List of Requested Information

Sioux Energy Center (8501 MO-94, West Alton, Missouri)
Meramec Energy Center (8200 Fine Road, St. Louis, Missouri)
Labadie Energy Center (226 Labadie Power Plant Road, Labadie, Missouri)
Rush Island Energy Center (100 Big Hollow Road, Festus, Missouri)

1. EPA has reviewed Ameren's 2019 Remedy Selection report which covers all four referenced facilities. Ameren selected an engineered cap with monitored natural attenuation. Please provide the following:

    a. Pilot study reports prepared by XDD Environmental for each location where a pilot study has been implemented. This includes, but is not limited to, tabular data of all sampling performed as part of these pilot programs and any analysis of the effectiveness of the potential remedies.

    Ameren Response:

    Groundwater and soil samples were analyzed from all four of Ameren's Energy Centers during the bench-scale treatability studies. As information was obtained, the studies of the individual centers were combined into a larger-scale singular study. In 2019, a preliminary report of the combined studies was developed but never finalized so that Ameren could progress more rapidly into the design phase for field pilot studies at Rush Island Energy Center and Sioux Energy Center. This report has been provided in **AMEREN_00003135 - AMEREN_00003172***. Preliminary memoranda for Rush Island Energy Center, Sioux Energy Center and Labadie Energy Center were developed and updated in January 2022. These memoranda have been provided* ***A*****MEREN_00003173 - AMEREN_00003183, AMEREN_00003184 - AMEREN_00003197 and AMEREN_00003198 - AMEREN_00003211***. The findings in the bench-scale treatability testing were crucial in developing the treatment train sequence and selecting the resin.*

    Field pilot studies were performed at both Rush Island Energy Center and Sioux Energy Center in 2021. Detailed reports were not developed as full-scale design for Rush Island Energy Center was being conducted simultaneously using information obtained in real-time for each site. Information from the construction and early-stage operation of the Rush Island Energy Center system were used in the final design of the Sioux Energy Center system. Data from the field pilot studies are presented in tabular format in **AMEREN_00003212** *and* **AMEREN_00003213***.*

    b. Page one of the Remedy Selection Report states, "Ongoing monitoring and modeling evaluations will document that concentrations are decreasing as modeled. MNA occurs due to naturally occurring processes within the aquifer." Please provide data supporting MNA and the MNA modeling conducted at each facility that supports

Ameren's conclusion that MNA will achieve groundwater protection standards and any additional analysis of the model results not already posted on Ameren's publicly available webpage. Also provide any modeling or analysis that demonstrates that MNA will satisfy the mandatory criterion in 40 C.F.R. § 257.97(b)(4) that the selected remedy removes as much contamination from the environment as feasible.

Ameren Response:

Groundwater modeling completed in 2018-2019 predicted future concentrations for Constituents of Concern (COCs) at each site after capping and closing of the CCR Units in Corrective Action. These reports are provided in **AMEREN_00003660 - AMEREN_00003974, AMEREN_00003975 - AMEREN_00003996, AMEREN_00002960 - AMEREN_00003020, AMEREN_00003021 - AMEREN_00003023, AMEREN_00004010 - AMEREN_00004102, *and* AMEREN_00003024 - AMEREN_00003134***. In addition to installation of low-permeability caps and MNA, as discussed in the Remedy Selection Report, pilot studies were also being completed to determine if groundwater treatment was a viable corrective measure. Since the completion of the Remedy Selection Report in 2019, pilot studies have demonstrated that groundwater treatment is effective in reducing COC concentrations. Following the success of these pilot studies, rapid design and installation of the treatment systems is being completed and groundwater treatment has commenced at the Rush Island Energy Center (RIEC) and Sioux Energy Center (SEC).*

Due to the success of the groundwater treatment pilot study tests, Ameren began collecting additional data, and the results support the downward trends of COCs as shown in the Annual Groundwater Monitoring and Corrective Action Reports. Additionally, an MNA evaluation was performed at the Labadie Energy Center (LEC) and has been provided in **AMEREN_00003218 - AMEREN_00003386 *and* AMEREN_00003387 - AMEREN_00003440.** *The evaluation for the SEC is underway and is anticipated to be completed in May 2024. The modeling provided in* **AMEREN_00003660 - AMEREN_00003974 *and* AMEREN_00003975 - AMEREN_00003996** *for RIEC includes MNA components.*

Groundwater at the MEC is rarely (if ever) in contact with historic ash basins. Ameren is currently working with the Missouri Department of Natural Resources (MDNR) to develop a site-specific industrial NPDES permit for that site. This permit is anticipated to contain provisions for groundwater monitoring and potential treatment (which may include MNA) as required to meet CCR Rule and state groundwater quality standards.

c. Progress updates regarding any supplemental corrective measures and indicate which, if any, are planned to be selected as a final corrective measure at each Ameren facility.

Ameren Response:

Ameren prepared an initial Remedy Selection Report for the Rush Island, Labadie, Sioux and Meramec Energy Centers dated August 30, 2019, which is available on Ameren's CCR compliance website. Remedy selection followed comprehensive corrective measures assessments that included a range of alternatives, opportunities for public input and numerous technical evaluations (including groundwater modeling, human health and ecological risk assessments, groundwater treatment assessments, and various other studies). The decision in 2019 was to select a remedy that included installation of a low-permeability, geomembrane cap system, monitored natural attenuation, and implementation of a long-term performance monitoring plan. In addition, Ameren explained that it was exploring potential supplemental corrective measures with its environmental consultant, XDD. The performance data collected since 2019 (where available) demonstrate that the remedy selected in 2019 is working to reduce groundwater concentrations. In addition, supplemental corrective measures are now in place at the Rush Island and Sioux Energy Centers and are in the process of analysis and evaluation for the Labadie and Meramec Energy Centers, and the results of those efforts have been separately produced with this response (see **AMEREN_00003135 - AMEREN_00003172, AMEREN_00003173 - AMEREN_00003183, AMEREN_00003184 - AMEREN_00003197, AMEREN_00003198 - AMEREN_00003211, AMEREN_00003212 and AMEREN_00003213***). The data from those treatment systems show that they are successful in accelerating and enhancing the initial remedies that were selected. Ameren is in the process of preparing supplemental Remedy Selection Reports that reflect and specifically incorporate these supplemental corrective measures, together with the latest data and updated modeling results. Ameren will share those reports with EPA and post them to the operating record and CCR compliance website as soon as they are finalized and certified by a qualified professional engineer.*

2. EPA has reviewed the CCR Rule compliance documents posted on Ameren's publicly available webpage for the Rush Island facility. Please provide the information set forth below.

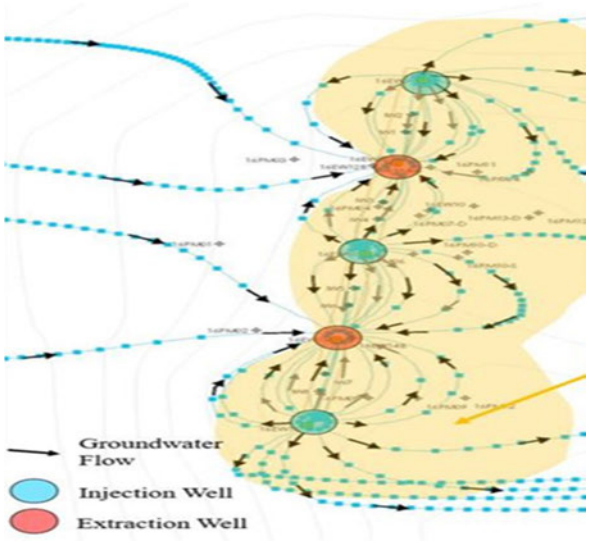
    a. EPA has reviewed Ameren's 2022 Annual Groundwater Monitoring and Corrective Action Report for the Rush Island facility. On page ES-3, Ameren states that the pilot study has been completed and that the pump and treat technology has been expanded to the entire downgradient side of the RCPA and it became fully operational in 2022. Based on the information in that report, EPA is requesting:

        i. Information that indicates the capture zone of the extraction wells.

Ameren Response:

The capture zone is based on annual flow conditions across the Rush Island Energy Center ash basin of 34 ft/year as documented in the 2018 Annual Groundwater Monitoring and Corrective Action Report. This represents an average historical movement of a transport particle across the basin in an east/southeast direction over a given calendar year. It accounts for overall vector movement of that particle during normal, stagnant, flood and low-level river stages throughout that calendar year. A combination of both extraction and injection wells to capture and control that movement is used to ensure a net-zero difference in overall groundwater flow conditions. Essentially, what is removed for treatment is re-introduced in the same area so that outside the small corridor of capture and injection there is no change in overall flow conditions. The design accounts for treating the volume of water within the effective porosity of that control area, which is 34 feet wide by 70 feet of water column by 800 linear feet per building. To be conservative, a 45-foot width and 32% effective porosity were used to calculate 6,000,000 gallons of water per building per year for annual control. The well spacing and offset of the extraction well row and injection well row were modeled to reach a point of intermixing with 2-3 years. This resulted in 8 extraction wells and 8 injection wells in individual rows separated by 18 feet spaced 120 feet between wells on a 60-foot offset so that injection wells were approximately 60 feet from extraction wells. At 8 extraction wells per building with a 90% run time, the extraction rate per well equates to approximately 1.5 gpm.

The figure to the right illustrates how injection and extraction well integrate to form a linear control wall.



ii. Documentation which demonstrates that the treatment system is effective for all appendix IV constituents.

Ameren Response:

During the bench testing and pilot-scale testing, metals exceeding the Appendix IV constituent action levels specific to the Rush Island Energy Center ash pond were targeted for the treatment train. These metals of concern for treatment purposes were arsenic and molybdenum. As the treatment train was being designed and injection of the treated waters was key to control, the application process for an Underground Injection Control (UIC) permit was initiated with the Missouri Department of Natural Resources (MDNR). The initial intent was to treat the site-specific constituents of concern which were determined through the CCR rule process; however, MDNR opted to set the treatment limitations using federal drinking water standards, thereby also setting specific limitations for boron and sulfate, which are not part of the Appendix IV constituents. Monthly compliance testing and reporting to MDNR are required under the UIC permit (UI0000043) and demonstrate that the process is not only effective for treatment of the Appendix IV constituents identified as concerns at Rush Island Energy Center, but that the process also meets drinking water standards for these and other constituents. See **AMEREN_00002770 - AMEREN_00002877** *for copies of the monthly compliance reports submitted to MDNR and see* **AMEREN_00002878 - AMEREN_00002879** *for a summary of the UIC system performance since beginning full-scale operation. Refer to* **AMEREN_00003173 - AMEREN_00003183** *for documentation on the metals treatability study and* **AMEREN_00003212** *for documentation of the pilot-scale system operation as a demonstration of the system's ability to address the applicable Appendix IV constituents.*

iii. Information that indicates the effects of the injection pressure to localized groundwater elevation, including any supporting data maps and/or modeling.

Ameren Response:

The Mississippi River alluvial deposits at the Rush Island Energy Center in which the injection of treated water occurs is a high yield aquifer. Treated water transferred to the injection wells is gravity fed into 4-inch diameter wells with 60+ foot screens. Due to the low flow into each well of less than 2 gpm return into a high yield sand unit, pressures and localized groundwater elevation changes are negligible.

iv. Information that indicates the intended life of this remedy.

Ameren Response:

Assuming proper operation, maintenance and upkeep of the treatment system, Ameren expects that it will remain in service as long as needed to achieve compliance with the applicable groundwater protection standards.

v. Any contingency plans or measures prepared to address the possibility of a failure of pump and treat system or if the system is temporarily disabled.

Ameren Response:

There are several contingencies in place regarding the operation of the treatment system. While the system is automated, it is an operator-controlled design similar to a water or wastewater treatment plant. Alarms and telemetry provide 24 hour/day, 7 day/week knowledge of the system. Additionally, this telemetry capability allows for remote operation of the system. An extensive inventory of replacement parts is available for immediate access by the operator(s) on an as-needed basis and agreements have been established with local vendors for services that cannot be addressed at the facility level. In addition, the Rush Island Energy Center has four treatment buildings which are fully interconnected, so if required, water can be transferred from one operating segment to another for treatment and an equivalent volume of treated water can be returned to that segment for injection to maintain a net-zero difference in groundwater flow.

vi. A map that identifies all wells for the pump and treat system. Please distinguish between sentinel wells, injection wells, extraction wells, and any other wells associated with that system.

Ameren Response:

Only injection and extraction wells are associated with the Rush Island Energy Center pump and treat system. A figure identifying these wells has been provided in ***AMEREN_00000174****.*

vii. Information that explains whether and how the pump and treat system is resilient to flooding.

Ameren Response:

The pump and treat system, including the well field, is located directly adjacent to and on top of the closed ash basin berm. The elevation of the ash basin and its designed berm are significantly above the 100-year flood elevation. In addition, extraction well top of casings and system components within the treatment building are elevated above the ground surface elevation and building floor to provide additional conservatism for flooding resiliency.

b. The well construction, development, lithologic, and drilling records for all wells Ameren is utilizing for its CCR program.

Ameren Response:

See **AMEREN_00003441 - AMEREN_00003659***. In Table 2-6 Piezometer Development Summary provided in the referenced document, wells being utilized in the CCR program have been identified using green highlighted text. The additional piezometer development records in Table 2-6 are not being utilized in the current CCR program monitoring network.*

c. Sampling and analysis plans or groundwater monitoring plans detailing the procedures for collecting CCR groundwater compliance sampling.

Ameren Response:

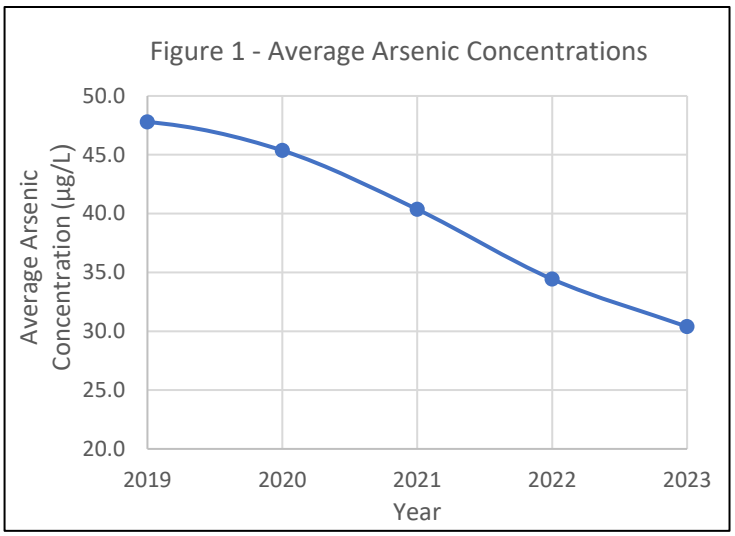
See ***AMEREN_00000176 - AMEREN_00000362 and AMEREN_00000363 - AMEREN_00000497****.*

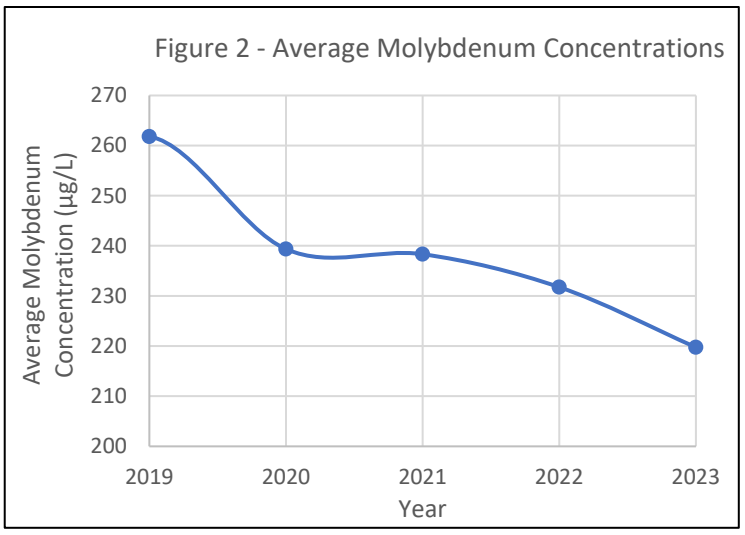
d. A summary of the volume/amount of released Appendix IV constituents at statistically significant levels. Provide any plume map figures that define the nature and extent of the SSL releases.

Ameren Response:

Arsenic and molybdenum at the Rush Island Energy Center (RIEC) have been detected at a Statistically Significant Level (SSL) over their respective site-specific Groundwater Protection Standards (GWPS). These constituents at SSLs were first determined in 2018 and more information on the semiannual SSL statistical evaluations is provided in the Annual Groundwater Monitoring and Corrective Action Reports.

As discussed in the 2023 Annual Groundwater Monitoring and Corrective Action Report, average concentrations of arsenic in monitoring wells downgradient of the RCPA have decreased approximately 36% since commencing closure of the RCPA in 2019 (See Figure 1 below). Additionally, since 2019, average concentrations of molybdenum in monitoring wells downgradient of the RCPA have decreased approximately 16% (See Figure 2 below).





e. The groundwater modeling report(s), analysis, and conclusions (including but not limited to model inputs, boundary conditions, model calibration, etc.) cited in the Corrective Measures Assessment that supports the analysis on the time required for GWPS to be attained.

Ameren Response:

The timeframes reported in the Corrective Measures Assessment (CMA) to attain the GWPS reflect groundwater modeling simulating a $1x10^{-7}$ cm/s cap (which represents the cap as installed). The groundwater modeling supporting these timeframes was summarized in two documents prepared by Golder, [Groundwater and Geochemical Modeling Summary for Ameren Rush Island Energy Center Corrective Measures Assessment (Jan. 2019 Memo) and Groundwater and Geochemical Modeling Summary Updates for the Rush Island Energy Center Corrective Measures Assessment (March 2019 Update)] which have been provided as **AMEREN_00003660 - AMEREN_00003974 and AMEREN_00003975 - AMEREN_00003996***, respectively. It is noteworthy that various cap alternatives were considered which are included in these documents. However, the final Ameren determination was to use a cap with a permeability of $1x10^{-7}$ cm/s. The Jan. 2019 Memo explains the overall fate and transport modeling approach, analysis and conclusions. The Mar. 2019 Update provides output specific to the $1x10^{-7}$ cm/s cap alternative. Ameren is evaluating the need to update the existing groundwater model to reflect current groundwater treatment activities.*

f. A copy of the engineer's certification that the selected remedy meets the requirements of 40 C.F.R. § 257.97.

Ameren Response:

See response to item no. 1.c.

g. A comprehensive narrative explanation with supporting data to substantiate the claim on Page 7 of the CMA that groundwater preferentially flows under the RCPA.

Ameren Response:

In 2019, Golder Associates Inc (Golder) developed a 3D Groundwater Fate and Transport Model for the Rush Island Energy Center (RIEC) using the United States Geological Survey (USGS) MODFLOW, MT3DMS, MODPATH, and PEST packages. Groundwater Vistas was used as the graphical user interface for the groundwater model. Additional details on the groundwater model are provided in **AMEREN_00003660 - AMEREN_00003974 and AMEREN_00003975 - AMEREN_00003996**.

As discussed in Section 2.2 of **AMEREN_00003975 - AMEREN_00003996**, *the model was used to predict the amount of groundwater that will flow under/around, as opposed to through the RCPA after closure of the CCR Unit. For this evaluation, several hydrostratigraphic units (HydroStratigraphy property in Groundwater Vistas or "HSUs") were incorporated into the model for the CCR and alluvial materials. The mass balance between the two HSUs was used to predict groundwater flow under/around, versus through, the RCPA.*

For Rush Island, a sensitivity analysis was completed based on the horizontal conductivity of the CCR materials. As displayed in Table 2 of the report (see below), at least 94.7% of groundwater flow is calculated to flow under/around the CCR, even when using the highest value of horizontal conductivity for the CCR. With lower conductivity values, the model predicts zero flow through the RCPA.

Table 2: Model Estimates of Flow Under/Around vs Into the RCPA Based on Ash Conductivity

Horizontal Hydraulic Conductivity (Kx,Ky) of RCPA Ash	Vertical Hydraulic Conductivity (Kz) of RCPA Ash	Flow Under/ Around the RCPA	Flow Through the RCPA	Percent Flow Under/Around RCPA	Percent Flow Through the RCPA
Centimeter per Second		Gallons per Minute		Percent	
3.0×10^{-3}	9.8×10^{-5}	3.6	0.2	94.7%	5.3%
3.0×10^{-4}	9.8×10^{-5}	4.1	0.0	100.0%	0.0%
3.0×10^{-5}	9.8×10^{-5}	4.2	0.0	100.0%	0.0%

Notes:
1) In all future model scenarios, the RCPA was modeled as drained, inactive, and with the RCPA cap resulting in an infiltration rate of 1 inch/year to the RCPA based on Haley & Aldrich 2018 HELP model net infiltration prediction for 1 x 10-7 cm/s cap.
2) Mississippi River stage of 366 ft amsl is the steady-state equivalent river stage used in each of the model scenarios.
3) Horizontal hydraulic conductivity based on 4 slug tests completed in 2014 by Natural Resource Technology (NRT), each with result of 1.0E-4 cm/s, and model calibrations. Vertical hydraulic conductivity based on model calibrations.

To further illustrate the effects of the groundwater flow under and/or around the lower conductivity CCR materials, Figure 7 of **AMEREN_00003975 - AMEREN_00003996** *displays MODPATH results from placing a particle directly adjacent to the RCPA on the established upgradient side. As shown on the figure, the particle preferentially flows underneath and/or around the RCPA through the higher conductivity alluvial deposits (sands, silts, gravels, etc.) rather than through the lower conductivity materials associated with the RCPA. Further description of the analysis is provided in* **AMEREN_00003975 - AMEREN_00003996***.*

3. EPA has reviewed the CCR Rule compliance documents posted on Ameren's publicly available website for the Meramec Energy Center. Please provide the requested information as set forth below.

    a. EPA has reviewed Ameren's 2022 Annual Groundwater Monitoring and Corrective Action Report for the Meramec Energy Center facility. On page 3, Ameren states that a pilot groundwater treatment system will begin in 2023 or 2024. Based on the information in that report, EPA is requesting:

        i. Information that indicates the capture zone of the extraction wells.

<u>Ameren Response:</u>

The pilot groundwater treatment system envisioned in the Corrective Action Report for Ameren's Meramec Energy Center is still being designed. Ameren proceeded expeditiously with similar projects at both the Rush Island Energy Center and Sioux Energy Center. Based on recommendations from its consultants, Ameren deferred implementation of a groundwater treatment system at the Meramec Energy Center in order to utilize lessons learned and best practices from the projects at Rush Island Energy Center and Sioux Energy Center. This will enable Ameren to ascertain important operational best practices from these unique installations and determine the best course of action at the Meramec Energy Center. Ameren also notes that potential new EPA CCR regulations are expected in early 2024 pursuant to Docket ID EPA-HQ-OLEM-2020-0107. Since these new regulations could affect future treatment plans at the Meramec Energy Center, Ameren will need to incorporate them into its final design plans, as appropriate.

Ameren further notes that a new NPDES permit for the Meramec Energy Center is currently under development with the Missouri Department of Natural Resources (MDNR) and is expected to contain provisions for groundwater compliance. These potential permit requirements will be incorporated into any future final remedy selection for the Meramec Energy Center.

ii. Documentation which demonstrates that the treatment system is effective for all appendix IV constituents.

Ameren Response:

See response to item no. 3.a.i.

iii. Information that indicates the effects of the injection pressure to localized groundwater elevation, including any supporting data maps and/or modeling.

Ameren Response:

See response to item no. 3.a.i.

iv. Information that indicates the intended life of this remedy.

Ameren Response:

See response to item no. 3.a.i.

v. Any contingency plans or measures prepared to address the possibility of a failure of pump and treat system or if the system is temporarily disabled.

Ameren Response:

See response to item no. 3.a.i.

vi. A map that identifies all wells for the pump and treat system. Please distinguish between sentinel wells, injection wells, extraction wells, and any other wells associated with that system.

Ameren Response:

See response to item no. 3.a.i.

vii. Information that explains whether and how the pump and treat system is resilient to flooding.

Ameren Response:

See response to item no. 3.a.i.

b. Well construction, development, lithologic, and drilling records for piezometers BMW-3, BMW-4, and BMW-5.

Ameren Response:

*See **AMEREN_00000498 - AMEREN_00000515**.*

c. Well construction, development, lithologic, and drilling records for all the wells Ameren is utilizing for its CCR program at the Meramec Energy Center.

Ameren Response:

*See **AMEREN_00000516 - AMEREN_00000599**.*

d. Groundwater modeling report(s), analysis, and conclusions (including but not limited to model inputs, boundary conditions, model calibration, etc.) cited in the Corrective Measures Assessment that supports the analysis on the time required for GWPS to be attained.

Ameren Response:

The timeframes reported in the Corrective Measures Assessment (CMA) to attain the GWPS reflect groundwater modeling simulating a $1x10^{-7}$ cm/s cap (which represents the cap as installed). The groundwater modeling supporting these timeframes was summarized in a groundwater modeling report and figure update prepared by Burns & McDonnell, [Meramec Energy Center Groundwater Model, Draft Rev 0 (May 2019 Report) and revised Appendix C Figures to the May 2019 Report (2019 Updated Figures] which have been provided as **AMEREN_00002960 - AMEREN_00003020 and AMEREN_00003021 - AMEREN_00003023***, respectively. It is noteworthy that various cap alternatives were considered in the May 2019 Report. However, the final Ameren determination was to use a cap with a permeability of $1x10^{-7}$ cm/s. The May 2019 Report explains the overall fate and transport modeling approach, analysis and conclusions. The 2019 Updated Figures provides the revised Capping and Potential Remediation Simulation Concentration Graphs included in the Corrective Measures Assessment report.*

In addition, MDNR is preparing an NPDES permit for Meramec Energy Center that is expected to include additional groundwater investigation and remedial requirements to achieve compliance with state groundwater standards, and Ameren anticipates implementing those requirements under active oversight and direction from MDNR.

e. On page 7 of the CMA, Ameren concludes that public or private wells located on the opposite side of the Meramec River are isolated from the MEC. Provide any evidence and/or analysis to substantiate that claim.

Ameren Response:

As detailed in **AMEREN_00003997 - AMEREN_00004009***, the private wells (no public wells have been identified in the area) located west of the Meramec River, across from the Meramec Energy Center (MEC) are not impacted by the MEC. Using publicly available well records, three wells were identified within one mile of the MEC west of the Meramec River. The nearest well is approximately 4,000 feet west of the surface impoundments along the western side of the MEC. The remaining two wells are located farther to the northwest of the MEC. Each of these wells is screened in the bedrock aquifer hundreds of feet below ground surface. There are no nearby wells screened in the alluvial aquifer that is actively monitored at the MEC .*

Based on regional bedrock groundwater levels, the three private wells are hydraulically upgradient of the MEC and screened in the bedrock aquifer. As a predominantly gaining stream, groundwater along both sides of the river is directed towards the river, limiting groundwater flow under and across the river boundary. Consequently, the Meramec River acts as a hydraulic boundary for groundwater flow in the alluvial aquifer between the two sides of the river, further isolating these wells from the MEC. Additionally, regional bedrock groundwater flow is towards the Mississippi River.

f. Sampling and analysis plans or groundwater monitoring plans detailing the procedures for collecting CCR groundwater compliance sampling.

Ameren Response:

See ***AMEREN_00000600 - AMEREN_00000767 and AMEREN_00000768 - AMEREN_00000849****.*

g. Location restriction demonstrations for MCPE.

Ameren Response:

See **AMEREN_00004103 - AMEREN_00004115***.*

h. A summary of the volume/amount of released Appendix IV constituents at

statistically significant levels. Provide any plume map figures that define the nature and extent of the SSL releases.

Ameren Response:

Arsenic, lithium, and molybdenum at the Meramec Energy Center (MEC) have been detected at a Statistically Significant Level (SSL) over their respective site-specific Groundwater Protection Standards (GWPS). These constituents at SSLs were first determined in 2018 and more information on the semiannual SSL statistical evaluations is provided in the Annual Groundwater Monitoring and Corrective Action Reports.

As discussed in the 2023 Annual Groundwater Monitoring and Corrective Action Report, the final surface impoundment closures associated with the MEC multi-unit network were completed in October 2023. Only one sampling event has been conducted since all surface impoundments have been closed (within approximately one month of closure), therefore, no evaluation on the effectiveness of monitored natural attenuation (MNA) has been completed to-date. Closure and MNA are expected to decrease concentrations of these constituents in the alluvial aquifer over time.

i. A copy of the engineer's certification that the selected remedy meets the requirements of 40 C.F.R. § 257.97.

Ameren Response:

See response to item no. 1.c.

4. EPA has reviewed the CCR Rule compliance documents posted on Ameren's publicly available website for the Sioux Energy Center. Please provide the requested information as set forth below.

    a. EPA has reviewed Ameren's 2022 Annual Groundwater Monitoring and Corrective Action Report for the Sioux Energy Center facility. On page 3, Ameren states that the groundwater treatment system will be fully operational in 2023. Based on the information in that report, EPA is requesting:

        i. Information that indicates the capture zone of the extraction wells.

Ameren Response:

The capture zone is based on annual flow conditions radially away from the Sioux Energy Center ash basin of 11 ft/year as documented in the 2018 Annual Groundwater Monitoring and Corrective Action Report. This represents an average historical movement of a transport particle across the basin in all directions over a given calendar year. It accounts for overall vector movement of that particle during normal, stagnant,

flood and low-level river stages throughout that calendar year. A combination of both extraction and injection wells to capture and control that movement is used to ensure a net-zero difference in overall groundwater flow conditions. Unlike at the Rush Island Energy Center, in which flow is linear, the Sioux Energy Center experiences near stagnant flow conditions in which movement from the ash basin is limited in all directions. The system is designed for internal capture with injection radially along the ash pond perimeter. While some areas in the basin's interior experience reverse flow towards an extraction point, the volume treated is re-introduced along the perimeter, resulting in no change in overall flow conditions a short distance from the injection points. The well spacing and locations provide for placement of treated water along the basin's entire perimeter. This design resulted in 9 extraction wells and 23 injection wells of varied extraction and injection rates at individual wells but equal in summation for a net-zero distribution. See **AMEREN_00003214 - AMEREN_00003217** *for additional information.*

ii. Documentation which demonstrates that the treatment system is effective for all appendix IV constituents.

Ameren Response:

During the bench testing and pilot-scale testing, metals exceeding the Appendix IV constituent action levels specific to the Sioux Energy Center ash pond were targeted for the treatment train. The metal of concern identified for treatment purposes was molybdenum. As the treatment train was being designed and injection of the treated waters was key to control, the application process for an Underground Injection Control (UIC) permit was initiated with the Missouri Department of Natural Resources (MDNR). The initial intent was to treat to the site-specific statistical levels determined through the CCR rule process; however, MDNR opted to set the treatment limitations using federal drinking water standards, thereby also setting specific limitations for boron and sulfate, which are not part of the Appendix IV constituents. Monthly compliance testing and reporting to MDNR are required under the UIC permit (UI0000044) and demonstrate that the process is not only effective for treatment of the Appendix IV constituents identified as concerns at Sioux Energy Center, but that the process also meets drinking water standards for these and other constituents. See **AMEREN_00002880 - AMEREN_00002957** *for copies of the monthly compliance reports submitted to MDNR and see* **AMEREN_00002958 - AMEREN_00002959** *for a summary of the UIC system performance since beginning full-scale operation. Refer to* **AMEREN_00003184 - AMEREN_00003197** *for documentation on the metals treatability study and* **AMEREN_00003213** *for documentation of the pilot-scale system operation as a demonstration of the system's ability to address the applicable Appendix IV constituents. During the pilot study, there was no injection into the aquifer. Treated waters were discharged to the adjacent Low Volume Waste (LVW) facility. The samples collected for location SP801 in* **AMEREN_00003213** *represent the treated water discharged to the LVW facility.*

iii. Information that indicates the effects of the injection pressure to localized groundwater elevation, including any supporting data maps and/or modeling.

Ameren Response:

The Mississippi River alluvial deposits at the Sioux Energy Center in which the injection of treated water occurs is a high yield aquifer; however, due to the downstream lock and dam along the river, the area acts similar to a lake rather than a river. Treated waters transferred to the injection wells are gravity fed into 4-inch diameter wells with 60+ foot screens. Due to the low flow into each well of less than 1 gpm to 7 gpm return into a high yield sand unit, pressures and localized groundwater elevation changes are negligible.

iv. Information that indicates the intended life of this remedy.

Ameren Response:

Assuming proper operation, maintenance and upkeep of the treatment system, Ameren expects that it will remain in service as long as needed to achieve compliance with the applicable groundwater protection standards.

v. Any contingency plans or measures prepared to address the possibility of a failure of pump and treat system or if the system is temporarily disabled.

Ameren Response:

There are several contingencies in place regarding the operation of the treatment system. While the system is automated, it is an operator-controlled design similar to a water or wastewater treatment plant. Alarms and telemetry provide 24 hour/day, 7 day/week knowledge of the system. Additionally, this telemetry capability allows for remote operation of the system. An extensive inventory of replacement parts is available for immediate access by the operator(s) on an as needed basis and agreements have been established with local vendors for services that cannot be addressed at the facility level.

vi. A map that identifies all wells for the pump and treat system. Please distinguish between sentinel wells, injection wells, extraction wells, and any other wells associated with that system.

Ameren Response:

Only injection and extraction wells are associated with the Sioux Energy Center pump and treat system. A figure identifying these wells has been provided in ***AMEREN_00000175****.*

vii. Information that explains whether and how the pump and treat system is resilient to flooding.

Ameren Response:

The pump and treat system, including the well field, is located directly adjacent to and on top of the closed ash basin berm. The elevation of the ash basin and its designed berm are significantly above the 100-year flood elevation. In addition, system components within the treatment building are elevated above the ground surface elevation and building floor to provide additional conservatism for flooding resiliency. Extraction well and injection well top of casings are located in vaults with watertight lids. Should surface water enter the vaults, the system is designed to be submersible, and water will absorb into the surrounding soils over time.

b. Ameren's 2017 Annual Groundwater Monitoring and Corrective Action Report for the Sioux facility stated that background monitoring wells BMW-2D and BMW-2S were deemed to not be representative of background. Please provide an explanation and supporting documentation of the analysis that led Ameren to that conclusion.

Ameren Response:

The Sioux Energy Center is located at the confluence of the Missouri and Mississippi Rivers. As a result, a "bathtub effect" occurs whereby groundwater flows towards and away from these two rivers depending upon the relative stage of each river. (Note that the design and placement of extraction wells takes into account this oscillating pattern.)

After completing the first three groundwater elevation events for the SCPA and SCPB as a part of the baseline sampling, it was apparent that groundwater near the SCPA and SCPB did not always flow southward as indicated in previous site information. Groundwater elevation maps from the first three sampling events display that groundwater flow, while dynamic across the site, typically flowed towards the north or northeast, from the SCPA/SCPB towards the Mississippi River, in the area near BMW-2S/BMW-2D from the SCPA/SCPB towards the Mississippi River. As a result, these monitoring wells were determined to be unsuitable as background wells. Based on groundwater potentiometric surface mapping completed at the time, a new background well pair (BMW-3S/BMW-3D) was installed on the northwest area of the SEC property, upgradient of the CCR units.

c. The well construction, development, lithologic, and drilling records for the following wells: BMW-2S, BMW-2D, UG-1A, UG-2, UG-3, DG-1 through DG-12, and PZ-1S/D through PZ-9S/D.

Ameren Response:

*See **AMEREN_00000001 - AMEREN_00000173.** Records were provided for all requested wells including DG-8, DG-10, DG-11, PZ-3S, PZ-4S, PZ-5S, PZ-6S, PZ-7S, and PZ-8S which are not being utilized in the CCR program.*

d. Well construction, development, lithologic, and drilling records Ameren is utilizing for its CCR program at the Sioux Energy Center.

Ameren Response:

*See **AMEREN_00000850 - AMEREN_00001032**.*

e. The groundwater modeling report(s), analysis, and conclusions (including but not limited to model inputs, boundary conditions, model calibration, etc.) cited in the Corrective Measures Assessment that supports the analysis on the time required for GWPS to be attained.

Ameren Response:

The relative timeframes reported in the Corrective Measures Assessment (CMA) to attain the GWPS reflect groundwater modeling simulating a $1x10^{-7}$ cm/s cap (which represents the cap as installed). The groundwater modeling supporting these comparative timeframes was summarized in a groundwater modeling technical memo prepared by Golder, [Groundwater and Geochemical Modeling Summary for Ameren Sioux Energy Center Corrective Measures Assessment dated March 15, 2019 (March 2019 Memo)] which has been provided as **AMEREN_00004010 - AMEREN_00004102**. *The March 2019 Memo explains the overall fate and transport modeling approach, analysis and conclusions that support the information presented in the Corrective Measures Assessment report. Ameren is evaluating the need to update the existing model to reflect current groundwater treatment activities.*

f. Sampling and analysis plans or groundwater monitoring plans detailing the procedures for collecting CCR groundwater compliance sampling.

Ameren Response:

*See **AMEREN_00001033 - AMEREN_00001179, AMEREN_00001180 - AMEREN_00001337, AMEREN_00001338 - AMEREN_00001459, AMEREN_00001460 - AMEREN_00001590, AMEREN_00001591 - AMEREN_00001775, AMEREN_00001776 - AMEREN_00001888**.*

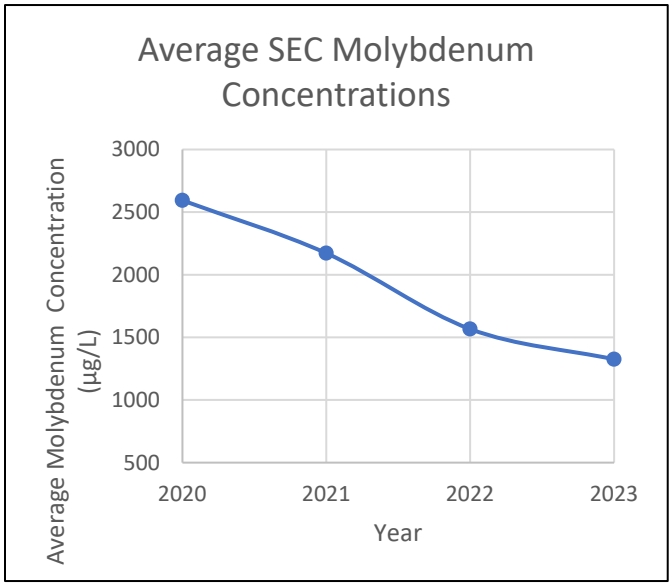
g. A summary of the volume/amount of released Appendix IV constituents at statistically significant levels. Provide any plume map figures that define the nature

and extent of the SSL releases.

Ameren Response:

Molybdenum is the only constituent at the Sioux Energy Center (SEC) that is present at a Statistically Significant Level (SSL) over the site-specific Groundwater Protection Standard (GWPS). This exceedance was determined in 2018. Additional information regarding the SSL statistical evaluations is provided in the Annual Groundwater Monitoring and Corrective Action Reports.

As discussed in the 2023 Annual Groundwater Monitoring and Corrective Action Report, average concentrations of molybdenum in monitoring wells adjacent to the SCPA have decreased approximately 49% since commencing closure of the SCPA in 2020 (See Figure).



h. Provide a copy of the engineer's certification that the selected remedy meets the requirements of 40 C.F.R. § 257.97.

Ameren Response:

See response to item no. 1.c.

i. A comprehensive narrative explanation with supporting data to substantiate the claim on Page 7 of the CMA that groundwater preferentially flows under the SCPA.

Ameren Response:

In 2019, Golder Associates Inc (Golder) developed a 3D Groundwater Fate and Transport Model for the Sioux Energy Center (SEC) using the United States Geological Survey (USGS) MODFLOW, MT3DMS, MODPATH, and PEST packages. Groundwater Vistas was used as the graphical user interface for this groundwater model, and more details on the groundwater model are provided in **AMEREN_00004010 - AMEREN_00004102**.

As discussed in Section 2.9.1 of **AMEREN_00004010 - AMEREN_00004102***, the model was used to predict the amount of groundwater that will flow under/around, as opposed to through, the SCPA after closure of the CCR Unit. For this evaluation, several hydrostratigraphic units (HydroStratigraphy property in Groundwater Vistas or "HSUs") were incorporated into the model for the CCR and alluvial materials. Due to the complexities of groundwater flow direction at the SEC caused by the changes in the Mississippi and Missouri River levels, a transient model was used to predict the interactions between the alluvial aquifer and CCR. The transient model incorporated river levels from 1987 to 2018. Using these conditions, the mass balance between the HSUs was used to predict groundwater flow under/around, versus through, the SCPA.*

Table 3 and Figure 14 in **AMEREN_00004010 - AMEREN_00004102,** *summarize the average flow between the different HSUs. Based on this evaluation, the model predicts that 87% of the post closure groundwater flow is estimated to flow under/around the SCPA.*

5. EPA has reviewed the CCR Rule compliance documents posted on Ameren's publicly available webpage for the Labadie Energy Center. Please provide the requested information as set forth below.

    a. EPA has reviewed Ameren's 2022 Annual Groundwater Monitoring and Corrective Action Report for the Labadie Energy Center facility, LCPA. On page ES-3, Ameren states that the groundwater treatment system will be completed in 2023 and expected to be fully operational in 2024. Based on the information in that report, EPA is requesting:

        i. Information that indicates the capture zone of the extraction wells.

<u>Ameren Response:</u>

The pilot groundwater treatment system envisioned in the Corrective Action Report for Ameren's Labadie Energy Center is still being designed. Ameren proceeded expeditiously with similar projects at both the Rush Island Energy Center and Sioux Energy Center. Based on recommendations from its consultants, Ameren deferred implementation of a groundwater treatment system at the Labadie Energy Center in order to utilize lessons learned and best practices from the projects at Rush Island Energy Center and Sioux Energy Center. This will enable Ameren to ascertain important operational best practices from these unique installations and determine the best course of action at the Labadie Energy Center. Ameren also notes that potential new EPA CCR regulations are expected in early 2024 pursuant to Docket ID EPA-HQ-OLEM-2020-0107. Since these new regulations could affect future treatment plans at the Labadie Energy Center, Ameren will need to incorporate them into its final design plans, as appropriate.

        ii. Documentation which demonstrates that the treatment system is effective

for all appendix IV constituents.

Ameren Response:

See response to item no. 5.a.i.

iii. Information that indicates the effects of the injection pressure to localized groundwater elevation, including any supporting data maps and/or modeling.

Ameren Response:

See response to item no. 5.a.i.

iv. Information that indicates the intended life of this remedy. Any contingency plans or measures prepared to address the possibility of a failure of pump and treat system or if the system is temporarily disabled.

Ameren Response:

See response to item no. 5.a.i.

v. A map that identifies all wells for the pump and treat system. Please distinguish between sentinel wells, injection wells, extraction wells, and any other wells associated with that system.

Ameren Response:

See response to item no. 5.a.i.

vi. Information that explains whether and how the pump and treat system is resilient to flooding.

Ameren Response:

See response to item no. 5.a.i.

b. Well construction, development, lithologic, and drilling records Ameren is utilizing for its CCR program at the Labadie Energy Center.

Ameren Response:

*See **AMEREN_00001889 - AMEREN_00002193**.*

c. The groundwater modeling report(s), analysis, and conclusions (including but not limited to model inputs, boundary conditions, model calibration, etc.) cited in the Corrective Measures Assessment that supports the analysis on the time required for GWPS to be attained.

Ameren Response:

The relative timeframes reported in the Corrective Measures Assessment (CMA) to attain the GWPS reflect groundwater modeling simulating a $1x10^{-7}$ cm/s cap (which represents the cap as installed). The groundwater modeling supporting these comparative timeframes was summarized in a report prepared by Gredell Engineering Resources, Inc. [Ameren Missouri Labadie Energy Center Bottom Ash Pond Groundwater Model Report dated April 2019 (April 2019 Report)] which has been provided as **AMEREN_00003024 - AMEREN_00003134***. The April 2019 Report explains the overall fate and transport modeling approach, setup, calibration, analysis and conclusions that support the information presented in the Corrective Measures Assessment report.*

d. Sampling and analysis plans or groundwater monitoring plans detailing the procedures for collecting CCR groundwater compliance sampling.

Ameren Response:

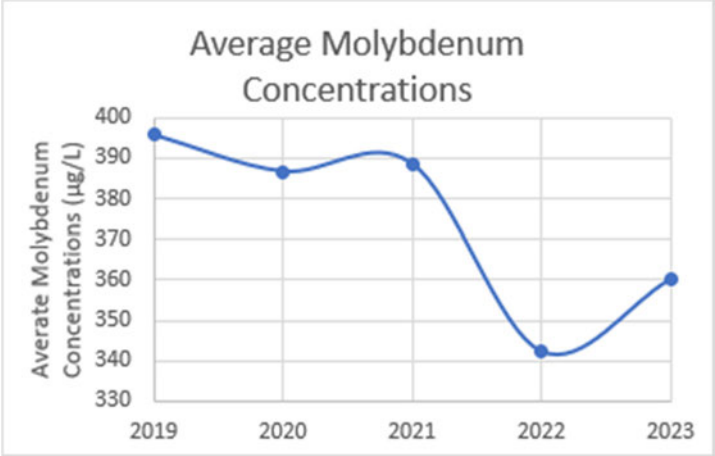
See ***AMEREN_00002194 - AMEREN_00002371, AMEREN_00002372 - AMEREN_00002524, AMEREN_00002525 - AMEREN_00002654, AMEREN_00002655 - AMEREN_00002769****.*

e. A summary of the volume/amount of released Appendix IV constituents at statistically significant levels. Provide any plume map figures that define the nature and extent of the SSL releases.

Ameren Response:

Molybdenum is the only constituent at the Labadie Energy Center (LEC) that is present at a Statistically Significant Level (SSL) over the site-specific Groundwater Protection Standard (GWPS). This was determined in 2018 and more information on the SSL statistical evaluations is provided in the Annual Groundwater Monitoring and Corrective Action Reports.

As discussed in the 2023 Annual Groundwater Monitoring and Corrective Action Report, average concentrations of molybdenum in monitoring wells downgradient of the LCPA have decreased approximately 9% since commencing closure of the LCPA in 2019 (See Figure).



f. Provide a copy of the engineer's certification that the selected remedy meets the requirements of 40 C.F.R. § 257.97.

Ameren Response:

See response to item no. 1.c.

g. A comprehensive narrative explanation with supporting data to substantiate the claim on Page 7 of the CMA that groundwater preferentially flows under the LCPA.

Ameren Response:

In 2019, GREDELL Engineering Resources, Inc. (GER) developed a calibrated 3D numerical model to evaluate groundwater fate and transport for the Labadie Energy Center (LEC). The model uses United States Geological Survey (USGS) MODFLOW, MT3DMS, MODPATH, and ZONEBUDGET (ZONBUD), a program developed by the USGS in 1990 for computing subregional water budgets for MODFLOW groundwater flow models. The model also uses data from the Hydrologic Evaluation of Landfill Performance (H.E.L.P.) model to evaluate precipitation percolation through the cap after capping and closure of the ash ponds. Additional details on the groundwater model are provided in **AMEREN_00003024 - AMEREN_00003134**.

As discussed in Section 2.2 of **AMEREN_00003024 - AMEREN_00003134**, *the model was used to predict the amount of groundwater that will flow around and beneath, as opposed to through the LCPA, after closure of the CCR unit. Three zones representing two subsets of the modeled alluvial aquifer and a third zone representing the LCPA (and its contents) were delineated utilizing the ZONEBUDGET package of MODFLOW to evaluate flow rates through and around the LCPA.*

The groundwater model is a four-layer three-dimensional model. The LCPA occupies a subset of the first (top) and second layers, but the base of the LCPA is above layers 3 and

4. Layers 3 and 4 correspond to the lower part of the alluvial aquifer, which is bounded below by bedrock (no-flow model boundary). The model also incorporates three ZONBUD zones that represent the subsets of the modeled domain that are:

- *Down gradient of the LCPA (Zone 1),*
- *The LCPA (Zone 2), and*
- *Upgradient of the LCPA (Zone 3).*

The components of flow between the three modeled Zones were evaluated at a model time of 29,200 days (after closure and dewatering of the LCPA) and the model predicts only two outflows from Zone 3, which correspond to Zone 1 (down gradient or the LCPA), and Zone 2 (LCPA). ZONBUD calculated that 95,917 cubic feet of groundwater per day preferentially flows from Zone 3 to Zone 1, while 73.071 cubic feet of groundwater per day flows from Zone 3 to Zone 2 (LCPA). Therefore, less than 1% of the water moving through Zone 3 will enter Zone 2, and ***over 99%*** *preferentially flows under (and around) Zone 2 and into Zone 1.*

STATEMENT OF CERTIFICATION

I certify that I am authorized to respond to this information request on behalf of Union Electric Company d/b/a Ameren Missouri. I certify under penalty of law that I have examined and am familiar with the information submitted in this document and all attachments and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment.

APRIL 1, 2024
Executed on (date)

Craig J. Giesmann
(Signature)

CRAIG J. GIESMANN
(Printed Name)

DIRECTOR, ENVIRONMENTAL SERVICES
(Title)

AMEREN MISSOURI
(Company)

Note: For the purposes of this form, your typed name, title, and date as an electronic signature is equivalent to your valid signature on a paper copy of the form. As such, this electronically completed form bears the same rights and responsibilities as a hand-signed form.