acute).
USEPA Aquatic Life Ambient Water Quality Criteria (Acute).
Missouri State Water Quality Criteria for Irrigation.
Missouri State Water Quality Criteria for Livestock Wildlife Watering.

**TABLE 7**
**SUMMARY OF MERAMEC RIVER SURFACE WATER TOTAL (UNFILTERED) AND DISSOLVED (FILTERED) RESULTS COMPARISON TO HUMAN HEALTH DRINKING WATER SCREENING LEVELS**
**MERAMEC ENERGY CENTER, ST. LOUIS COUNTY, MO**
**AMEREN MISSOURI**

| | | Human Health Drinking Water Screening (a) | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Constituent** | Boron | | Calcium | | Chloride | pH | Sulfate | TDS | Fluoride | Antimony | | Arsenic | | Barium | | Beryllium | | Cadmium | | Chromium | |
| | **Fraction** | Total | Dissolved | Total | Dissolved | Total | Total | Total | Total | Total | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Dissolved |
| **Sample** | **HH DW SL** | 4 | 4 | NA | NA | 250 | 6.5-8.5 | 250 | 500 | 4 | 0.006 | 0.006 | 0.05 | 0.05 | 2 | 2 | 0.004 | 0.004 | 0.005 | 0.005 | 0.1 | 0.1 |
| **Location ID** | **Sampling Event Date** | mg/L | mg/L | mg/L | mg/L | mg/L | S.U. | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L |
| **UPSTREAM** | | | | | | | | | | | | | | | | | | | | | | |
| M-MEC-7S | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| M-MEC-8S | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| M-MEC-9D | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| M-MEC-9S | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| **ADJACENT** | | | | | | | | | | | | | | | | | | | | | | |
| M-MEC-4S | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| M-MEC-5S | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| M-MEC-6D | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| M-MEC-6S | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| **DOWNSTREAM** | | | | | | | | | | | | | | | | | | | | | | |
| M-MEC-1S | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| M-MEC-2D | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| M-MEC-2S | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| M-MEC-3D | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| M-MEC-3S | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |

Notes:
< - less than the Human Health Drinking Water Screening Level.
DW - Drinking Water.
HH - Human Health.
MCL - Maximum Contaminant Level.
mg/L - milligram per liter.
NA - Not Applicable/Not Analyzed.
pCi/L - picoCurie per liter.
RSL - Risk-Based Screening Level.
SL - Screening Level.
S.U. - Standard Units.
TDS - Total Dissolved Solids.
USEPA - United States Environmental Protection Agency.

(a) - Drinking Water Screening Levels selected in Table 1 following the following hierarchy:
Missouri State Water Quality Criteria for Drinking Water Supply.
Federal USEPA MCL for Drinking Water.
Federal November 2017 USEPA Tapwater RSL.
Federal USEPA SMCL for Drinking Water.

**TABLE 7**
**SUMMARY OF MERAMEC RIVER SURFACE WATER TOTAL (UNFILTERED) AND DISSOLVED (FILTERED) RESULTS COMPARISON TO HUMAN HEALTH DRINKING WATER SCREENING LEVELS**
**MERAMEC ENERGY CENTER, ST. LOUIS COUNTY, MO**
**AMEREN MISSOURI**

| | | Human Health Drinking Water Screening (a) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Constituent** | Cobalt | | Lead | | Lithium | | Mercury | | Molybdenum | | Selenium | | Thallium | | Radium-226/228 | Hardness |
| | **Fraction** | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Total |
| **Sample** | **HH DW SL** | 0.006 | 0.006 | 0.015 | 0.015 | 0.04 | 0.04 | 0.002 | 0.002 | 0.1 | 0.1 | 0.05 | 0.05 | 0.002 | 0.002 | 5 | NA |
| **Location ID** | **Sampling Event Date** | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | pCi/L | mg/L |
| **UPSTREAM** | | | | | | | | | | | | | | | | | |
| M-MEC-7S | Sep-17 | < | < | 0.0172 | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MEC-8S | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MEC-9D | Sep-17 | < | < | 0.0205 | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MEC-9S | Sep-17 | < | < | 0.0196 | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| **ADJACENT** | | | | | | | | | | | | | | | | | |
| M-MEC-4S | Sep-17 | < | < | 0.0175 | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MEC-5S | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MEC-6D | Sep-17 | < | < | 0.018 | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MEC-6S | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| **DOWNSTREAM** | | | | | | | | | | | | | | | | | |
| M-MEC-1S | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MEC-2D | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MEC-2S | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MEC-3D | Sep-17 | < | < | 0.0155 | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MEC-3S | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |

Notes:
< - less than the Human Health Drinking Water Screening Level.
DW - Drinking Water.
HH - Human Health.
MCL - Maximum Contaminant Level.
mg/L - milligram per liter.
NA - Not Applicable/Not Analyzed.
pCi/L - picoCurie per liter.
RSL - Risk-Based Screening Level.
SL - Screening Level.
S.U. - Standard Units.
TDS - Total Dissolved Solids.
USEPA - United States Environmental Protection Agency.

(a) - Drinking Water Screening Levels selected in Table 1 following the following hierarchy:
Missouri State Water Quality Criteria for Drinking Water Supply.
Federal USEPA MCL for Drinking Water.
Federal November 2017 USEPA Tapwater RSL.
Federal USEPA SMCL for Drinking Water.

**TABLE 8**
**SUMMARY OF MERAMEC RIVER SURFACE WATER TOTAL (UNFILTERED) AND DISSOLVED (FILTERED) RESULTS COMPARISON TO HUMAN HEALTH RECREATIONAL USE SCREENING LEVELS**
**MERAMEC ENERGY CENTER, ST. LOUIS COUNTY, MO**
**AMEREN MISSOURI**

| | | Human Health Recreational Use Screening (a) | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Constituent** | Boron | | Calcium | | Chloride | pH | Sulfate | TDS | Fluoride | Antimony | | Arsenic | | Barium | | Beryllium | | Cadmium | | Chromium | |
| | **Fraction** | Total | Dissolved | Total | Dissolved | Total | Total | Total | Total | Total | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Dissolved |
| | **HH REC SL** | NA | NA | NA | NA | NA | 6.5-8.5 | NA | NA | NA | 4.3 | 4.3 | 0.00014 | 0.00014 | NA | NA | NA | NA | NA | NA | NA | NA |
| **Sample Location ID** | **Sampling Event Date** | mg/L | mg/L | mg/L | mg/L | mg/L | S.U. | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L |
| **UPSTREAM** | | | | | | | | | | | | | | | | | | | | | | |
| M-MEC-7S | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | 0.0018 | 0.0016 | < | < | < | < | < | < | < | < |
| M-MEC-8S | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | 0.0014 | 0.0013 | < | < | < | < | < | < | < | < |
| M-MEC-9D | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | 0.0013 | 0.0011 | < | < | < | < | < | < | < | < |
| M-MEC-9S | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | 0.0012 | 0.0011 | < | < | < | < | < | < | < | < |
| **ADJACENT** | | | | | | | | | | | | | | | | | | | | | | |
| M-MEC-4S | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | 0.0018 | 0.0014 | < | < | < | < | < | < | < | < |
| M-MEC-5S | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | 0.0016 | 0.0013 | < | < | < | < | < | < | < | < |
| M-MEC-6D | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | 0.0014 | 0.0012 | < | < | < | < | < | < | < | < |
| M-MEC-6S | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | 0.0013 | 0.0011 | < | < | < | < | < | < | < | < |
| **DOWNSTREAM** | | | | | | | | | | | | | | | | | | | | | | |
| M-MEC-1S | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | 0.0016 | 0.0013 | < | < | < | < | < | < | < | < |
| M-MEC-2D | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | 0.0014 | 0.0012 | < | < | < | < | < | < | < | < |
| M-MEC-2S | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | 0.0015 | 0.0011 | < | < | < | < | < | < | < | < |
| M-MEC-3D | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | 0.0014 | 0.0011 | < | < | < | < | < | < | < | < |
| M-MEC-3S | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | 0.0015 | 0.0012 | < | < | < | < | < | < | < | < |

Notes:
< - Less than the Human Health Recreational Use Screening Level.
HH - Human Health.
mg/L - milligram per liter.
NA - Not Applicable/Not Analyzed.
pCi/L - picoCurie per liter.
REC - Recreational Use.
SL - Screening Level.
S.U. - Standard Units.
TDS - Total Dissolved Solids.
USEPA - United States Environmental Protection Agency.

(a) - Recreational Use Screening Levels selected in Table 1 following the following hierarchy:
Missouri State Water Quality Criteria for Human Health Fish Consumption.
USEPA Ambient Water Quality Criteria for Human Health Consumption of Organism Only.

**TABLE 8**
**SUMMARY OF MERAMEC RIVER SURFACE WATER TOTAL (UNFILTERED) AND DISSOLVED (FILTERED) RESULTS COMPARISON TO HUMAN HEALTH RECREATIONAL USE SCREENING LEVELS**
**MERAMEC ENERGY CENTER, ST. LOUIS COUNTY, MO**
**AMEREN MISSOURI**

| | | Human Health Recreational Use Screening (a) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Constituent** | Cobalt | | Lead | | Lithium | | Mercury | | Molybdenum | | Selenium | | Thallium | | Radium-226/228 | Hardness |
| | **Fraction** | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Total |
| | **HH REC SL** | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 4.2 | 4.2 | 0.0063 | 0.0063 | NA | NA |
| **Sample Location ID** | **Sampling Event Date** | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | pCi/L | mg/L |
| **UPSTREAM** | | | | | | | | | | | | | | | | | |
| M-MEC-7S | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MEC-8S | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MEC-9D | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MEC-9S | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| **ADJACENT** | | | | | | | | | | | | | | | | | |
| M-MEC-4S | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MEC-5S | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MEC-6D | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MEC-6S | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| **DOWNSTREAM** | | | | | | | | | | | | | | | | | |
| M-MEC-1S | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MEC-2D | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MEC-2S | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MEC-3D | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MEC-3S | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |

Notes:
< - Less than the Human Health Recreational Use Screening Level.
HH - Human Health.
mg/L - milligram per liter.
NA - Not Applicable/Not Analyzed.
pCi/L - picoCurie per liter.
REC - Recreational Use.
SL - Screening Level.
S.U. - Standard Units.
TDS - Total Dissolved Solids.
USEPA - United States Environmental Protection Agency.

(a) - Recreational Use Screening Levels selected in Table 1 following the following hierarchy:
Missouri State Water Quality Criteria for Human Health Fish Consumption.
USEPA Ambient Water Quality Criteria for Human Health Consumption of Organism Only.

**TABLE 9**
**SUMMARY OF MERAMEC RIVER SURFACE WATER TOTAL (UNFILTERED) AND DISSOLVED (FILTERED) RESULTS COMPARISON TO ECOLOGICAL SCREENING LEVELS**
**MERAMEC ENERGY CENTER, ST. LOUIS COUNTY, MO**
**AMEREN MISSOURI**

| | | Ecological Screening (a) | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Constituent** | Boron | | Calcium | | Chloride | pH | Sulfate | TDS | Fluoride | Antimony | | Arsenic | | Barium | | Beryllium | | Cadmium | | Chromium | |
| | **Fraction** | Total | Dissolved | Total | Dissolved | Total | Total | Total | Total | Total | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Dissolved |
| **Sample** | **ECO SL** | 2 | 2 | NA | NA | 230 | 6.5-8.5 | 1608 | NA | 4 | NA | NA | 0.15 | 0.15 | NA | NA | 0.1 | 0.1 | 0.0015 | 0.0015 | 0.167 | 0.167 |
| **Location ID** | **Sampling Event Date** | mg/L | mg/L | mg/L | mg/L | mg/L | S.U | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L |
| **UPSTREAM** | | | | | | | | | | | | | | | | | | | | | | |
| M-MEC-7S | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| M-MEC-8S | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| M-MEC-9D | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| M-MEC-9S | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| **ADJACENT** | | | | | | | | | | | | | | | | | | | | | | |
| M-MEC-4S | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| M-MEC-5S | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| M-MEC-6D | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| M-MEC-6S | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| **DOWNSTREAM** | | | | | | | | | | | | | | | | | | | | | | |
| M-MEC-1S | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| M-MEC-2D | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| M-MEC-2S | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| M-MEC-3D | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| M-MEC-3S | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |

Notes:
< - Less than the Ecological Screening Level.
ECO - Ecological.
mg/L - milligram per liter.
NA - Not Applicable/Not Analyzed.
pCi/L - picoCurie per liter.
SL - Screening Level.
S.U. - Standard Units.
TDS - Total Dissolved Solids.
USEPA - United States Environmental Protection Agency.

(a) - Ecological Screening Levels selected in Table 2 following the following hierarchy:
Missouri State Water Quality Criteria for the Protection of Aquatic Life (Chronic).
USEPA Aquatic Life Ambient Water Quality Criteria (Chronic).
Missouri State Water Quality Criteria for the Protection of Aquatic Life (Acute).
USEPA Aquatic Life Ambient Water Quality Criteria (Acute).
Missouri State Water Quality Criteria for Irrigation.
Missouri State Water Quality Criteria for Livestock Wildlife Watering.

**TABLE 9**
**SUMMARY OF MERAMEC RIVER SURFACE WATER TOTAL (UNFILTERED) AND DISSOLVED (FILTERED) RESULTS COMPARISON TO ECOLOGICAL SCREENING LEVELS**
**MERAMEC ENERGY CENTER, ST. LOUIS COUNTY, MO**
**AMEREN MISSOURI**

| | | Ecological Screening (a) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Constituent** | Cobalt | | Lead | | Lithium | | Mercury | | Molybdenum | | Selenium | | Thallium | | Radium-226/228 | Hardness |
| | **Fraction** | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Total |
| **Sample** | **ECO SL** | 1 | 1 | 0.0089 | 0.0089 | NA | NA | 0.0005 | 0.0005 | NA | NA | 0.005 | 0.005 | NA | NA | NA | NA |
| **Location ID** | **Sampling Event Date** | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | pCi/L | mg/L |
| **UPSTREAM** | | | | | | | | | | | | | | | | | |
| M-MEC-7S | Sep-17 | < | < | 0.0172 | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MEC-8S | Sep-17 | < | < | 0.0112 | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MEC-9D | Sep-17 | < | < | 0.0205 | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MEC-9S | Sep-17 | < | < | 0.0196 | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| **ADJACENT** | | | | | | | | | | | | | | | | | |
| M-MEC-4S | Sep-17 | < | < | 0.0175 | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MEC-5S | Sep-17 | < | < | 0.0139 | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MEC-6D | Sep-17 | < | < | 0.018 | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MEC-6S | Sep-17 | < | < | 0.0121 | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| **DOWNSTREAM** | | | | | | | | | | | | | | | | | |
| M-MEC-1S | Sep-17 | < | < | 0.014 | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MEC-2D | Sep-17 | < | < | 0.0142 | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MEC-2S | Sep-17 | < | < | 0.0146 | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MEC-3D | Sep-17 | < | < | 0.0155 | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| M-MEC-3S | Sep-17 | < | < | 0.0143 | < | < | < | < | < | < | < | < | < | < | < | NA | < |

Notes:
< - Less than the Ecological Screening Level.
ECO - Ecological.
mg/L - milligram per liter.
NA - Not Applicable/Not Analyzed.
pCi/L - picoCurie per liter.
SL - Screening Level.
S.U. - Standard Units.
TDS - Total Dissolved Solids.
USEPA - United States Environmental Protection Agency.

(a) - Ecological Screening Levels selected in Table 2 following the following hierarchy:
Missouri State Water Quality Criteria for the Protection of Aquatic Life (Chronic).
USEPA Aquatic Life Ambient Water Quality Criteria (Chronic).
Missouri State Water Quality Criteria for the Protection of Aquatic Life (Acute).
USEPA Aquatic Life Ambient Water Quality Criteria (Acute).
Missouri State Water Quality Criteria for Irrigation.
Missouri State Water Quality Criteria for Livestock Wildlife Watering.

**TABLE 10**
**SUMMARY OF CREEK/DRAINAGE SURFACE WATER TOTAL (UNFILTERED) AND DISSOLVED (FILTERED) RESULTS COMPARISON TO HUMAN HEALTH DRINKING WATER SCREENING LEVELS**
**MERAMEC ENERGY CENTER, ST. LOUIS COUNTY, MO**
**AMEREN MISSOURI**

| | | Human Health Drinking Water Screening (a) | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Constituent** | Boron | | Calcium | | Chloride | pH | Sulfate | TDS | Fluoride | Antimony | | Arsenic | | Barium | | Beryllium | | Cadmium | | Chromium | |
| | **Fraction** | Total | Dissolved | Total | Dissolved | Total | Total | Total | Total | Total | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Dissolved |
| **Sample** | **HH DW SL** | 4 | 4 | NA | NA | 250 | 6.5-8.5 | 250 | 500 | 4 | 0.006 | 0.006 | 0.05 | 0.05 | 2 | 2 | 0.004 | 0.004 | 0.005 | 0.005 | 0.1 | 0.1 |
| **Location ID** | **Sampling Event Date** | mg/L | mg/L | mg/L | mg/L | mg/L | S.U | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L |
| **UPSTREAM** | | | | | | | | | | | | | | | | | | | | | | |
| M-C-1 | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| **ADJACENT** | | | | | | | | | | | | | | | | | | | | | | |
| M-C-2 | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| **DOWNSTREAM** | | | | | | | | | | | | | | | | | | | | | | |
| M-C-3 | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |

Notes:
< - Less than the Human Health Drinking Water Screening Level.
CCR - Coal Combustion Residuals.
DW - Drinking Water.
HH - Human Health.
MCL - Maximum Contaminant Level.
mg/L - milligram per liter.
NA - Not Applicable/Not Analyzed.
pCi/L - picoCurie per liter.
RSL - Risk-Based Screening Level.
SL - Screening Level.
S.U. - Standard Units.
TDS - Total Dissolved Solids.
USEPA - United States Environmental Protection Agency.

(a) - Drinking Water Screening Levels selected in Table 1 following the following hierarchy:
Missouri State Water Quality Criteria for Drinking Water Supply.
Federal USEPA MCL for Drinking Water.
Federal November 2017 USEPA Tapwater RSL.
Federal USEPA SMCL for Drinking Water.

**TABLE 10**
**SUMMARY OF CREEK/DRAINAGE SURFACE WATER TOTAL (UNFILTERED) AND DISSOLVED (FILTERED) RESULTS COMPARISON TO HUMAN HEALTH DRINKING WATER SCREENING LEVELS**
**MERAMEC ENERGY CENTER, ST. LOUIS COUNTY, MO**
**AMEREN MISSOURI**

| | | Human Health Drinking Water Screening (a) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Constituent** | Cobalt | | Lead | | Lithium | | Mercury | | Molybdenum | | Selenium | | Thallium | | Radium-226/228 | Hardness |
| | **Fraction** | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Total |
| **Sample** | **HH DW SL** | 0.006 | 0.006 | 0.015 | 0.015 | 0.04 | 0.04 | 0.002 | 0.002 | 0.1 | 0.1 | 0.05 | 0.05 | 0.002 | 0.002 | 5 | NA |
| **Location ID** | **Sampling Event Date** | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | pCi/L | mg/L |
| **UPSTREAM** | | | | | | | | | | | | | | | | | |
| M-C-1 | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| **ADJACENT** | | | | | | | | | | | | | | | | | |
| M-C-2 | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| **DOWNSTREAM** | | | | | | | | | | | | | | | | | |
| M-C-3 | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |

Notes:
< - Less than the Human Health Drinking Water Screening Level.
CCR - Coal Combustion Residuals.
DW - Drinking Water.
HH - Human Health.
MCL - Maximum Contaminant Level.
mg/L - milligram per liter.
NA - Not Applicable/Not Analyzed.
pCi/L - picoCurie per liter.
RSL - Risk-Based Screening Level.
SL - Screening Level.
S.U. - Standard Units.
TDS - Total Dissolved Solids.
USEPA - United States Environmental Protection Agency.

(a) - Drinking Water Screening Levels selected in Table 1 following the following hierarchy:
Missouri State Water Quality Criteria for Drinking Water Supply.
Federal USEPA MCL for Drinking Water.
Federal November 2017 USEPA Tapwater RSL.
Federal USEPA SMCL for Drinking Water.

**TABLE 11**
**SUMMARY OF CREEK/DRAINAGE SURFACE WATER TOTAL (UNFILTERED) AND DISSOLVED (FILTERED) RESULTS COMPARISON TO HUMAN HEALTH RECREATIONAL SCREENING LEVELS**
**MERAMEC ENERGY CENTER, ST. LOUIS COUNTY, MO**
**AMEREN MISSOURI**

| | | Human Health Recreational Use Screening (a) | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Constituent** | Boron | | Calcium | | Chloride | pH | Sulfate | TDS | Fluoride | Antimony | | Arsenic | | Barium | | Beryllium | | Cadmium | | Chromium | |
| | **Fraction** | Total | Dissolved | Total | Dissolved | Total | Total | Total | Total | ecreational l | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Dissolved |
| | **HH REC SL** | NA | NA | NA | NA | NA | 6.5-8.5 | NA | NA | NA | 4.3 | 4.3 | 0.00014 | 0.00014 | NA | NA | NA | NA | NA | NA | NA | NA |
| **Sample Location ID** | **Sampling Event Date** | mg/L | mg/L | mg/L | mg/L | mg/L | S.U. | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L |
| **UPSTREAM** | | | | | | | | | | | | | | | | | | | | | | |
| M-C-1 | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | 0.00077 J | 0.00084 J | < | < | < | < | < | < | < | < |
| **ADJACENT** | | | | | | | | | | | | | | | | | | | | | | |
| M-C-2 | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | 0.0022 | 0.0023 | < | < | < | < | < | < | < | < |
| **DOWNSTREAM** | | | | | | | | | | | | | | | | | | | | | | |
| M-C-3 | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | 0.0025 | 0.0024 | < | < | < | < | < | < | < | < |

Notes:
< - Less than the Human Health Recreational Use Screening Level.
HH - Human Health.
mg/L - milligram per liter.
pCi/L - picoCurie per liter.
NA - Not Applicable/Not Analyzed.
REC - Recreational Use.
SL - Screening Level.
S.U. - Standard Units.
TDS - Total Dissolved Solids.
USEPA - United States Environmental Protection Agency.

Qualifiers:
J - Value is estimated.

(a) - Recreational Use Screening Levels selected in Table 1 following the following hierarchy:
Missouri State Water Quality Criteria for Human Health Fish Consumption.
USEPA Ambient Water Quality Criteria for Human Health Consumption of Organism Only.

**TABLE 11**
**SUMMARY OF CREEK/DRAINAGE SURFACE WATER TOTAL (UNFILTERED) AND DISSOLVED (FILTERED) RESULTS COMPARISON TO HUMAN HEALTH RECREATIONAL SCREENING LEVELS**
**MERAMEC ENERGY CENTER, ST. LOUIS COUNTY, MO**
**AMEREN MISSOURI**

| | | Human Health Recreational Use Screening (a) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Constituent** | Cobalt | | Lead | | Lithium | | Mercury | | Molybdenum | | Selenium | | Thallium | | Radium-226/228 | Hardness |
| | **Fraction** | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Total |
| | **HH REC SL** | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 4.2 | 4.2 | 0.0063 | 0.0063 | NA | NA |
| **Sample Location ID** | **Sampling Event Date** | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | pCi/L | mg/L |
| **UPSTREAM** | | | | | | | | | | | | | | | | | |
| M-C-1 | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| **ADJACENT** | | | | | | | | | | | | | | | | | |
| M-C-2 | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| **DOWNSTREAM** | | | | | | | | | | | | | | | | | |
| M-C-3 | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |

Notes:
< - Less than the Human Health Recreational Use Screening Level.
HH - Human Health.
mg/L - milligram per liter.
pCi/L - picoCurie per liter.
NA - Not Applicable/Not Analyzed.
REC - Recreational Use.
SL - Screening Level.
S.U. - Standard Units.
TDS - Total Dissolved Solids.
USEPA - United States Environmental Protection Agency.

Qualifiers:
J - Value is estimated.

(a) - Recreational Use Screening Levels selected in Table 1 following the following hierarchy:
Missouri State Water Quality Criteria for Human Health Fish Consumption.
USEPA Ambient Water Quality Criteria for Human Health Consumption of Organism Only.

**TABLE 12**
**SUMMARY OF CREEK/DRAINAGE SURFACE WATER TOTAL (UNFILTERED) AND DISSOLVED (FILTERED) RESULTS COMPARISON TO ECOLOGICAL SCREENING LEVELS**
**MERAMEC ENERGY CENTER, ST. LOUIS COUNTY, MO**
**AMEREN MISSOURI**

| | | Ecological Screening (a) | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Constituent** | Boron | | Calcium | | Chloride | pH | Sulfate | TDS | Fluoride | Antimony | | Arsenic | | Barium | | Beryllium | | Cadmium | | Chromium | |
| | **Fraction** | Total | Dissolved | Total | Dissolved | Total | Total | Total | Total | Total | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Dissolved |
| | **ECO SL** | 2 | 2 | NA | NA | 230 | 6.5-8.5 | 1608 | NA | 4 | NA | NA | 0.15 | 0.15 | NA | NA | 0.1 | 0.1 | 0.0015 | 0.0015 | 0.167 | 0.167 |
| **Sample Location ID** | **Sampling Event Date** | mg/L | mg/L | mg/L | mg/L | mg/L | S.U | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L |
| **UPSTREAM** | | | | | | | | | | | | | | | | | | | | | | |
| M-C-1 | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| **ADJACENT** | | | | | | | | | | | | | | | | | | | | | | |
| M-C-2 | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |
| **DOWNSTREAM** | | | | | | | | | | | | | | | | | | | | | | |
| M-C-3 | Sep-17 | < | < | < | < | < | NA | < | < | < | < | < | < | < | < | < | < | < | < | < | < | < |

Notes:
< - Less than the Ecological Screening Level.
ECO - Ecological.
mg/L - milligram per liter.
NA - Not Applicable/Not Analyzed.
pCi/L - picoCurie per liter.
SL - Screening Level.
S.U. - Standard Units.
TDS - Total Dissolved Solids.
USEPA - United States Environmental Protection Agency.

(a) - Ecological Screening Levels selected in Table 2 following the following hierarchy:
Missouri State Water Quality Criteria for the Protection of Aquatic Life (Chronic).
USEPA Aquatic Life Ambient Water Quality Criteria (Chronic).
Missouri State Water Quality Criteria for the Protection of Aquatic Life (Acute).
USEPA Aquatic Life Ambient Water Quality Criteria (Acute).
Missouri State Water Quality Criteria for Irrigation.
Missouri State Water Quality Criteria for Livestock Wildlife Watering.

**TABLE 12**
**SUMMARY OF CREEK/DRAINAGE SURFACE WATER TOTAL (UNFILTERED) AND DISSOLVED (FILTERED) RESULTS COMPARISON TO ECOLOGICAL SCREENING LEVELS**
**MERAMEC ENERGY CENTER, ST. LOUIS COUNTY, MO**
**AMEREN MISSOURI**

| | | Ecological Screening (a) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Constituent** | Cobalt | | Lead | | Lithium | | Mercury | | Molybdenum | | Selenium | | Thallium | | Radium-226/228 | Hardness |
| | **Fraction** | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Dissolved | Total | Total |
| **Sample** | **ECO SL** | 1 | 1 | 0.0089 | 0.0089 | NA | NA | 0.0005 | 0.0005 | NA | NA | 0.005 | 0.005 | NA | NA | NA | NA |
| **Location ID** | **Sampling Event Date** | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | pCi/L | mg/L |
| **UPSTREAM** | | | | | | | | | | | | | | | | | |
| M-C-1 | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| **ADJACENT** | | | | | | | | | | | | | | | | | |
| M-C-2 | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |
| **DOWNSTREAM** | | | | | | | | | | | | | | | | | |
| M-C-3 | Sep-17 | < | < | < | < | < | < | < | < | < | < | < | < | < | < | NA | < |

Notes:
< - Less than the Ecological Screening Level.
ECO - Ecological.
mg/L - milligram per liter.
NA - Not Applicable/Not Analyzed.
pCi/L - picoCurie per liter.
SL - Screening Level.
S.U. - Standard Units.
TDS - Total Dissolved Solids.
USEPA - United States Environmental Protection Agency.

(a) - Ecological Screening Levels selected in Table 2 following the following hierarchy:
Missouri State Water Quality Criteria for the Protection of Aquatic Life (Chronic).
USEPA Aquatic Life Ambient Water Quality Criteria (Chronic).
Missouri State Water Quality Criteria for the Protection of Aquatic Life (Acute).
USEPA Aquatic Life Ambient Water Quality Criteria (Acute).
Missouri State Water Quality Criteria for Irrigation.
Missouri State Water Quality Criteria for Livestock Wildlife Watering.

**TABLE 13**
**SUMMARY OF WHOLE EFFLUENT TOXICITY TESTING RESULTS FOR NPDES OUTFALL 003 AND 009**
**MERAMEC ENERGY CENTER, ST. LOUIS COUNTY, MO**
**AMEREN MISSOURI**

| Sampling Event | Treatment | Percent Survival at 48 hours | |
|---|---|---|---|
| | | ***Pimephales promelas*** | ***Ceriodaphnia dubia*** |
| **Outfall 003 (Ash Retention Pond)** | | | |
| January 2013 | 10% Effluent | 100% | 100% |
| | Reconstituted Control | 100% | 100% |
| | Upstream Control | 100% | 100% |
| January 2014 | 10% Effluent | 100% | 100% |
| | Reconstituted Control | 100% | 100% |
| | Upstream Control | 100% | 100% |
| January 2015 | 10% Effluent | 100% | 100% |
| | Reconstituted Control | 100% | 100% |
| | Upstream Control | 98% | 100% |
| January 2016 | 10% Effluent | 100% | 100% |
| | Reconstituted Control | 100% | 100% |
| | Upstream Control | 100% | 100% |
| January 2017 | 10% Effluent | 100% | 100% |
| | Reconstituted Control | 100% | 100% |
| | Upstream Control | 100% | 100% |
| **Outfall 009 (489 Pond)** | | | |
| July 2016 | 10% Effluent | 100% | 100% |
| | Reconstituted Control | 100% | 100% |
| | Upstream Control | 100% | 100% |

Notes:
NPDES - Natual Pollutant Discharge Elimination System.

No significant difference (alpha = 0.05) between effluent and control survival data for the above test.
Effluent passes in all tests conducted from 2013 through 2017.
10% Effluent - Outfall 003 and Outfall 009 effluent mixed with Mississippi River water.
Reconstituted Control - Laboratory reconstituted water.
Upstream Control - Mississippi River water.

**TABLE 14**
**DERIVATION OF RISK-BASED SCREENING LEVELS FOR GROUNDWATER BASED ON THE MISSISSIPPI RIVER**
**MERAMEC ENERGY CENTER, ST. LOUIS COUNTY, MO**
**AMEREN MISSOURI**

| | | | | Estimated Dilution Factor (d) = | 100,000 | | | |
|---|---|---|---|---|---|---|---|---|
| **Constituents** | **HH DW SL (a) (mg/L)** | **HH REC SL (b) (mg/L)** | **ECO SL (c) (mg/L)** | **Lowest of the Human Health and Ecological Screening Levels (mg/L)** | **Groundwater Risk-Based Screening Level* (mg/L)** | **Maximum MEC Groundwater Concentration (mg/L)** | | **Ratio Between Groundwater Risk-Based Screening Level and the Maximum MEC Groundwater Concentration** |
| Boron | 4 | NA | 2 | 2 | 200000 | 30.3 | M-MW-7 | >6,000 |
| Sulfate | 250 | NA | 1773 | 250 | 25000000 | 1250 | M-MW-7 | >20,000 |
| TDS | 500 | NA | NA | 500 | 50000000 | 2320 | M-MW-7 | >21,000 |
| Cobalt | 0.006 | NA | 1 | 0.006 | 600 | 0.0078 | M-MW-6 | >76,000 |
| Lithium | 0.04 | NA | NA | 0.04 | 4000 | 0.164 | M-MW-6 | >24,000 |
| Molybdenum | 0.1 | NA | NA | 0.1 | 10000 | 0.717 | M-MW-7 | >13,000 |

Notes:
* Where the Groundwater Risk-Based Screening Level = Screening Level x Dilution Factor.
ECO SL - Ecological Screening Level.
HH DW SL - Human Health Drinking Water Screening Level.
HH REC SL - Human Health Recreational Use Screening Level.
mg/L - milligram per liter.
NA - Not Available.

(a) - Drinking Water Screening Levels selected in Table 1 following the following hierarchy:
Missouri State Water Quality Criteria for Drinking Water Supply.
Federal USEPA MCL for Drinking Water.
Federal November 2017 USEPA Tapwater RSL.
Federal USEPA SMCL for Drinking Water.

(b) - Recreational Use Screening Levels selected in Table 1 following the following hierarchy:
Missouri State Water Quality Criteria for Human Health Fish Consumption.
USEPA Ambient Water Quality Criteria for Human Health Consumption of Organism Only.

(c) - Ecological Screening Levels selected in Table 2 following the following hierarchy:
Missouri State Water Quality Criteria for the Protection of Aquatic Life (Chronic).
USEPA Aquatic Life Ambient Water Quality Criteria (Chronic).
Missouri State Water Quality Criteria for the Protection of Aquatic Life (Acute).
USEPA Aquatic Life Ambient Water Quality Criteria (Acute).
Missouri State Water Quality Criteria for Irrigation.
Missouri State Water Quality Criteria for Livestock Wildlife Watering.

(d) - Estimated value, see text and Attachment B for derivation.

**TABLE 15**
**DERIVATION OF RISK-BASED SCREENING LEVELS FOR GROUNDWATER BASED ON THE MERAMEC RIVEF**
**MERAMEC ENERGY CENTER, ST. LOUIS COUNTY, MO**
**AMEREN MISSOURI**

| | | | | Estimated Dilution Factor (d) = | 700 | | | |
|---|---|---|---|---|---|---|---|---|
| **Constituents** | **HH DW SL (a) (mg/L)** | **HH REC SL (b) (mg/L)** | **ECO SL (c) (mg/L)** | **Lowest of the Human Health and Ecological Screening Levels (mg/L)** | **Groundwater Risk-Based Screening Level* (mg/L)** | **Maximum MEC Groundwater Concentration (mg/L)** | | **Ratio Between Groundwater Risk-Based Screening Level and the Maximum MEC Groundwater Concentration** |
| Boron | 4 | NA | 2 | 2 | 1400 | 30.3 | M-MW-7 | >40 |
| Sulfate | 250 | NA | 1773 | 250 | 175000 | 1250 | M-MW-7 | >100 |
| TDS | 500 | NA | NA | 500 | 350000 | 2320 | M-MW-7 | >100 |
| Cobalt | 0.006 | NA | 1 | 0.006 | 4.2 | 0.0078 | M-MW-6 | >500 |
| Lithium | 0.04 | NA | NA | 0.04 | 28 | 0.164 | M-MW-6 | >100 |
| Molybdenum | 0.1 | NA | NA | 0.1 | 70 | 0.717 | M-MW-7 | >90 |

Notes:
* Where the Groundwater Risk-Based Screening Level = Screening Level x Dilution Factor.
ECO SL - Ecological Screening Level.
HH DW SL - Human Health Drinking Water Screening Level.
HH REC SL - Human Health Recreational Use Screening Level.
mg/L - milligram per liter.
NA - Not Available.

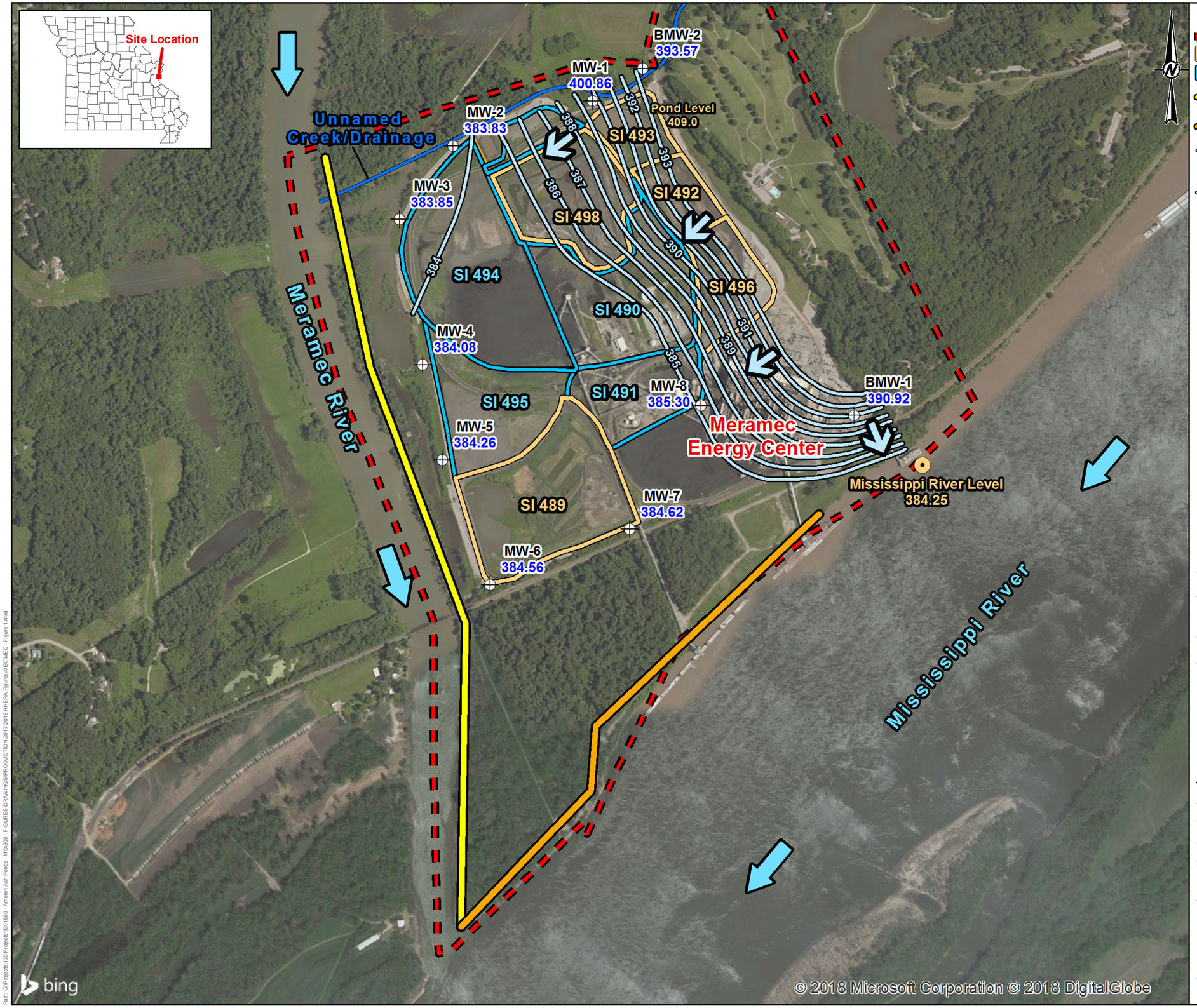
(a) - Drinking Water Screening Levels selected in Table 1 following the following hierarchy:
Missouri State Water Quality Criteria for Drinking Water Supply.
Federal USEPA MCL for Drinking Water.
Federal November 2017 USEPA Tapwater RSL.

(b) - Recreational Use Screening Levels selected in Table 1 following the following hierarchy:
Missouri State Water Quality Criteria for Human Health Fish Consumption.
USEPA Ambient Water Quality Criteria for Human Health Consumption of Organism Only.

(c) - Ecological Screening Levels selected in Table 2 following the following hierarchy:
Missouri State Water Quality Criteria for the Protection of Aquatic Life (Chronic).
USEPA Aquatic Life Ambient Water Quality Criteria (Chronic).
Missouri State Water Quality Criteria for the Protection of Aquatic Life (Acute).
USEPA Aquatic Life Ambient Water Quality Criteria (Acute).
Missouri State Water Quality Criteria for Irrigation.
Missouri State Water Quality Criteria for Livestock Wildlife Watering.

(d) - Estimated value, see text and Attachment B for derivation.

# FIGURES




LEGEND

- Meramec Energy Center Property Boundary
- Active Surface Impoundment
- Exempt Surface Impoundment
- Length of Groundwater Discharge Used in the Dilution Factor Calculations for the Meramec River
- Length of Groundwater Discharge Used in the Dilution Factor Calculations for the Mississippi River
- Unnamed Creek/Drainage

**Groundwater Elevation Contours**

- Groundwater Elevation Contour (FT MSL)

**Ground/Surface Water Measurement Locations**

- Groundwater Monitoring Well
- Mississippi River Gauge
- Groundwater Flow Direction
- Surface Water Flow Direction

NOTES

1. ALL LOCATIONS AND BOUNDARIES ARE APPROXIMATE.
2. GROUNDWATER ELEVATION MEASUREMENTS OBTAINED BY GOLDER ON JULY 18, 2016.
3. GROUNDWATER MONITORING WELLS SURVEYED BY ZAHNER AND ASSOCIATES, INC. ON FEBRUARY 4 AND APRIL 28, 2016.
4. WELL MW-1 NOT USED FOR POTENTIOMETRIC SURFACE MAP CONTOURING.
5. GROUNDWATER ELEVATIONS DISPLAYED IN FT MSL (FEET ABOVE MEAN SEA LEVEL).
6. MISSISSIPPI RIVER AND POND LEVELS PROVIDED BY AMEREN.

REFERENCES

1.) AMEREN MISSOURI MERAMEC ENERGY CENTER, MERAMEC PROPERTY CONTROL MAP, FEBRUARY 2011.
2.) COORDINATE SYSTEM: NAD 1983 STATEPLANE MISSOURI EAST FIPS 2401 FEET.

0 250 500 1,000 1,500 2,000 Feet

CLIENT
AMEREN MISSOURI
MERAMEC ENERGY CENTER

PROJECT
AMEREN HYDROGEOLOGICAL CONSULTING

TITLE
**ESTIMATED LENGTH OF DISCHARGE AND EXAMPLE GROUNDWATER FLOW MAP**

CONSULTANT
Golder Associates

| | |
|---|---|
| YYYY-MM-DD | 2017-12-19 |
| PREPARED | JS |
| DESIGN | JS |
| REVIEW | RJF |
| APPROVED | MNH |

PROJECT No.
130-1560

FIGURE
1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM:

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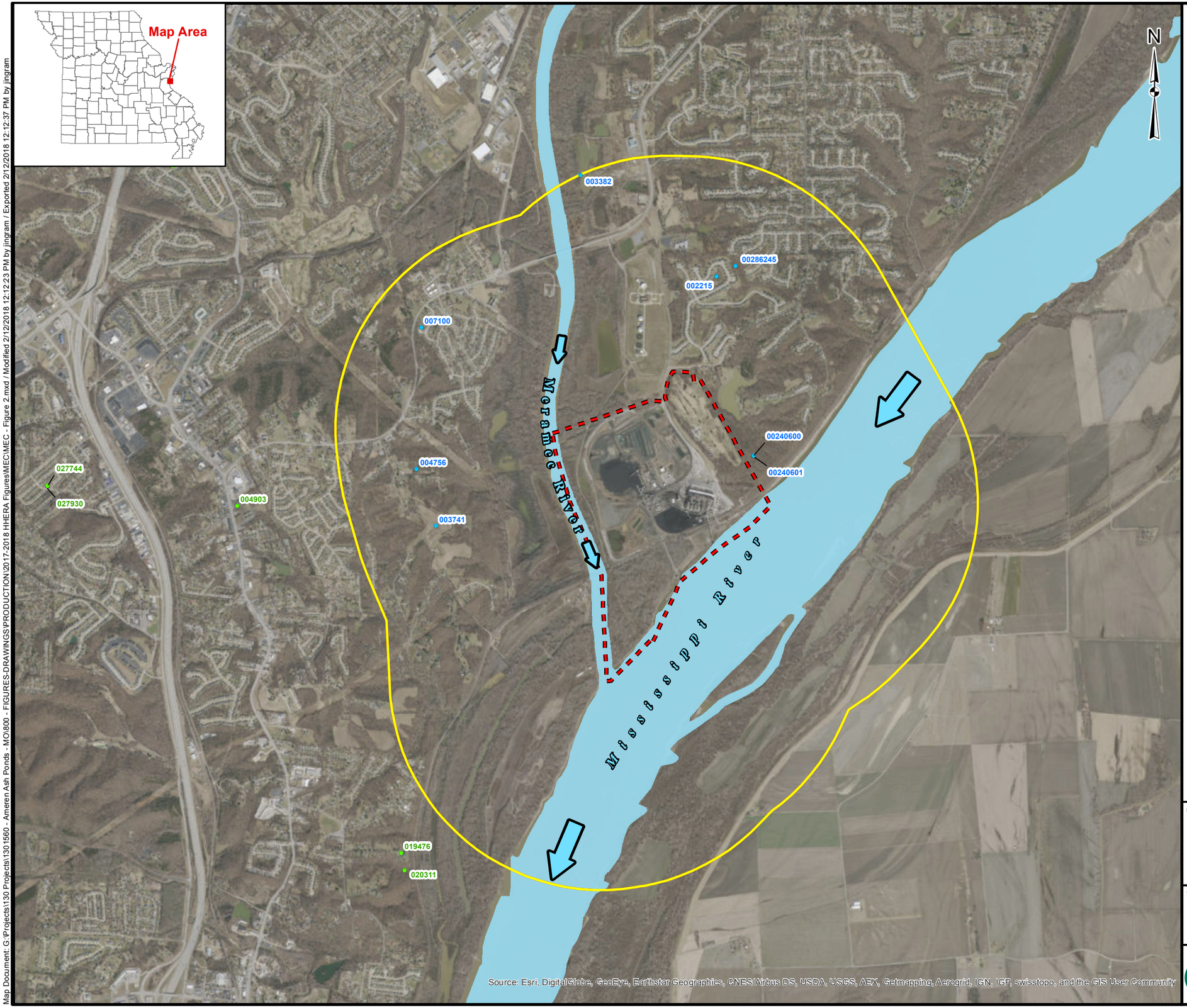


## LEGEND

- Meramec Energy Center Property Boundary
- Approximate 1-Mile Radius
- Private Well
- Public Well
- Surface Water Flow Direction

## NOTES

1.) Wells are labeled with state issued reference number or log ID.
2.) Search radius is approximately one mile beyond the Ameren property boundary line.
3.) Wells in Illinois are not shown.
4.) See Table 1 for details on wells within the 1-mile radius.
5.) Private wells outside of the approximate 1-mile radius are not shown for clarity.

## REFERENCES

1.) MDNR - Missouri Department of Natural Resources
2.) MSDIS - Missouri Spatial Data Information Service
3.) University of Missouri - Columbia - Department of Geography - MSDIS Database
4.) Missouri Department of Natural Resources - Water Resources Center - Geologic Well Logs
5.) Missouri Environmental Geology Atlas 2007 (MEGA)
6.) MDNR Wellhead Protection Program
7.) COORDINATE SYSTEM: NAD 1983 UTM Zone 15N

0 2,000 4,000
Feet

PROJECT

Ameren

AMEREN MISSOURI COAL FIRED POWER PLANTS
ST. LOUIS COUNTY, MISSOURI

TITLE

# PRIVATE WELL LOCATION WITHIN 1-MILE RADIUS OF FACILITY BOUNDARY

Golder Associates

| | | | | |
|---|---|---|---|---|
| PROJECT No. 130-1560 | | | FILE No. | MEC - Figure 2.mxd |
| DESIGN | - | - | SCALE: AS SHOWN | REV. 0 |
| GIS | JSI | 2/12/2018 | FIGURE 2 | |
| CHECK | MWD | 2/12/2018 | | |
| REVIEW | MNH | 2/12/2018 | | |

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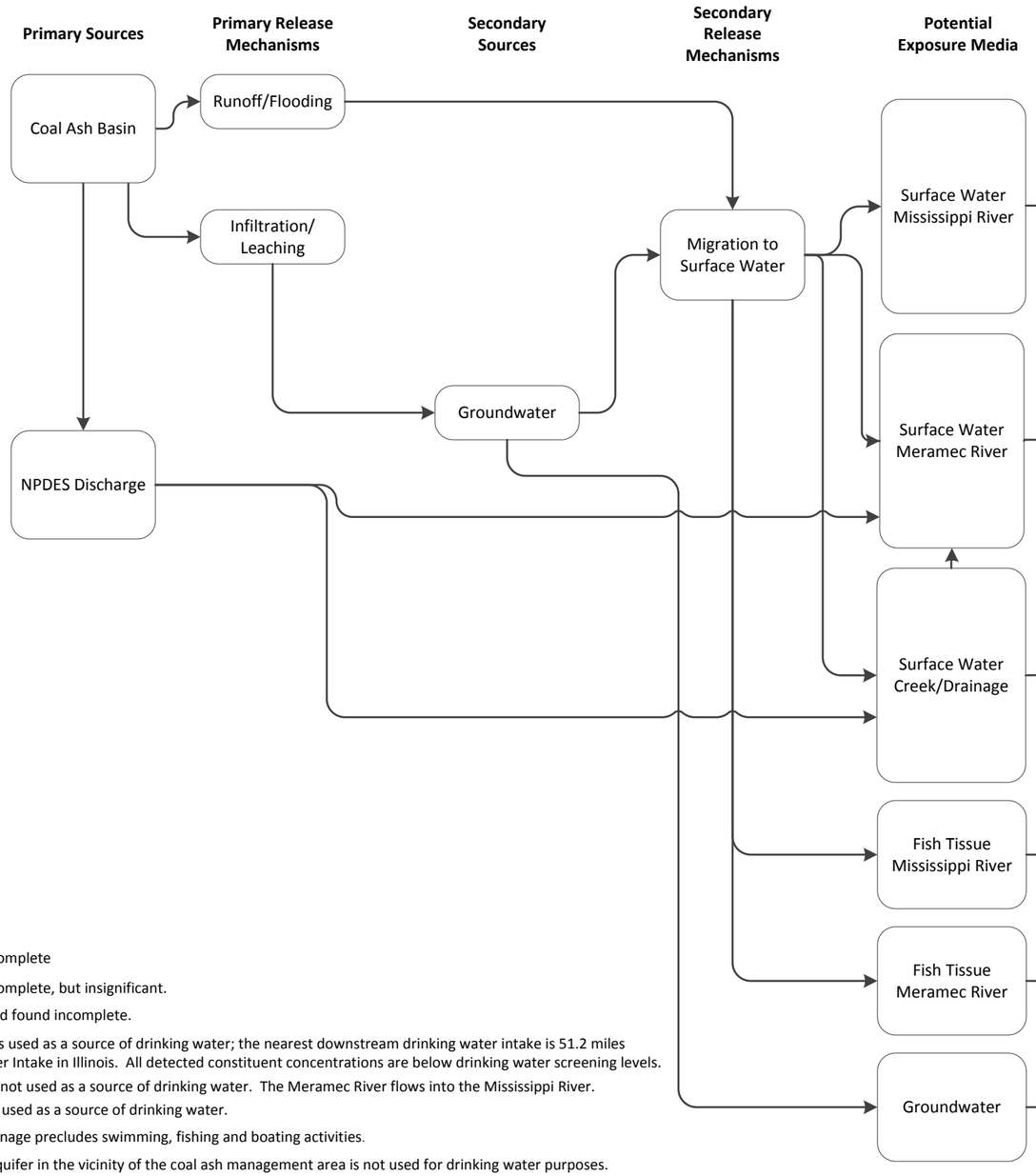
**FIGURE 3**
**CONCEPTUAL SITE MODEL**
**MERAMEC ENERGY CENTER, ST. LOUIS COUNTY, MO**
**AMEREN MISSOURI**




| Potential Exposure Route | Potential Human Health Receptors: Current/Future Off-Site Resident Adult/Child | Current/Future Off-Site Recreational Swimmer | Current/Future Off-Site Recreational Wader | Current/Future Off-Site Recreational Boater | Current/Future Off-Site Recreational Fisher | Potential Ecological Receptors: Aquatic Receptors |
|---|---|---|---|---|---|---|
| **Surface Water Mississippi River** | | | | | | |
| Drinking Water Use | ⊙ (a) | O | O | O | O | NA |
| Incidental Ingestion | O | ⊙ | ⊙ | ⊙ | ⊙ | NA |
| Dermal Contact | O | ⊙ | ⊙ | ⊙ | ⊙ | NA |
| Aquatic Exposure | NA | NA | NA | NA | NA | ⊙ |
| **Surface Water Meramec River** | | | | | | |
| Drinking Water Use | ⊙ (b) | O | O | O | O | NA |
| Incidental Ingestion | O | ⊙ | ⊙ | ⊙ | ⊙ | NA |
| Dermal Contact | O | ⊙ | ⊙ | ⊙ | ⊙ | NA |
| Aquatic Exposure | NA | NA | NA | NA | NA | ⊙ |
| **Surface Water Creek/Drainage** | | | | | | |
| Drinking Water Use | O (c) | O | O | O | O | NA |
| Incidental Ingestion | O | O | ⊙ | O | O | NA |
| Dermal Contact | O | O (d) | ⊙ | O (d) | O (d) | NA |
| Aquatic Exposure | NA | NA | NA | NA | NA | ⊙ |
| **Fish Tissue Mississippi River** | | | | | | |
| Ingestion | O | O | O | O | ● | NA |
| Aquatic Exposure | NA | NA | NA | NA | NA | ⊙ |
| **Fish Tissue Meramec River** | | | | | | |
| Ingestion | O | O | O | O | ● | NA |
| Aquatic Exposure | NA | NA | NA | NA | NA | ⊙ |
| **Groundwater** | | | | | | |
| Drinking Water Use | O (e) | O | O | O | O | NA |
| Aquatic Exposure | NA | NA | NA | NA | NA | O (f) |

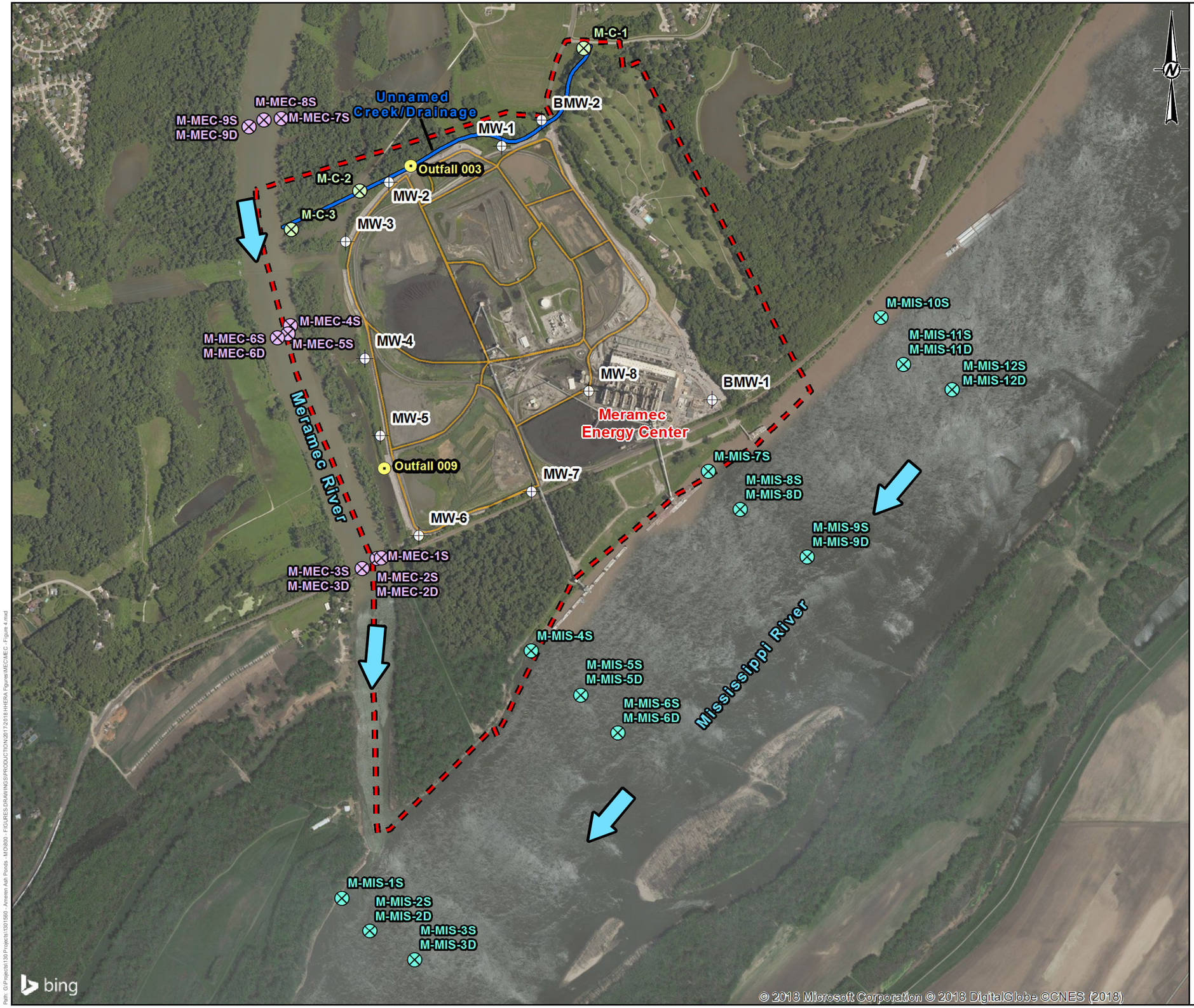
Notes:

- ● Pathway potentially complete
- ⊙ Pathway potentially complete, but insignificant.
- O Pathway evaluated and found incomplete.
- (a) The Mississippi River is used as a source of drinking water; the nearest downstream drinking water intake is 51.2 miles downstream at Chester Intake in Illinois. All detected constituent concentrations are below drinking water screening levels.
- (b) The Meramec River is not used as a source of drinking water. The Meramec River flows into the Mississippi River.
- (c) Creek/Drainage is not used as a source of drinking water.
- (d) The size of Creek/Drainage precludes swimming, fishing and boating activities.
- (e) The shallow alluvial aquifer in the vicinity of the coal ash management area is not used for drinking water purposes.
- (f) Ecological Receptors are not exposed to groundwater.

NA – Not Applicable.

NPDES - National Pollutant Discharge Elimination System.

HALEY ALDRICH




LEGEND

- Meramec Energy Center Property Boundary
- All Surface Impoundments
- Unnamed Creek/Drainage

**Ground/Surface Water Measurement Locations**

- Groundwater Monitoring Well
- Creek/Drainage Sample Location
- Meramec River Sample Location
- Mississippi River Sample Location
- NPDES Outfall Location
- Surface Water Flow Direction

KEY MAP


NOTES

1. ALL LOCATIONS AND BOUNDARIES ARE APPROXIMATE.
2. GROUNDWATER MONITORING WELLS SURVEYED BY ZAHNER AND ASSOCIATES, INC. ON FEBRUARY 4 AND APRIL 28, 2016.
3. SAMPLE LOCATIONS BASED ON HANDHELD TRIMBLE GPS UNIT.
4. SAMPLE LOCATIONS REPRESENT MIDPOINT BETWEEN STARTING AND ENDING LOCATIONS.
5. NPDES - NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM.

REFERENCES

1.) AMEREN MISSOURI MERAMEC ENERGY CENTER, MERAMEC PROPERTY CONTROL MAP, FEBRUARY 2011.
2.) COORDINATE SYSTEM: NAD 1983 STATEPLANE MISSOURI EAST FIPS 2401 FEET.

0 250 500 1,000 1,500 2,000 2,500 3,000 Feet

CLIENT
AMEREN MISSOURI
MERAMEC ENERGY CENTER

PROJECT
AMEREN HYDROGEOLOGICAL CONSULTING

TITLE
**SURFACE WATER SAMPLING LOCATIONS**
**MERAMEC ENERGY CENTER**

CONSULTANT
Golder Associates

| | |
|---|---|
| YYYY-MM-DD | 2017-09-28 |
| PREPARED | JSI |
| DESIGN | JSI |
| REVIEW | JS |
| APPROVED | MNH |

| PROJECT No. | PHASE | Rev. | FIGURE |
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IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 1 in 0

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# ATTACHMENT A

## Constituents Present in Coal Ash and in Our Natural Environment

# Attachment A

# Constituents Present in Coal Ash and in Our Natural Environment

It is important to understand what constituents are present in coal ash, which can be released to the environment, and to understand the natural occurrence of these constituents in our environment.

Coal is a type of sedimentary rock that is a natural component of the earth's crust and the inorganic minerals and elements it contains are also naturally occurring. It is the organic component of coal that burns and produces energy, and it is the inorganic minerals and elements that remain after combustion the make up the coal ash, or coal combustion products (CCPs).

## A.1 Major, Minor and Trace Constituents in Coal Ash

All of the inorganic minerals and elements that are present in coal ash are also present in our natural environment. This is one fact that that the public seems either not to understand or will not acknowledge. **Figure A-1** shows the major and minor components of fly ash, bottom ash, volcanic ash, and shale. It is important to understand that the constituents that are the focus of many of the concerns expressed by the public about the toxicity of coal ash (e.g., lead, arsenic, mercury, cadmium, selenium, etc.) are trace elements, so called because they are present in such low concentrations (in the mg/kg or part per million (ppm) range). Together, the trace elements generally make up less than 1 percent of the total mass of these materials. To put these concentrations into context, a mg/kg or ppm is equivalent to:

- 1 penny in a large container holding $10,000 worth of pennies, or
- 1 second in 11.5 days, or
- 1 inch in 15.8 miles

These trace elements have been referred to by the public and even in the popular press as "toxic"—without any context provided for what this means. Moreover, claims have been made that there is no safe level of exposure to any of these elements.

This is simply not true, and there are two important facts that must be understood to put this in context. The first relates to background levels of constituents in our environment and the second relates to toxicity.

## A.2 Background Levels in Soils

The first fact that must be understood is that all of the constituents present in coal ash occur naturally in our environment. U.S. Geological Survey (USGS) data demonstrate the presence of these constituents in the soils across the U.S. Prime examples include arsenic, lead, mercury and selenium. With respect to arsenic, **Figure A-2** shows the range of background levels of arsenic in soils across the U.S., as published by the USGS. The USGS is conducting a "national geochemical survey" to identify background levels of elements in soils in the U.S. (USGS, 2013). **Figures A-3 – A-6** provide maps prepared by the USGS demonstrating the naturally-occurring presence of other trace elements in soils in the U.S., including aluminum and copper (**Figure A-3**), iron and lead (**Figure A-4**), manganese and mercury (**Figure A-5**), and selenium and zinc (**Figure A-6**).

These soils are found in our backyards, schools, parks, etc., and because of their presence in soil, these constituents are also present in the foods we eat. Some of these constituents are present in

our vitamins, such as manganese and selenium. Thus, we are exposed to these trace elements in our natural environment every day, and in many ways.

## A.3 Toxicity and Risk

The second fact is that all constituents and materials that we encounter in our natural environment can be toxic, but what determines whether a toxic effect actually occurs is how one is exposed to the constituent, the amount of material to which one may be exposed, and the timing and duration of that exposure. Without sufficient exposure the science tells us that there are no toxic effects. Put another way, when a toxic effect is demonstrated by a particular constituent, it is generally caused by high levels of exposure over a long-term duration. The fundamental principles here are:

- All constituents can exert toxic effects (from aspirin[1] to table salt to water to minerals).
- For such toxic effects to occur, exposure must occur at a sufficiently high level for a sufficiently long period of time.
- If there is no exposure, there is no risk.

## A.4 Risk-Based Screening Levels

The U.S. Environmental Protection Agency (USEPA) uses information on the potential toxicity of constituents to identify concentrations of trace elements in soil in a residential setting that are considered by USEPA to be protective for humans (including sensitive groups) over a lifetime (USEPA, 2014c). Specifically, residential soil screening levels are levels that are protective of a child and adult's daily exposure to constituents present in soil or a solid matrix over a residential lifetime. In the context of regulatory decision making, at sites where constituent concentrations fall below these screening levels, no further action or study is warranted under the federal Superfund program. Missouri Department of Natural Resources also applies this concept to the development of screening levels in its Risk-Based Corrective Action program (MDNR, 2006).

**Figure A-7** shows USEPA's residential soil screening levels for a variety of trace elements that are present in coal ash. USEPA considers it to be safe for children to be exposed to these concentrations of each of these trace elements in soils on a daily basis, throughout their lifetime. What this tells us is that by developing these residential soil screening levels, USEPA considers the presence of these levels of these constituents in soils to be safe for humans, even for exposure on a daily basis. It is, therefore, simply not true that there are no safe levels of exposure to these constituents.

## A.5 Comparison of Coal Ash Constituent Concentrations to Risk-Based Screening Levels and Background

A comparison of constituent concentrations in coal ash, as reported by the USGS (USGS, 2011a) to USEPA's risk-based screening levels for residential soil indicates that with only a few exceptions, constituent concentrations in coal ash are below screening levels developed by the USEPA for residential soils, and are similar in concentration to background U.S. soils. Details of this evaluation are provided in the report titled "Coal Ash Material Safety: A Health Risk-Based Evaluation of USGS

[1] For example, if one takes two aspirin every four hours as directed, aspirin is not toxic. If one takes the entire bottle at once, the aspirin is very toxic.

Coal Ash Data from Five US Power Plants" (AECOM, 2012). The study is available at: http://www.acaa-usa.org/associations/8003/files/ACAA_CoalAshMaterialSafety_June2012.pdf.

**Figure A-8** is an updated chart from this study comparing ranges of trace element concentrations in fly ash produced from coal from the Powder River Basin in Wyoming (the same type of coal used at Rush Island Energy Center) to USEPA screening levels, and to background levels in soils in the U.S. The USEPA screening levels for residential soils (USEPA, 2014c) are shown as the green vertical bars, the ranges for the Wyoming coal fly ash are shown in purple on top of the green vertical bars, and the ranges of background levels in U.S. soils are shown in the grey bars. What this figure shows is that all but one of the constituents are present in the Wyoming fly ash at concentrations that are below the USEPA residential soil screening levels; and for cobalt, the concentration range is only marginally above the screening level. As noted in detail in the report itself, the toxicity value upon which the USEPA soil screening level for cobalt is based is two levels of magnitude lower than what has been derived by other regulatory agencies; thus a much higher health protective soil screening level for cobalt exists. What the data also show is that constituent concentrations in coal ash are not that different from concentrations in soils in the U.S.

The results are similar for all of the coal ashes evaluated in the report (AECOM, 2012). The evaluation in the report included not only the simple comparison of constituent concentrations in coal ash to USEPA screening levels, but also provided a detailed cumulative risk screen for each coal ash data set to account for potential additive effects of combined exposures to the trace elements in coal ash. The results confirm the simple screening results, which indicate that no significant risk would be posed by direct exposure to coal ash in a residential setting.

Thus, by considering the levels of trace elements in coal ash in comparison to the background levels in soils in the U.S., and in comparison to the USEPA screening levels for these constituents in residential soil, screening levels that are protective of daily exposure to soils by children and adults, including sensitive subgroups, it is concluded that even daily direct contact to trace elements in coal ash would not pose a significant risk to human health.

## A.6 Background Levels in Groundwater

Because these constituents are naturally present in soils and rocks, they are also naturally present in our groundwaters and surface waters. The USGS has published a report titled "Trace Elements and Radon in Groundwater Across the United States" (USGS, 2011b). Just as for soil, it is important to understand that there are background levels of constituents in groundwater. Constituent concentrations in groundwater that is upgradient of a source represent background conditions. To demonstrate a release to groundwater by a source, concentrations downgradient of the source must be greater than the background/upgradient concentrations at a statistically significant level for a consistent period of time.

The same concept applies to surface water. These same constituents are naturally present in surface water due to discharge of groundwater to surface water and the effect of erosion of soil into our surface waters. To demonstrate an effect of a source on surface water, the concentrations downgradient/downstream of the source must be greater than the background/upstream concentrations at a statistically significant level for a consistent period of time.

Constituents in groundwater and surface water can be in a dissolved form, or they can be adhered to or part of a soil or sediment particle. Movement of these particles in groundwater is generally more difficult because of the presence of the soil and rock that the groundwater must move through. Surface water is constantly impacted by erosion of soils, thus in surface water, it is much more

common for constituents to be bound to particles rather than dissolved in the water. For this reason, it is important to evaluate both total concentrations of constituents in water (which represents constituents dissolved in the water and as part of a soil or sediment particle) and the dissolved component (by filtering out the soil/sediment particles).

## A.7 Toxicity Evaluation for Cobalt and Chromium

### A.7.1 Cobalt

Cobalt is the only constituent in the Powder River Basin coal ash (the coal that is used at the Rush Island Energy Center) with concentrations above the USEPA screening level for residential soils. There is much uncertainty associated with the USEPA dose-response value for cobalt, and with the resulting screening level for residential soil. The World Health Organization (WHO) indicates that "there are no suitable data with which to derive a tolerable intake for chronic ingestion of cobalt" (WHO, 2006). Agency for Toxic Substances and Disease Registry (ATSDR, 2004) states that "adequate chronic studies of the oral toxicity of cobalt or cobalt compounds in humans and animals are not presently available." However, using a short-term study in six human volunteers, ATSDR (2004) derived an intermediate-term (15–364 days) minimal risk level (MRL) of 0.05 mg/kg-day. The "adverse" effect was identified as increased red blood cell count, although it is also noted that cobalt is used as a treatment for anemia (low red blood cell count). ATSDR also notes that "Since cobalt is naturally found in the environment, people cannot avoid being exposed to it. However, the relatively low concentrations present do not warrant any immediate steps to reduce exposure." WHO notes that the largest source of exposure to cobalt for the general population is the food supply; the estimated intake from food is 5–40 ug/day, most of which is inorganic cobalt (WHO, 2006). Expressed on a mg/kg-day basis, this is 0.00007–0.0005 mg/kg-day from the diet.

USEPA however has derived a Provisional Peer-Reviewed Toxicity Value (PPRTV) for cobalt of 0.0003 mg/kg-day, this is two orders of magnitude lower than the ATSDR intermediate term MRL, and is higher that most dietary intake estimates. Thus the RSL for cobalt for residential soil is much lower than values derived by other regulatory bodies.

### A.7.2 Hexavalent Chromium

The data provided by USGS (2011a) for chromium is for total chromium in the samples; the Ameren data for groundwater and surface water are also based on analysis of total chromium. Many metals can exist in different oxidation states; for some metals, the oxidation state can have different toxicities. This is the case for chromium. Chromium exists in two common oxidation states: trivalent chromium (chromium-3, Cr(III) or Cr+3), and hexavalent chromium (chromium-6, Cr(VI) or Cr+6). Trivalent chromium is essentially nontoxic, as evidenced by its RSL of 120,000 mg/kg. It can be bought over-the-counter as a supplement, and is included in most vitamins. Hexavalent chromium has been concluded to be a human carcinogen by the inhalation route of exposure (USEPA, 2014a).

Currently on USEPA's toxicity database, the Integrated Risk Information System (IRIS) (USEPA, 2014a), the primary source of dose-response information for risk assessment and for the RSL tables, an oral reference dose is available for trivalent chromium, and IRIS provides an inhalation IUR for potential inhalation carcinogenic effects and an oral reference dose and inhalation reference concentration for hexavalent chromium. The oral noncancer dose-response value for hexavalent chromium is based on a study where no adverse effects were reported; thus the target endpoint is identified as "none reported."

Recent studies by the National Toxicology Program (NTP) have shown that when present in high concentrations in drinking water, hexavalent chromium can cause gastrointestinal tract tumors in mice (NTP, 2008). IRIS does not present an oral CSF for hexavalent chromium; a value developed by the New Jersey Department of Environmental Protection (NJDEP, 2009) was used in the development of the RSLs. USEPA developed a draft oral cancer dose-response value for hexavalent chromium, based on the same study and was the same as the NJDEP value. However, it should be noted that USEPA's Science Advisory Board (SAB) provided comments in July 2011 on the draft USEPA derivation of the oral CSF for hexavalent chromium and indicated many reservations with the assumptions of mode of action, and in the derivation itself. The SAB review can be accessed at http://cfpub.epa.gov/ncea/iris_drafts/recordisplay.cfm?deid=221433. Thus, the value used to develop the RSLs for hexavalent chromium has been called into question by USEPA's peer review panel. Currently there is much scientific debate about whether the mode of action of hexavalent chromium in very high concentrations in drinking water is relevant to the low concentrations most likely to be encountered in environmental situations (Proctor, et al., 2012).

Therefore, for this evaluation of chromium in the Powder River Basin coal ash, total chromium is evaluated assuming the total concentration is hexavalent chromium and using RSLs calculated using USEPA's on-line RSL calculator (USEPA, 2014b), based on the primary dose-response values provided in the IRIS database (USEPA, 2014a) for both potential carcinogenic and noncarcinogenic endpoints.

The assumption that all chromium in CCPs is in the hexavalent form is very conservative, and in fact unrealistic. Data for the Alaska Power Plant indicate that hexavalent chromium comprises 0.25% of the total chromium concentration in the combined fly ash/bottom ash material from that facility. Literature data for analyses of CCPs from US coals (total CCPs) indicate that hexavalent chromium can comprise up to 5% of the total chromium (Huggins, et al., 1999); thus over 95% of the total chromium is present in the nontoxic trivalent form. This is consistent with data from USEPA, though there are some single higher results (USEPA, 2009).

## A.8 Summary

Constituents present in coal ash are also present in our natural environment, and we are exposed to them every day, in the soils that we contact and the food that we eat. All of these constituents have USEPA-derived risk-based screening levels for residential soils. The constituent concentrations in coal ash from the Powder River Basin, the source of the coal used at the Rush Island Energy Center, are below risk-based screening levels for residential soils (with one exception) and the concentrations are similar to background levels in U.S. soils.

## A.9 References

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USGS. 2011b. Trace Elements and Radon in Groundwater Across the United States. U.S. Geological Survey. Scientific Investigations Report 2011-5059. Authors: Ayotte, J.D. Gronberg, J.M., and Apodaca, L.E. Available at: http://pubs.usgs.gov/sir/2011/5059/pdf/sir2011-5059_report-covers_508.pdf

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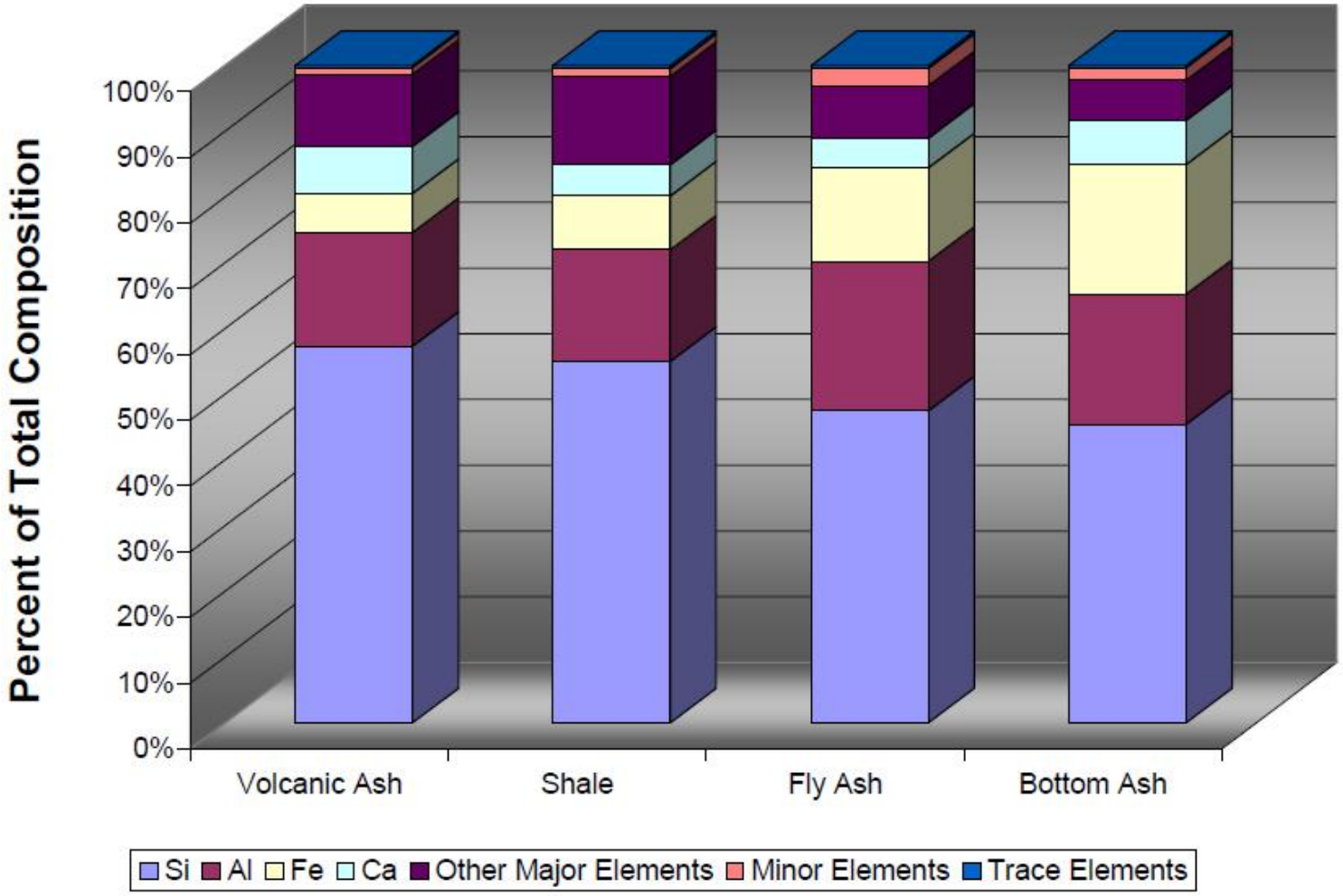
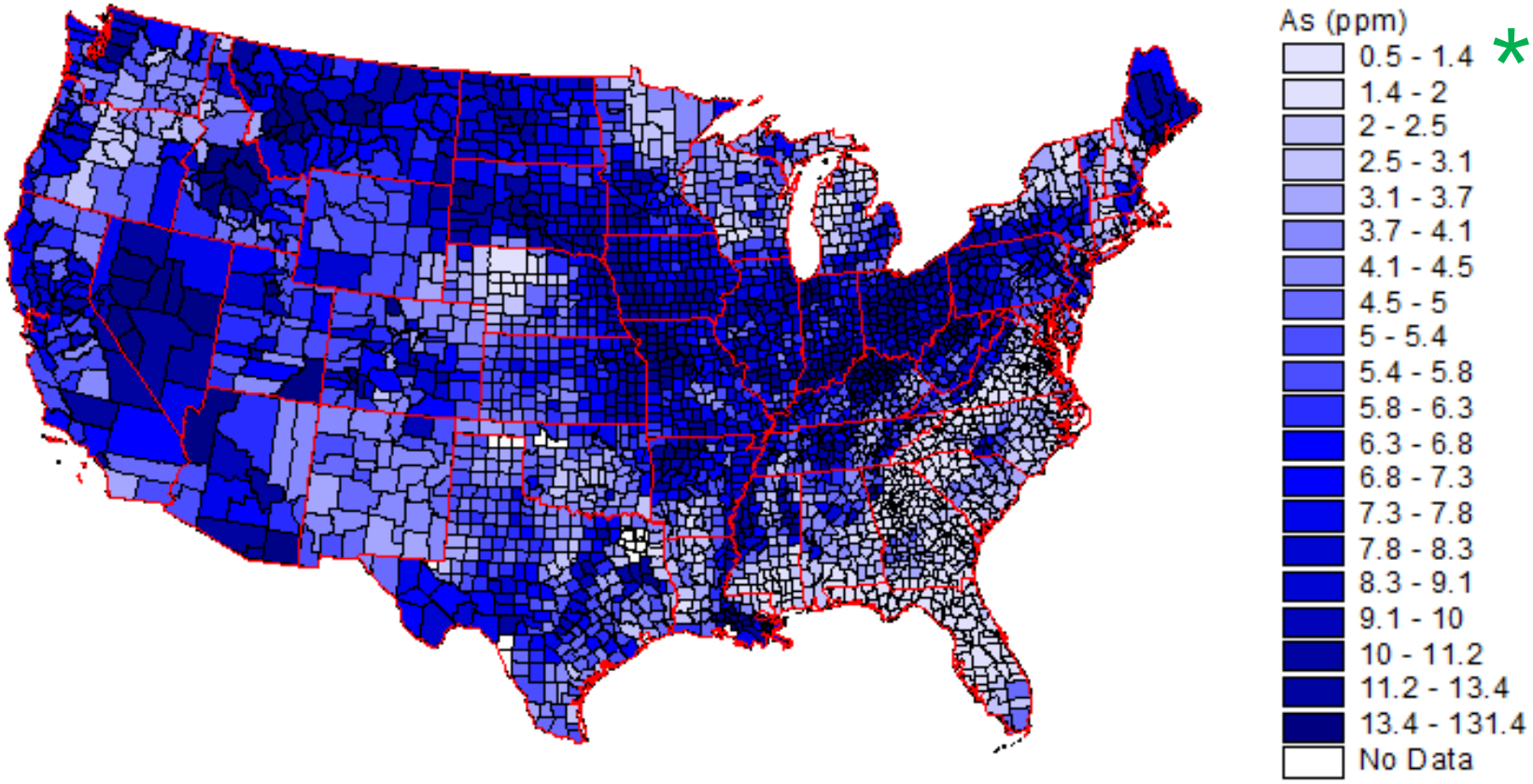
# Attachment A – Figures

# Figure A-1
# Composition of Coal Ash and Other Natural Materials




**Source: EPRI. 2010. Comparison of Coal Combustion Products to Other Common Materials – Chemical Characteristics. Report No. 1020556. Available for download at www.epri.com.**

Figure A-2
Arsenic is Present in our Natural Environment –
Background Levels in Soils in the U.S.

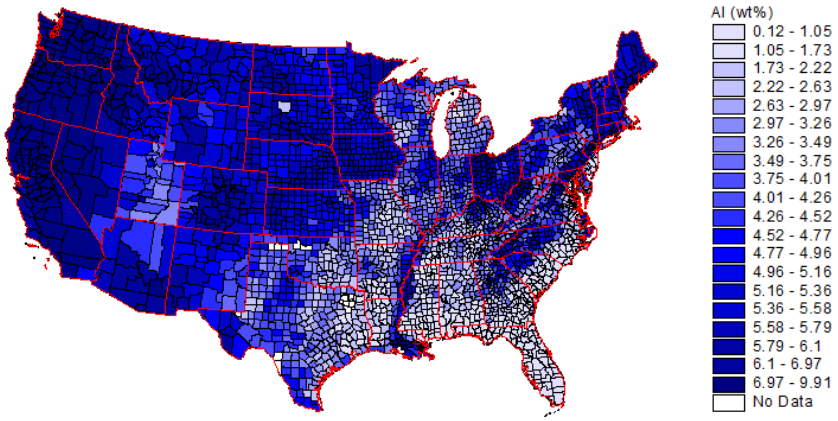



***The USEPA regional screening level for arsenic in residential soil at a one in one million risk level is 0.67 mg/kg. USEPA. 2014c.** http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm
**Thus the arsenic concentration in the majority of the soils in the U.S. are above the one in one million risk level.**

**Source: USGS. 2013. National Geochemical Survey**. http://mrdata.usgs.gov/geochem/doc/averages/countydata.htm

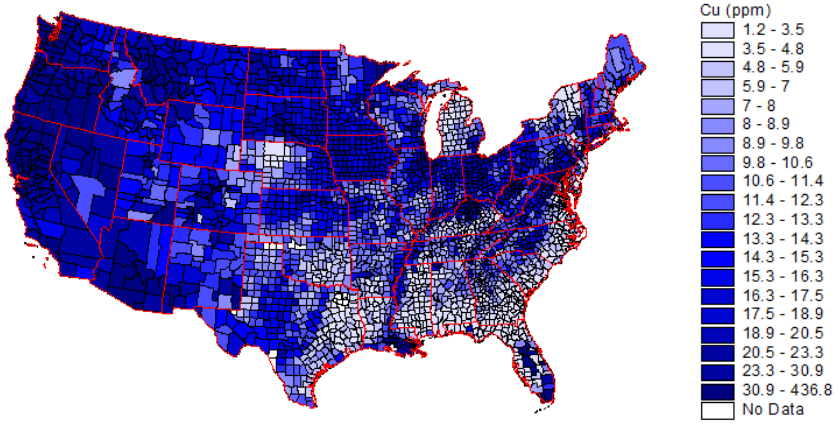
# Figure A-3

Aluminum is Present in our Natural Environment –
Background Levels in Soils in the U.S.




**Source: USGS. 2013. National Geochemical Survey**. http://mrdata.usgs.gov/geochem/doc/averages/countydata.htm

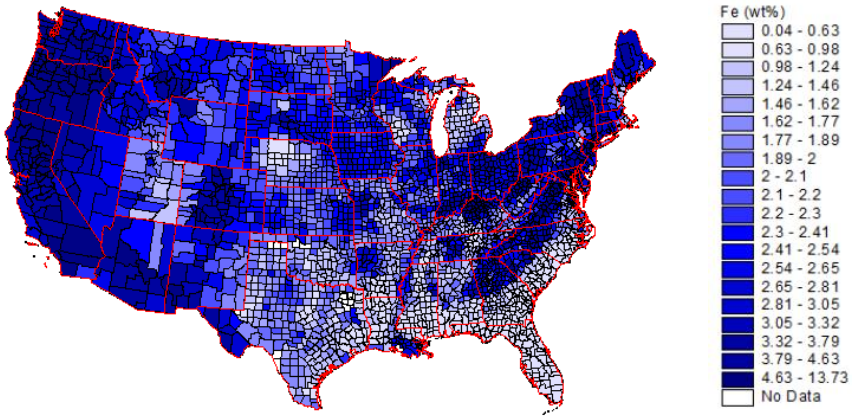
Copper is Present in our Natural Environment –
Background Levels in Soils in the U.S.




**Source: USGS. 2013. National Geochemical Survey**. http://mrdata.usgs.gov/geochem/doc/averages/countydata.htm

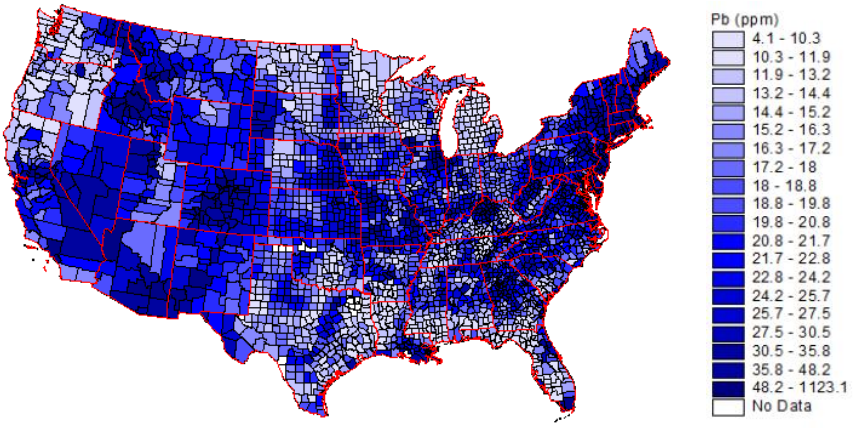
# Figure A-4

Iron is present in our natural environment –
Background levels in soils in the U.S.




**Source: USGS. 2013. National Geochemical Survey**. http://mrdata.usgs.gov/geochem/doc/averages/countydata.htm

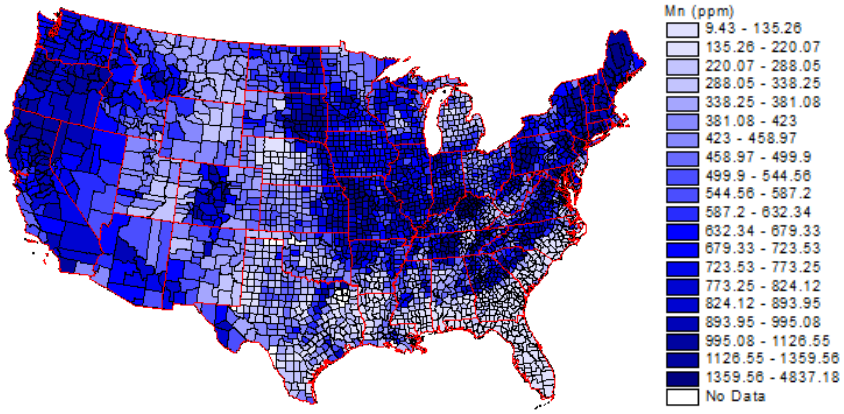
Lead is present in our natural environment –
Background levels in soils in the U.S.




**Source: USGS. 2013. National Geochemical Survey**. http://mrdata.usgs.gov/geochem/doc/averages/countydata.htm

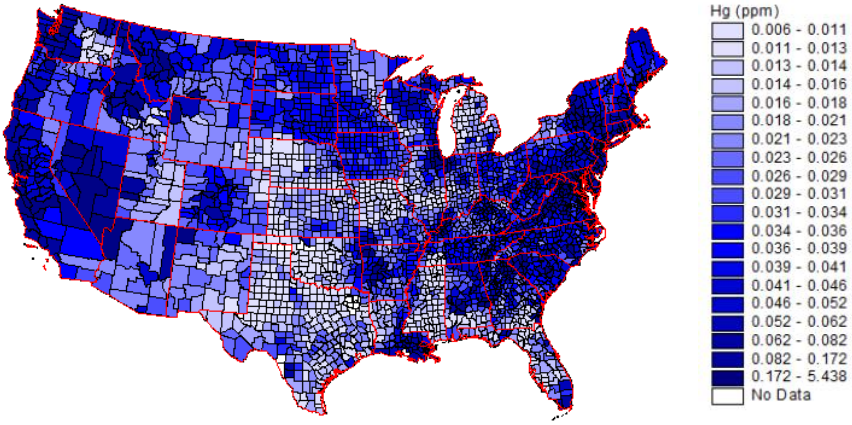
# Figure A-5

Manganese is present in our natural environment –
Background levels in soils in the U.S.




**Source: USGS. 2013. National Geochemical Survey**. http://mrdata.usgs.gov/geochem/doc/averages/countydata.htm

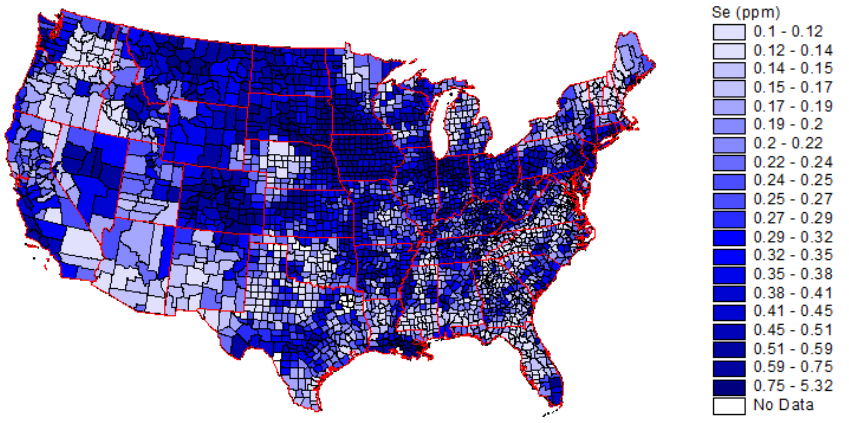
Mercury is present in our natural environment –
Background levels in soils in the U.S.




**Source: USGS. 2013. National Geochemical Survey**. http://mrdata.usgs.gov/geochem/doc/averages/countydata.htm

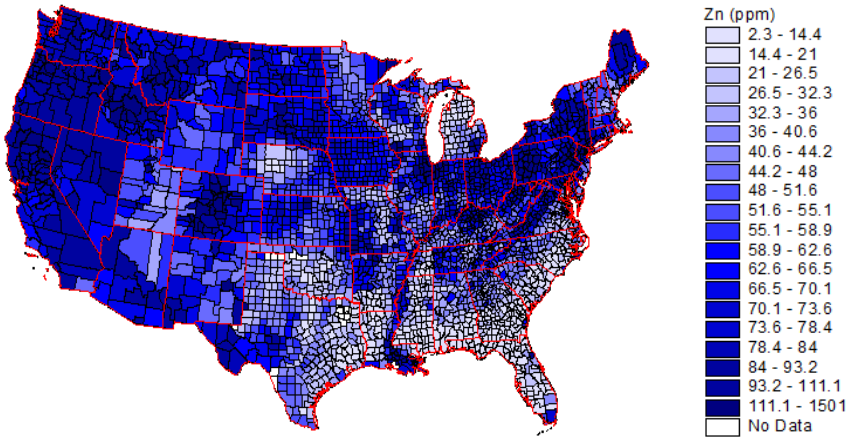
# Figure A-6

Selenium is present in our natural environment –
Background levels in soils in the U.S.




**Source: USGS. 2013. National Geochemical Survey**. http://mrdata.usgs.gov/geochem/doc/averages/countydata.htm

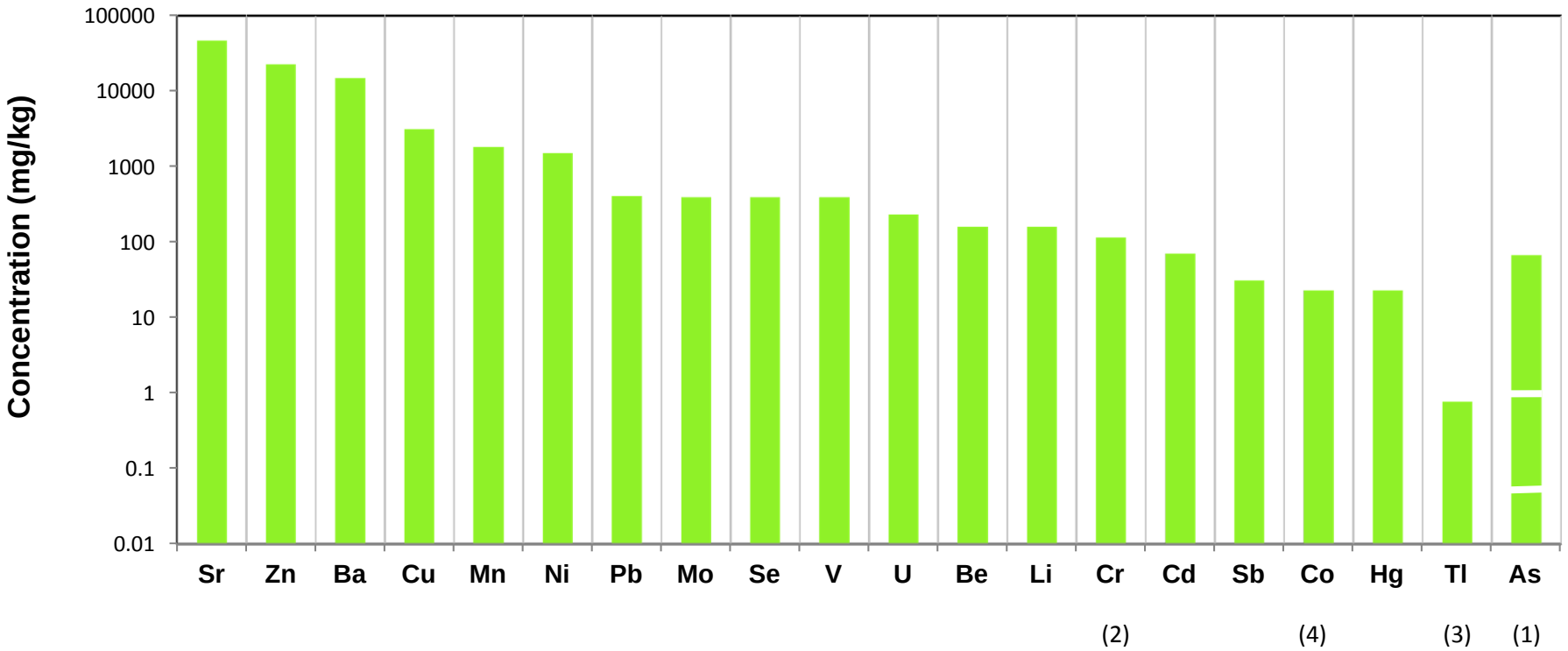
Zinc is present in our natural environment –
Background levels in soils in the U.S.




**Source: USGS. 2013. National Geochemical Survey**. http://mrdata.usgs.gov/geochem/doc/averages/countydata.htm

**Figure A-7**

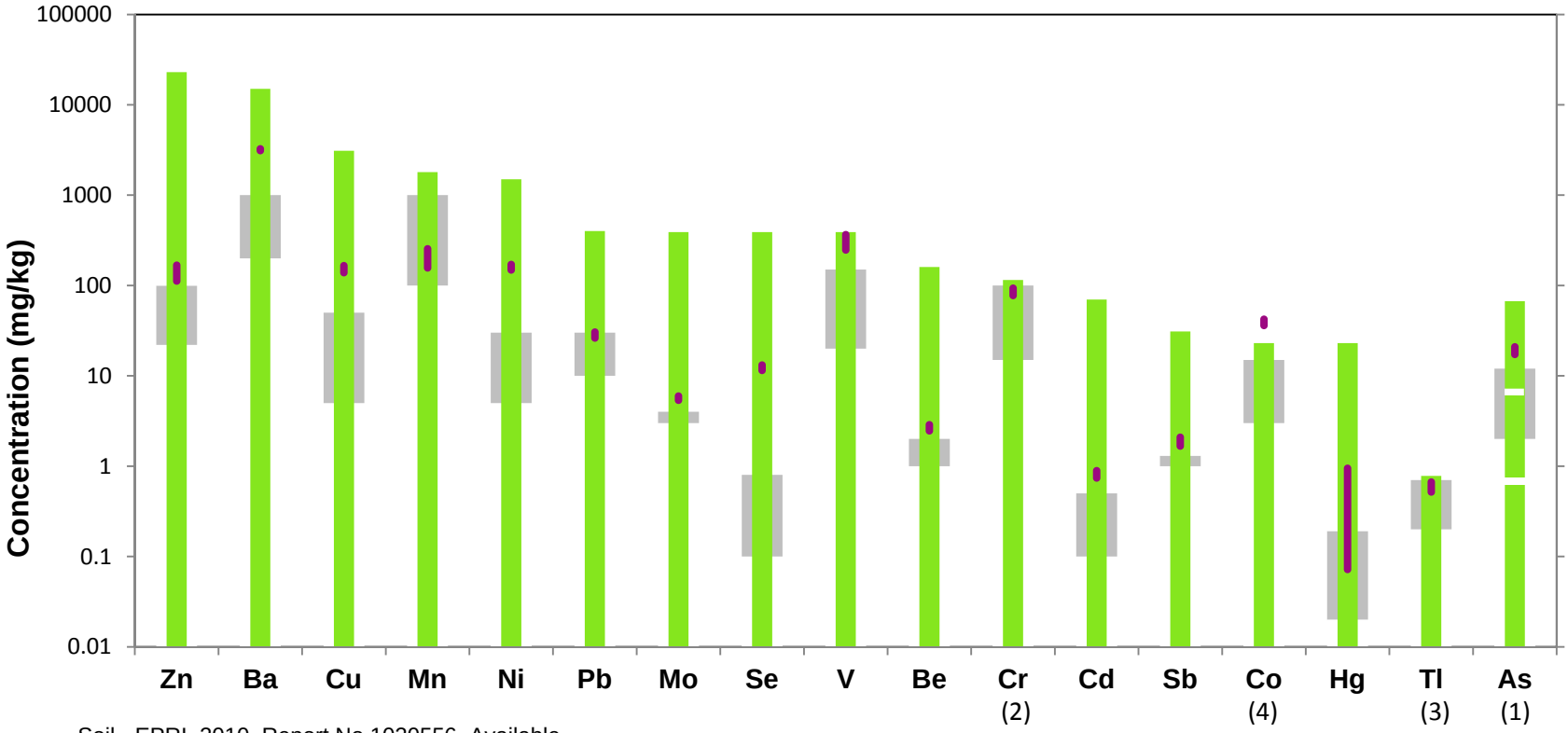
## USEPA Regional Screening Levels for Residential Soils - Coal Ash Constituents




Top of bar corresponds to the USEPA Regional Screening Level (RSL) - Residential Soil (May 2014)
http://www.epa.gov/region9/superfund//prg/index.html

Notes:
(1) Arsenic RSLs for target risk level of $10^{-4}$ (top of green bar), $10^{-5}$ (middle white bar), $10^{-6}$ (lower white bar.
(2) The screening level shown for chromium is the value calculated using toxicity information for hexavalent chromium currently available on USEPA's IRIS database [http://www.epa.gov/iris/subst/0144.htm]. The screening level for trivalent chromium is 120,000 mg/kg.
(3) The RSL for thallium is identified by USEPA as a "provisional value" of "limited usefulness" that was developed for information purposes although USEPA states "it is inappropriate to derive a provisional subchronic or chronic [toxicity value] for thallium" [http://hhpprtv.ornl.gov/issue_papers/ThalliumandCompounds.pdf]
(4) The RSL for cobalt is based on a provisional dose-response value that is two orders of magnitude lower than values from other regulatory sources, and higher than most dietary intake estimates. Thus, a more realistic RSL could be more than an order of magnitude higher than the value shown here.

**Figure A-8** **Comparison of 10th and 90th percentile USGS Database Constituent Concentrations in Fly Ash from the Wyoming Coal Power Plant and Background Levels in US Soils to the USEPA Regional Screening Levels for Residential Soils**




Soil - EPRI, 2010. Report No.1020556. Available for download at www.epri.com.

USEPA Regional Screening Level (RSL) - Residential Soil (May 2014)
http://www.epa.gov/region9/superfund//prg/index.html

Concentration Range (10th - 90th Percentile) in Wyoming Fly Ash; USGS, 2011.
http://pubs.usgs.gov/ds/635/

Notes:
(1) Arsenic RSLs for target risk level of $10^{-4}$ (top of green bar), $10^{-5}$ (middle white bar), $10^{-6}$ (lower white bar).
(2) The screening level shown for chromium is the value calculated using toxicity information for hexavalent chromium currently available on USEPA's IRIS database [http://www.epa.gov/iris/subst/0144.htm]. The screening level for trivalent chromium is 120,000 mg/kg.
(3) The RSL for thallium is identified by USEPA as a "provisional value" of "limited usefulness" that was developed for information purposes although USEPA states "it is inappropriate to derive a provisional subchronic or chronic [toxicity value] for thallium" [http://hhpprtv.ornl.gov/issue_papers/ThalliumandCompounds.pdf]
(4) The RSL for cobalt is based on a provisional dose-response value that is two orders of magnitude lower than values from other regulatory sources, and higher than most dietary intake estimates. Thus, a more realistic RSL could be more than an order of magnitude higher than the value shown here.

# ATTACHMENT B

# Meramec Energy Center Dilution Factor Calculations

# CALCULATIONS

**Date: February 8, 2018** | **Made by:** J. Ingram

**Project No.: 130-1560** | **Checked by:** E. Kidner

**Subject: Meramec Energy Center Dilution Factor Calculations - Mississippi River** | **Reviewed by:** M.Haddock

## 1.0 Introduction

The Mississippi River is a large, flowing water body and daily flow at the Meramec Energy Center (MEC) is estimated to range between 36 and 538 billion gallons per day, depending upon the river stage. In contrast, during low river flow conditions, average daily groundwater flow into the river is a fraction (estimated to be 131.000 gallons or 0.0004%) of the receiving water body. This ratio of flow is referred to as a "dilution factor" and is useful when assessing the relationship between smaller and larger water bodies. Set forth below is a calculation of a dilution factor based on specific criteria and assumptions delineated in Section 1.6.

## 1.1 Low River Conditions

| Date | St. Louis Gauge Height | St. Louis Gauge Elevation | Mississippi River Elevation at St. Louis Gauge | Chester Gauge Height | Chester Gauge Elevation | Mississippi River Elevation at Chester Gauge |
|---|---|---|---|---|---|---|
| Units | ft above gauge | ft MSL | ft MSL | ft above gauge | ft MSL | ft MSL |
| 1/1/2013 12:00 | -4.55 | 379.58 | 375.03 | -1.12 | 341.05 | 339.93 |
| 1/2/2013 19:00 | -4.35 | 379.58 | 375.23 | -1.28 | 341.05 | 339.77 |

Notes:
1) ft - feet
2) ft MSL - feet above mean sea level
3) Information and Data for the St. Louis gauge available at https://waterdata.usgs.gov/usa/nwis/uv?07010000.
4) Information and Data for the Chester gauge available at https://waterdata.usgs.gov/nwis/uv?site_no=07020500.

| Mississippi River Elevation at St. Louis Gauge | Mississippi River Elevation at Chester Gauge | Distance Between St. Louis and Chester Gauges | Calculated Mississippi River Gradient | Distance from St. Louis Gauge to MEC | Estimated Mississippi River Elevation at MEC |
|---|---|---|---|---|---|
| ft MSL | ft MSL | River Miles | foot/foot | River Miles | ft MSL |
| 375.03 | 339.93 | 70.1 | 0.00009 | 18.5 | 366 |

Notes
1) Estimated Mississippi River Elevation at the MEC calculated by subtracting the gradient of the Mississippi River multiplied distance from the St. Louis gauge (in river feet) from the St. Louis gauge.

**Date: February 8, 2018** **Made by:** J. Ingram

**Project No.: 130-1560** **Checked by:** E. Kidner

**Subject: Meramec Energy Center Dilution Factor Calculations - Mississippi River** **Reviewed by:** M.Haddock

## 1.2 Aquifer Discharge Length and Area

| Description | Value | Units |
|---|---|---|
| Estimated length of discharge zone | 4,400 | feet |
| Estimated top of discharge zone (1Q10 river level) | 366 | feet above mean sea level |
| Estimated bottom of discharge zone (Bedrock) | 310 | feet above mean sea level |
| Estimated thickness of discharge zone (Top - Bottom) | 56 | feet |
| Estimated area of discharge zone (length x thickness) | 246,400 | $feet^2$ |

## 1.3 Groundwater Properties

| Description | Symbol | Value | Units |
|---|---|---|---|
| Average Hydraulic Conductivity (includes MW-6, MW-7, MW-8 | K | 31 | feet/day |
| Average Groundwater Gradient (from GMP) | I | 0.0023 | feet/feet |
| Effective Porosity (from GMP) | n | 35 | % |
| Average linear groundwater velocity (V=KI/n) | *V* | 0.2 | feet/day |

## 1.4 Groundwater Discharge

| Description | *Symbol* | Value | Units |
|---|---|---|---|
| Average linear groundwater velocity | *V* | 0.2 | feet/day |
| Estimated Discharge zone area | *A* | 246,400 | $feet^2$ |
| Effective Porosity (from GMP) | *n* | 35 | % |
| Estimated total GW Discharge (Q=V*A*n) | *Q* | 17,568 | $feet^3$/day |

## 1.5 Mississippi River Flow

| Description | *Value* | Units |
|---|---|---|
| Estimated low Mississippi River Conditions (1/1/2013) | 366 | feet MSL |
| Corresponding STL Discharge (1/1/2013) | 56,400 | $feet^3$/sec |
| Seconds per Day | 86,400 | seconds/day |
| Estimated low Flow Daily Discharge (Average Discharge * seconds per day) | 4,872,960,000 | $feet^3$/day |

**Date: February 8, 2018** **Made by:** J. Ingram

**Project No.: 130-1560** **Checked by:** E. Kidner

**Subject: Meramec Energy Center Dilution Factor Calculations - Mississippi River** **Reviewed by:** M.Haddock

## 1.5 Dilution Factor

| Description | Values | Units |
|---|---|---|
| Estimated Daily Groundwater Discharge | 17,568 | $feet^3$/day |
| Estimated Daily Groundwater Discharge | 131,420 | gallons/day |
| Estimated Daily River Flow | 4,872,960,000 | $feet^3$/day |
| Estimated Daily River Flow | 36,452,274,739 | gallons/day |
| Estimated Dilution Factor (River / GW) | **277,372 or >100,000** | Unitless |

## 1.6 List of Conservative Assumptions Used

1) Calculations are based on estimated flow rates under low flow river conditions. As an example, low flow values used for Meramec are from January 1, 2013 which is the lowest value since 1989 and the 9th lowest in recorded history at the St. Louis Mississippi River gauge. Using river flow averages would greatly increase the dilution by an order of magnitude. Mississippi River data is available at http://water.weather.gov/ahps2/hydrograph.php?wfo=lsx&gage=EADM7.

2) To simplify the calculations, the alluvial aquifer was assumed to consist of higher permeability sands, resulting in conservative (higher) estimates of groundwater discharge.

3) The calculations do not take into account any dilution from the alluvial aquifer itself. The river locally recharges the aquifer at varying rates depending on river stage. In addition, on a near continuous basis, groundwater flows from the bedrock aquifer into the shallow alluvial aquifer. All of these sources increase dilution within the alluvial aquifer.

Although these calculations use conservative assumptions which would serve to increase the dilution factor ratio, the calculated value for the dilution factor has been rounded down. This dilution factor ratio represents a worst case scenario and actual dilution factors are likely greater.

Golder Associates

# CALCULATIONS

**Date: February 8, 2018** | **Made by:** J. Ingram

**Project No.: 130-1560** | **Checked by:** E. Kidner

**Subject: Meramec Energy Center Dilution Factor Calculations - Meramec River** | **Reviewed by:** M. Haddock

## 1.0 Introduction

The Meramec River is a large, flowing water body and daily flow at the Meramec Energy Center (MEC) is estimated to range between 171 million and 103 billion gallons per day, depending upon the river stage. In contrast, during low river flow conditions, average daily groundwater flow into the river is a fraction (estimated to be 231,000 gallons or 0.13%) of the receiving water body. This ratio of flow is referred to as a "dilution factor" and is useful when assessing the relationship between smaller and larger water bodies. Set forth below is a calculation of a dilution factor based on specific criteria and assumptions delineated in Section 1.6.

## 1.1 Low River Conditions

| Date | Arnold Gauge Height | Arnold Gauge Elevation | Meramec River Elevation at Arnold Gauge | Valley Park Gauge Height | Valley Park Gauge Elevation | Meramec River Elevation at Valley Park Gauge |
|---|---|---|---|---|---|---|
| **Units** | **ft above gauge** | **ft MSL** | **ft MSL** | **ft above gauge** | **ft MSL** | **ft MSL** |
| 7/28/2012 21:00 | 5.47 | 373.21 | 378.68 | -3.88 | 391.22 | 387.34 |

Notes:
1) ft - feet
2) ft MSL - feet above mean sea level
3) Information and Data for the Arnold gauge available at https://waterdata.usgs.gov/nwis/uv?site_no=07019300,
4) Information and Data for the Valley Park gauge available at https://waterdata.usgs.gov/nwis/uv?site_no=07019130,

| Meramec River Elevation at Arnold Gauge | Meramec River Elevation at Valley Park Gauge | Distance Between Arnold and Valley Park Gauges | Calculated Meramec River Gradient | Distance from Arnold Gauge to MEC | Estimated Meramec River Elevation at MEC |
|---|---|---|---|---|---|
| **ft MSL** | **ft MSL** | **River Miles** | **foot/foot** | **River Miles** | **ft MSL** |
| 378.68 | 387.34 | 15.5 | 0.00011 | 5.6 | 376 |

Notes
1) Estimated Meramec River Elevation at the MEC calculated by subtracting the gradient of the Meramec River multiplied distance from the Arnold gauge (in river feet) from the Arnold gauge.

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## 1.2 Alluvial Aquifer Geological Properties

| Description | Value | Units |
|---|---|---|
| Estimated length of discharge zone | 6,200 | feet |
| Estimated top of discharge zone (low river level) | 376 | feet above mean sea level |
| Estimated bottom of discharge zone (Bedrock) | 310 | feet above mean sea level |
| Estimated thickness of discharge zone (Top - Bottom) | 66 | feet |
| Estimated area of discharge zone (length x thickness) | 409,200 | $feet^2$ |
| Estimated percentage of discharge area that consists of channel deposits (mostly sands and gravels) | 34 | % |
| Estimated percentage of discharge area that consists of floodplain deposits (mostly Silty Clay, Silt or Clay) | 66 | % |
| Estimated channel deposits discharge area | 139,128 | $feet^2$ |
| Estimated floodplain deposits discharge area | 270,072 | $feet^2$ |

## 1.3 Groundwater Properties

| Description | Symbol | Value | Units |
|---|---|---|---|
| **Channel Deposits (Sand, Silty Sand, Gravel)** | | | |
| Average Hydraulic Conductivity (includes MW-3, MW-4, and MW-5) | K | 96 | feet/day |
| Average Groundwater Gradient (from GMP) | I | 0.0023 | feet/feet |
| Effective Porosity (from GMP) | n | 35 | % |
| Average linear groundwater velocity (V=KI/n) | *V* | 0.6 | feet/day |
| **Floodplain Deposits (Silt, Clay, Sitly Clay)** | | | |
| Estimated Average Hydraulic Conductivity (inorganic silts, Geotechdata.info (see below)) | K | 0.284 | feet/day |
| Average Groundwater Gradient (from GMP) | I | 0.0023 | feet/feet |
| Effective Porosity (from GMP) | n | 35 | % |
| Average linear groundwater velocity (V=KI/n) | *V* | 0.002 | feet/day |

Hydraulic Conductivity for floodplain deposits based on data for inorganic silts, silty or clayey fine sands, with slight plasticity available at http://www.geotechdata.info/parameter/permeability.html.

## 1.4 Groundwater Discharge

| Description | *Symbol* | Value | Units |
|---|---|---|---|
| **Channel Deposits (Sand, Silty Sand, Gravel)** | | | |
| Average linear groundwater velocity | *V* | 0.6 | feet/day |
| Estimated Discharge zone area | *A* | 139,128 | $feet^2$ |
| Effective Porosity (from GMP) | *n* | 35 | % |
| Estimated total GW Discharge (Q=V*A*n) | *Q* | 30,719 | $feet^3$/day |
| **Floodplain Deposits (Silt, Clay, Sitly Clay)** | | | |
| Average linear groundwater velocity | *V* | 0.002 | feet/day |
| Estimated Discharge zone area | *A* | 270,072 | $feet^2$ |
| Effective Porosity (from GMP) | *n* | 35 | % |
| Estimated total GW Discharge (Q=V*A*n) | *Q* | 176 | $feet^3$/day |

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**Subject: Meramec Energy Center Dilution Factor Calculations - Meramec River** **Reviewed by:** M. Haddock

## 1.4 Meramec River Flow

| Description | *Value* | Units |
|---|---|---|
| Estimated low Meramec River Conditions (7/28/2012) | 376 | feet MSL |
| Corresponding Discharge for Eureka Gauge (7/28/2012) | 265 | $feet^3/sec$ |
| Seconds per Day | 86,400 | seconds/day |
| Estimated low Flow Daily Discharge (Average Discharge * seconds per day) | 22,896,000 | $feet^3/day$ |

Nearest upstream gauge with discharge data is the Eureka gauge. No discharge data is available for the Arnold, Fenton, or Valley Park gauges. Information and data for the Eureka gauge is available at https://waterdata.usgs.gov/nwis/uv?site_no=07019000.

## 1.5 Dilution Factor

| Description | Values | Units |
|---|---|---|
| Estimated Daily Channel Deposit Groundwater Discharge | 30,719 | $feet^3/day$ |
| Estimated Daily Floodplain Deposit Groundwater Discharge | 176 | $feet^3/day$ |
| Estimated Daily Groundwater Discharge | 30,896 | $feet^3/day$ |
| Estimated Daily Groundwater Discharge | 231,117 | gallons/day |
| Estimated Daily River Flow | 22,896,000 | $feet^3/day$ |
| Estimated Daily River Flow | 171,273,986 | gallons/day |
| Estimated Dilution Factor (River / GW) | **741 or >700** | Unitless |

## 1.6 List of Conservative Assumptions Used

1) Calculations are based on estimated flow rates under low flow river conditions. As an example, low flow values used for Meramec are from July 28, 2012 which is the lowest value since 2001 at the Meramec Arnold Gauge. Using river flow averages would greatly increase the dilution by an order of magnitude. Meramec River data is available at http://water.weather.gov/ahps2/hydrograph.php?gage=arnm7&wfo=lsx.
2) The calculations do not take into account any dilution from the alluvial aquifer itself. The river locally recharges the aquifer at varying rates depending on river stage. In addition, on a near continuous basis, groundwater flows from the bedrock aquifer into the shallow alluvial aquifer. All of these sources increase dilution within the alluvial aquifer.
3) The nearest Meramec River gauge with discharge values for July 28, 2012 is the Eureka gauge, which is located approximately 34 river miles upstream. The discharge as the river flows downstream is greater as it approaches the Mississippi River. Additionally, under low Meramec conditions, the Mississippi River can also flow upstream, causing additional dilution of the area near the MEC, which was not accounted for in the calculation.

Although these calculations use conservative assumptions which would serve to increase the dilution factor ratio, the calculated value for the dilution factor has been rounded down. This dilution factor ratio represents a worst case scenario and actual dilution factors are likely greater.