SUPPLEMENTAL REMEDY SELECTION REPORT
AMEREN MISSOURI LABADIE ENERGY CENTER
FRANKLIN COUNTY, MISSOURI

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1. Introduction

1.1 PURPOSE

This Supplemental Remedy Selection Report (RSR) was prepared by Haley & Aldrich, Inc. on behalf of Union Electric Company d/b/a Ameren Missouri (Ameren) for the LCPA Coal Combustion Residuals (CCR) surface impoundment located at the Labadie Energy Center (LEC, Site) located in Franklin County, Missouri. The subject LCPA CCR surface impoundment is subject to requirements of the United States Environmental Protection Agency rule entitled *Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities* (CCR Rule) effective 17 April 2015, including subsequent revisions. Under the CCR Rule, a Corrective Measure Assessment (CMA) report for LEC was prepared in May 2019 to evaluate five remedial alternatives against threshold criteria and balancing criteria outlined in the CCR Rule. An RSR for four of Ameren's CCR facilities, including LEC, was prepared on 30 August 2019 and posted to the LEC publicly available CCR website.[1] Ameren indicated in the 2019 RSR that it was actively exploring various groundwater treatment methodologies based on Site-specific data and bench scale testing. Since preparation of the 2019 RSR, such technologies have been installed and are operational at Ameren's Rush Island Energy Center (RIEC) and Sioux Energy Center (SEC).

The National Pollutant Discharge Elimination System (NPDES) Permit MO-0004812 for LEC (effective 1 December 2021), issued by the Missouri Department of Natural Resources (MDNR), allows subsurface discharge and subsurface-to-surface discharge (including groundwater) of constituents from the LCPA to Waters of the State (Permit No. MO-0004812, Pages 13 and 18). MDNR has established concentration values for arsenic, boron, manganese, and sulfate at compliance points located at the perimeter of the Site. During the current permit term and prior to seeking renewal in 2026, Ameren must develop a remediation plan and/or risk assessment per Missouri Code of State Regulations (CSR) Title 10 CSR 20-7.015 to address any exceedances of the concentration values. MDNR's permit requirements are extensive and require an assessment of the potential impact of the closed ponds on the Missouri River, Labadie Creek, and any other nearby waterbodies. In addition, Ameren must prepare a corrective measures assessment and report results for "diffuse groundwater impacts" associated with the closed ash ponds (Permit No. MO-0004812, Page 18). Consistent with those obligations, Ameren has prepared a report that analyzes the efficacy of monitored natural attenuation (MNA) based on Site-specific geochemical conditions (see Appendix F). Ameren is also evaluating various supplemental corrective measures, including how to optimize groundwater treatment systems used at other facilities (i.e., RIEC and Sioux), and they will be tailored to Labadie's Site-specific conditions. Such evaluations may include implementation of a pilot test under MDNR's permitting authority and oversight.

The intent of this Supplemental RSR is to document the corrective measures implemented since development of the 2019 RSR, the results of implementing those measures, and any additional supplemental measures that may be anticipated in the future.

1.2 FACILITY DESCRIPTION

The LEC property encompasses approximately 2,400 acres along the Missouri River at its confluence with Labadie Creek in northeastern Franklin County, Missouri. LEC began electric-generating operations

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[1] Documents referenced in this report as posted to the Ameren LEC publicly available CCR website may be obtained at the following website address: https://www.ameren.com/company/environment-and-sustainability/managing-coal-combustion/ccr-compliance-reports/labadie-energy-center

in 1970. CCR, including fly ash and bottom ash, produced as a byproduct of the coal combustion process was historically managed in the LCPA. The LCPA is an approximately 165-acre unlined CCR surface impoundment that began receipt of CCR in the 1970s. The lined LCPB CCR surface impoundment is located immediately northeast of the LCPA, and the lined Utility Waste Landfill (UWL, also referred to as LCL1), which manages dry CCR, is located east of the LCPB. Although the LCPB and UWL are CCR units subject to the CCR Rule, those units are not the subject of this Supplemental RSR because Alternative Source Demonstrations (ASDs) have been prepared that indicate statistically significant increases (SSIs) recorded for Appendix III constituents are caused by a source other than those CCR units (e.g., an alternative source, sampling and analysis errors, and/or natural variation in groundwater quality). The LCPB and UWL remain in detection monitoring as a result of completing the ASDs.

Ameren initiated LCPA closure in September 2019 by dewatering, consolidating CCR material to provide stabilization and erosion control, armoring of berms, implementing stormwater controls, and installing low permeability capping. Such closure in place (CIP) activities involved dewatering in support of closure, general stabilization of existing CCR, placement of general fill, and the installation of a low-permeability geomembrane final cover system over the CCR to minimize erosion and infiltration. LCPA closure was substantially completed on 30 December 2020, with additional aspects of closure (e.g., erosion and sedimentation control activities, including minor maintenance or repairs related to topsoil, vegetative cover, drainage, and other features) completed in spring 2021. Upon closure, the LCPA thereby transitioned into the post-closure care requirements of the CCR Rule outlined in the Code of Federal Regulations Title 40 (40 CFR) §257.104. The estimated volume of CCR within the limits of the closed RCPA is approximately 17.3 million cubic yards, with a maximum depth of CCR of approximately 90 feet.

1.3 CCR RULE COMPLIANCE SUMMARY

CCR Rule groundwater monitoring has been performed in accordance with CCR Rule requirements outlined in 40 CFR §257.90 through §257.95. The monitoring has been completed through a phased approach to allow for a graduated response (i.e., detection monitoring followed by assessment monitoring and then nature and extent [N&E] investigation, as applicable):

- The CCR groundwater monitoring network includes two background wells and nine detection and assessment monitoring wells located around the perimeter of the LCPA (Figure 1) and screened in the alluvial aquifer zone. These monitoring wells were installed in November 2015 (UMW-1D through UMW-9D) and February 2016 (BMW-1D and BMW-2D), with UMW-3D replaced in October 2018 after equipment damaged the original well.
- Detection monitoring events occurred in 2017 and 2018, and results indicated concentrations of Appendix III constituents above Site-specific background values (i.e., SSIs). As a result, an Assessment Monitoring Program was initiated for the LCPA.
- Assessment monitoring events initially occurred in April 2018 and subsequently in May 2018 and November 2018. Those results indicated concentrations of Appendix IV constituent molybdenum above its Site-specific Groundwater Protection Standard (GWPS) (i.e., at statistically significant levels [SSLs]). As a result, a notification of the detection of SSLs above the molybdenum GWPS was placed in the operating record and on the publicly available CCR website, and an investigation into the N&E of impacts to groundwater was initiated.
- N&E monitoring events occurred in November 2018 and April through August 2019. Results from the N&E investigation were summarized in the *2019 Annual Groundwater Monitoring and Corrective Action Report*. Those results formed the basis for the CMA report and original RSR and were used to select the Corrective Action Monitoring Well Network.

Two different groundwater monitoring networks are currently used to collect groundwater samples near the LCPA: the Detection and Assessment Monitoring Well Network (established under 40 CFR §257.91) and the Corrective Action Monitoring Well Network (established under 40 CFR §257.98). Monitoring of the two networks is conducted on a semiannual basis each year, generally simultaneously during the second and fourth quarters. A map displaying the locations of groundwater monitoring wells is provided as Figure 1.

Based on monitoring data available at the time, a CMA report for LEC was prepared in May 2019, and a public meeting was held on 29 May 2019. A summary of verbal comments received during the public meeting and written comments received after the meeting is provided in Appendix A. After completion of the CMA report and solicitation of public comment, an RSR that identified the selected remedy for the LCPA (and CCR surface impoundments at three other Ameren facilities) was prepared in August 2019. Section 1.4 provides an overview of the 2019 RSR.

1.4 2019 SELECTION OF REMEDY REPORT SUMMARY

On 30 August 2019, Ameren prepared a report entitled *Remedy Selection Report - 40 CFR § 257.97 - Rush Island, Labadie, Sioux, and Meramec CCR Basins* (2019 RSR) that outlined the remedy selected for the LCPA and CCR surface impoundments at other sites (Appendix B). The 2019 RSR indicated that numerous technical evaluations informed the final remedy selection, including groundwater modeling; human health and ecological risk assessments; groundwater treatment assessments; on-Site and off-Site monitoring data; rail, barge, and truck transportation studies; and a deep excavation study report. The remedy selected for the LCPA was outlined in the CMA report as Alternative 1 (CIP with low-permeability capping and MNA). The 2019 RSR outlined three phases to the selected remedy:

1. Source control, stabilization, and containment of CCR by installation of a low-permeability geomembrane cap (a minimum 1 x 10^{-7} centimeters per second [cm/sec] versus 1 x 10^{-5} cm/sec required by the CCR Rule).
2. Implement MNA of groundwater concentrations upon completion of source control to address limited and localized CCR-related impacts, including modeling evaluations.
3. Preparation of Annual Groundwater Monitoring and Corrective Action Reports that address the following:
    - Demonstration that the groundwater plume(s) are stable or decreasing and not expanding.
    - An ongoing summary of baseline and periodic geochemical analysis including groundwater chemistry, subsurface soils chemical composition, and mineralogy.
    - Determine Site-specific attenuation factors and rate of attenuation process.
    - Design a long-term performance monitoring program based on the specific attenuation mechanism to confirm concentration reductions and document trends.

In addition, the 2019 RSR also outlined potential supplemental corrective measures that may be considered to supplement groundwater concentration reductions that are expected to result from source control (including dewatering in support of closure and installation of a low-permeability cover system) and MNA. The 2019 RSR indicated those supplemental corrective measures may include groundwater treatment and summarized results from ongoing treatment studies. The 2019 RSR also concluded that the laboratory results indicate reduction of arsenic and molybdenum concentrations may be supported by pH level adjustment in soils and groundwater, use of chemical reduction (e.g., zero valence iron), and/or bioremediation.

Implementation of supplemental corrective measures at two other Ameren facilities in Missouri (RIEC and SEC) has followed an iterative process, ultimately resulting in construction and operation of groundwater extraction, ex-situ treatment, and re-injection systems at those facilities. Implementation of supplemental corrective measures is also planned for LEC, including consideration of how to develop a groundwater treatment system that targets treatment of groundwater impacted by CCR constituents while minimizing the treatment of unimpacted groundwater.

Since completion of the four-site 2019 RSR, annual groundwater monitoring and corrective action reports have continued to document the status of the LCPA groundwater monitoring and corrective action program, in accordance with 40 CFR §257.90(e). Since 2019, substantial progress has been made in completing closure for the LCPA (from September 2019 through December 2020) and implementing post-closure MNA (starting with the February 2021 sampling event). Consideration of supplemental corrective measures for the LCPA is ongoing, including consideration of groundwater extraction and treatment technologies implemented at other Ameren facilities, as discussed in Section 2.3. Section 2 documents remedy implementation progress achieved to-date, including remedy activities completed and the results of those completed activities.

2. Remedy Implementation Progress

2.1 SUMMARY OF IMPLEMENTED REMEDIAL ACTIVITIES

As summarized in Section 1.4, the selected remedy for the LCPA included source control through dewatering in support of closure and CIP using a low-permeability geomembrane final cover system, MNA, preparation of Annual Groundwater Monitoring and Corrective Action Reports, and potential supplemental corrective measures. Table 1 below summarizes the timeline of remedial activities that have been implemented to-date for the LCPA.

Table 1. Timeline of Remedy Implementation

Date	Activity
August 2019	2019 RSR completed (Appendix B)
September 2019	CCR sluicing to the LCPA ceased
December 2019	Preliminary treatability study results report developed to document findings from a three-phase treatability study for the remediation of arsenic, molybdenum, and other metals of concern. The treatability testing focused on refining the ex-situ remedial approach in order to finalize the pilot test design (Appendix D).
January 2020	*2019 Groundwater Monitoring and Corrective Action Report* completed[1]
December 2020	LCPA closure completed (Appendix C)
January 2021	*2020 Groundwater Monitoring and Corrective Action Report* completed[1]
February 2021	Post-closure MNA initiated, as documented in *2021 Groundwater Monitoring and Corrective Action Report*[1]
January 2022	Treatability study memorandum developed to document the final treatment design for ex-situ treatment based on results from extensive bench-scale laboratory treatability studies for LEC, RIEC, and SEC and a 2021 in-field pilot study performed at RIEC (Appendix D).
January 2022	*2021 Groundwater Monitoring and Corrective Action Report* completed[1]
January 2023	*2022 Groundwater Monitoring and Corrective Action Report* completed[1]
January 2024	*2023 Groundwater Monitoring and Corrective Action Report* completed[1]

[1] *Annual groundwater monitoring and corrective action reports for the LCPA can be found on the Ameren LEC publicly available CCR website*

In addition to development of routine annual reports that summarize groundwater monitoring and corrective action progress, the primary remedial activities that have been completed to-date include:

- LCPA source control through dewatering and CIP using a low-permeability geomembrane final cover system:
  - Initiated September 2019; and
  - Completed December 2020 (substantial completion).
- Post-closure MNA:
  - Initiated February 2021; and
  - Ongoing.

An overview of the selected remedy, including locations at the Site where the selected remedy has been implemented, is provided in Figure 2.

Table 2 below summarizes pertinent details of the remedial activities implemented to-date for the LCPA.

Table 2. Summary of Implemented Remedial Activity Details

Remedial Activity	**Details**
LCPA Source Control	Ameren began closure of the LCPA and placed a "Notification of Intent to Close a CCR Unit and Certification for Final Cover Design System" for the LCPA surface impoundment onto its publicly available CCR website on 28 August 2019. Source control of the LCPA entailed dewatering in support of closure, closing the LCPA in-place, and installing an engineered low-permeability geomembrane cover system over the LCPA to prevent infiltration and promote stormwater drainage. Closure was substantially completed for the LCPA in December 2020, with additional aspects of closure completed in spring 2021. As certified in the closure certifications, closure for the LCPA was completed in accordance with generally accepted and appropriate engineering practices, the LCPA Closure Plan, and requirements of the CCR Rule. The notification of intent to close, closure completion certification, Closure Plan, and Post-Closure Plan for the LCPA are available on the LEC publicly available CCR website and are attached to this report as Appendix C.
Post-Closure MNA	After substantial closure was completed in December 2020, post-closure MNA began with the February/April 2021 sampling event to address CCR-related impacts. Post-closure MNA includes monitoring of the Corrective Action Monitoring Well Network (Figure 1), and monitoring is ongoing semi-annually, generally during the second and fourth quarters of each year.

Supplemental corrective measures, including potential groundwater extraction and treatment, are being planned for implementation at the LCPA. As referenced in Appendix D, although treatability studies at Ameren CCR facilities were initially conducted under the assumption that results may be incorporated into in-situ groundwater treatment design considerations, evaluation of the potential for clogging from metals precipitation and considerations for treating boron led to a transition from an in-situ to an ex-situ concept for groundwater treatment at Ameren CCR surface impoundments.

As of July 2024, potential supplemental corrective measures are being considered for LEC. The groundwater treatment systems installed at both RIEC and SEC demonstrate that such technology constitutes an effective corrective measure and that constituent concentrations in groundwater will reduce over time and at an increased rate when compared to source control and MNA alone. At Labadie, Ameren seeks to optimize such systems in a manner that focuses on treating impacted groundwater while minimizing the management of unimpacted groundwater. In addition to capital, O&M expenses associated with such systems can be considerable with customers ultimately bearing the costs of both categories. One of Ameren's primary objectives is to comply with CCR Rule requirements while stewarding resources and minimizing expenses to the extent practicable. Note that Ameren also plans to incorporate applicable outcomes from the recently issued "legacy" CCR Rule into its final treatability and design plans for the LCPA, if appropriate.

Evaluation of groundwater monitoring results indicate generally positive results, as described in Section 2.2. In the long term, constituent concentrations are expected to decrease as a result of completed source control, ongoing natural attenuation processes, and any supplemental corrective measures that may be implemented at the Site.

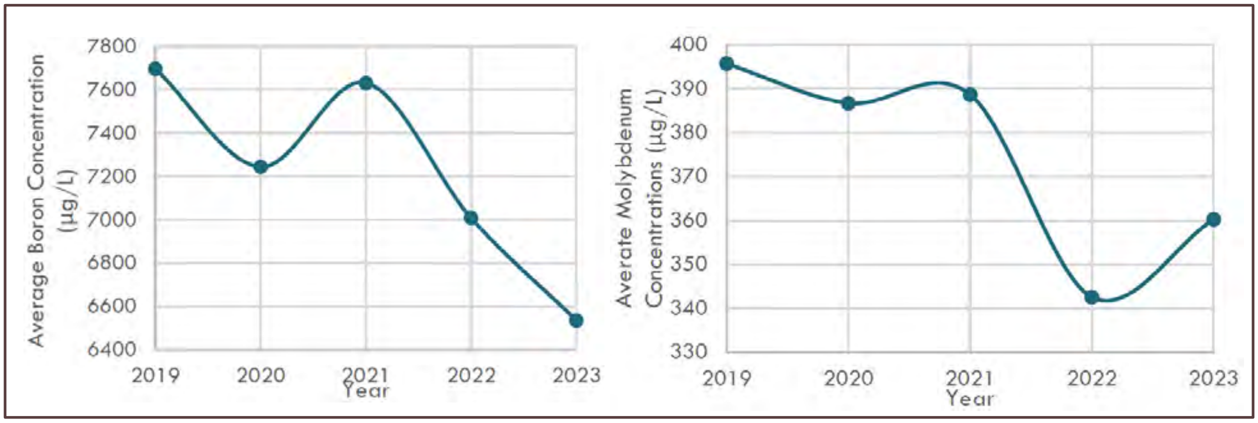
2.2 SUMMARY OF REMEDIAL RESULTS

Based on available monitoring data, source control completed for the LCPA (including dewatering in support of closure, CIP of CCR, and installation of a low-permeability cover system) and ongoing natural attenuation processes appear to be collectively contributing to a general reduction in most constituent concentrations in groundwater near the LCPA.

Since the remedy for the LCPA was selected in 2019, annual groundwater monitoring and corrective action reports have documented progress in remedy implementation and summarized groundwater monitoring results. As discussed in annual groundwater monitoring and corrective measures reports posted to the LEC publicly available CCR website, completed source control and ongoing natural attenuation processes are anticipated to positively influence groundwater near the LCPA over time.

Based on statistical evaluations documented in annual CCR groundwater monitoring and corrective action reports[2], stable or decreasing constituent concentrations have been recorded in groundwater at many monitoring wells directly adjacent to and downgradient of the LCPA since initiation of impoundment closure in September 2019. For instance, as illustrated on Figure 3 below, the average concentrations for boron and molybdenum in groundwater have shown generally decreasing trends based on data from monitoring wells that contained a current statistical exceedance for molybdenum in either Assessment Monitoring or Corrective Action Monitoring Networks for the LCPA, as described in the *2023 Annual Groundwater Monitoring and Corrective Action Report* produced by Rocksmith Geoengineering, LLC.

Figure 3. Groundwater Constituent Concentration Trend Plots



Source: Figures 2 and 3 from 2023 Annual Groundwater Monitoring and Corrective Action Report. LCPA Surface Impoundment, Labadie Energy Center, Franklin County, Missouri, USA. 31 January 2024. Created by Rocksmith Geoengineering, LLC.

As illustrated on Figure 3 above, average concentrations in monitoring wells with statistical exceedances for molybdenum have decreased, with average concentration reductions as follows[3]:

- Boron – decreased by 15 percent

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[2] Individual monitoring well statistical evaluations are conducted for semiannual assessment and corrective action monitoring results for Appendix IV constituents. Those statistical analyses are documented in annual groundwater monitoring and corrective action reports posted on the publicly available CCR website.

[3] Based on calculations performed by Rocksmith Geoengineering, LLC, for data collected from 2019 to 2023.

- Molybdenum – decreased by 9 percent

Although these averaging evaluations provide helpful insight into how constituent concentrations are generally changing over time in impacted areas downgradient of the LCPA, consideration of concentration changes over time for individual downgradient well-constituent pairs provides additional insight into changing conditions over time. Appendix E contains time-series plots using data for individual well-constituent pairs downgradient of the LCPA. Plots were produced for boron, sulfate, and molybdenum for each of the following downgradient monitoring wells:

- Assessment/detection monitoring wells: UMW-3D through UMW-7D; and
- Corrective action monitoring wells: AM-1D, AMW-8, LMW-2S, LMW-4S, LMW-7S, LMW-8S, MW-33D, MW-34D, MW-35D, TP-2D, TP-3M, and TP-3D.

The monitoring wells listed above were selected for inclusion in Appendix E because they are monitoring wells with consistent or historical molybdenum SSLs. Key conclusions related to boron, sulfate, and molybdenum concentration trends for the above-referenced monitoring wells are as follows (Appendix E):

- Boron:
    - Assessment/detection monitoring wells: Boron concentrations have significantly decreased in UMW-7D and have generally decreased in UMW-6D. These wells are located in the northeastern corner of the LCPA where effluent from the lined LCPB surface impoundment historically discharged into the LCPA. These decreasing boron concentration trends likely reflect localized improvement in groundwater quality conditions as a result of completed source control.
    - Corrective action monitoring wells: Boron concentrations appear to be relatively stable or fluctuating in most wells, with no clear dominant trend. Generally decreasing boron concentration trends are apparent for LMW-8S; generally increasing boron concentration trends are apparent for AM-1D.
- Sulfate:
    - Assessment/detection monitoring wells: The most notable sulfate concentration trend is a significantly decreasing trend for UMW-7D, similar to the significantly decreasing boron concentration trend for UMW-7D.
    - Corrective action monitoring wells: Sulfate concentrations appear to be relatively stable or fluctuating in most wells, with no clear dominant trend. Generally decreasing sulfate concentration trends are apparent for LMW-8S and MW-35D; generally increasing sulfate concentration trends are apparent for LMW-2S and MW-33D.
- Molybdenum:
    - Assessment/detection monitoring wells: Molybdenum concentrations have generally increased in UMW-4D and UMW-5D and generally decreased in UMW-7D. The increasing concentrations in UMW-4D and UMW-5D are not characteristic of the rest of the molybdenum plume downgradient of the LCPA and are expected to be a temporary phenomenon restricted to a discrete portion of the plume along the northeastern LCPA boundary.
    - Corrective action monitoring wells: Molybdenum concentrations appear to be relatively stable or fluctuating in most wells, with no clear dominant trend. Generally decreasing

molybdenum concentration trends are apparent for LMW-8S, MW-33D, MW-34D, and TP-3D; generally increasing molybdenum concentration trends are apparent for LMW-2S.

As additional time passes since completion of LCPA source control and after supplemental corrective measures are implemented at the Site, constituent mass and concentrations in groundwater near the LCPA are anticipated to continue decreasing. Furthermore, groundwater modeling for the Site (which currently does not incorporate supplemental corrective measures) indicates constituent concentrations are anticipated to decrease in magnitude downgradient of the LCPA in the long term. Section 2.5 provides information regarding a Labadie MNA evaluation prepared in September 2021 by Golder Associates, Inc. (Golder), which also indicates constituent concentrations are anticipated to decrease in magnitude downgradient of the LCPA in the long term.

2.3 SUMMARY OF ANTICIPATED SUPPLEMENTAL CORRECTIVE MEASURES

Post-closure MNA is ongoing at LEC, and closure of the LCPA was substantially completed in December 2020. Ameren is evaluating various supplemental corrective measures to comply with both MDNR and federal CCR Rule requirements, including groundwater treatment systems such as those employed at the RIEC and SEC facilities.

2.4 DEMONSTRATION OF 40 CFR §257.97(B) REQUIREMENTS

In accordance with 40 CFR §257.97(b), a remedy must meet the following requirements (i.e., “threshold criteria”):

> *(1) Be protective of human health and the environment;*
>
> *(2) Achieve the groundwater protection standard pursuant to 40 CFR §257.95(h);*
>
> *(3) Control the source(s) of releases so as to reduce or eliminate, to the maximum extent feasible, further releases of constituents in Appendix IV [of the CCR Rule] into the environment;*
>
> *(4) Remove from the environment as much of the contaminated material that was released from the CCR unit as is feasible, taking into account factors such as avoiding inappropriate disturbance of sensitive ecosystems; and*
>
> *(5) Comply with certain standards for management of wastes as specified in [40 CFR] §257.98(d).*

In May 2019, Ameren completed the CMA Report for the LCPA and posted the report to its publicly available CCR website. The CMA Report considered five corrective measures alternatives, all of which were demonstrated to meet the threshold criteria listed above. The CMA Report also included the summary results of the assessment of numerous technical evaluations conducted, which include groundwater and geochemical modeling, human health and ecological risk assessments, and N&E of CCR constituents in groundwater assessments. Results of these technical evaluations indicated each of the five corrective measures alternatives effectively satisfied the requirements under 40 CFR §257.97(b), listed above.

In its 2019 RSR, Ameren selected CMA Alternative 1 (CIP with capping and MNA), noting that supplemental corrective measures were being evaluated and may be implemented as part of an iterative remedial strategy. Since completion of the CMA Report and 2019 RSR, Ameren has completed closure of the LCPA and initiated post-closure MNA sampling in February 2021. The remedy implemented to-date for each of the MEC CCR Surface Impoundments aligns with the CMA Report's Alternative 1, which was considered to effectively satisfy the requirements under 40 CFR §257.97(b) in the CMA Report.

Based on the prior CMA evaluation, the remedy implemented for the LCPA meets the requirements of the 40 CFR §257.97(b) threshold criteria.

Supplemental corrective measures in the form of groundwater extraction, ex-situ treatment, and re-injection systems have been constructed and are operating at Ameren's RIEC and SEC. Ameren is in the process of evaluating future supplemental corrective measures at LEC to comply with both MDNR and federal CCR Rule requirements. Supplemental corrective measures would serve to supplement, or enhance, constituent concentration reductions already promoted by completed closure of the LCPA and ongoing natural attenuation processes. Assuming supplemental corrective measures are implemented in the future, the implemented remedy (like Alternative 1 and Alternative 4 in the CMA Report) would be expected to effectively satisfy the requirements under 40 CFR §257.97(b).

2.5 DEMONSTRATION OF 40 CFR §257.97(C) CONSIDERATIONS

In accordance with 40 CFR §257.97(c), the owner of a CCR unit must consider the following evaluation factors (i.e., "balancing criteria") when selecting a remedy that satisfies the threshold criteria under 40 CFR §257.97(b):

> *(1) The long- and short-term effectiveness and protectiveness of the potential remedy(s), along with the degree of certainty that the remedy will prove successful based on consideration of the following:*
>
> > *(i) Magnitude of reduction of existing risks;*
> >
> > *(ii) Magnitude of residual risks in terms of likelihood of further releases due to CCR remaining following implementation of a remedy;*
> >
> > *(iii) The type and degree of long-term management required, including monitoring, operation, and maintenance;*
> >
> > *(iv) Short-term risks that might be posed to the community or the environment during implementation of such a remedy, including potential threats to human health and the environment associated with excavation, transportation, and re-disposal of contaminant;*
> >
> > *(v) Time until full protection is achieved;*
> >
> > *(vi) Potential for exposure of humans and environmental receptors to remaining wastes, considering the potential threat to human health and the environment associated with excavation, transportation, re-disposal, or containment;*
> >
> > *(vii) Long-term reliability of the engineering and institutional controls; and*
> >
> > *(viii) Potential need for replacement of the remedy.*
>
> *(2) The effectiveness of the remedy in controlling the source to reduce further releases based on consideration of the following factors:*
>
> > *(i) The extent to which containment practices will reduce further releases; and*
> >
> > *(ii) The extent to which treatment technologies may be used.*
>
> *(3) The ease or difficulty of implementing a potential remedy(s) based on consideration of the following types of factors:*
>
> > *(i) Degree of difficulty associated with constructing the technology;*

(ii) Expected operational reliability of the technologies;

(iii) Need to coordinate with and obtain necessary approvals and permits from other agencies;

(iv) Availability of necessary equipment and specialists; and

(v) Available capacity and location of needed treatment, storage, and disposal services.

(4) The degree to which community concerns are addressed by a potential remedy(s).

The CMA Report compared the five corrective measures alternatives relative to one another with respect to the first three primary balancing criteria identified in the CCR Rule: long-term and short-term effectiveness, source control, and implementability. The fourth balancing criterion, community concerns, was considered after the public meeting was held on 29 May 2019 and the period of public comment was completed.

Similar to consideration of the threshold criteria under 40 CFR §257.97(b) discussed in Section 2.4, appropriate consideration of the balancing criteria under 40 CFR §257.97(c) for the implemented LCPA remedy should consider how the CMA Report evaluated Alternative 1. In the CMA Report, Alternative 1 received a “favorable” or “less favorable” rating for each of the balancing criteria, and the alternative received no “unfavorable” ratings under any of the balancing criteria. Based on the CMA favorability ratings for Alternative 1, the implemented remedy is considered relatively highly favorable.

Table 3 provides an evaluation of the implemented remedy against each of the balancing criteria outlined under 40 CFR §257.97(c). Based on the prior CMA evaluation and consideration of the corrective measures implemented to-date, the remedy implemented for the LCPA effectively addresses the 40 CFR §257.97(c) balancing criteria, as documented in Table 3.

Assuming supplemental corrective measures are implemented in the future, the implemented remedy (like Alternative 1 and Alternative 4 in the CMA Report) would be expected to be relatively highly favorable based on evaluation against the balancing criteria outlined in 40 CFR §257.97(c). Ameren will also periodically consider the potential need for performing future modeling updates to predict the timeframe for attaining the constituent GWPSs based on the implemented remedy.

Previously completed modeling results indicate completed source control (including dewatering in support of closure and installation of a low-permeability cover system) and ongoing natural attenuation processes are expected to result in overall reductions of molybdenum concentrations in groundwater over time. Implementation of supplemental corrective measures would be expected to result in additional reductions of molybdenum concentrations in groundwater near implemented measures over time to achieve the GWPS more effectively and at an increased rate when compared to source control and MNA alone.

In addition to modeling, Golder, on behalf of Ameren, developed a multi-tiered MNA evaluation report to evaluate the anticipated effects of natural attenuation processes on molybdenum concentrations in groundwater (Appendix F). This evaluation did not consider the effects of potential supplemental corrective measures, which are being considered for the Site. The methods and assumptions Golder used to estimate the amount of time for molybdenum concentrations in groundwater to decrease to the GWPS as well as the results of their evaluations (including their estimated timeframes to achieve the GWPS) are documented in Appendix F. Results from ongoing post-closure corrective action monitoring will be used to determine the effectiveness of MNA (in conjunction with source control and potential supplemental corrective measures) in remediating molybdenum SSLs above the GWPS beyond the LCPA waste boundary.

2.6 SCHEDULE FOR IMPLEMENTING AND COMPLETING REMEDIAL ACTIVITIES

Section 2.1 summarizes remedial activities that have been implemented for the LCPA. Closure of the LCPA was substantially completed in December 2020. Evaluation of monitoring results and documentation of remedy implementation progress have been included in annual groundwater monitoring and corrective action reports. Preparation of annual reports will continue.

In accordance with 40 CFR §257.97(d), the owner of a CCR unit must specify schedule(s) for implementing and completing remedial activities, requiring completion of remedial activities within a reasonable timeframe that considers the following factors:

> *(1) Extent and nature of contamination, as determined by the characterization required under §257.95(g);*
>
> *(2) Reasonable probabilities of remedial technologies in achieving compliance with the groundwater protection standards established under §257.95(h) and other objectives of the Remedy;*
>
> *(3) Availability of treatment or disposal capacity for CCR managed during implementation of the remedy;*
>
> *(4) Potential risks to human health and the environment from exposure to contamination prior to completion of the remedy;*
>
> *(5) Resource value of the aquifer including:*
>
> > *(i) Current and future uses;*
> >
> > *(ii) Proximity and withdrawal rate of users;*
> >
> > *(iii) Groundwater quantity and quality;*
> >
> > *(iv) The potential damage to wildlife, crops, vegetation, and physical structures caused by exposure to CCR constituents;*
> >
> > *(v) The hydrogeologic characteristic of the facility and surrounding land; and*
>
> *(6) Other relevant factors.*

Implementation of LCPA closure has been performed in an expeditious fashion, as summarized in Section 2.1. As of the date of the 2019 CMA report, the LCPA still actively received sluiced CCR inflows. Closure of LCPA was completed in approximately 15 months after final receipt of CCR into the impoundment. Closure of the LCPA by CIP allowed source control to be completed much sooner (approximately 35 or more years sooner, based on the CMA Report) than would have been possible with an alternative closure by removal method, especially given the technical and logistical challenges with excavating near the Missouri River.

The risk assessment report developed for the Site in 2018 concluded no unacceptable risk to human health or the environment associated with groundwater at the LCPA (Appendix G). Since completion of the risk assessment report, closure of the LCPA is complete, constituent concentration reductions have been observed, and supplemental corrective measures are being evaluated. The potential for exposure of humans and the environment to CCR material that existed prior to closure of LCPA has been mitigated by completion of closure and installation of an engineered final cover system. The final cover system was constructed quickly and allowed CCR material to remain onsite, thereby limiting the duration of potential exposure of humans or the environment to the CCR. Based on improved Site conditions since completion of the 2018 risk assessment report, conclusions from that risk assessment are validated.

The 2018 risk assessment report also noted that approximately 76 private and 2 public water supply wells located within a 1-mile radius of the Site. The private and public water supply wells are located in a bluff area south and upgradient of the Site and are, therefore, beyond the extent of CCR constituent migration from the LCPA.

Results from ongoing post-closure corrective action monitoring will be used to determine the effectiveness of MNA (in conjunction with source control and potential supplemental corrective measures) in remediating molybdenum SSLs above the GWPS beyond the LCPA waste boundary. Ameren is evaluating potential supplemental corrective measures to address SSLs near the LCPA. Ameren will also periodically consider the potential need for performing modeling updates.

Anticipated future remedy-related activities include:

- Semiannual corrective action monitoring (ongoing).
- Evaluation of corrective action effectiveness on CCR constituent concentrations in groundwater (ongoing).
- Annual groundwater monitoring and corrective action report development (ongoing).
- Evaluation of supplemental corrective measures (ongoing).

Annual groundwater monitoring and corrective action reports will continue to document groundwater analytical results and constituent concentration trends over time. Updated Site data and available modeling results will be used to confirm model-predicted durations for achievement of GWPSs. Supplemental or alternative corrective measures may continue to be considered if results or modeling indicate constituent concentration reductions are not occurring sufficient to achieve GWPSs within a reasonable timeframe. In such a case, the array of potential supplemental or alternative corrective measures that may be considered would likely be similar to the measures and alternatives developed and evaluated in the CMA report.

Based on the information outlined above, the remedy has been implemented and is anticipated to be completed in a manner consistent with consideration of the factors listed in 40 CFR §257.97(d).

3. Supplemental Remedy Selection Report Certification Statement

I, Steven F. Putrich, am a professional engineer and licensed in the state of Missouri. I have reviewed this Selection of Remedy report for the LCPA coal combustion residuals surface impoundment at the Ameren Missouri Labadie Energy Center located in Franklin County, Missouri. I hereby certify that this report has been prepared in general conformance with and meets the requirements of Title 40 Code of Federal Regulations (40 CFR) § 257.97 of the U. S. Environmental Protection Agency's Rule entitled "Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities." 80 Fed. Reg. 21302 (17 April 2015) (promulgating 40 CFR § 257.61); 83 Fed. Reg. 36435 (30 July 2018) (amending 40 CFR § 257.61) (the CCR Rule).

Signed:__________________________________
Certifying Engineer

Print Name: Steven F. Putrich, P.E.
Missouri License No.: 2014035813
Title: Project Principal
Company: Haley & Aldrich, Inc.

Professional Engineers Seal:

STEVEN F.
PUTRICH
NUMBER
PE-2014035813

8/13/2024

TABLES

TABLE 3

EVALUATION OF IMPLEMENTED REMEDY – 40 CFR §257.97(c) REQUIREMENTS

SUPPLEMENTAL REMEDY SELECTION REPORT – LCPA
LABADIE ENERGY CENTER – FRANKLIN COUNTY, MISSOURI

General Description	Implemented Remedy[1]
	CIP with Capping and MNA with Supplemental Corrective Measures[1]
257.97(c)(1) The long- and short-term effectiveness and protectiveness of the remedy(s), along with the degree of certainty that the remedy will prove successful	
(i) Magnitude of reduction of existing risk	No unacceptable risk to human health and the environment exists based on the risk assessment in Appendix G and included in the CMA Report. The LCPA has been closed in place with a low-permeability engineered final cover system. The final cover system further contains the CCR material in the impoundments and reduces the risk of the CCR entering the environment.
(ii) Magnitude of residual risks in terms of likelihood of further releases due to CCR remaining following implementation of a remedy	The low-permeability final cover system for the LCPA contains the underlying CCR material and significantly reduces the infiltration of precipitation into the CCR. Therefore, the residual risks in terms of likelihood of further releases due to CCR remaining is considered low.
(iii) The type and degree of long-term management required, including monitoring, operation, and maintenance	Long-term management of the implemented remedy includes limited O&M of the final cover system and monitoring wells. The degree of long-term management required for the closed LCPA is generally limited to routine vegetative maintenance (e.g., mowing/trimming) of the final cover system during the growing season and the potential for non-routine maintenance of the final cover system (e.g., limited soil regrading in the event of side-slope erosion caused by stormwater runoff). Post-closure MNA involves relatively limited long-term management, including routine groundwater monitoring and the potential for non-routine monitoring well maintenance (e.g., repair or replacement in the event that damage occurs to a monitoring well).
(iv) Short-term risks that might be posed to the community or the environment during implementation of such a remedy	Since closure construction activities have already been completed, potential short-term risks to the community or the environment are very limited. Also, the implemented remedy is entirely contained within the Site boundary, which greatly reduces any potential risks to the community or environment. Closure of the LCPA was completed via CIP from September 2019 through spring 2021. CIP involves a relatively lower degree of short-term risks posed to the community or environment.
(v) Time until full protection is achieved	No unacceptable risk to human health or the environment exists based on the risk assessment in Appendix G and included in the CMA Report. Therefore, protection is already achieved. Previously completed modeling results indicate completed source control (including dewatering in support of closure and installation of a low-permeability cover system) and ongoing natural attenuation processes are expected to result in overall reductions of molybdenum concentrations in groundwater over time. Implementation of supplemental corrective measures would be expected to result in additional reductions of molybdenum concentrations in groundwater near implemented measures over time to achieve the GWPS more effectively and at an increased rate when compared to source control and MNA alone. In addition to modeling, Golder Associates, Inc. (Golder), on behalf of Ameren, developed a multi-tiered MNA evaluation report in 2021 to evaluate the anticipated effects of natural attenuation processes on molybdenum concentrations in groundwater (Appendix F). This evaluation did not consider the effects of potential supplemental corrective measures, which are being considered for the Site. The methods and assumptions Golder used to estimate the amount of time for molybdenum concentrations in groundwater to decrease to the GWPS as well as the results of their evaluations (including their estimated timeframes to achieve the GWPS) are documented in Appendix F. Results from ongoing post-closure corrective action monitoring will be used to determine the effectiveness of MNA (in conjunction with source control and potential supplemental corrective measures) in remediating molybdenum SSLs above the GWPS beyond the LCPA waste boundary.
(vi) Potential for exposure of humans and environmental receptors to remaining wastes, considering the potential threat to human health and the environment associated with excavation, transportation, re-disposal, or containment	Closure of the LCPA was completed in spring 2021 via CIP, which substantially reduced the potential for exposure of humans and environmental receptors to remaining wastes during closure activities compared to CBR. The remaining CCR material is contained within a low-permeability engineered final cover system, which greatly limits the potential for post-closure exposure to the CCR.
(vii) Long-term reliability of the engineering and institutional controls	Closure of the LCPA by CIP has already been completed, and CIP is a proven long-term solution for CCR management.
(viii) Potential need for replacement of the remedy	The CIP method used to close the LCPA is considered permanent and effective at preventing CCR release into the environment and reducing infiltration of precipitation into the CCR. Although groundwater modeling indicates constituent concentrations are predicted to reduce over time, the system could be modified in the future if remedial objectives are not being met as expected.
257.97(c)(2) The Effectiveness of the Remedy in Controlling the Source to Reduce Further Releases	
(i) The extent to which containment practices will reduce further releases	Closure of the LCPA was completed in spring 2021 via CIP using a low-permeability final cover system that limits infiltration of precipitation into underlying CCR material and protects from future CCR releases through engineered containment of the underlying CCR material.
(ii) The extent to which treatment technologies may be used	Treatment technologies are not currently used for the implemented remedy. Treatment technologies may be used in the future if groundwater extraction, ex-situ treatment, and re-injection is implemented at LEC similar to supplemental corrective measures implemented at other Ameren CCR facilities.
257.97(c)(3) The Ease or Difficulty of Implementing a Potential Remedy	
(i) Degree of difficulty associated with constructing the technology	The CIP method used to close the LCPA was substantially less difficult to implement than the alternative CBR method that was considered unfavorable under this balancing criterion in the CMA Report due to technical and logistical challenges.
(ii) Expected operational reliability of the technologies	Closure of the LCPA is complete, and only ongoing O&M of the final cover system is necessary.
(iii) Need to coordinate with and obtain necessary approvals and permits from other agencies	Closure-related permitting and approvals were obtained to support closure of the LCPA by CIP, which required less permitting and approvals than the alternative CBR method that was considered unfavorable under this balancing criterion in the CMA Report.
(iv) Availability of necessary equipment and specialists	Equipment and specialist needs were less to support closure of the LCPA by CIP relative to the alternative CBR method that was considered unfavorable under this balancing criterion in the CMA Report.
(v) Available capacity and location of needed treatment, storage, and disposal services	CIP of the LCPA allowed CCR material to remain onsite and in-place, which would not have been possible under a CBR scenario.

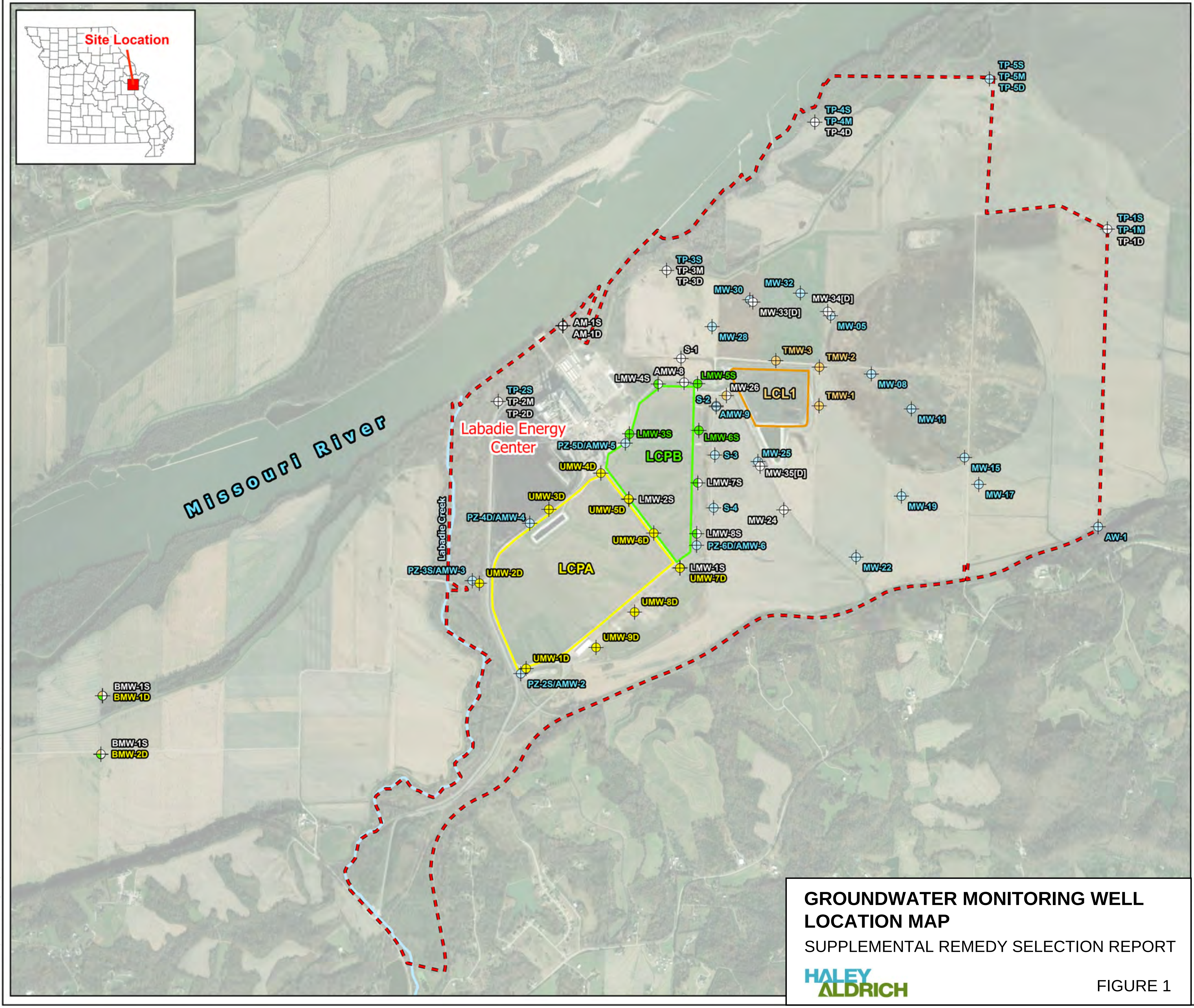
Notes:

[1] - The currently implemented remedy is a combination of source control and post-closure MNA. Supplemental corrective measures in the form of groundwater extraction, ex-situ treatment, and re-injection have been implemented at other Ameren CCR facilities, and the pilot groundwater treatment system envisioned for LEC is in the process of being designed. This table only evaluates the discrete components of the remedy that has been implemented at the Site to-date and does not consider a groundwater extraction and treatment system that may be implemented in the future.

Abbreviations:

CBR = closure by removal
CCR = coal combustion residuals
CIP = closure in place
CMA = Corrective Measures Assessment
GWPS = Groundwater Protection Standard
LEC = Labadie Energy Center
MNA = monitored natural attenuation
O&M = operations and maintenance

FIGURES



TITLE

LABADIE ENERGY CENTER GROUNDWATER MONITORING PROGRAMS AND MONITORING WELL LOCATION MAP

Legend

🟥 Approximate Property Boundary

Labadie Energy Center CCR Units

▭ LCPA - Closed Bottom Ash Surface Impoundment

▭ LCPB - Closed Fly Ash Surface Impoundment

▭ LCL1 - Utility Waste Landfill Cell 1

Monitoring Well Network

⊕ Corrective Action Monitoring Well

⊕ LCPA Monitoring Well

⊕ LCPB Monitoring Well

⊕ LCPB and Corrective Action Monitoring Well

⊕ LCL1 Monitoring Well

⊕ LCL1 and Corrective Action Monitoring Well

⊕ Background Well Used for LCPA, Corrective Action, LCPB, and LCL1 Monitoring

⊕ Monitoring Well Used for Water Level Elevation Measurements Only

NOTES

1. All locations and boundaries are approximate.

REFERENCES

1. Zahner and Associates, Inc. 2016. Lot Consolidation Plat of "Labadie Energy Center" - Prepared for Ameren Missouri. Revised June 15, 2016.
2. USGS (United States Geological Survey), National Water Information System, USGS Gauge 06935550 Missouri River near Labadie, MO.

0 500 1,000 2,000 3,000 4,000
Feet

GROUNDWATER MONITORING WELL LOCATION MAP

SUPPLEMENTAL REMEDY SELECTION REPORT

HALEY ALDRICH

FIGURE 1

PROJECT
CCR RULE GROUNDWATER MONITORING PROGRAM

CLIENT
AMEREN MISSOURI
LABADIE ENERGY CENTER

Ameren

ROCKSMITH GEOENGINEERING

DESIGN	JSI	YYYY-MM-DD	2023-12-18
PREPARED	JSI	PROJECT No.	23007
REVIEW	GTM		
APPROVED	MNH		

FIGURE 1

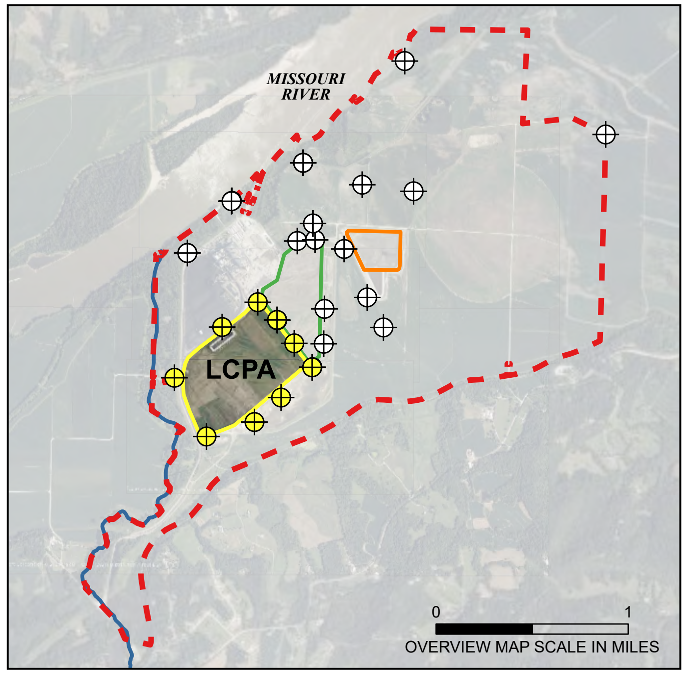
Path: C:\Users\GrantMorey\Rocksmith Geoengineering LLC\23007 - Ameren GW - Documents\400 - Drawings, Figures\4.1-LEC\4.1.2 - Production\Other Maps\Annual Report Figure 1.aprx

LEGEND

- ⌖ CORRECTIVE ACTION MONITORING WELL
- ⌖ LCPA DETECTION AND ASSESSMENT MONITORING WELL
- — LABADIE AND FIDDLE CREEKS
- 🟩 LCPB - CLOSED FLY ASH SURFACE IMPOUNDMENT
- 🟨 LCPA - CLOSED BOTTOM ASH SURFACE IMPOUNDMENT
- 🟧 LCL1 - UTILITY WASTE LANDFILL CELL 1
- 🟥 PROPERTY BOUNDARY

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. SEE FIGURE 1 FOR INDIVIDUAL MONITORING WELL IDENTIFICATION INFORMATION.
3. AERIAL IMAGERY SOURCE: EAGLEVIEW AND MICROSOFT, 2024



HALEY ALDRICH

LABADIE ENERGY CENTER
FRANKLIN COUNTY, MISSOURI
SUPPLEMENTAL REMEDY SELECTION REPORT

SELECTED REMEDY OVERVIEW MAP

AUGUST 2024

FIGURE 2

GIS FILE PATH: \\haleyaldrich.com\share\CF\Projects\132002\GIS\132002_AMEREN_ASH_WELLS.aprx - USER: dverrier - LAST SAVED: 6/21/2024 2:13 PM

APPENDIX A
Response to 2019 CMA Public Comments

Response To Community Comments On Ameren Missouri Corrective Measures Assessments For Rush Island, Labadie, Sioux And Meramec Energy Centers

Contents

SUMMARY OVERVIEW

In May 2019, Ameren Missouri held public meetings regarding Corrective Measures Assessment (CMA) Reports for the Rush Island, Labadie, Meramec and Sioux Energy Centers. At those meetings and afterwards in written comments, the public raised a variety of concerns regarding CCR basins located at the energy centers. This Response to Community Comments addresses those concerns. In addition, Ameren Missouri ("Ameren") has performed additional technical analysis which has been posted on Ameren's CCR website along with this Response. Ameren summarizes key response items below:

- *Groundwater Impacts are Limited and No Risk to Public Health Exists.* Groundwater impacts at Ameren's energy centers are limited and localized in nature. Drinking water supplies, whether residential wells or adjacent rivers, are not impacted by the energy centers. Suggestions that Ameren has somehow "skewed" or misrepresented the data are inaccurate. *See* Section 2 and 3 and Attachments 1 and 2.

- *Excavation Delays Compliance with Groundwater Standards*. Several commenters argue that the only way to comply with the CCR Rule is to excavate the ash. Not true. Concentration levels will diminish over time due to installation of a geomembrane cap, the water table lowers, and pH conditions stabilize. Excavation requires the basins to remain open to ongoing infiltration. To address such comments, Ameren performed additional modeling analysis to assess groundwater impact at Rush Island under both containment and excavation scenarios. Containment results in a predicted return to standards in 2027, approximately 6-7 years post-closure, as compared to 2057 under an excavation scenario. *See* Section 11 and in Attachments 6 and 7. Concerns relating to groundwater compliance are addressed more expeditiously by promply closing and capping the ash basins and cutting off infiltration.

- *Trucking is Less Burdensome than Rail but Neither is Fast.* The Lochmueller Extraction & Transportation Study (CMA, Appendix C) described the logistics behind hauling CCR from the energy centers to a commercial landfill. Certain commenters took issue with that analysis and instead contend that railroad carrier CSX provides such services. Connecting to the CSX railroad would require multiple carriers, installation of onsite storage yards, nine dedicated, 100-car unit trains, and commercial landfill unloading facilites. No Illinois or Missouri landfill was identified as having adequate rail facilities. *See* Section 4 and Attachment 3.

- *The CCR Basins are Structurally Sound, Built to Withstand Extreme Weather Events*. Several commenters expressed concerns regarding the risk of "wash out" or "liquefaction" of the stored material should a flood or seismic event occur. All of Ameren's CCR units are protected by massive embankments designed to prevent failure. The potential for extreme events has been specifically considered and we have provided a stability analysis summary chart. *See* Section 5.

GENERAL COMMENTS

To the extent a number of commenters raised identical or similar issues, such comments are grouped by subject matter.

1. The Public Meetings Facilitated One-on-One Discussions and Were Designed to Foster Collaboration

The public meetings provided a forum to define the community concerns; promote one-on-one communication between Ameren and the community; and to foster collaboration. Ameren and its experts presented information about the CMAs and made themselves available to discuss questions and concerns expressed by those in attendance. Importantly, the CCR Rule does not specify a format for the public meeting nor does the rule require that specific responses be provided. The rule simply states that the remedy selection by the owner should consider the "degree to which community concerns are addressed by a potential remedy(s)." Nevertheless, Ameren believes responses to the concerns are important.

Ameren organized the public meetings with much thought and consideration. The meetings featured technical experts located at discrete stations who were available to discuss a number of topics relevant to the corrective measures options; groundwater data collection; risk assessment analysis; modeling analysis; the corrective measures assessment process; and dam safety issues. The goal was to maximize for the community one-on-one time with company representatives and the experts so the community could provide their input and present questions.

A number of commenters expressed frustration with the meeting time, a perceived lack of notice and a perceived lack of time to review the CMAs. Ameren wishes to address these concerns. First, as to notice, Ameren placed notices of the meeting on its CCR website and in a variety of media outlets (***St. Louis Community News, Festus Jefferson Leader and the Washington Missourian***) during the weeks of May 1 and May 9, 2019. Second, as to the CMAs, Ameren posted the CMA reports on its CCR webpage starting on May 16, 2019, with printed copies available at the meetings.[1] We note that there is no requirement to make the CMAs available prior to the meeting but Ameren chose to do so regardless. Indeed, social media postings by the Labadie Environmental Organization (LEO) and Sierra Club clearly reflect that local environmental activists were not only well aware of the meeting dates and times, but also of the CMA posting. In fact, activist groups had members attend each of the meetings. Lastly, as to the time of day, Ameren selected the afternoon and all of the meetings were well attended. For those who could not attend, Ameren received comments through a dedicated email address box and, as requested, posted the exhibits used at the meetings to the Ameren website following the meetings. Again, all of this is more than is required by the CCR Rule.

---

[1] The CMA reports were removed temporarily from the website on May 30, 2019, during an IT system migration but were re-posted the next day.

While the format did not include or facilitate speechmaking, the format was informational and not a "public relations event." The amount of direct questioning and explanation clearly resonated with many members of the community. Again, Ameren chose the format to provide the greatest amount of direct contact with company representatives and the technical experts. Videos taken by the environmental activists during the meetings demonstrate that attendees effectively utilized the question and answer approach.

2. CCR Constituents Do Not Threaten Human Health or Drinking Water

Some commenters expressed concern that CCR constituents in groundwater at Ameren's energy centers present a risk to drinking water sources and to public health. **Public or private drinking water supplies are not at risk from Ameren's CCR units.** As depicted in the charts below and as presented in numerous technical reports including the CMAs, the CCR units have not affected the bedrock aquifer that serves as a water source to residences located within the general vicinity of the Labadie and Rush Island energy centers. To the extent impacts from coal ash exist on Ameren's property and immediately adjacent to surface impoundments, the public has no direct or indirect access to such groundwater. Further, as presented in numerous technical reports including the CMAs, sampling results demonstrate that public drinking water sources that draw from the Meramec, Mississippi and Missouri Rivers are not impacted by Ameren's CCR units. As made clear in published risk assessments, where there is no exposure, there can be no risk.

More specifically, in calendar years 2012-2014, going beyond then existing or current regulatory requirements, Ameren installed offsite monitoring well networks at both Labadie and Rush Island in an effort to provide the community with data to address concerns about the sites' impact on their drinking water wells. Through these monitoring networks, Ameren evaluated groundwater quality, flow direction and water column height within the bedrock aquifers. So that representative samples were taken, the monitoring wells mirrored the actual depths of the residential wells. Groundwater elevations in residential wells are at a higher elevation than groundwater levels near the ash basins. Groundwater moves from the bluffs to the river valleys and **no physical mechanism exists** through which groundwater from Ameren's coal ash basins could travel uphill to domestic water supplies. This is true even under an extreme flood; hypothetically assuming river levels match the highest flood of record for 55 straight days. *See Golder Technical Memorandum dated June 26, 2019* attached hereto as **Attachment 1**.

Labadie – No Impact to Bedrock Aquifer

Do values from offsite well network exceed CCR Rule GWPS (Yes or No)

Analyte	UNITS	GWPS	September/October 2014 Samples							
			TGP-A	TGP-B	TGP-C	TGP-D	TGP-E	TGP-F	TGP-G	BW-1
Sample Date			9/9/2014	9/8/2014	10/3/2014	10/6/2014	9/8/2014	9/30/2014	9/3/2014	9/9/2014
ARSENIC, TOTAL	µg/L	42.6	NO	NO	NO	NO	NO	NO	NO	NO
BARIUM, TOTAL	µg/L	2,000	NO	NO	NO	NO	NO	NO	NO	NO
BERYLLIUM, TOTAL	µg/L	4	NO	NO	NO	NO	NO	NO	NO	NO
CADMIUM, TOTAL	µg/L	5	NO	NO	NO	NO	NO	NO	NO	NO
CHROMIUM, TOTAL	µg/L	100	NO	NO	NO	NO	NO	NO	NO	NO
COBALT, TOTAL	µg/L	6	NO	NO	NO	NO	NO	NO	NO	NO
FLUORIDE, TOTAL	µg/L	4	NO	NO	NO	NO	NO	NO	NO	NO
LEAD, TOTAL	µg/L	15	NO	NO	NO	NO	NO	NO	NO	NO
MERCURY, TOTAL	µg/L	2	NO	NO	NO	NO	NO	NO	NO	NO
MOLYBDENUM, TOTAL	µg/L	100	NO	NO	NO	NO	NO	NO	NO	NO
SELENIUM, TOTAL	µg/L	50	NO	NO	NO	NO	NO	NO	NO	NO
THALLIUM, TOTAL	µg/L	2	NO	NO	NO	NO	NO	NO	NO	NO

Notes:
1) µg/L – micrograms per liter, mg/L – milligrams per liter,
2) GWPS – Site-specific Groundwater Protection Standard applicable to Labadie CCR units

Rush Island – No Impact to Bedrock Aquifer

Do values from offsite well network exceed CCR Rule GWPS (Yes or No)

Analyte	UNITS	GWPS	TBW-1	TBW-2	TBW-3
Samples Collected in 2014					
ARSENIC, TOTAL	µg/L	30	NO	NO	NO
BARIUM, TOTAL	µg/L	2,000	NO	NO	NO
BERYLLIUM, TOTAL	µg/L	4	NO	NO	NO
CADMIUM, TOTAL	µg/L	5	NO	NO	NO
CHROMIUM, TOTAL	µg/L	100	NO	NO	NO
COBALT, TOTAL	µg/L	6	NO	NO	NO
FLUORIDE, TOTAL	µg/L	4,000	NO	NO	NO
LEAD, TOTAL	µg/L	15	NO	NO	NO
MERCURY, TOTAL	µg/L	2	NO	NO	NO
MOLYBDENUM, TOTAL	µg/L	100	NO	NO	NO
SELENIUM, TOTAL	µg/L	50	NO	NO	NO
THALLIUM, TOTAL	µg/L	2	NO	NO	NO

Notes:
1) µg/L – micrograms per liter.
2) GWPS – Site Specific Groundwater Protection Standard applicable to Rush CCR Unit.

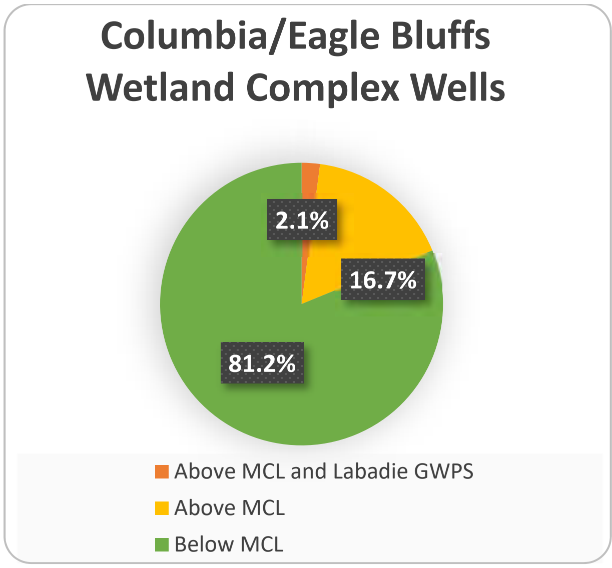
With respect to St. Charles and St. Louis County communities located near the Sioux and Meramec energy centers, all residences are connected to public water suppliers that draw from drinking water intakes located within the Missouri, Mississippi or Meramec Rivers and are miles away from the facilities. Extensive river sampling immediately adjacent, downstream and upstream from Ameren's facilities (again this sampling is over and above what is required by any rule), confirms that all such surface water samples (more than 250 sample locations and over 16,000 individual analyses) comply with federal and state drinking water standards. **Ameren's energy centers do not adversely impact those surface waterbodies.**

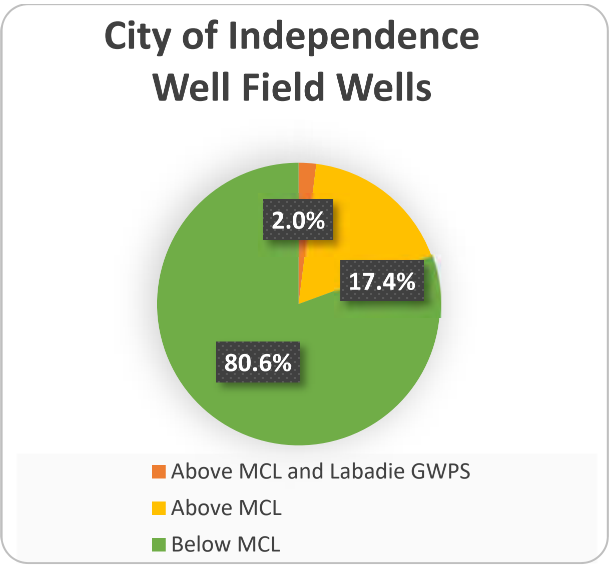
3. The Groundwater Protection Standards Set by Ameren are Protective and Comply with the CCR Rule

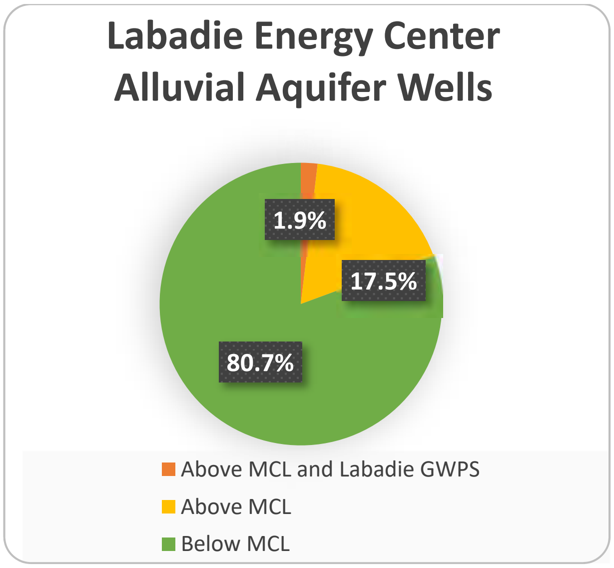
Groundwater impacts at Ameren's energy centers are limited in nature with more than 95% of assessment monitoring results statistically **below** site groundwater protection standards. This is good news. And yet, rather than being reassured by such results, activists instead argue in comments that Ameren "skewed" the data and calculated "abnormally high" background levels and, consequently, protection standards. Nothing could be further from the truth. The CCR Rule prescribes a specific process for the siting of wells, collecting data, and then statistically analyzing the results to calculate the Groundwater Protection Standards (GWPS) used in the CCR process. The CCR Rule requires that a licensed professional engineer certify all critical steps of the process and EPA has issued a Unified Guidance for determining the applicable statistical methodology, *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities*, (Unified Guidance) EPA-530-F-09-020 (March 2009). The GWPS calculated for each site fully comply with the CCR Rule and Unified Guidance. Ameren's independent licensed professional engineer and hydrogeologist who certified the standards prepared an additional technical memorandum to address comments received from the Washington University Environmental Law Clinic (WUELC), **Attachment 2** to this response document.

Ameren also responds to additional more specific comments received on two naturally occurring constituents, arsenic and molybdenum. Those comments relate to the setting of GWPS for those constituents at Labadie and Rush Island. As to arsenic, contrary to the WUELC's claims that arsenic present in background wells emanates from Ameren's CCR units, naturally occurring levels of arsenic with concentrations above EPA standards are widespread within the Missouri River alluvial aquifer. In fact, the National Water Quality Monitoring Council (NWQMC) reports in a publicly available database that approximately 20% of groundwater samples collected near groundwater municipal well fields in Missouri (Columbia and Independence), have ambient arsenic levels above the MCL. As the charts below reflect (prepared using the NWQMC data), the data closely align with sampling results collected in the alluvial aquifer at Labadie. In other words, naturally occurring levels of arsenic are found within various locations in Missouri and such levels are consistent with background conditions found upgradient from Ameren's sites. But putting aside data from other locations in Missouri, it is important to note that the background wells at Labadie are ***more than one-mile upgradient/cross-gradient*** from the facility and located in an agricultural field ***unimpacted*** by CCR. Additionally, background wells at Rush Island are located north of the power plant building and upgradient/cross-gradient of the CCR unit.

<u>Naturally Occurring/Non-CCR Arsenic Exist At Labadie and Other Municipal Sites</u>







Golder calculated the arsenic GWPS using sixteen (16) data points per site, consisting of eight (8) baseline samples from each of the two background wells. Due to the spatial variability in the arsenic samples between the background wells (one with high results and one with low results), Golder used a statistical method consistent with EPA's Unified Guidance to calculate the GWPS. The remainder of this paragraph describes the statistical test used to determine a single background level where measured results vary. The terms used are standard statistical language, perhaps not familiar to the reader. Where spatial variability exists, Golder performed statistical outlier analysis, removed any outliers and then calculated a tolerance level. Because the background data varied spatially at both sites, the resulting GWPS is equal to the highest background value in each data set. Because the background data were not normally distributed for either site, the concentrations of 42.6 µg/L (Labadie) and 30 µg/L (Rush Island), respectively, are from observed values, not outliers, and therefore are statistically part of the background population. In addition, it is clear from well logs that the selected background locations are not influenced by site operations due to their upgradient/cross-gradient locations and the limited groundwater concentrations of either boron or molybdenum, indicating the lack of CCR impact. As a result, and notwithstanding differences between the sample populations of the two wells at each site, the background data from the higher concentration wells must be considered. The higher concentrations in background wells at each site demonstrate that arsenic exists, unrelated to plant operations, representing a background condition that must be included in the statistical analysis of data.

As to molybdenum and based upon their comments, the Missouri Confluence Water-keeper (Waterkeeper) seems to have misunderstood the purpose behind the Molybdenum Fact Sheet provided by Ameren at the public meetings. Molybdenum, while naturally occurring, is not a commonly known element and Ameren thought it would be helpful to provide a separate background fact sheet with each of its CMA reports to provide context for the public. The fact sheet notes that the Institute of Medicine of the National Academy of Sciences (NAS) defines molybdenum as an essential nutrient for human health. In addition to developing a Recommended Daily Allowance (RDA) that defines the amount of molybdenum needed to maintain good health, the NAS also developed an Upper Tolerable Limit for molybdenum, a limit that equates to a safe drinking water level of 600 µg/L. The Fact Sheet presented this value purely as a point of context; **Ameren knows and acknowledges that it is the GWPS that is used as the basis of decision making under the CCR Rule.**

Further, in 2018, EPA revised its regulations to designate a specific protection standard for molybdenum and adopted 100 ug/L for molybdenum. 83 Fed. Reg. 36435,36444 (June 30, 2018) (Emphasis added.) Importantly, EPA went on to say:

> "These levels were derived using the same methodology that EPA proposed to require States to use to establish alternative GWPS (*See* 83 Fed. Reg. 11598–11599, 11613). The methodology follows Agency guidelines for assessment of human health risks of an environmental pollutant. This means that **these GWPSs are expected to be concentrations to which the human population could be exposed to on a daily basis without an appreciable risk of deleterious effects during a lifetime**." *Id.* (Emphasis added.)

Ameren used the GWPS of 100 µg/L for molybdenum at all four of its facilities. While we agree with the Waterkeeper that EPA included molybdenum on its 2009 Contaminant Candidate List, 74 Fed. Reg. 51850,51852 (Oct. 8, 2009), no regulatory action has occurred in the intervening ***10-year period*** and where the EPA may go with this rulemaking is unknown.

4. Railing or Barging CCR from Ameren's Energy Centers is Neither Reliable Nor Economical

WUELC argues, seemingly based on a CSX marketing brochure that it references, that rail transport would avoid local impacts to the community inherent in truck hauling and therefore rail is a viable option for transporting CCR for the offsite disposal. However, as the brochure notes, "CSX offers direct connections to numerous cement producers, fly ash and slag locations, and cement terminals **throughout the East Coast."** Ameren Missouri's energy centers are all located west of the Mississippi River.

Ameren receives coal via rail delivery and has extensive experience with the challenges associated with such transport mode. Ameren asked its transportation expert to expand its consideration of rail and barge in response to comments received. Set forth below are key considerations based on Ameren's experience and the Lochmueller Group review (**Attachment 3**):

- *Multiple Carriers.* Neither CSX nor its short-line rail partners have direct access to Ameren's energy centers. To connect to CSX at its Rose Lake Yard in East St. Louis, a unit train (a set of similar railcars that typically remain together in a dedicated train), would need to first transfer to the Terminal Railroad Association in St. Louis via the Burlington Northern (BNSF: Rush Island, Sioux) or Union Pacific railroads (UP: Meramec, Labadie).

- *Coal Trains Can't Be Repurposed.* Dedicated coal unit trains leave the the Powder River Coal Basin on a near-daily basis and travel directly to the energy centers via the UP or BN railroads, unload, and then return in a near-continuous loop. The train cars are specifically designed to carry and unload coal and are NOT designed to carry CCR.

- *Single Loop Rail Tracks Require Coal Delivery Prioritization.* The energy centers have single loop rail tracks that, in order to maintain reliable generating operations, must prioritize coal deliveries. The hauling of large volumes of CCR woud require separate onsite car storage areas known as "ladder tracks" and specialized, covered rail cars traveling in a "unit train". Sufficient or adequate property for ladder tracks may not be available at all locations such as Rush Island.

- *Carriers Control Haul Cycles, Not Shippers.* Unlike truck hauling, the carrier, not the shipper, controls the availability of locomotives and timing of shipments. In order to get to the CSX, the unit train would need to be staged on ladder tracks at the energy center until the originator carrier (UP or BNSF) is available to transport the unit train to a rail yard in St. Louis where a terminal railroad would then move the loaded unit train to CSX's Rose Lake yard located in East St. Louis. From there, the CSX would take possession of the unit cars and haul to a landfill with proper rail unloading facilities large enough to accommodate a unit train. Alternatively, the loaded unit train could be delivered to a train-to-truck transfer station located close to the disposal site where the CCR would be unloaded from rail cars and then hauled via truck to a landfill. Once emptied, the unit train cars would return via the reverse route (CSX, Terminal, and UP/BNSF railroads). The entire process entails multiple railroad crew exchanges.

- *Logistical Issues Impact Reliability of Rail.* Due to the haul cycles and load/unload times, a single unit, 100-car train is capable of transporting at most one load per week.

Nine (9) unit trains would be required to to maintain parity with trucking estimates of 5,000 tons per day. The cost of procuring such trainsets is approximately $90M ($100,000 per car x 9 unit trains). Interruptions with multiple railroad crews or service anywhere along the haul routes, rail yards or energy centers would disrupt shipments. Based on Ameren's experience with coal deliveries, it is highly unlikely that the rail carriers could consistently maintain such productivity.

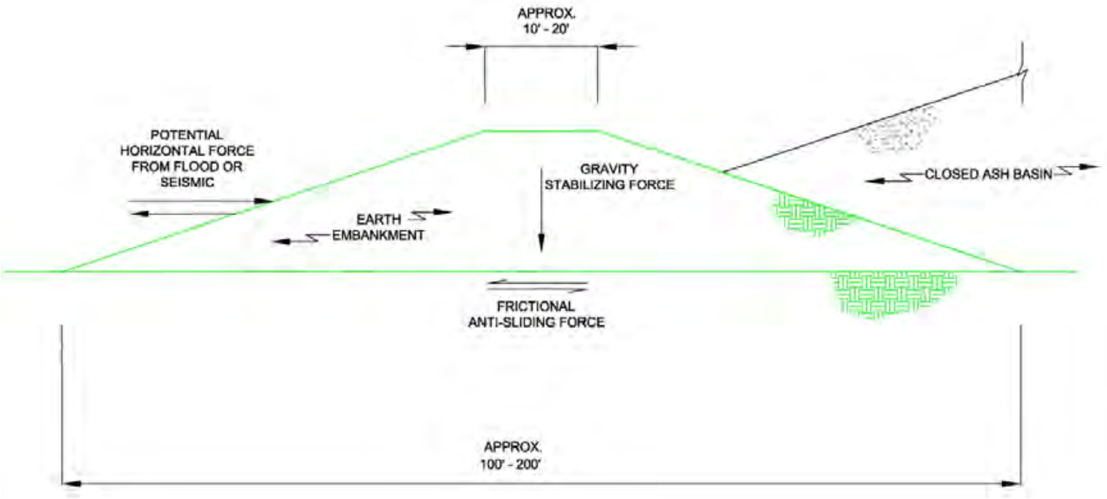
- Shipment via barge is not a viable option due to a lack of existing loading/unloading facilities and environmental concerns associated with large scale, long term shipments on unpredictable waterways.

5. Ameren Ash Basins: Sound Structural Integrity Even Under Flood Conditions

Several commenters expressed concerns that the in-place closure of CCR units could increase the risk of "wash out" or "liquefaction" of the stored material should a flood or seismic event occur. We understand these concerns. The CCR Rule specifically requires owners of ash basins and landfills to perform extensive structural and geotechnical analyses to verify the stability of such units during both normal operations and natural disasters. All of Ameren's CCR units have been inspected, evaluated and verified by third-party geotechnical engineering firms and are inspected weekly by specially-trained plant personnel and annually by Dam Safety specialists.

Ameren's coal ash basins are protected by massive embankments and designed to prevent failure. The potential for extreme events has been specifically considered. The embankment slopes have undergone rigorous evaluations as part of the CCR Rule's structural integrity requirements and are subject to weekly surveillance and monthly maintenance protocols. Engineering evaluations calculate the slope stability of the embankments and compare the driving forces within a cross-section of slope to the resisting forces and determining a factor of safety (FOS). Slope stability analysis includes multiple geotechnical borings and laboratory analysis to assess soil properties. Gravity forces tend to move the slope downward (driving force), while resisting forces derived from soil shear strength, tend to keep the slope in place. When the driving force on a slope is greater than the resisting force, sliding can occur. Ameren's embankments have broad foundations that are at least 4 to 6 times as wide as their height and narrow to a minimum of approximately 10 to 20 feet at their crests. This slope configuration functions as a solid pyramid designed to withstand flooding and seismic events. The diagram below depicts a typical configuration and illustrates the shear mass that would need to erode or otherwise be compromised before a "wash out" of compacted ash stored within the basin could occur.

EMBANKMENT SLOPES & FORCES



Lastly, the embankments surrounding the basins can withstand an estimated 7.0 to 8.0 magnitude earthquake. Both EPA and the Missouri Department of Natural Resources (MDNR) have published target safety factors for a variety of potential structural conditions and all of Ameren's CCR units meet or exceed those requirements.[2] The calculated FOS are expected to increase post-closure as surface waters are removed reducing internal force and pressures. In addition, an engineered cap and stormwater measures will prevent pooling on and within the basins.

SLOPE STABILITY ANALYSIS

	Condition	Target FOS	Minimum Calculated FOS
Labadie	**Major Flood Event**	1.40	1.52
	Steady State	1.50	1.64
	Liquefaction	1.20	1.27
	Slope with Seismic Forces	1.00	1.08

	Condition	Target FOS	Minimum Calculated FOS
Rush Island	**Major Flood Event**	1.40	1.42
	Steady State	1.50	1.51
	Liquefaction	1.20	1.29
	Slope with Seismic Forces	1.00	1.07

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[2] 80 Fed. Reg. 214755-77

	Condition	Target FOS	Minimum Calculated FOS
Sioux	**Major Flood Event**	1.40	1.42
	Steady State	1.50	1.50
	Liquefaction	1.20	1.26
	Slope with Seismic Forces	1.00	1.12

	Condition	Target FOS	Minimum Calculated FOS
Meramec	**Major Flood Event**	1.4	1.62
	Steady State	1.5	1.71
	Liquefaction	1.2	1.62
	Slope with Seismic Forces	1.0	1.18

Lastly, closure design includes armoring the riverside of embankment slopes to mitigate erosion from floodwater rises and rapid draw down conditions. In addition to routine examinations, qualified Dam and Safety personnel inspect embankments before, during and after flood conditions to ensure proper ongoing maintenance. All of Ameren's ash pond embankments remain structurally sound following the recent 2019 floods crests.

6. The WUELC Misconstrues the CCR Rule and Seeks to Create a New Standard

WUELC's interpretation of the federal CCR rule as those rules relate to elimination of *"free liquids"* is simply misplaced. The requirement cited by WUELC is located within the closure provisions of the regulations that address the activity of drainage or dewatering, and subsequent stabilization of the CCR, to allow for the construction and installation of the final cover system. EPA specifically defined "f*ree liquids"* in relation to ambient pressure and temperature, a clear reference to removal of standing water as part of the draining/dewatering of a CCR basin in preparation for installation of a closure capping system in accordance with best engineering practices. Nowhere does the CCR Rule require draining or dewatering CCR impoundments at depth to meet the closure in place requirements.

The CCR rule requires that owners of CCR units meet two main performance criteria: contain the CCR waste mass in a covered, stabilized unit; and address impacted groundwater outside of the CCR unit boundaries. *See* 40 CFR §257.102 and §257.97, respectively. The rule does not require a compliance monitoring point *within* the waste that is contained in place. EPA specifically authorized two closure options: removal or closure in place and EPA does not select, or even prefer, one to the other.[3]

By conflating CCR Rule performance standards, WUELC attempts to create a *new* performance standard, one that does not exist in the rule and in effect would mandate excavation regardless of environmental impact. WUELC's position is also in direct contradiction to the actual language of the rule and RCRA's governing standards of "*no reasonable probability of adverse effect on health or the environment.*" EPA found that monitoring groundwater throughout the active and post-closure periods and requiring the owner to perform appropriate corrective measures adequately addresses any groundwater impacts.

7. **The Estimated Timeline for Excavation is Reasonable Given the Volumes and Complexity of an Excavation Project**

Estimated timelines contained in the Lochmueller report are based on a number of factors including transportation related factors. Using Rush Island as an example, such factors include: volume of stored material including soil amendments; travel time and distance to disposal site; maximum daily haul rate (5,000 tons); 8-hour daily operation and a range of 115-192 days per year of operation (adjusted for equipment breakdown, weather, holidays, vacation, imperfect execution, etc.). The daily haul rate assumes a fleet of trucks making multiple roundtrips per day and that the landfill has capacity, manpower, and authority to accept the maximum daily load of trucks (192). Haul trucks leaving the site every 2.5 minutes would still take decades upon decades to complete the project. Even assuming a constant stream of available trucks, there is simply a practical limitation on how quickly an excavator can load a truck even if there were multiple trucks and multiple excavators onsite.

Furthermore, in addition to the transportation challenges outlined by Lochmueller, there are a number of construction-related issues associated with excavating large volumes of material adjacent to large river systems in alluvial (i.e., river deposited) sands and up to depths of approzimately 100 feet. To further explain the timeline for excavation, Reitz & Jens, a geotechnical engineering firm, examined the construction related issues identified by Lochmueller and supplemented the analysis. Reitz & Jens prepared a white paper outlining its analysis found here in **Attachment 4**. In its *Study of Deep Excavation*, Reitz & Jens notes the following:

- *Excavation Methods.* There are two principal methods of removal or excavation of the CCRs from the basins: 1) excavation in the "dry" by first pumping out the water to some depth below the excavation; or 2) excavation in the "wet" by dredging. Other

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[3] "In practice, EPA does not routinely require complete removal of all contamination (that is, cleanup to 'background') from a closing unit even for hazardous waste units. Requiring CCR units to clean up soils to levels before the site was contaminated, would be more stringent than current hazardous waste policies. There is no basis in the current record to impose provisions for the remediation of CCR units that are more stringent than those imposed on hazardous wastes." 80 Fed. Reg. 21302, 21412.

than at the top 20-30 feet, the location of the basins would preclude large-scale excavation via "dry" techniques and the use of conventional equipment.

- *Conventional Dredging has an Adverse Impact on Groundwater.* Dredging with an open bucket (i.e., backhoe, dragline or clamshell) could result in suspension of particles in the remaining groundwater, and an increase in the hydraulic conductivity of the remaining CCR, both potentially causing additional release of contaminants to groundwater.

- *Specially Designed Equipment*. Due to these concerns, the only viable method identified by Reitz & Jens for deep excavation is a cutter-head dredge that would need to be specifically designed and manufactured for Ameren's sites. The unique dredge may pump approximately 14,000 gallons per minute and could remove up to 650 cubic yards of CCR per hour. A suction dredge may be used for depths up to 20 to 30 feet.

- *Construction and Permitting of Settling Basins.* To use the specially designed dredge, a large volume of water would need to be routed from the CCR unit to multiple lined settling ponds. These ponds currently do not exist and would require permitting from MDNR. After CCR settles in the ponds, the dredged material is excavated and dried to allow for overland hauling to a commercial landfill. This double-handling and drying process takes substantial space and time, increasing the costs substantially as well. Remaining water would need to be monitored, potentially treated, and discharged in accordance with regulatory requirements.

- *Dredging Operations Could Take a Decade or More.* It would take more than a decade of full-time dredging operation to remove the CCRs from the largest of Ameren Missouri’s CCR units—this time estimate does not take into account permitting, construction activities, drying, double-handling of CCR, weather, maintenance, transportation of the CCR for disposal off-site and handling of the water that remains in the settling ponds.

With all of these considerations taken into account, Reitz & Jens' conclusions are consistent with the time estimates determined by Lochmueller in its transportation study. In no sense are Ameren's basins (total system in-place volume 31M tons) similar to the City of Columbia's three year, 90,000 ton excavation from a single, four (4) acre former farmer's pond. WUELC erroneously relies on this example to demonstrate the ease by which such a project could be executed without disclosing the dissimilarities between that site and Ameren’s sites.

8. <u>Closure Plans Posted on Ameren's Website Were Required by the CCR Rule and Do Not Indicate a Final Remedy has been Selected</u>

Several commenters suggested that Ameren is disingenuous in even requesting comments on the CMAs because Ameren has announced previously its plans to close the CCR basins. Such comments ignore the fact that the CCR Rule required Ameren to post on its CCR website closure and post-closure plans by October 2016, one year from the effective date of the CCR Rule. This federal requirement applied even though investigatory efforts were ongoing. (In fact, closure plans are required to be included with *applications* for *new* CCR units.)

Moreover, Ameren's approach continues to evolve through ongoing investigation and analysis, risk assessments and the corrective action options, including groundwater treatment, as outlined in the CMAs. The groundwater impacts observed at the CCR basins are few and localized in nature and do not pose a risk to human health even if the units were to remain open. Preliminary indications are that geochemical conditions within the alluvium are such that concentrations will reduce over time as pH levels stabilize.[4] In addition, Ameren is exploring a variety of treatment techniques that may reduce the amount of time needed to achieve groundwater protection standards at the designated compliance point (that is, the toe of the berm). That analysis will continue for several months.

In the meantime, Ameren has constructed wastewater treatment facilities at Rush Island and Labadie that isolate the ash basin systems and allow for the removal of surface waters from the basins. In fact, MDNR in a recently issued permit required Ameren to remove all standing surface water from the Rush Island CCR basin by this summer. The CCR Rule requires closure to commence shortly after the known final receipt of CCR. *40 CFR 257 §102.* For Labadie, Rush Island and Sioux, such "known final receipt" date is linked to the in-service dates for waste water treatment facilities. Even the most ardent environmental activist would have to concede that removing surface water reduces recharge into groundwater and that by eliminating the exposure of ponded ash to the elements, the environment benefits immensely. Having been very vocal about the ash basins for years, Ameren is surprised that activists now accuse it of moving too quickly.

SPECIFIC ISSUES RASIED BY COMMENTORS

9. “Litigation Risk” is not a CCR Rule Remedy Selection Factor

The first seven pages of the Waterkeeper's public comment contains a lengthy discussion on its view of legal issues that the United States Supreme Court may or may not entertain and the applicability or non-applicability of the Clean Water Act to CCR basins. None of that is relevant to CCR Rule requirements for remedy selection. No litigation has been brought by any person or entity regarding Ameren's CCR Units.

Furthermore, to the extent Waterkeeper suggests that Ameren should have solicited public comments before issuing its CMAs, they have clearly misread the CCR Rule requirements.

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[4] A discussion of the behavior of metals in soil and groundwater can be found at **Attachment 5**.

10. Closure of the CCR Basins Will Control Source Material and Mitigate Groundwater Impacts

WUELC suggests that the only way Ameren can comply with the CCR Rule's closure performance standards is to excavate and remove all CCR, a positon rejected by EPA. In fact, EPA explicitly did not choose closure by removal over closure in place, indicating that both options, when done properly, are acceptable.

> *EPA did not propose to require clean closure nor to establish restrictions on the situations in which clean closure would be appropriate. As EPA acknowledged in the proposal, most facilities will likely not clean close their CCR units given the expense and difficulty of such an operation. Because clean closure is generally preferable from the standpoint of land re-use and redevelopment, EPA has explicitly identified this as an acceptable means of closing a CCR unit. However,* ***both methods*** *of closure (i.e., clean closure and closure with waste in place) can be* ***equally protective, provided they are conducted properly****. Thus, consistent with the proposal, the final rule* ***allows the owner or operator to determine*** *whether clean closure or closure with the waste in place is appropriate for their particular unit. EPA agrees that the RBCA [risk based corrective action] process, using recognized and generally accepted good engineering practices such as the ASTM Eco–RBCA process, can be a useful tool to evaluate whether waste removal is appropriate at the site. It is, however, not a prerequisite.*

80 Fed Reg at 21411-12 (emphasis added); *See also 80* Fed Reg at 21407.[5]

The CMAs step through the regulatory criteria for each of the considered remedial alternatives, all of which meets the requirements of 40 CFR §257.97. In addition, geochemical conditions across the sites indicate that concentration levels of the few parameters that exceed GWPS will reduce over time as infiltration is eliminated by installation of a cap, the water table lowers and pH conditions stabilize through a variety of natural in situ processes.[6] To optimize this process, Ameren is evaluating groundwater treatment options particularly for arsenic. Treatment methods for arsenic are well established.[7] While metals (unlike organics) cannot be destroyed, by changing the environmental conditions of the soil and groundwater, the leaching or dissolution of such metals can be reduced through the formation of stable minerals or by

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[5] Contrary to WUELC assertions, the CCR Rule does not require returning CCR units to pre-construction conditions. EPA itself determined that was inappropriate, unnecessary, and would result in stricter standards than at hazardous waste sites. 80 Fed. Reg. 21302, 21412 **("There is no basis in the current record to impose provisions for the remediation of CCR units that are more stringent than those imposed on hazardous wastes.")**

[6] EPA specifically discussed that its lack of pH-specific data could impact its risk assessment. In its response to comments on the risk assessment, EPA indicates that pH-specific data, as well as other site-specific factors could yield site-specific remediation alternatives that cannot be addressed in a nationwide risk assessment. 80 Fed. Reg. 21302, 21434-37. Ameren is using site-specific data in the CMAs to make remedy comparisons that fit the unique nature of these surface impoundments.

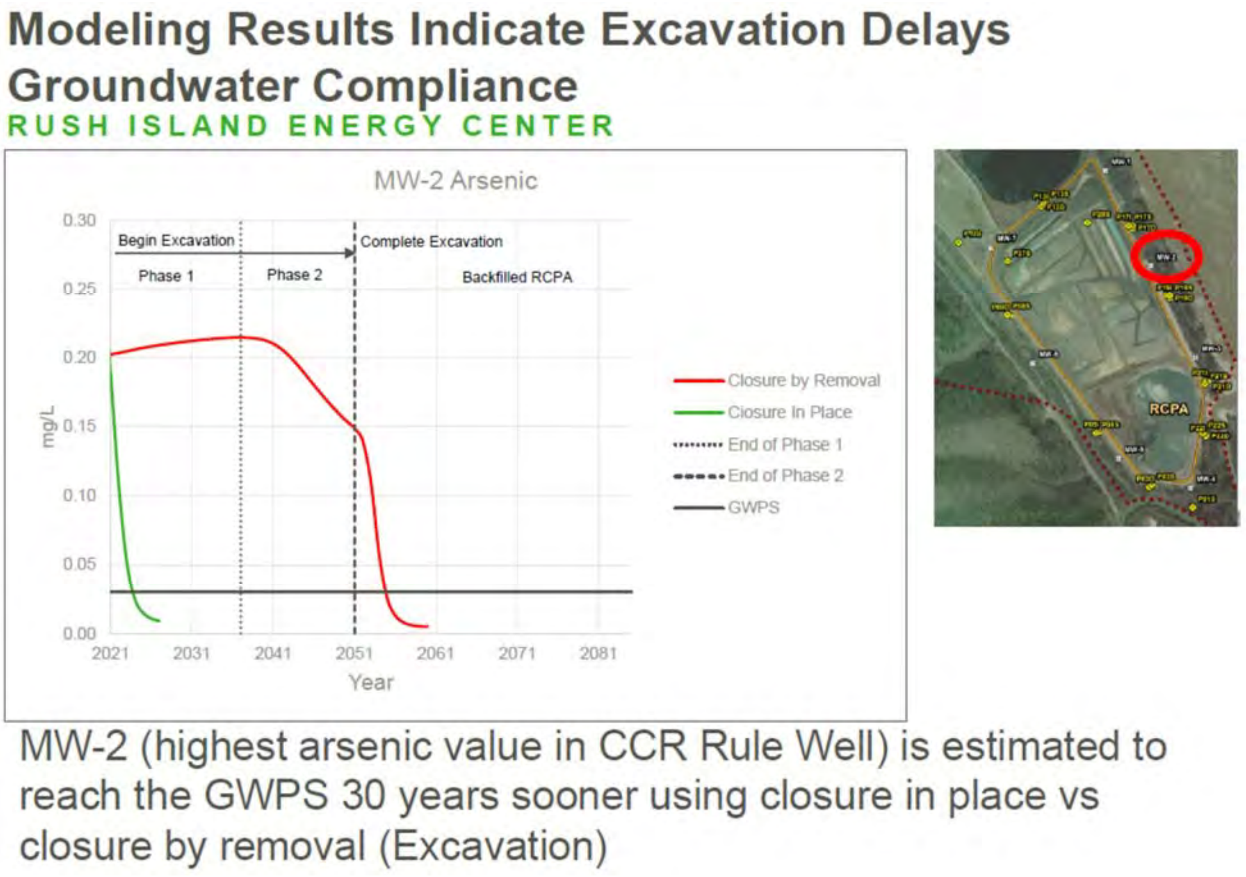
[7] https://www.epa.gov/remedytech/arsenic-treatment-technologies-soil-waste-and-water.

binding such metals more strongly to other minerals. XDD has prepared a short description of this process, appended hereto as **Attachment 5**, *Behavior of Metals in Soil and Groundwater*.

Predictive modeling also indicates that compliance with GWPS at the designated compliance point is achievable. Once that occurs and is confirmed by three years of groundwater monitoring, corrective actions are complete.

11. Excavation Would Delay Compliance Until After 2050

Several commenters believe that excavation is the only way to ensure compliance with GWPS. As the Lochmueller and Reitz & Jens reports make clear, excavation projects at these sites are complex, take decades to execute and will be a burden on local communities. During the entirety of the process, the ash basins remain open to weather, and recharge (contaminant loading due to infiltration from precipitation) to groundwater would continue during this entire period. Using Rush Island as an example, Ameren performed additional predictive modeling to illustrate the timeframe needed to come into compliance under an excavation scenario. (*See Golder Rush Island Closure by Removal Modeling,* **Attachment 6**). Under a containment/capping scenario, compliance with GWPS is predicted to occur in approximately 6-7 years post-closure (2027) as compared to thirty (30) or more years (2057) after beginning the excavation.



Modeling Results Indicate Excavation Delays Groundwater Compliance

RUSH ISLAND ENERGY CENTER

MW-2 (highest arsenic value in CCR Rule Well) is estimated to reach the GWPS 30 years sooner using closure in place vs closure by removal (Excavation)

12. Evaluation of Climate Change is Not Required by EPA

One commentor suggested that Ameren should have evaluated climate-related issues as part of its corrective measures assessment. EPA did not designate consideration of climate change as a requirement of the CCR Rule. However, to the extent precipitation events increase in severity or number as some climate models suggest, maintaining the proper Factors of Safety and structural stability of ash basins effectively counters those risks. Ameren addressed these issues in Section 5.

13. Transportation of Waste from Westlake Landfill has Less Impact on Community Due to Access Route and Volume

At the Westlake Landfill CERCLA Site in St. Louis, EPA recently ordered the **limited** excavation of **radioactive** material improperly sent to a sanitary landfill that due to its chemical composition set off subsurface fires. The proposed excavation is limited to approximately 1.5M in-place cubic yards (cy), located up to depths of 16 feet with deeper materials left in place at depths up to 89 feet below ground surface. EPA estimates the excavation will cost approximately $274M*. See Proposed Record of Decision Amendment Westlake Landfill Superfund Site (EPA, 2018).* The volumes proposed for excavation at Westlake are a fraction (5%) of the CCR material stored in Ameren's ash ponds (30M in-place cy; 41.3M with soil amendments) and would very likely also take the fraction of the time to transport off-site. Westlake Landfill is located in close proximity to interstate highways that function as major regional transportation arteries, thus minimizing disruption to local communities and neighborhoods. To Ameren's knowledge, specific transportation plans for Westlake have not been published.

Attachment List

1. **Golder Technical Memorandum dated June 26, 2019**
2. **Golder Response to CMA Public Comments Regarding Groundwater Protection Standards and Background Water Quality**
3. **Lochmueller Group Rail & Barge Transportation Assessment**
4. **Reitz & Jenz, Inc. Deep Excavation Analysis**
5. **XDD Behavior of Metals in Soil and Groundwater**
6. **Golder Rush Island Closure by Removal Groundwater Modeling**

GOLDER

TECHNICAL MEMORANDUM

DATE June 26, 2019 **Project No.** 153140601

TO Ameren Missouri

CC

FROM Mark Haddock, PE, RG **EMAIL mark_haddock@golder.com**

GROUNDWATER MODELING INDICATES NO IMPACT FROM LABADIE ENERGY CENTER CCR BASINS ON RESIDENTIAL WELLS EVEN UNDER EXTREME FLOOD CONDITIONS

Ameren Missouri (Ameren) recently held public meetings to discuss its Corrective Measures Assessment (CMA) as required under the United States Environmental Protection Agency's Coal Combustion Residual (CCR) Rule. In public comments raised either at these meetings or submitted to Ameren, members of the public questioned whether groundwater used by residential supply wells could be adversely impacted by CCR basins located at the Labadie Energy Center. The results of the modeling and testing conclude that bedrock groundwater quality in the residential areas of the bluffs is unaffected by CCR impacts to the alluvial aquifer based upon the following:

- The bedrock groundwater flow direction is consistently from high elevation areas (i.e. the bluffs) to low elevation areas (river bottoms).
- The closest community water supply well is located approximately two miles south of the LEC. Some individual wells are located within a mile of the LEC and all draw water from the bedrock aquifer in the bluffs area.
- Groundwater in the bedrock beneath the bluffs flows from the bluffs to the river valley areas, even under extreme river flood stage conditions. The higher groundwater levels in the bluffs prevent groundwater impacted by CCR on Ameren's property from travelling upgradient to residential water supplies.
- To assess groundwater flow under flood conditions, Golder modeled a worst case scenario (i.e. the 1993 flood of record (486.6 feet at the LEC), at a constant elevation and lasting for 55 straight days)[1]. The modeling results indicate that groundwater in the bluffs still flows in a northward direction, towards the Bottoms, and not vice versa.
- Multiple bedrock groundwater quality samples collected from wells in the bluffs area near the existing residential wells confirm that water quality is unaffected by CCR.

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[1] In 1993, this peak elevation level lasted one day at Labadie.

Below is a reproduction of a technical memorandum originally produced on August 5, 2015 regarding Golder's groundwater modeling analysis.

August 5, 2015 Golder Technical Memorandum on flood conditions groundwater modeling at LEC

1.0 INTRODUCTION AND BACKGROUND

At the request of Ameren Missouri (Ameren), Golder performed limited groundwater modeling for the Labadie Bottoms area in the vicinity of the Labadie Energy Center (LEC) located in Labadie, Missouri. The modeling was primarily intended to investigate movement of groundwater near the LEC for a flood condition in the Missouri River. The intent of the modeling was to investigate the potential for reversal of groundwater hydraulic gradient from the alluvial aquifer toward the bedrock aquifer located in the Bluffs area south of the LEC during and following a significant flood event. Specifically, the intent was to investigate the potential that groundwater flow in the alluvial aquifer was significantly reversed toward the bedrock aquifer due to flood conditions.

1.1 Modeling Software

Groundwater modeling was accomplished using MODFLOW 2000, a finite-difference numerical modeling code developed by the United States Geological Survey, and the most widely accepted groundwater modeling platform. MODFLOW 2000 is an updated version of the original MODFLOW code and incorporates improved functionality. Model development was facilitated by Groundwater Vistas, a graphical user interface used to develop the model domain, grid, properties, and to visualize model results.

1.2 Conceptual Model, Domain and Grid

The model domain was intended to model conditions in the alluvial aquifer under and near the LEC and the adjacent limestone bedrock aquifer to the south. The domain was approximately 47,000 feet by 35,000 feet, and was developed roughly parallel to the Missouri River (Figure 1). The model domain was rotated such that the northern model boundary corresponded approximately to the Missouri River. The southern boundary was set in the bedrock aquifer a sufficient distance away from the river so as to minimize boundary effects to the model output. The direction of groundwater flow has been determined to be generally from the bedrock aquifer toward the alluvial aquifer.

The total model thickness for the alluvial aquifer was set at 100 feet based on subsurface drilling information. The individual grid cells were 500 feet by 500 feet, and the model was split into four layers, each 25 feet thick, for increased computational resolution. The model layers were sloped with the top of the model set to 600 feet at the southern model boundary and to approximately 454 feet at the Missouri River, based on general topographic trends in both areas. Initial modeling was conducted with the model layers both horizontal and sloped as a comparison. However, early model runs indicated that preliminary results for the sloped layer configuration were more conservative (i.e., greater effect at the area of interest).

1.3 Boundary Conditions

The eastern and western boundaries of the domain were treated as essentially parallel to groundwater flow and therefore were considered to be no-flow boundaries. The southern and northern boundaries of the model domain were considered to be constant head boundaries. The model boundaries are shown on Figure 2.

Groundwater elevations in the bedrock aquifer near the bluffs and the alluvial aquifer were used to extrapolate the hydraulic gradient throughout the model domain to the south. The intent was that the model emulate the approximate groundwater elevations determined in the installed bedrock wells. In order to do this, the southern constant head boundary was set to 590 feet. It is important to note that the actual groundwater elevations at the southern domain boundary are not expected to be 590 feet at all locations, but this was done as a convenience to generate the anticipated groundwater elevations in the middle of the model and avoid boundary effects.

The northern constant head boundary was set to 455.4 feet to represent a typical stage of the Missouri River. This constant head boundary was increased to 486.6 feet to represent the flood event, as observed during the flood event of 1993. This was a historic severe flood event with water in the Missouri River above flood stage for 55 days, primarily at modest elevations. The peak elevation of the flood near the LEC was 486.6 feet and only lasted one day. However, the intent was to model a worst case flood scenario so the peak elevation was extended for the entire 55-day flood event.

The alluvial aquifer was modeled as a single unit with a hydraulic conductivity of 70 feet per day (ft/d) based on a mean value for the alluvial aquifer from the Detailed Site Investigation (DSI) (GREDELL Engineering Resources and Reitz & Jens, Inc., 2011) for the LEC. The bedrock aquifer was modeled as a single unit with a hydraulic conductivity of 3 ft/d, based on a published value for limestone from Todd (1980). Specific yield for the alluvium and bedrock aquifers were set at 0.3 and 0.14, respectively, based on published estimates from Anderson and Woessner (1992), and were also used to approximate porosity. Specific storage for the alluvium and bedrock aquifers was set to 2.3E-04 ft^{-1} and 1.1E-05 ft^{-1}, respectively, based on published estimates from Anderson and Woessner (1992).

2.0 STEADY STATE GROUNDWATER MODELING RESULTS

The model was initially run in steady state to generate the typical groundwater gradient and movement from the bedrock aquifer to the alluvial aquifer toward the Missouri River, as observed from direct measurements. A general comparison was made between the model estimated groundwater elevations in the bedrock aquifer and the measured groundwater elevations in the area of the bluffs. The model estimated groundwater elevations at the edge of the bluffs were approximately 460 feet, which closely approximates the measured groundwater elevations in this area (Figure 3).

3.0 TRANSIENT GROUNDWATER MODELING RESULTS

Golder was asked to model the effects of a significant flood event, comparable to the 1993 flood event of the Missouri River, on the groundwater movement in the alluvial aquifer. The 1993 flood saw an increase in river flows and levels above flood stage for a period of 55 days. The maximum river stage in the Missouri River near the Labadie Plant during this flood was 486.6 feet, an increase of approximately 31 feet over typical flows in the Missouri River in this area. Use of the peak flood elevation for the entire length of the flood was conducted to represent an extreme worst case scenario.

A transient model run was conducted in which the southern constant head boundary, representing the Missouri River, was set to 486.6 feet for 55 days, then was returned to the same level as in the steady state model run (455.4 feet). Three stress periods were simulated in the model run: Period 1 is the steady state condition with the Missouri River set to 455.4 feet, Period 2 is a transient, 55-day period with the Missouri River set to 486.6 feet, and Period 3 is a transient, 100-year period with the Missouri River returned to 455.4 feet. Changes to water levels near a location of interest were monitored throughout the model run. This location of interest is a hypothetical monitoring well as shown on Figure 4.

Figure 4 shows the modeled groundwater level contours after the 55 day flood event. Modeled groundwater elevations near the limestone bluffs remained at approximately 460 feet at the end of the 55 day flood event, rising less than 0.5 foot (Figure 5). The groundwater divide, the area where the original hydraulic gradient from the bedrock aquifer and the hydraulic gradient from the alluvial aquifer meet, was located well north of the northern edge of the bluff area demonstrating no reversal of flow at the location of interest.

3.1 Particle Tracking

Particle tracking was conducted using the computer code MODPATH (Polluck, 1989). With this analysis, particles are placed in an area of the model to represent points in the groundwater system, and their flow paths through the groundwater system are traced by moving the particles along the vector of maximum velocity within each model cell. In this way, particle tracking can estimate the movement of groundwater under a simulated condition, in this case, a flood event on the Missouri River. Particles were started within the area of the Labadie Plant and tracked throughout the flood event and during the subsequent recovery period. The particles moved in toward the bedrock aquifer during the flood event, and for a period of about 100 days after the event, until the hydraulic gradient reversed again toward the Missouri River in response to the decrease in river stage. The total distance traveled in toward the bedrock aquifer is small (about 50 feet). This is consistent with independent calculations of the average groundwater flow velocity assuming the same parameters used in the model (Darcy's law equation for advection, Fetter, 1988).

4.0 SENSITIVITY ANALYSIS

Numerical modeling always involves a certain level of uncertainty in assigning model parameters. A sensitivity analysis was conducted in which model parameters were systematically varied to determine the variability in the model estimated response to the flood event, as shown in Table 1. The structure of the model runs remained unchanged, only the parameters indicated in Table 1 were modified. The model presented above in this report, model 1, is the preferred model because the model parameters are considered the most likely for the aquifer systems near the LEC. Four sensitivity runs, models 2 through 5, were conducted in which the hydraulic conductivity, storage, and porosity were deliberately altered to facilitate greater movement of groundwater. The results for all of these sensitivity runs were not consistent with reversal of flow at the location of interest.

The particle tracking analysis was repeated for sensitivity model run 5 because this model had the largest response at the monitoring well location. Particles released in the area of the Labadie Plant travel toward the bedrock aquifer for approximately 60 days and travel approximately 235 feet before the hydraulic gradient is again reversed back toward the Missouri River.

5.0 CONCLUSIONS

Groundwater modeling was conducted for an extreme worst case flood event, using the maximum elevation of the 1993 flood and carrying this elevation for the entire 55 days of this flood. The results of groundwater modeling did not indicate any reversal of groundwater flow at the location of interest. Groundwater flow was consistently from the bedrock aquifer to the alluvial aquifer based on the results of this model.

Attachments or Enclosures:

Table 1 – Groundwater Model Parameters

Figure 1 – Groundwater Model Domain Boundary and Model Grid

Figure 2 – No-flow and Constant Head Boundaries

Figure 3 – Pre-flood Groundwater Elevations

Figure 4 – Groundwater Model Domain Boundary and Resulting Groundwater Elevations

Figure 5 – Water Level Changes at Point of Interest

References

Anderson, Mary P., and Woessner, William W., 1992. Applied Groundwater Modeling – Simulation of Flow and Advective Transport.

Fetter, C.W., 1988. Applied Hydrogeology, Second Edition.

GREDELL Engineering Resources and Reitz & Jens, Inc. 2011. Detailed Site Investigation. Ameren Missouri Labadie Power Plant Proposed Utility Waste Disposal Area. Franklin County, Missouri. February 4, 2011.

Todd, David Keith, 1980. Groundwater Hydrology, Second Edition.

USGS 2000, Modflow-2000, the U.S. Geological Survey Modular Ground-Water Model – User Guide to Modularization Concepts and the Ground-Water Flow Process.

TABLES

Table 1
Groundwater Model Parameters
Labadie Energy Center, Franklin County, MO
Ameren Missouri

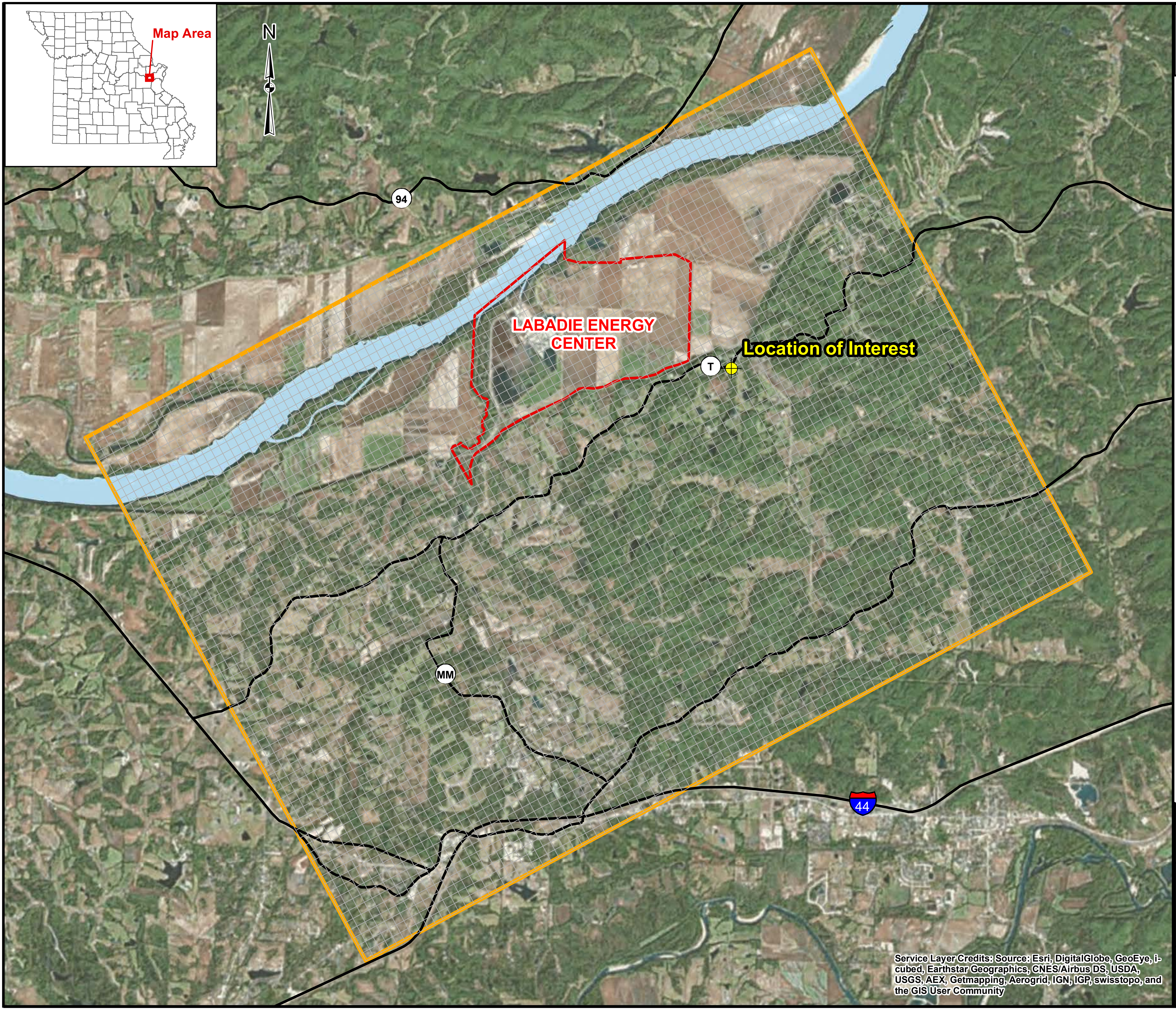
Model Number	Conductivity of Alluvium (feet/day)	Conductivity of Limestone (feet/day)	Specific Yield of Alluvium	Specific Yield of Limestone	Storativity of Alluvium (feet^{-1})	Storativity of Limestone (feet^{-1})	Model Results
1	70	3	0.3	0.14	2.30E-04	1.10E-05	Preferred
2	70	3	0.15	0.05	2.30E-04	1.10E-05	Sensitivity
3	70	10	0.15	0.05	2.30E-04	1.10E-05	Sensitivity
4	70	10	0.1	0.01	2.30E-04	1.10E-05	Sensitivity
5	120	10	0.1	0.01	2.30E-04	1.10E-05	Sensitivity

Prepared By:	BS/JSI
Checked By:	JS
Review By:	JRS

FIGURES

TITLE

GROUNDWATER MODEL DOMAIN BOUNDARY AND MODEL GRID



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LEGEND

- 🟥 Labadie Energy Center Property Boundary
- 🟧 Groundwater Model Domain
- ⌖ Location of Interest

NOTES

1.) All boundaries and locations are approximate.

REFERENCES

1.) Ameren, 2011. Ameren Missouri Labadie Energy Center, Labadie Property Control Map, November 2011.

2.) MSDIS (Missouri Spatial Data Information Service) Database, 2014.

3.) MODFLOW groundwater modeling program.

4.) COORDINATE SYSTEM: NAD 1983 StatePlane Missouri East FIPS 2401 Feet.

0 5,000 10,000
Feet

PROJECT

Ameren

AMEREN MISSOURI LABADIE ENERGY CENTER
FRANKLIN COUNTY, MISSOURI

Golder Associates

PROJECT No. 130-1560			Figure 1 - Domain Boundary and Model Grid.mxd	
DESIGN	-	-	SCALE: AS SHOWN	REV. 0
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CHECK	JS	7/10/2015		
REVIEW	JRS	7/10/2015		

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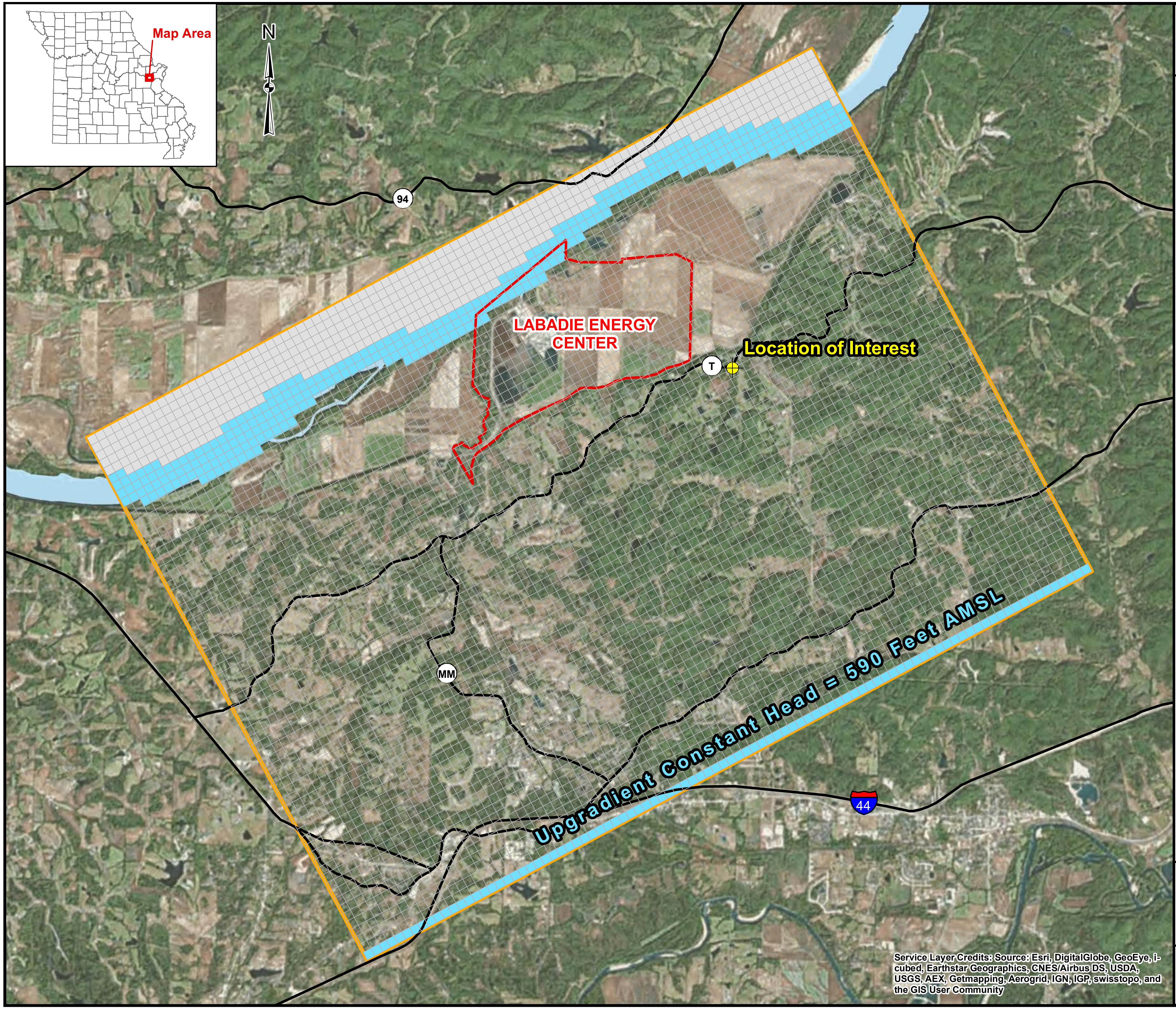
Map Document: G:\Projects\130 Projects\1301560 - Ameren Ash Ponds - MO\800 - FIGURES-DRAWINGS\PRODUCTION\Phase 0001 - Labadie\Arcgis\GW_Model_Tech_Memo\Figure 2 - Domain Boundary and Model Grid.mxd / Modified 7/10/2015 4:21:17 PM by JIngram / Exported 7/10/2015 4:21:24 PM by JIngram



Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

TITLE

NO-FLOW AND CONSTANT HEAD BOUNDARIES

LEGEND

- 🟥 Labadie Energy Center Property Boundary
- 🟧 Groundwater Model Domain
- ⊕ Location of Interest
- 🟦 Constant Head Boundaries
- ⬜ No-Flow Boundaries

NOTES

1.) All boundaries and locations are approximate.
2.) Constant Head Boundaries are 455.4 feet AMSL under average conditions, 486.6 ft AMSL under extreme flood conditons (peak of the 1993 flood), and are 590 feet AMSL upgradient.
3.) AMSL - Above Mean Sea Level.

REFERENCES

1.) Ameren, 2011. Ameren Missouri Labadie Energy Center, Labadie Property Control Map, November 2011.
2.) MSDIS (Missouri Spatial Data Information Service) Database, 2014.
3.) MODFLOW groundwater modeling program.
4.) COORDINATE SYSTEM: NAD 1983 StatePlane Missouri East FIPS 2401 Feet.

0 5,000 10,000
Feet

PROJECT

AMEREN MISSOURI LABADIE ENERGY CENTER
FRANKLIN COUNTY, MISSOURI

PROJECT No. 130-1560			Figure 2 - Domain Boundary and Model Grid.mxd
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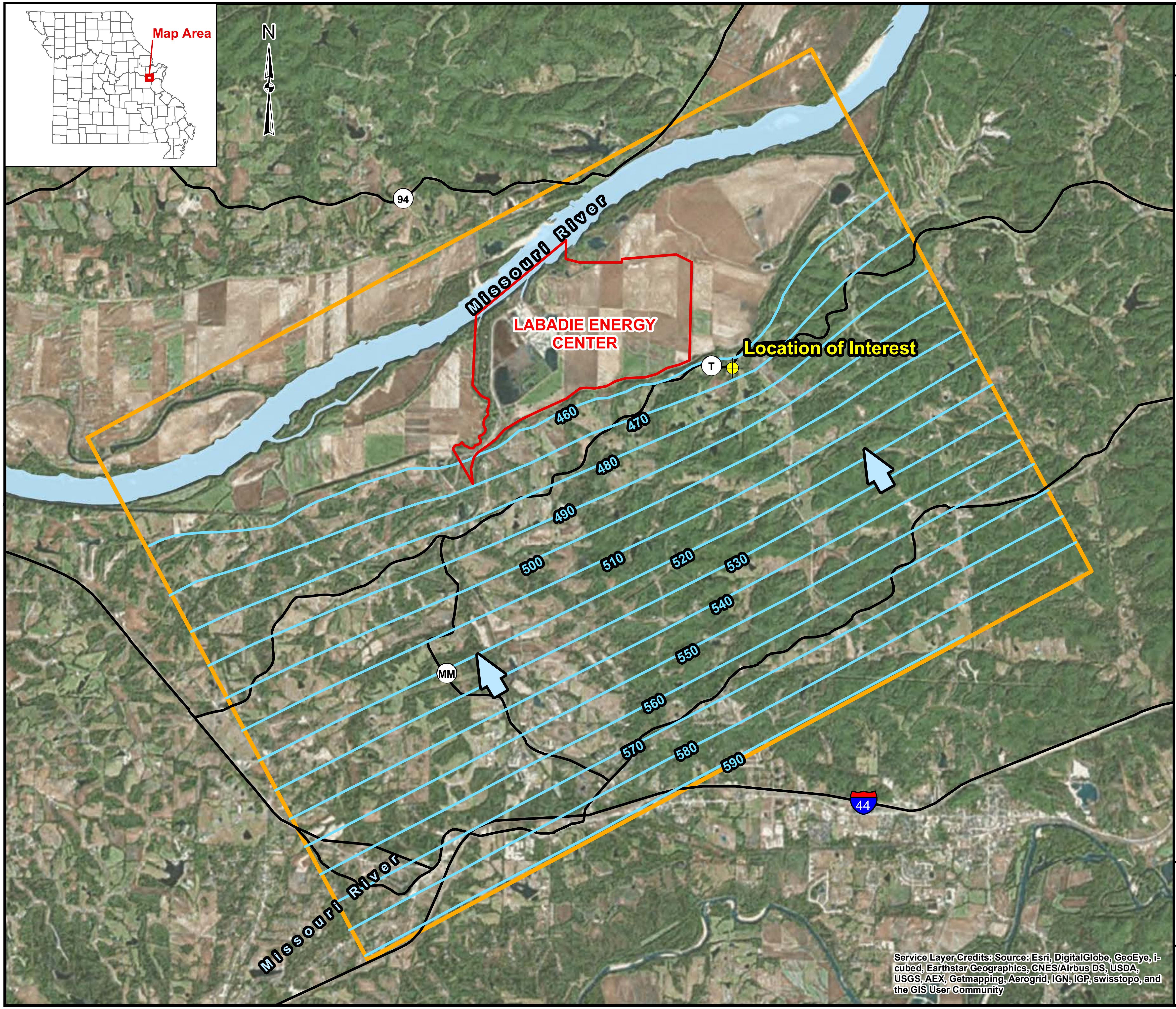
REVIEW	JRS	7/10/2015	

TITLE

PRE-FLOOD GROUNDWATER ELEVATIONS



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LEGEND

- 🟥 Labadie Energy Center Property Boundary
- 🟧 Groundwater Model Domain
- ⊕ Location of Interest
- — Model Groundwater Elevation Contours
- ⇖ Groundwater Flow Direction

NOTES

1.) All boundaries and locations are approximate.
2.) Model contour interval is 10 feet.
3.) Upgradient contours are used for generalized gradient and are not considered locally accurate.
4.) Model results reflect pre-flood river conditions.

REFERENCES

1.) Ameren, 2011. Ameren Missouri Labadie Energy Center, Labadie Property Control Map, November 2011.
2.) MSDIS (Missouri Spatial Data Information Service) Database, 2014.
3.) MODFLOW groundwater modeling program.
4.) COORDINATE SYSTEM: NAD 1983 StatePlane Missouri East FIPS 2401 Feet.

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Feet

PROJECT

AMEREN MISSOURI LABADIE ENERGY CENTER
FRANKLIN COUNTY, MISSOURI

PROJECT No. 130-1560			Figure 3 - Pre-flood groundwater elevations .mxd	
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CHECK	JS	7/10/2015		
REVIEW	JRS	7/10/2015		

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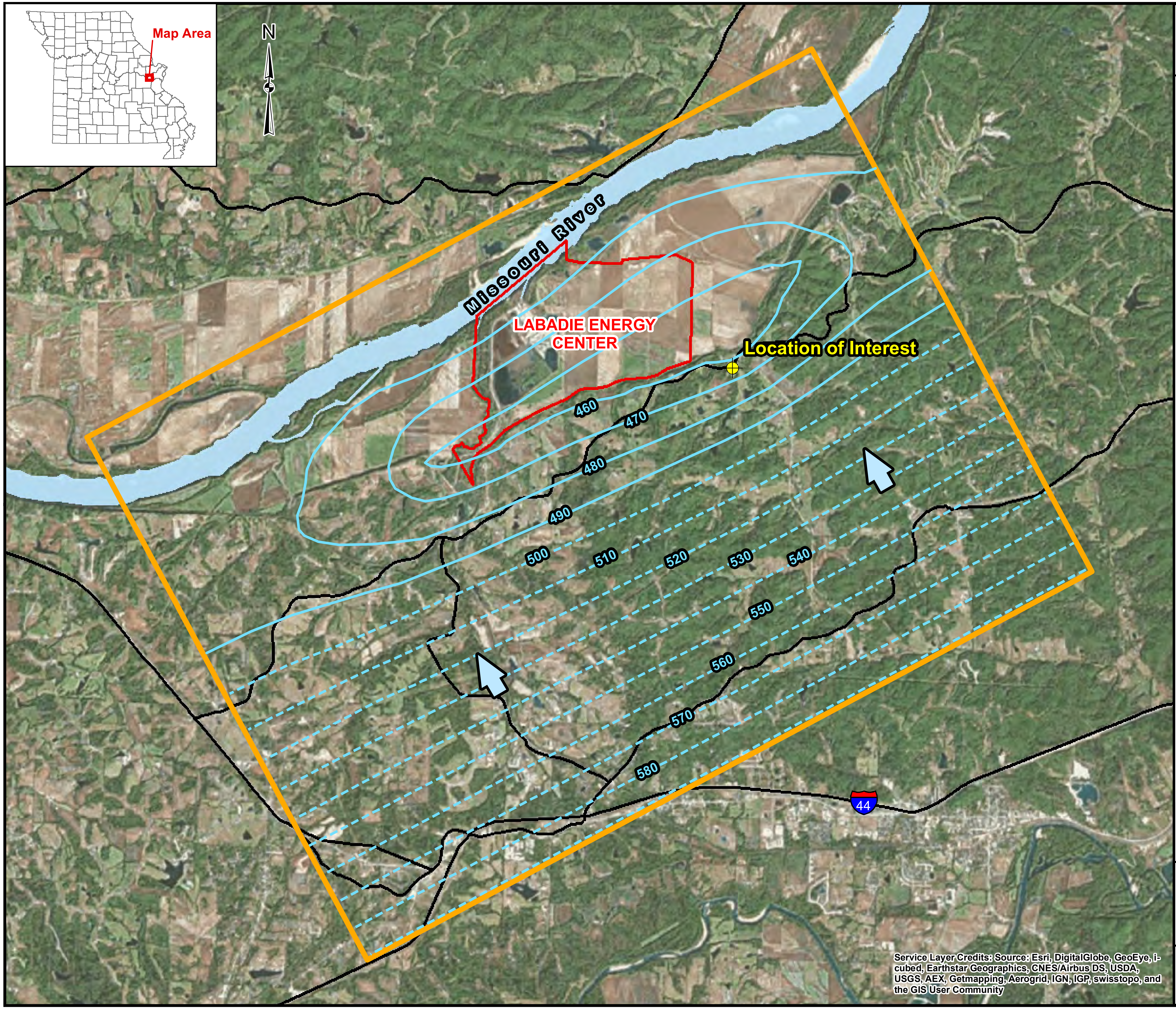

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

TITLE

GROUNDWATER MODEL DOMAIN BOUNDARY AND RESULTING GROUNDWATER ELEVATIONS DURING FLOOD

LEGEND

- 🟥 Labadie Energy Center Property Boundary
- 🟧 Groundwater Model Domain
- ⊕ Location of Interest
- — Model Groundwater Elevation Contours
- - - Model Estimated Groundwater Elevation Contours
- ↖ Groundwater Flow Direction

NOTES

1.) All boundaries and locations are approximate.
2.) Model contour interval is 10 feet.
3.) Upgradient contours are used for generalized gradient and are not considered locally accurate.
4.) Model results reflect 55 continuous days of river level at 486.6 feet above mean sea level (peak level of the 1993 flood).

REFERENCES

1.) Ameren, 2011. Ameren Missouri Labadie Energy Center, Labadie Property Control Map, November 2011.
2.) MSDIS (Missouri Spatial Data Information Service) Database, 2014.
3.) MODFLOW groundwater modeling program.
4.) COORDINATE SYSTEM: NAD 1983 StatePlane Missouri East FIPS 2401 Feet.

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PROJECT

AMEREN MISSOURI LABADIE ENERGY CENTER
FRANKLIN COUNTY, MISSOURI

PROJECT No. 130-1560		Figure-4 - Groundwater Elevation after 55 days.mxd	
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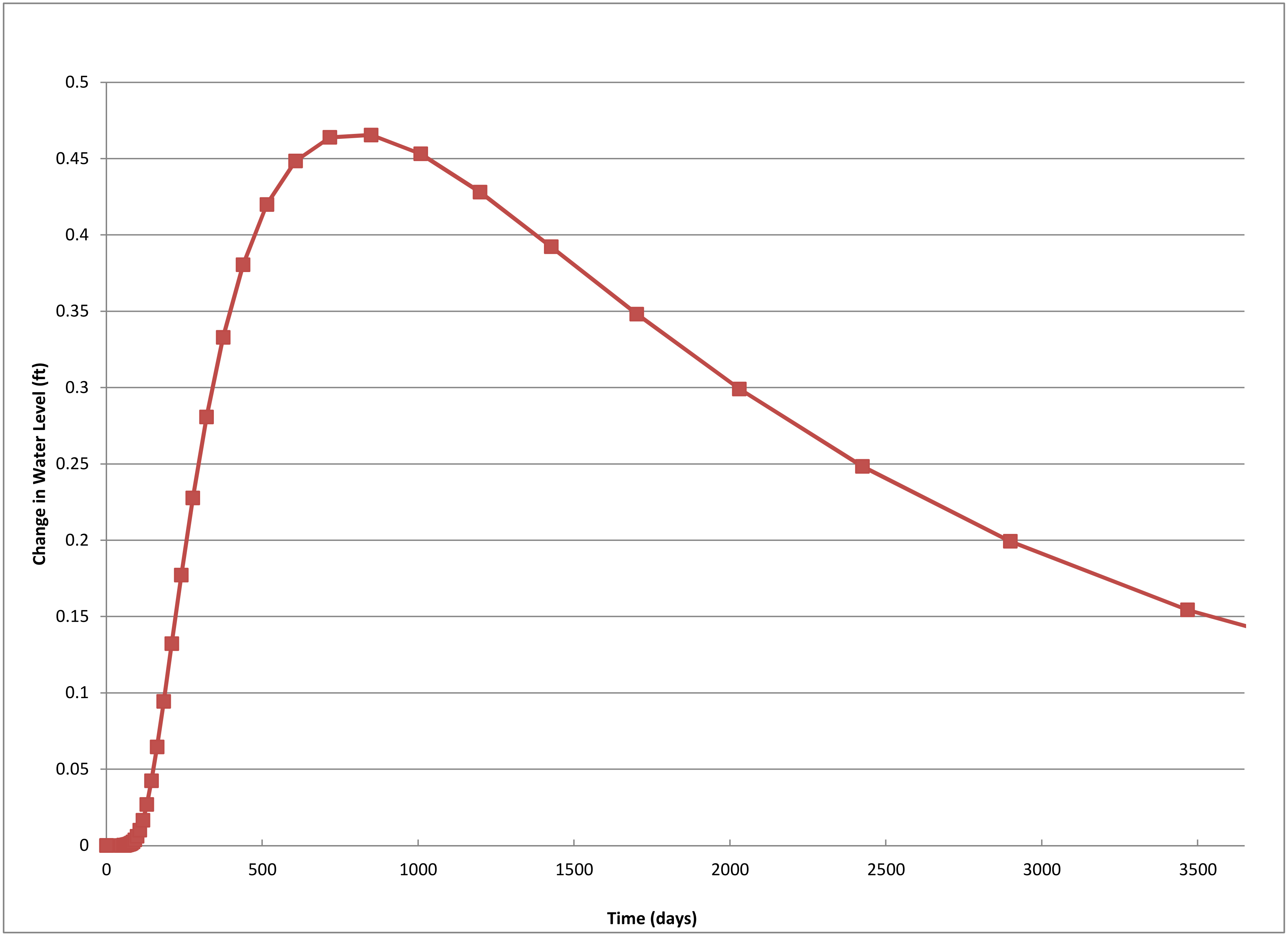
CHECK	JRS	6/16/2015	
REVIEW	MNH	6/17/2015	

Map Document: G:\Projects\130 Projects\1301560 - Ameren Ash Ponds - MO\800 - FIGURES-DRAWINGS\PRODUCTION\Phase 0001 - Labadie\Arcgis\GW_Model_Tech_Memo\Figure-4 - Groundwater Elevation after 55 days.mxd / Modified 8/5/2015 4:45:37 PM by JIngram / Exported 8/5/2015 4:45:44 PM by JIngram

Figure 5
Water Level Changes at Point of Interest
Labadie Energy Center, Franklin County, MO
Ameren Missouri



TECHNICAL MEMORANDUM

DATE June 20, 2019 **Project No.** 1531410601

TO Ameren Missouri

CC

FROM Golder Associates Inc. **EMAIL Mhaddock@golder.com**

RESPONSE TO CMA PUBLIC COMMETNS REGARDING GROUNDWATER PROTECTION STANDARDS AND BACKGROUND WATER QUALITY

1.0 INTRODUCTION

This Technical Memorandum discusses the methods, procedures, and reasoning used to calculate the Groundwater Protection Standards (GWPS) at the Rush Island Energy Center (RIEC) and the Labadie Energy Center (LEC), as well as a brief review of publicly available data regarding arsenic in the alluvial aquifer of the Missouri River in Missouri. Recent public comments to the Corrective Measures Assessment reports (CMAs) have suggested that the calculation of the GWPS for arsenic have “skewed” the results of the monitoring evaluation and rendered the groundwater monitoring networks incapable of detecting arsenic contamination, biasing the CMAs against clean closure. This Technical Memorandum discusses the specific requirements of the CCR Rule that Golder has followed, the best practices for statistical evaluation as outlined in the United States Environmental Protection Agency’s (USEPA) Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities (Unified Guidance), the locations of the background monitoring wells at the Labadie Energy Center (LEC) and Rush Island Energy Center (RIEC), and the presence of existing and naturally occurring arsenic in the alluvial aquifers of the Missouri and Mississippi River valleys.

2.0 LOCATION OF BACKGROUND MONITORING WELLS

The location of background wells is one of the most important factors in developing an effective monitoring well network. Section 257.91(a)(1) of the CCR Rule outlines the location requirements of background monitoring wells for a monitoring well network. The requirements are as follows:

> *(1) Accurately represent the quality of background groundwater that has not been affected by leakage from a CCR unit. A determination of background quality may include sampling of wells that are not hydraulically upgradient of the CCR management area where: (i) Hydrogeologic conditions do not allow the owner or operator of the CCR unit to determine what wells are hydraulically upgradient; or (ii) Sampling at other wells will provide an indication of background groundwater quality that is as representative or more representative than that provided by the upgradient wells;*

The CCR Rule requirements have been carefully followed and the locations selected for background monitoring wells accurately represent quality of background groundwater that has not been affected by a CCR unit.

2.1 Background Wells at the Labadie Energy Center

The background monitoring wells for the LCPA ash basin at the LEC are BMW-1D and BMW-2D and two other wells, BMW-1S and BMW-2S provide background monitoring for the LCPB ash basin. An aerial image with the

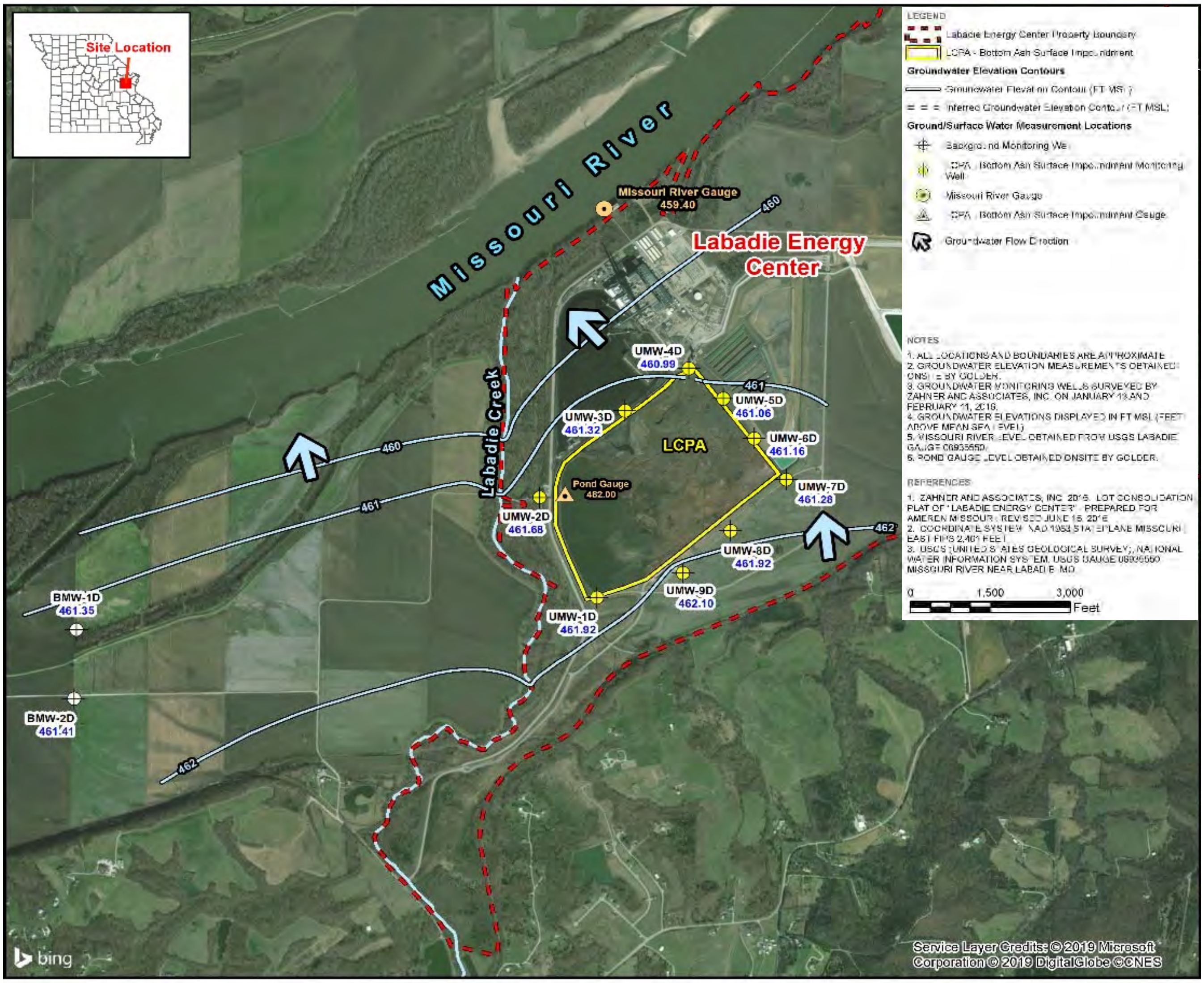


Figure 1: Labadie Monitoring Well Location and Groundwater Flow Map

location of the LCPA, the monitoring wells, and a representative groundwater flow map from 2018 is provided in Figure 1. The background monitoring wells are located approximately 1.5 miles west/southwest of the LCPA and 2,000 to 3,000 feet south of the Missouri River. These locations are upgradient and cross-gradient from the CCR at LCPA. Each of these two locations have shallow and deep zone wells (4 total) used for LCPB and LCPA monitoring purposes.

Groundwater flow within the alluvial aquifer is dynamic and can be influenced by seasonal changes in the water level of the Missouri River. Overall, as discussed in the annual reports (publicly available on Ameren website at https://www.ameren.com/company/environment-and-sustainability/managing-coal-combustion/ccr-compliance-reports), groundwater flows from the bluffs area toward the Missouri River at a rate of approximately 20 feet per year. Based on the upgradient/cross-gradient location of the background wells at LEC and the sampling results from these wells, there are no CCR impacts from the LCPA or the operation of the LEC in these wells and they are representative of un-impacted, background groundwater quality.

Background concentrations of arsenic in these wells have ranged from 0.12 µg/L to 42.6 µg/L and the spatial variability of concentrations is evident - at one location the deep well exhibits the highest concentration and at the other well-pair location the shallow well has the highest arsenic value. Spatial variability in these concentrations is the result of the heterogeneous makeup of the alluvial aquifer porous media and geochemical interactions of the aquifer media with groundwater. The alluvial aquifer is naturally composed of fine to coarse-grained sediments and clasts derived from soil and rock sources up the river basin that can contain arsenic and metallic minerals, as described in Section 4 below.

2.2 Background Wells at the Rush Island Energy Center

Figure 2: Rush Island Monitoring Well Location and Groundwater Flow Map

The background monitoring wells for the RCPA ash basin are MW-B1 and MW-B2. In addition, two monitoring wells from the 2014 Detailed Site Investigation (DSI) are present within 50 feet of MW-B2. These two wells include a shallow zone well (P29S) and a deep zone well (P29D). An aerial image of the location of the RCPA, the monitoring wells, and a representative groundwater flow map from 2018 are provided in Figure 2. The background monitoring wells are located approximately 2,500 to 4,500 feet north/northwest of the RCPA and 600 to 2,000 feet west of the Mississippi River. These wells are upgradient and cross-gradient from the CCR at RCPA.

Groundwater flow within the alluvial aquifer at the RIEC is also dynamic and can be influenced by seasonal changes in the water level of the Mississippi River. Overall, as discussed in the annual reports (publicly available on Ameren website at https://www.ameren.com/company/environment-and-sustainability/managing-coal-combustion/ccr-compliance-reports), groundwater flows easterly toward the Mississippi River. Based on the upgradient/cross-gradient location of the background wells at RIEC and the sampling results from these wells, there are no impacts from the RCPA or the operation of the RIEC in these wells and they are representative of un-impacted, background groundwater quality.

Background concentrations of arsenic in these wells have ranged from 1.9 to 30 µg/L in CCR Rule wells (MW-B1 and MW-B2) and from 1.1 to 51.7 µg/L in the DSI wells (P29S and P29D). Spatial variability in these concentrations is evident as the highest and lowest concentrations are in nested wells (P29S, and P29D) located 4,500 feet north of the RCPA. This variability in background concentrations is the result of the heterogeneous makeup of the alluvial aquifer porous media and geochemical interactions of the aquifer media with groundwater. The alluvial aquifer is naturally composed of fine to coarse-grained sediments and clasts derived from soil and rock sources upriver that can contain arsenic and metallic minerals, as further described in Section 4 below.

3.0 STATISTICAL METHODS AND CALCULATION OF THE GWPS

As required by the CCR Rule, prior to October 17th, 2017 Ameren posted a Statistical Method Certification (SMC) to its publicly available website for each of its CCR Units. These SMC's describe the statistical methods to be used for each CCR Unit for Detection and Assessment Monitoring. The methods included in the SMCs were selected because they comply with the requirements of the CCR Rule and are consistent with methods recommended in the USEPA Unified Guidance, which is specifically referenced as a statistical guidance document in the CCR Rule.

As required by the CCR Rule, once assessment monitoring is triggered at a site, site-specific GWPS must be calculated for each of the detected Appendix IV parameters. Following standard practice, the CCR Rule also requires that the site-specific GWPS be derived from either: (1) the United States Environmental Protection Agency's (USEPA) maximum contaminant levels (MCL), (2) health-based standards which were adopted by USEPA in July 2018 for Cobalt, Lead, Lithium, and Molybdenum, or (3) un-impacted background concentrations, for situations where the un-impacted background concentrations are higher than the MCL. Using these methods, the GWPS for arsenic at the LCPA was set at 42.6 µg/L, while the arsenic GWPS for the RCPA is 30.0 µg/L.

As outlined in the SMCs for both the LCPA and the RCPA, following the establishment of the GWPS, assessment monitoring statistics were performed using an interwell confidence interval method to compare results from downgradient/compliance monitoring wells with the GWPS. The confidence interval method used to evaluate Appendix IV results from both the LCPA and RCPA are consistent with the methods recommended in the Unified Guidance.

In summary, the methods used for the calculation of the GWPS at the LEC and RIEC, as well as the resulting GWPS values, follow standard practice in groundwater monitoring and are consistent with the CCR Rule and the USEPA Unified Guidance.

4.0 EXAMPLES OF NATURALLY OCCURING ARSENIC IN MISSOURI

There are numerous reports and publications that discuss the presence of naturally occurring arsenic in Missouri. Arsenic has been reported to occur in groundwater in Missouri from both naturally occurring and anthropogenic sources (https://health.mo.gov/living/environment/ privatedrinkingwater /contaminants.php). Additionally, as provided in the risk assessment reports for Labadie and Rush Island, United States Geological Survey (USGS) soil and groundwater maps by the United States Geological Survey (USGS) for arsenic in the groundwater and soils shows that arsenic is naturally present in our environment (USGS Reports available at https://mrdata.usgs.gov/geochem/doc/ averages/ countydata.htm and http://water.usgs.gov/nawqa/trace/pubs/ geo_v46n11 /fig2.html, Ameren risk assessment report available at https://www.ameren. com/company/environment-and-sustainability/managing-coal-combustion/water-quality).

The National Water Quality Monitoring Council's (NWQMC) Water Quality Portal (available at https://www.waterqualitydata.us/) summarizes data from the USGS, the USEPA, and the NWQMC databases. The NWQMC database includes arsenic results from a total of 1,215 groundwater samples for wells located upgradient of the LEC within the Missouri River alluvial aquifer. These 1,215 samples are from wells located just upstream of the LEC to the confluence of the Kansas and Missouri River in Kansas City, Missouri. The 1,215 samples consist of: 351 samples from the Independence Well Field near Independence Missouri, 852 samples are from the Columbia/Eagle Bluffs Wetland Complex wells, and the remaining 12 samples from various locations in the identified area. This is an extensive dataset. A USGS report on the data for Independence Missouri is available at https://pubs.er.usgs.gov/publication/sir20105232 and USGS Reports for the Columbia/Eagle Bluffs Wetland Complex wells are available at https://pubs.er.usgs.gov/publication/wri024227. Arsenic values within these samples ranged from non-detect (<0.022 ug/L) to 72 µg/L, with an average concentration of 6.7 µg/L.

Figure 3: Comparison of Missouri River Alluvial Aquifer Groundwater Arsenic Concentrations – Public Data and Labadie Results

Figure 3 compares the publicly available groundwater arsenic data in upgradient Missouri River alluvial aquifer settings to the Labadie background and monitoring well results, which ranged from non-detect (<0.052 µg/L) to 69.5 µg/L in CCR Rule monitoring wells, with an average concentration of 6.6 µg/L. Overall, the results at the upgradient locations in Missouri are nearly identical to those at the LEC with around 80% of the samples being below the MCL and 20% above the MCL. These data demonstrate that arsenic concentrations above the MCL are not unusual in the Missouri River alluvial aquifer and are primarily from naturally occurring sources or, potentially, from anthropogenic sources that are unrelated to CCR and power plant operations.

Additionally, using the NWQMC Water Quality Portal (available at https://www.waterqualitydata.us/) from the confluence of the Mississippi and Missouri Rivers to the RIEC there are 99 arsenic groundwater sampling locations with published data from the alluvial aquifer of the Mississippi River. Arsenic test results from these published well samples range from non-detect (<1.0 µg/L) to 39 µg/L with 4 sampling locations reporting arsenic concentrations greater than the MCL and 2 locations with concentrations over the site-specific GWPS for the RIEC. These levels are similar to background arsenic concentrations at the RIEC and further support that the concentrations in background wells are derived from naturally occurring or non-CCR anthropogenic sources of arsenic in the Mississippi River alluvial aquifer.

Additional comments to the CMA's make note that boron is a clear indicator of CCR impacts, which is acknowledged by EPRI (2012) documentation that boron is "*Typically present in leachate, non-reactive and mobile in common hydrogeological environments, and not a common anthropogenic contaminant*." The public comments also attempt to draw a correlation between the arsenic concentrations present onsite and boron concentrations. Since boron is not detected in background groundwater wells, this absence further supports the case that the arsenic observed in background wells is not from a CCR source and is naturally occurring, likely derived from sulfide minerals present in the aquifer.

5.0 REFERENCES

AECOM., 2014. Groundwater and Surface Water Data Demonstrate No Adverse Human Health Impact from Coal Ash Management at the Ameren Labadie Energy Center.

AECOM., 2014. Groundwater and Surface Water Data Demonstrate No Off-Site Impact from Rush Island Energy Center.

Electric Power Research Institute (EPRI)., 2012, Groundwater Quality Signatures for Assessing Potential Impacts from Coal Combustion Product Leachate, Report 1017923. October 2012.

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Golder Associates Inc., 2017b, 2017 Coal Combustion Residuals (CCR) Rule Statistical Method Certification (40 CFR §257.93(f)(6)), RCPA Surface Impoundment, Rush Island Energy Center, Jefferson County, Missouri.

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ADDENDUM

Rush Island, Meramec, Labadie and Sioux Ash Pond Closure: Rail & Barge Transportation Assessment

July 9, 2019

Lochmueller Group previously completed a planning-level assessment of the costs and logistics associated with extracting, stabilizing, and transporting coal combustion residuals (CCR) from existing ash ponds at the Rush Island, Meramec, Labadie, and Sioux Energy Centers to offsite landfills. Trucking is the most flexible and cost-effective mode of transporting CCR, given the relatively short distances (50 miles or less) between each energy center and the preferred landfill locations. The purpose of this addendum is to evaluate in detail the rail and barge transportation modes.

Rail and Barge Overview

Rail and barge typically become more cost-efficient than trucking over longer distances. In fact, the average barge trip length along the Mississippi River waterway system is 513 miles, which is indicative of the long distances that waterway freight commonly travels.

As compared to the highway network, the geographical reach of the rail and barge networks is limited. As such, payloads transported by rail and barge are commonly picked up by truck at the origin and delivered by truck to the destination, with intermediate transloads on and off trains and barges. Over short distances, the cost and time for these transloads renders rail and barge non-competitive with truck hauling.

To maintain parity with truck hauling, CCR transport by rail would require specialized rail cars fully lined with covers to prevent material escape (coal delivery trains are not suited for CCR removal). As such, these trains would be dedicated for CCR transportation and would run full to landfills and return empty. Such specialized rail cars are expensive and cost approximately $100,000 per car. Rail cars for each 100-car unit train are estimated to cost $10M.

CSX is a Class 1 railroad with acknowledged CCR transport capabilities. However, CSX does not directly serve any of Ameren's energy centers. For CSX to be a CCR hauler for Ameren, carrier transfers would be required involving the Class 1 serving each site (UP or BNSF). This would probably occur using the St. Louis Terminal Railroad (TRRA) as an intermediary to transfer train cars from UP and BNSF yards in Missouri to the CSX Rose Lake Yard in East St. Louis, Illinois. In total, the use of three separate carriers and multiple train yards would increase the complexity, cost, and haul cycle under the CSX option. Service disruptions would also be a concern, as Ameren would have little control over the means or methods of rail transport.

Given the carrier transfer process described above, a single 100-car unit train is assumed to be capable of transporting approximately one load every two weeks, although the actual timeframe depends on the landfill destination. To maintain the previously assumed CCR removal rates and assuming the 2-week roundtrip haul, unit trains would need to be loaded at each energy center one to four times per week dictating two to eight CCR unit trains in the cycle for each site. The capital expense to acquire a sufficient number of rail cars to support such haul cycles at Ameren's four energy centers would be approximately $90M.

Rail and barge transportation is more susceptible to disruptions, particularly due to flooding events that can close rivers and rail lines for extended periods. In addition, congestion on rail lines and in rail yards and at lock and dams affects the reliability of these modes. Barges also present a unique environmental and safety concern. In 2018, 15 coal barges broke loose on the Monongahela River near Pittsburg with two of the barges sinking and at least one spilling coal into the river. The leakage or spillage of CCR into waterways would have environmental ramifications. Given the sensitivities surrounding CCR generally, barging is simply not a desirable transport mode.

Ameren Energy Centers

As previously noted, each energy center has the potential for direct rail and barge loading. However, there are site constraints at each location that would hamper rail or barge operations, as follows:

Rush Island

The site currently has a rail loop off the BNSF line for unloading coal trains. A full 12-hours is required to unload a coal train and the site receives about one train per day. Hence, the existing rail spur is fully utilized and does not have capacity to temporarily store or load CCR trains.

It would be necessary to construct dedicated tracks for loading CCR unit trains known as “ladder track”. The site does not have space for such a facility, so land would need to be acquired or leased from an adjacent property owner or from the BNSF itself to construct a loading area. Since the loading would occur off-site, CCR would need to be trucked to the rail loading area.

Additionally, the BNSF mainline consists of a flood-prone single track. The line has been inoperable due to multiple flooding events in 2019 alone. Due to the single track, northbound and southbound trains must pass at sidings to maintain two-way operation. This significantly diminishes the capacity of the line. It is uncertain if existing BNSF operations can accommodate additional train volume. The addition of CCR train operations could disrupt coal delivery, impacting power generation and ultimately service to customers.

Rush Island does not presently have barge loading capabilities. Ameren would need to construct barge-loading facilities in the Mississippi River along with conveyors to transport the CCR from land to the barge loading area. This would require permits from multiple agencies, including the Army Corps of Engineers and US Coast Guard. This section of the Mississippi River is very active and the ability to obtain regulatory approvals for CCR removal by barge is uncertain.

Meramec

Similar to Rush Island, Meramec is located along a single-track mainline, which is operated by the UP. It is uncertain if existing UP operations can accommodate additional train volume, as this line has the same challenges maintaining two-way operations as the BNSF line. This line is also prone to closure due to flooding.

Concerning barge transportation, Meramec has barge loading facilities in place. However, environmental and safety concerns with barge transportation persist, in terms of the potential for CCR to leak or spill from barges into waterways or for barges to break away.

Labadie

Both the UP (and BNSF via trackage rights) and Central Midland Railroad (CMR) – a short line railroad running between St. Louis and Union – operate in proximity to the Labadie site. However, CMR's line sale contract contains a service restriction prohibiting the CMR line from serving the Labadie facility. That restriction was upheld by the Surface Transportation Board (STB Dockets NOR 42126, FD 33508, FD 33537, served Feb. 27, 2013). The UP presently delivers two loaded coal trains per day to Labadie.

The site's existing rail infrastructure is fully committed to unloading coal trains and would not have capacity to temporarily store or load CCR trains. Therefore, it would be necessary to construct dedicated tracks for loading CCR unit trains on site. Given the site's location in the Missouri River flood plain, such a facility would be subject to permitting and approval from numerous regulatory authorities, which could delay or prohibit construction.

Barge transportation on the Missouri River is considerably less reliable than on the Mississippi River. There are no lock and dams along the Missouri River; water levels are highly susceptible to rainfall and spring snowpack melt in the Rocky Mountains; and the Army Corps of Engineers has not consistently maintained a navigation channel. In recent years, the barging "season" has been at most six months per year. Given these issues, barge transportation would not be a reliable mode for removing CCR from Labadie.

In addition, the Labadie site does not presently have barge loading capabilities. Ameren would need to construct docking facilities along with conveyors to transport the CCR from land to the barge loading area. This would require permits from multiple agencies, including the Army Corps of Engineers and US Coast Guard. With the river not being navigable for half of the year, pursuit of permits and capital expenditures for barge loading facilities would not be economically viable.

Sioux

The site is located along a single-track BNSF line, which is also prone to closure due to flooding and two-way volume constrained. Similar to the other sites, existing on-site rail infrastructure is dedicated to unloading coal trains. Dedicated tracks for loading a CCR unit train would need to be constructed to facilitate removal of CCR by rail.

The Sioux site does not presently have barge-loading capabilities and Ameren would need to construct docking facilities along with conveyors to transport the CCR from land to the barge loading area. This would require permits from multiple agencies, including the Army Corps of Engineers and US Coast Guard. The environmentally sensitive nature of this section of the Mississippi River – influenced by the presence of wetlands, recreation and parks along the river, and eagle habitats – would further encumber the permitting process.

Potential Landfill Destinations

To avoid the need to transload CCR from rail or barge to trucks to reach the final destination, Lochmueller reviewed landfills located in proximity to rail lines or waterways to determine if facilities are in place to enable direct unloading of CCR from rail or barge. Sites across Missouri and Illinois (excluding the Chicago area) were reviewed using location information provided by each state's environmental agency.

While several landfills were discovered along active rail lines, none appears to have active rail unloading capabilities in place. The Five Oaks Recycling and Disposal located near Taylorville, Illinois had a rail unloading spur at one time, although it seems to have fallen into disuse. Moreover, if reactivated, it would not have the ability to store long CCR unit trains and would need to be extended.

Similarly, no landfills were discovered with unloading capabilities along waterways. It is our understanding that such facilities may exist in other states. However, the increase in travel distance to access those facilities would likely render them cost-prohibitive for purposes of CCR removal from these four sites.

Study of Deep Excavation at Ameren Missouri Energy Centers

INTRODUCTION

In response to questions raised at recent public meetings held by Ameren Missouri (Ameren), Reitz & Jens was asked to prepare a white paper that discusses the methods and implications of deep excavation and removal of Coal Combustion Residuals (CCRs) from the surface impoundments ("basins") located at Ameren's four coal-fired energy centers. The technical review presented in this paper is applicable in general to a deep excavation below the water table at the Sioux, Labadie and Rush Island Energy Centers[1]; specific characteristics of each individual energy center or CCR unit are not addressed.

GENERAL DESCRIPTION OF CCR BASINS

The principal characteristics of the CCR basins at each of Ameren Missouri's energy centers are:

1. The basins are built both below and above grade (that is "partially-incised") in alluvial sands in close proximity to a major river (Mississippi River or Missouri River). The basins were created by dredging the sands in the vicinity of each plant to obtain fill material to raise the actual area of the power plant building and appurtenant facilities to above flood levels of the adjacent river. The excavation was then repurposed to manage CCRs generated from the plant. The CCRs were generally placed in the excavation by sluicing (deposited by flowing water). At some point in the history of each plant, large perimeter berms were constructed around the basins. This is illustrated below:

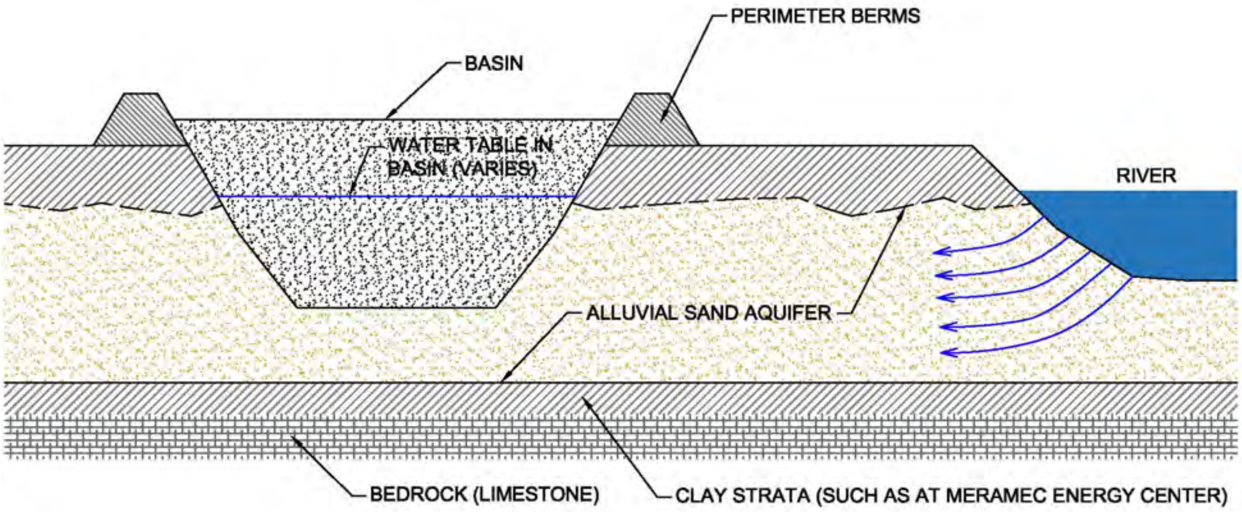

Figure 1 – Illustration of General Construction of CCR Basins (not to scale)

2. The size, depth and proximity to large rivers all impact the method of potential excavation. These basins are relatively large – up to 165 acres – compared to many CCR units at other power plants.

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[1] At normal river levels, most of the CCR basins at the Meramec Energy Center are above the water table and are excluded from this description.

The basins are relatively deep – up to 100 feet. Some basins, such as at the Rush Island Energy Center, extend close to the underlying bedrock.

3. The removal process of the ponded CCR is more difficult than traditional soils and would require specialized equipment and management prior to transport to a landfill. The characteristics of the CCRs vary from plant to plant and also depend upon the nature of the CCR – fly ash, bottom ash, and other coal combustion byproducts. Fly ash tends to hold water and will not drain by gravity alone such as in a pile; it typically requires some mechanical grading or agitation. Bottom ash is more like sand and will drain more freely. In addition, CCRs are lighter in weight than soils and compressible. Near the surface of the basins CCRs are generally in a loose state due to their placement via sluicing. At greater depths within the basins, CCRs generally compress and become more dense due to settlement from the weight of the upper CCRs. CCRs become less permeable with increasing density, that is, limiting the volume and velocity of water that may move through the CCRs. Eventually, fly ash may become as impermeable as fine-grain soils.

The principal characteristics of the CCR basins listed above are the determining factors in the feasibility of excavation at Ameren's Energy Centers and could differ from that observed at other power plants which may have burned coal or built basins with different characteristics.

PRINCIPAL METHODS OF EXCAVATION

There are two principal methods of removal or excavation of the CCRs from the basins: 1) excavation in the "dry" by first pumping out the water (i.e. "dewatering") to some depth below the excavation; or 2) excavation in the "wet" by dredging, which is how the basins were excavated originally. The "dredge" may be a backhoe with an extended arm and bucket, a crane with a dragline bucket, or a crane with a clam-shell bucket. Another type of dredge is the suction dredge which pumps the material and water to a disposal site. Small suction dredges have been used in CCR basins at other power plants, but they are limited to about 20 to 30 feet deep. Because of the greater depths, removing CCRs from Ameren's basins would require a cutter-head dredge, such as pictured below.

Figure 2 – Illustration of Cutter-Head Suction Dredge

The cutter-head dredge is designed to break through and remove compacted or cemented CCRs and, due to the depths of Ameren's basins, would need to be specially manufactured. The dredge would pump approximately 14,000 gallons per minute and could remove up to about 650 cubic yards of CCR per hour.

EXCAVATION IN THE "DRY"

Complete removal of water from the CCR basin prior to excavation may not be practical or technically feasible using either deep wells or cutoff walls. The volume of water requiring handling would be tremendous because the basins are in a sand aquifer near a major river as illustrated in Figure 1.

To keep water from filling the excavation would require concentric rectangles or "rings" of deep wells installed at close spacings and completely encircling each basin, with each well pumping hundreds of gallons per minute. The use of a deep well system to dewater the basins creates a number of technical and environmental problems:

1. Space limitations around the basins could impede or preclude the installation of such a large system of concentric wells around each basin. Each concentric system of wells must be separated from the next system by 15 feet or more for equipment and maintenance. Also, a stable slope must be maintained in the sand between each system as the excavation progresses. Therefore, the outside limits of the wells and excavation would need to extend well beyond the existing limits of the basin. The basins are in close proximity to each plant and operational facilities, such as railroad tracks, tanks, and buildings.

2. The drawdown would pull CCR-impacted water from the basin; therefore, a tremendous volume of water would have to be managed and/or treated, requiring a large water treatment plant to be constructed on site[2].

3. Depending upon location, the drawdown of the groundwater table could potentially impact the surrounding environment, such as surrounding vegetation and crops, and potential settlement of the natural soils surrounding the basins. This could cause settlement of shallow foundations, roads, railroad tracks, adjacent river banks or levees, and utilities.

Therefore, in lieu of a concentric well system, a cutoff wall would need to be designed and constructed around each CCR basin to prevent the surrounding groundwater from flowing into the basin as it is pumped dry and excavated. For the Labadie Energy Center, the cutoff wall would have to be up to two (2) miles long and would extend to the bottom of the aquifer, up to 100 feet deep or deeper. Construction of the cutoff wall alone could take up to a year. The water removed during excavation of CCRs inside the cutoff wall would need to be treated.

Structural Stability: Cutoff Walls and Cofferdams

Slurry cutoffs, structural panel cutoffs or sheetpile walls alone would not be structurally adequate due to the tremendous hydrostatic pressure and lateral earth pressures that would occur on the outside of the cutoff wall as the interior CCRs are dewatered and excavated. Installation of deep wells around the outside of the

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[2] Existing waste water treatment facilities are inadequate to manage the volume of water generated by a deep excavation project discussed here.

cutoff wall to reduce the hydrostatic pressure would create some of the same problems discussed above. A potential solution would be to install rows of tie-backs through the wall and into the underlying bedrock as the excavation progresses. This is illustrated in Figure 3 below:

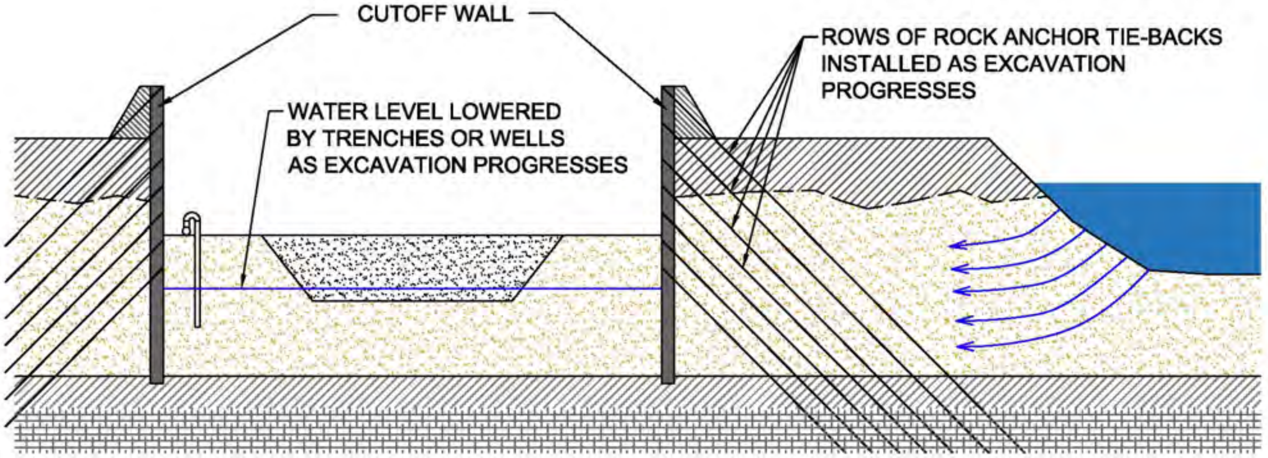


Figure 3 – Illustration of Cutoff Wall with Tie-Backs

There are several different methods of installing a structural concrete cutoff wall. One method is to excavate a deep trench, using a heavy mud slurry to keep the trench open in the sands. Reinforcing steel is then inserted into the trench, and the slurry is displaced by pumping concrete up from the bottom. An example is the structural concrete cutoff wall installed for the construction of the World Trade Center to hold back the water of the Hudson River.

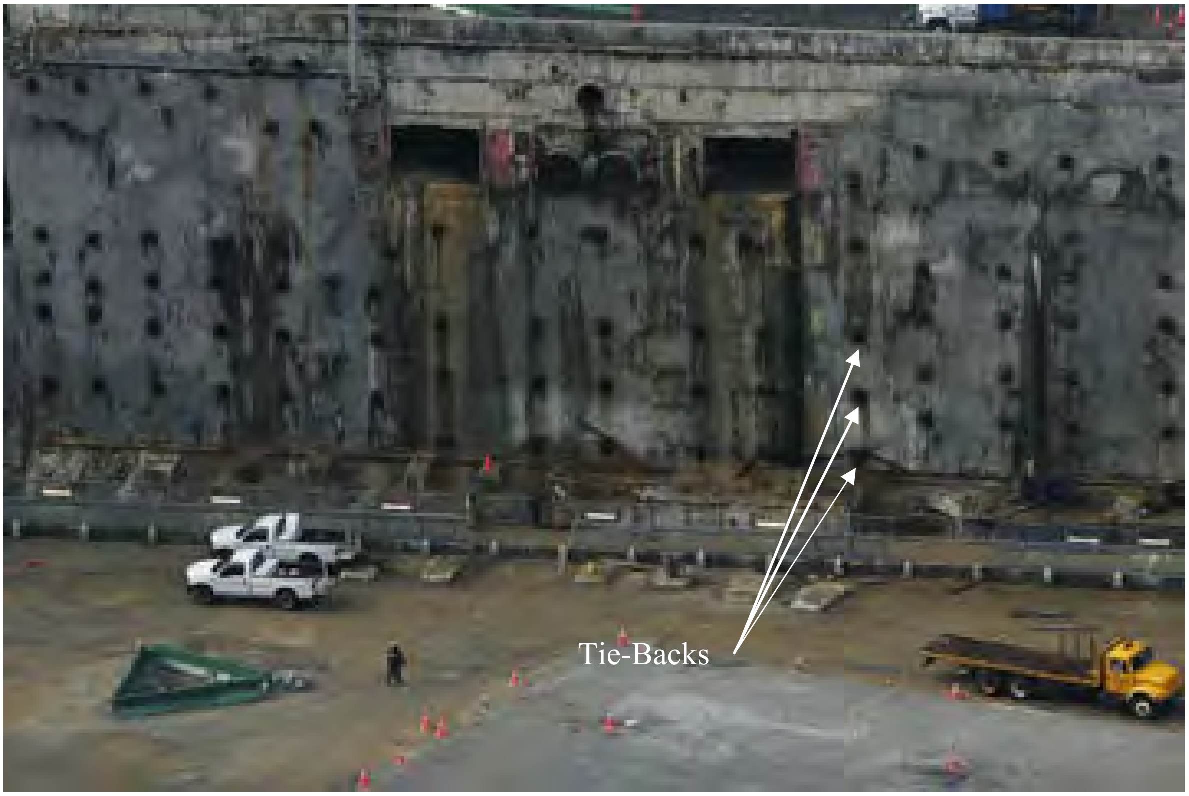


Figure 4 – Structural Concrete Cutoff Wall for the World Trade Center

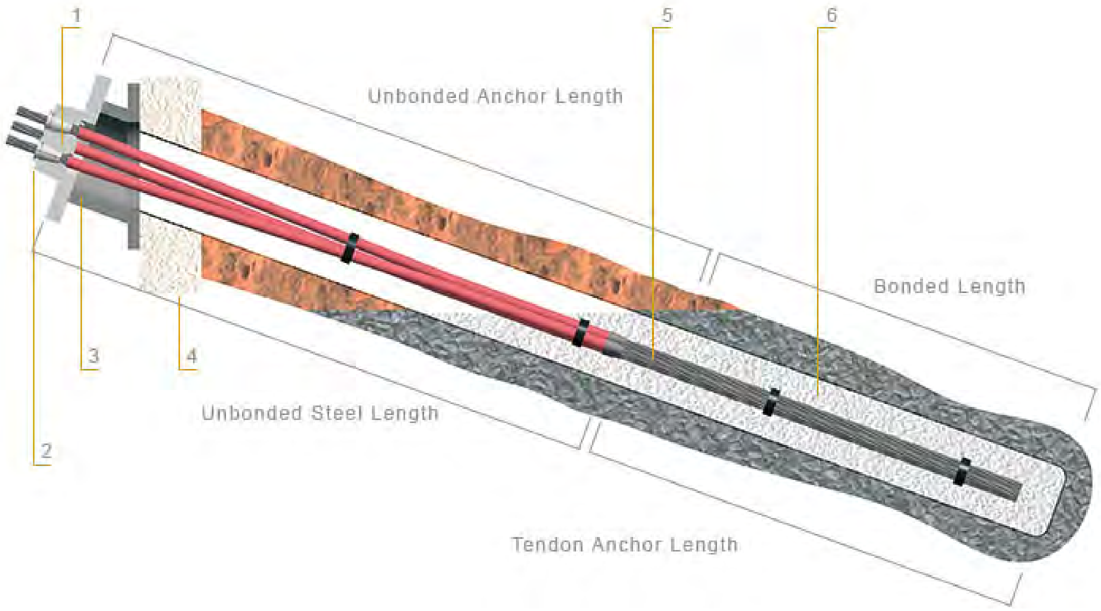


Figure 5 – Illustration of a Typical Rock Anchor Tie-Back

An illustration of a typical multi-stand rock anchor tie-back is shown in Figure 5. Tie-backs are installed by drilling in horizontal rows as the excavation progresses downward. Tie-backs ends can be seen in the photo of the cutoff wall in Figure 4. At some locations, the lengths of the upper tie-backs would need to be well over 100 feet to penetrate into the bedrock, such as at Labadie and Rush Island. The cost per tie-back could range from $10,000 to $40,000.

The construction of a structural concrete cutoff wall is problematic due to both the depths and the presence of large cobbles and boulders near the bedrock, such as at Labadie and Sioux Energy Centers. It is critical that the cutoff extend into the underlying clays where present, such as at Meramec, or into the bedrock, such as at Labadie and Rush Island. The cutoff has to be more than 90% sealed to have real effect at stopping the inflow of groundwater. Installation of hundreds to thousands of tie-backs as the excavation of the CCRs progresses would add years to the construction of the cutoff and the removal of the CCRs. The installation of the cutoff wall and tie-back rock anchors alone will add millions to tens of millions of dollars to the cost of removal of the CCRs by excavation in the dry.

Another type of cutoff sometimes used adjacent to a major river is a “cellular cofferdam.” This technique typically requires deep soil mixing, compaction grouting or drilled holes to make continuous lines of cylindrical columns to form a row of boxes or cells completely around each CCR basin. The width of the cells would have to be large to withstand the hydrostatic pressure and lateral earth pressures. This construction method requires a sufficient open area that may not exist at each energy center and is equally as expensive as a cutoff wall. The close proximity of the plant and appurtenances could be a limiting factor.

Treatment and Management of Water

As the excavation inside the cutoff walls progresses, water from the basin would need to be removed by temporary wells and trenches. This includes existing water and precipitation that falls over the years it would take to complete the project. The water would have to be evaluated to determine regulatory status before the pumped water could be discharged. Assuming such water exceeds regulatory standards, a water treatment plant would need to be constructed on site to handle the volume.

Summary

Since removal and treatment of sufficient volumes of water would be very problematic, extremely time consuming, and exceedingly costly, excavation of CCRs in the basins in the "dry" is not practically feasible.

EXCAVATION BY DREDGING

Excavation by dredging eliminates many issues associated with the removal of the water from an area of deep alluvial sands adjacent to a major river. There are, however, a number of technical challenges that remain with dredging. First, excavation by dredging is done blindly under water. Therefore, removal of CCRs from a basin with a bottom liner should not be done because there would be a very high probability that the bottom liner would be damaged, causing more environmental harm than if the basin were closed with the CCRs in place. Secondly, dredging with an open bucket – such as with a backhoe, dragline or clamshell – could result in suspension of contaminants and an increase in the hydraulic conductivity of the CCRs, resulting in an increase in release from the unlined basin. Because of these limitations, the only viable method is a suction dredge. As stated above, a cutter-head dredge would be necessary for the deep basins.

A suction dredge discharges a slurry of water and CCRs from the basin. The volume is tremendous – on the order of 14,000 gallons per minute for a large cutter-head dredge. Due to the volume, and to allow the CCRs to settle out, the slurry would be piped into one or more lined settling ponds constructed on site. The settling ponds would need to be located adjacent to the CCR basin so that the decanted water could flow by gravity or pumped back into the CCR basin. Excess water, such as from precipitation, would have to be tested and evaluated to determine the treatment that would be required before the water could be discharged. However, at all of the energy centers, space immediately adjacent to the basins is limited. Accordingly, settling basins would need to be located away from the CCR basins complicating ongoing excavation activities with delays inherent to the pumping and settling process.

The dredged material would need to be excavated and dried sufficiently to allow overland hauling to a commercial landfill. This double-handling and drying processes requires substantially more space and time, as well as cost, to complete. We estimate that it would take 10 years or more of a continuous dredging operation to remove the CCRs from the largest of Ameren Missouri's CCR basins. This time estimate does not take into account permitting and construction of the settling ponds which would further delay the completion schedule. Delays for weather, equipment maintenance, double-handing, drying, and transporting the CCRs to a landfill have the potential to further increase project duration.

Stability of Interior Slopes

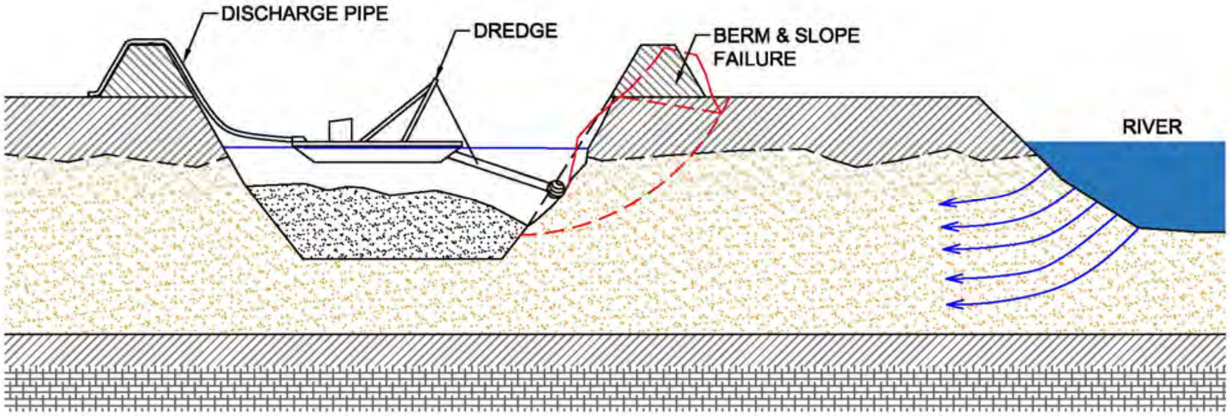


Figure 6 – Illustration of Problems with Stability of Interior Slopes

During an excavation project, the interior slopes of the basins have the potential to become unstable as illustrated in Figure 6. Instability is particularly problematic during a flood when water would be pushing on the perimeter berms. The basins were originally excavated by dredging, and the interior slopes were stable at that time. However, over time perimeter berms were constructed around the basins, in some cases after the deposition of the CCRs, to increase capacities and to protect against flooding. As excavation occurs, the interior slopes would become unstable unless the berms were removed. Removing the perimeter berms increases the risk that the basins would become flooded at high river stages. To prevent environmental risk associated with a flooded and unsecured CCR basin, new perimeter berms would need to be constructed far enough from the edge of the basin to prevent a slope failure and an uncontrolled release of CCR. Sufficient room may not exist at all energy centers to construct new temporary perimeter berms.

To ensure that all of the CCRs are removed, it is inevitable that some excavation will penetrate below the original bottom of the excavated basin and below the original interior side slopes. This would also cause instability of the interior side slopes. A failure of the perimeter of the partially-excavated basin has the potential to result in an uncontrolled release of CCR, particularly on the side adjacent to the river. An unstable slope would also be a major safety hazard for the construction and possibly for the adjacent energy center and operations. To mitigate such risks, temporary retaining walls with tie-backs may need to be constructed.

Completion of Project

Following completion of the excavation, the water remaining in each basin would have to be evaluated for compliance with regulatory water quality standards (GWPS) and some remedial clean-up activities would probably be required for each of the settling basins. After the water in each basin meets the required regulatory standards, the hole could be filled. Dredged sand from the adjacent river would likely be used for fill material because the excavation would contain water.

XDD ENVIRONMENTAL
GOLDER

TECHNICAL MEMORANDUM

TO: AMEREN MISSOURI

FROM: XDD ENVIRONMENTAL, GOLDER ASSOCIATES INC.

SUBJECT: BEHAVIOR OF METALS IN SOIL AND GROUNDWATER

DATE: JULY 9, 2019

CC: SCHIFF HARDIN LLP

Metals are found naturally at varying concentrations in the minerals that make up our soil. As groundwater comes in contact with the soil, some metals leach from the soil, into the groundwater. The metals cannot be destroyed, but by changing environmental conditions of the soil and groundwater, the leaching (dissolution) can be reduced through the formation of more stable minerals or by being bound more strongly to other minerals.

Two major factors that affect the dissolved concentrations of metals in are the pH and the oxidation-reduction potential (ORP) of the water. pH is a measure of the acidic or alkaline nature of the water; strongly acidic water has a low pH (e.g., less than 4), while strong alkaline water has a pH typically greater than 10. ORP is a measurement of the tendency of a substance to oxidize or reduce another substance. Highly oxygenated water typically has a high ORP (greater than +200 millivolts), and highly reduced groundwater typically has an ORP less than 200 millivolts. The pH and ORP of the groundwater strongly influence the form of the metal present and the associated dissolution of the metals into groundwater.

Many metals increase in dissolved concentration when the groundwater is more acidic or more alkaline, because the minerals in the soils can dissolve under these conditions and the metals are released. Similarly, extremes in the ORP can also cause increases in dissolved metals due to the impact on the minerals. By optimizing pH and/or ORP levels, minerals within the groundwater and surrounding soils stabilize thereby reducing the dissolved concentrations of metals and creating more stable minerals that resist leaching / dissolution of the metals.

Groundwater conditions at Rush Island provide a useful illustration of this process. Upgradient of the ash basins, pH ranges from 6.0 to 8.5 in the shallow and deep groundwater zones to the north and west of the CCR unit (RCPA). On the downgradient side of the RCPA (eastern side), where pH is neutral, there are limited concentrations above the arsenic GWPS. However, as shown in Figures 1 and 2, on the downgradient side of the RCPA where the pH is higher than normal neutral conditions, arsenic concentrations are also present at elevated concentrations.

By optimizing natural processes, as one would do with a swimming pool, such as adjusting the pH level within the intermediate zone, a stabilization zone is created, and concentration levels are predicted to drop. Installation of an engineered cap system with a nearly impermeable geomembrane will effectively eliminate precipitation infiltration through the ash, which is a driving force behind the physical process that causes metal impacts to groundwater.

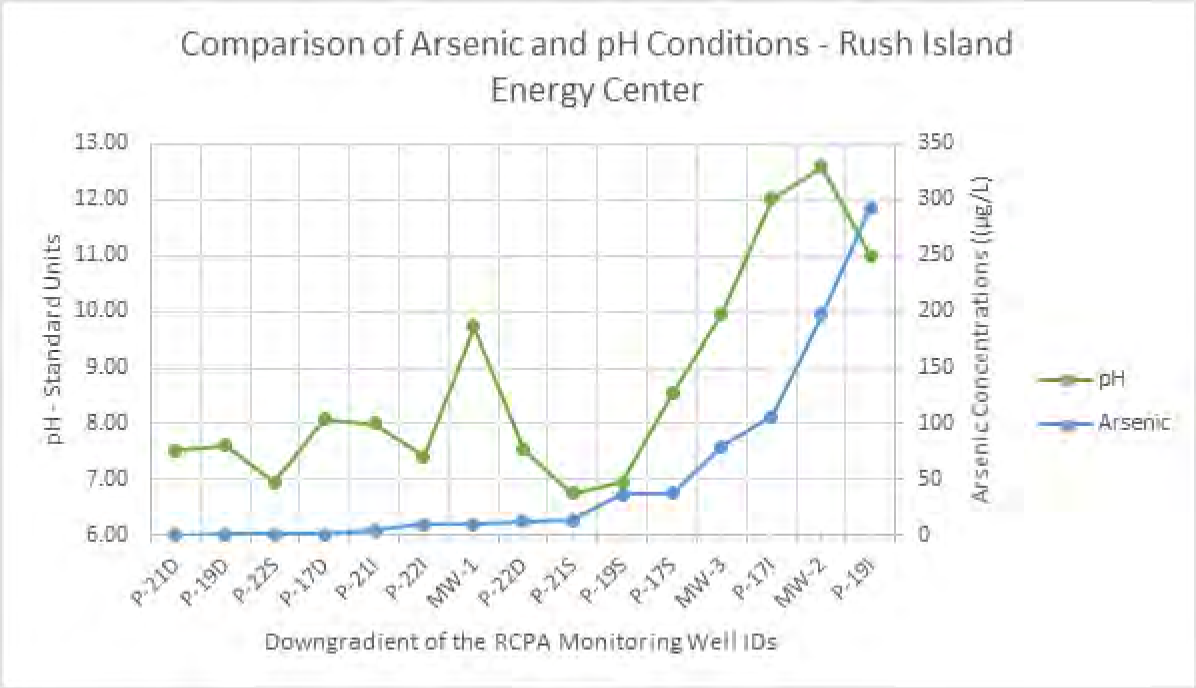
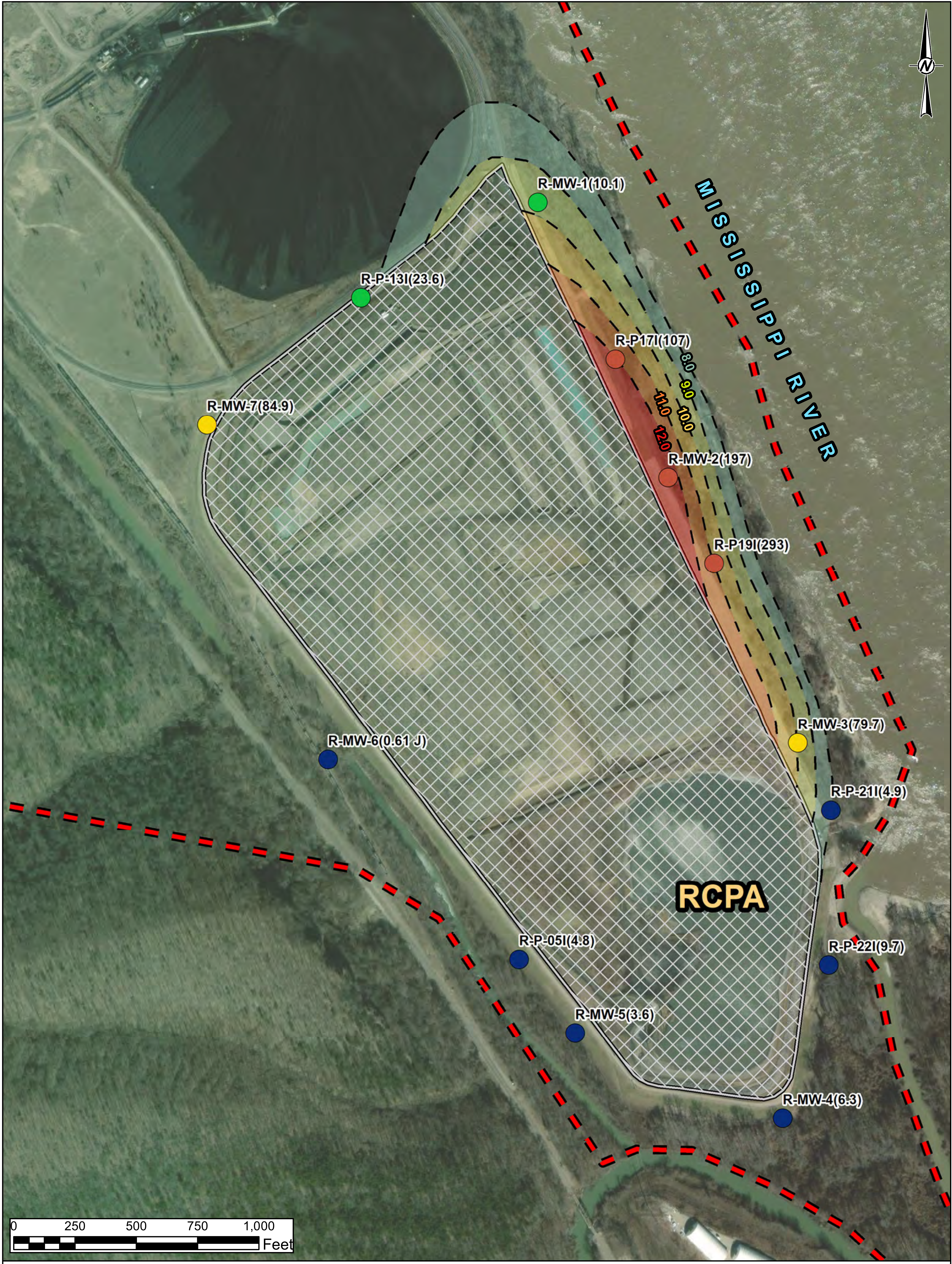


Figure 1 - Comparison of Arsenic and pH Conditions - Rush Island Energy Center

Path: G:\Projects\150 Projects\1531406 - Ameren GW Monitoring Program - MO\Phase 0001 - Labadie Energy\800 - FIGURES-DRAWINGS\PRODUCTION\ACM\ArsenicvsPh Map2.mxd



LEGEND

▨ Rush Island Energy Center Property Boundary

▨ RCPA Surface Impoundment

November 2018 Arsenic Concentrations (µg/L)

- ● Greater than 100 µg/L (Above Site GWPS)
- ● Greater than 30 µg/L (Above Site GWPS)
- ● Greater than 10 µg/L (Above MCL, Below GWPS)
- ● Less than 10 µg/L (Below MCL)

pH concentration Zones (Standard Units)

- ☐ pH values less than 8.0 are not colored
- ■ pH between 8.0 - 9.0
- ■ pH between 9.0 - 10.0
- ■ pH between 10.0 - 11.0
- ■ pH between 11.0 - 12.0
- ■ pH above 12.0

NOTES

1. ALL LOCATIONS AND BOUNDARIES ARE APPROXIMATE.
2. J - ESTIMATED CONCENTRATION ABOVE THE ADJUSTED METHOD DETECTION LIMIT AND BELOW THE ADJUSTED REPORTING LIMIT.
3. GWPS - GROUND WATER PROTECTION STANDARD (SITE SPECIFIC).

REFERENCE

1. AMEREN MISSOURI RUSH ISLAND ENERGY CENTER, RUSH ISLAND PROPERTY CONTROL MAP, JANUARY 2012.

CLIENT
AMEREN MISSOURI
RUSH ISLAND ENERGY CENTER

Ameren

PROJECT
GROUNDWATER MONITORING PROGRAM

TITLE
NOVEMBER 2018 ARSENIC VS PH CONCENTRATION MAP
INTERMEDIATE ZONE OF THE ALLUVIAL AQUIFER

CONSULTANT

GOLDER

YYYY-MM-DD	2019-07-02
PREPARED	JSI
DESIGN	JSI
REVIEW	EMS
APPROVED	MNH

PROJECT No. 153-140601
PHASE 0002
FIGURE 2

0
1 in
IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM:

GOLDER

Rush Island Closure by Removal Groundwater Modeling

June 27, 2019

AGENDA

Objective of Modeling 01

Construction/Assumptions of the Model 02

Modeling Results 03

Objective of the Model

RUSH ISLAND ENERGY CENTER

This modeling effort compared the estimated time to achieve groundwater concentrations below the Groundwater Protection Standard (GWPS) at monitoring wells around the RCPA. Modeling included updating the previous model(s) to simulate the effects of Closure by Removal (CBR) on the groundwater quality around the RCPA. These results were then compared with Closure in Place (CIP) to compare how long it would take to achieve GWPS at compliance wells in both scenarios.

Closure by Removal Modeling - Phases

Rush Island Energy Center

Phase 1 – Active Conditions	Active conditions were modeled the same way as previously reported. Assumed constant slurry recharge to the RCPA
Phase 2 – Dry CCR Removal	Removal of the top portion of the RCPA that would be above the static groundwater level after dewatering to static conditions.
Phase 3 – Wet CCR Removal	Removal of deeper portions of the RCPA were the CCRs are fully submerged.
Phase 4 – All CCR Removed and Backfilled	Modeling conditions after all CCR has been removed from the RCPA. Assumes fluvial sands/silts from the Mississippi River are to be used as backfill.

Phase – 1 Active Conditions

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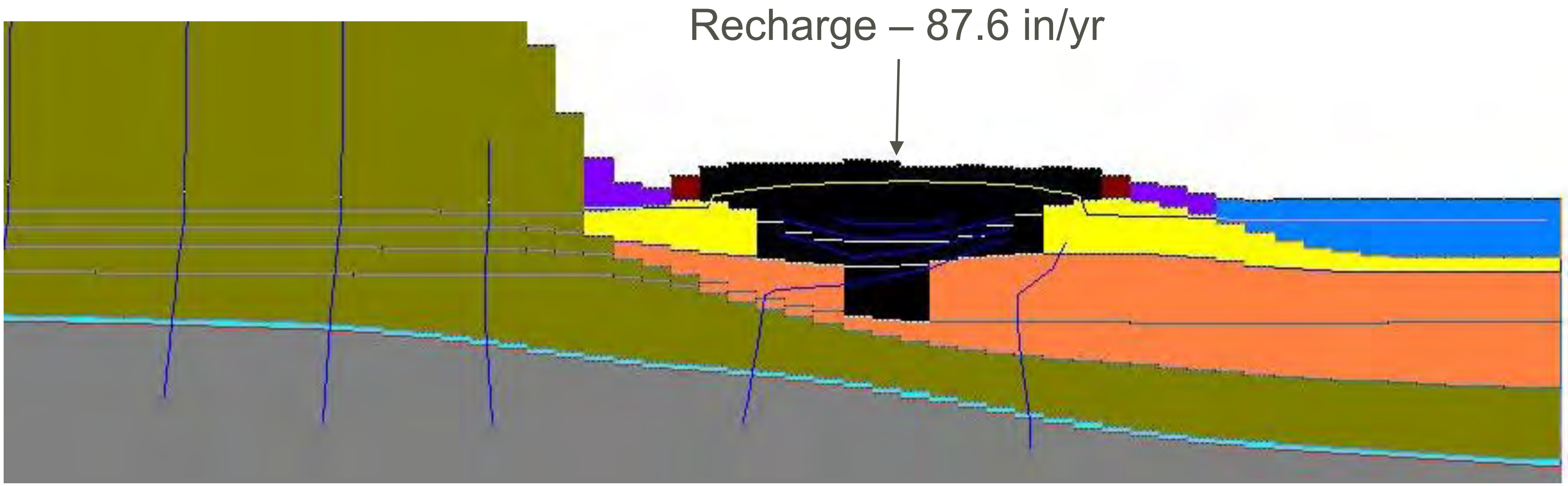

Recharge – 87.6 in/yr

Active Conditions Assumptions

1. Same model(s) used as described in previous modeling report.
2. Recharge into RCPA 87.6 inches per year (i.e. Active Conditions).
3. Results in predicted mound in RCPA as measured in present conditions.

Phase 1 – 3D Model Design

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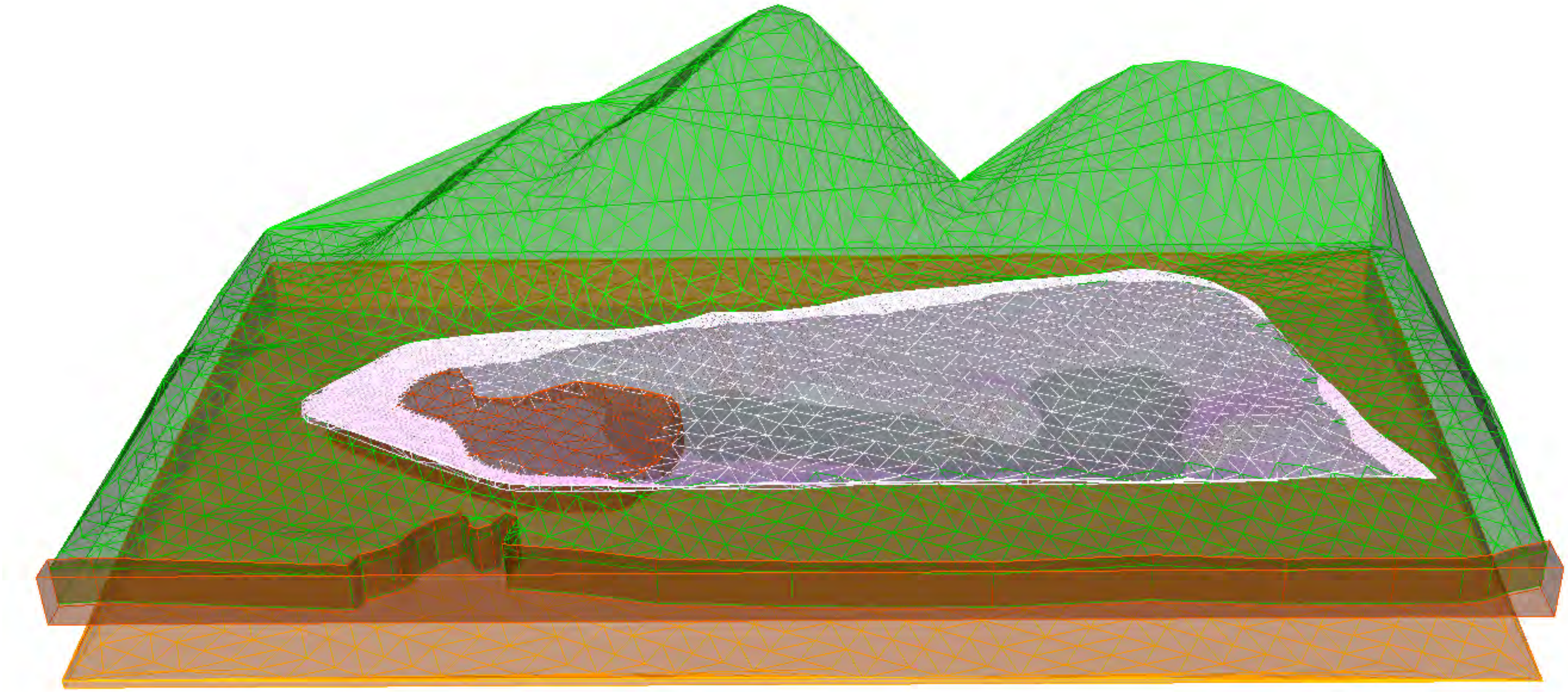
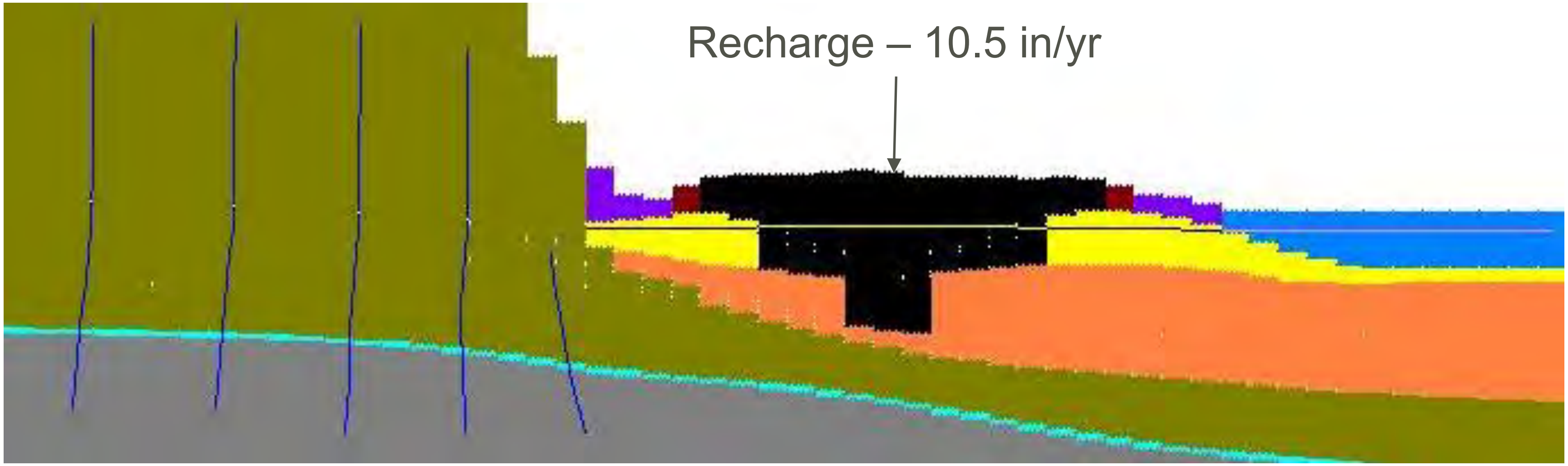


Phase 2 – Dry CCR Removal

RUSH ISLAND ENERGY CENTER



Dry CCR Removal Assumptions

1) Based on volume of CCR, it will take 16 years to excavate down the top 28 feet (dry excavation and partially wet excavation, based on Iochmuller (2019) report).
2) Recharge into the pond will be less than active conditions, but higher than cap and closed conditions. The vertical conductivity (Kz) of the ash is estimated to be $1\text{x}10^{-5}$ cm/sec, so for a conservative approach, the value calculated in the help model for a $1\text{x}10^{-5}$ cm/s cap was used for recharge (10.5 in/yr) during this stage. This recharge rate causes a small mound in the RCPA of ~1-3 feet during this phase.
3) Removed polishing pond from southern portion of the RCPA.

Phase 2 – Model Design

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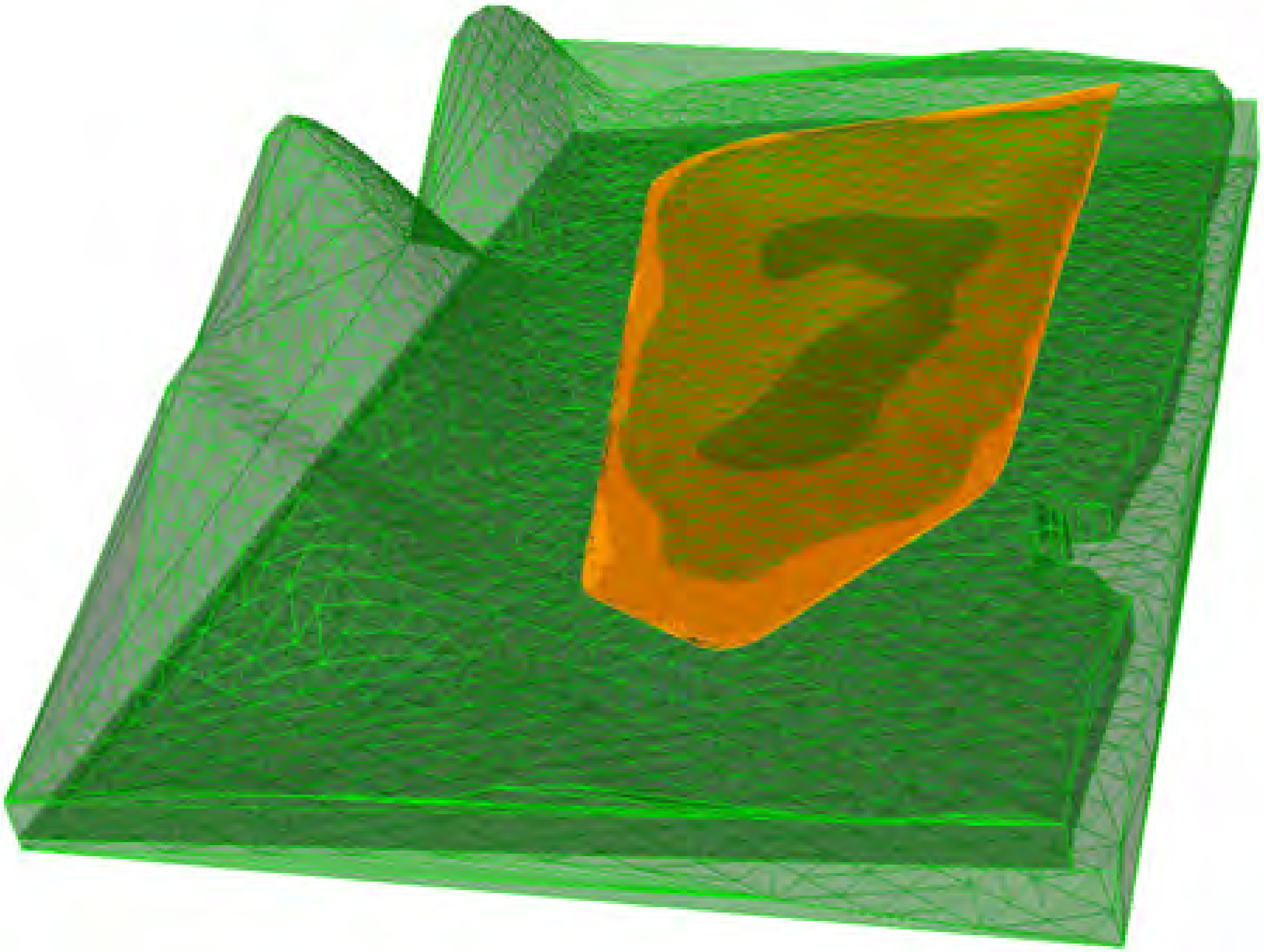
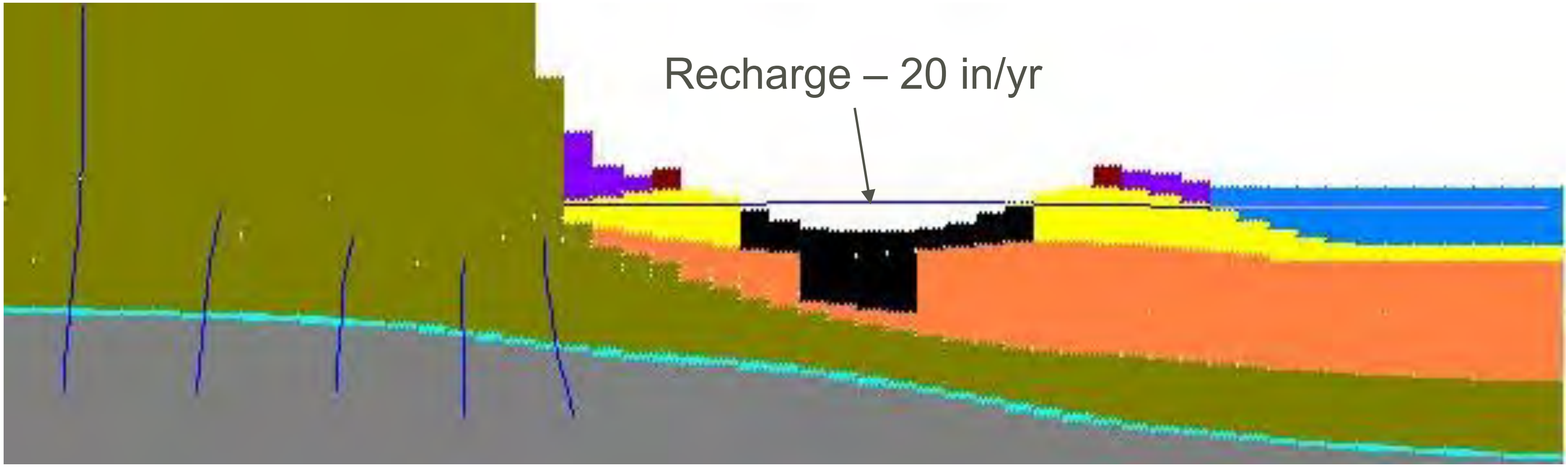


Phase 3 – Wet CCR Removal

RUSH ISLAND ENERGY CENTER

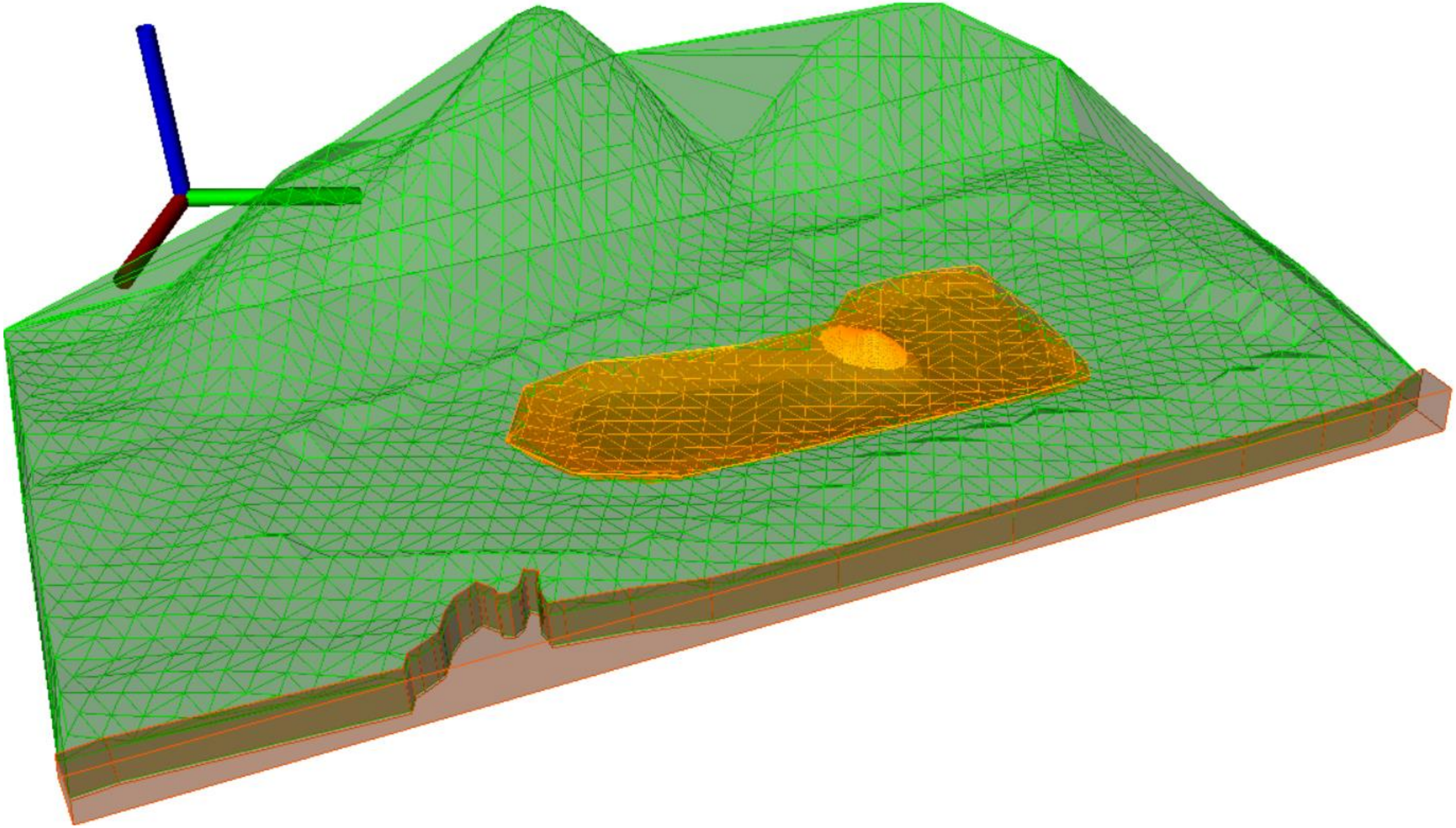


Wet CCR Removal Assumptions

1) Removed the upper portion of the CCR and treated resulting pit as an open hole.
2) Recharge was higher than the dry excavation stage, but less than the active conditions. It was assumed that there would be 43 in/year of rainfall (U.S. Climate Data, Festus). It was also assumed that the RCPA would evaporate similar to a lake, which according to U.S. Department of Commerce report, *Evaporation From Pans and Lakes*, a lake in Missouri can have ~23 inches a year in evaporation. Therefore, net annual recharge is expected to be ~20 inches/year. The rest of the water used for hydraulic dredging is assumed to be in a "closed" loop, and water used to pump the CCR out of the pond will be directed back to the RCPA after the materials are extracted.

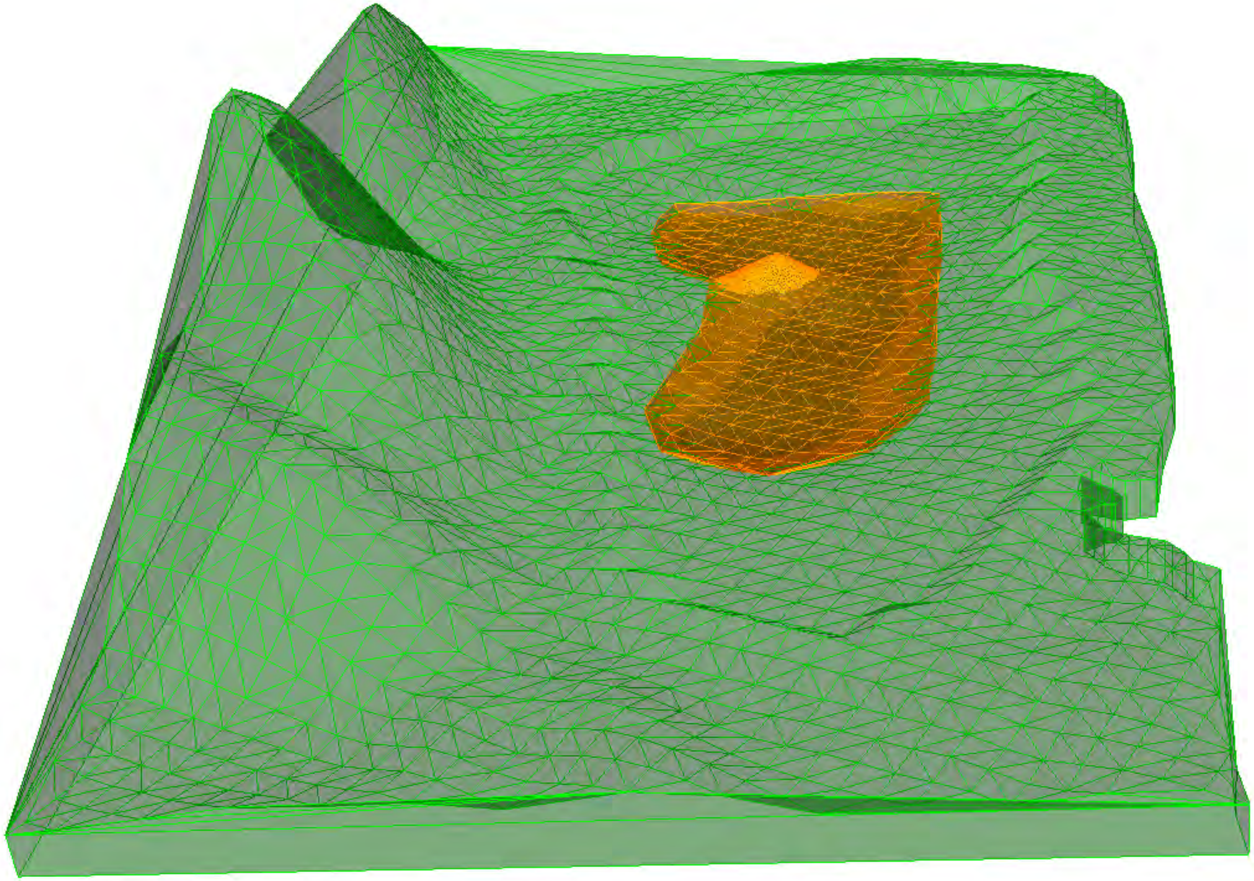
Phase 3 – Wet CCR Removal

RUSH ISLAND ENERGY CENTER



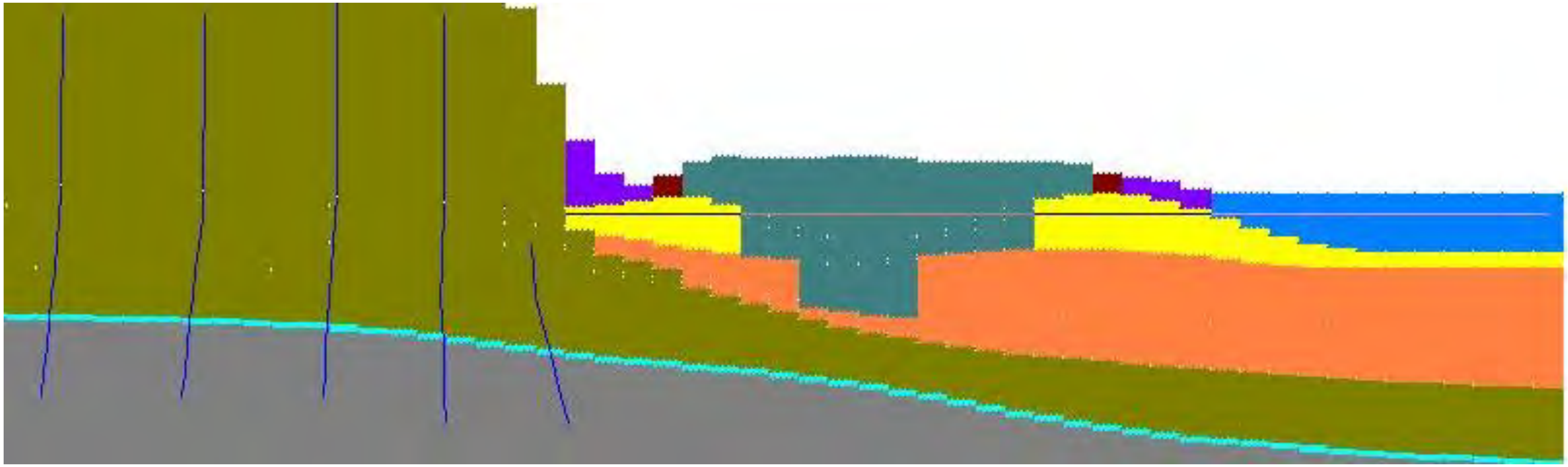
Phase 3 – Wet CCR Removal

RUSH ISLAND ENERGY CENTER



Phase 4 – Backfilled RCPA

RUSH ISLAND ENERGY CENTER



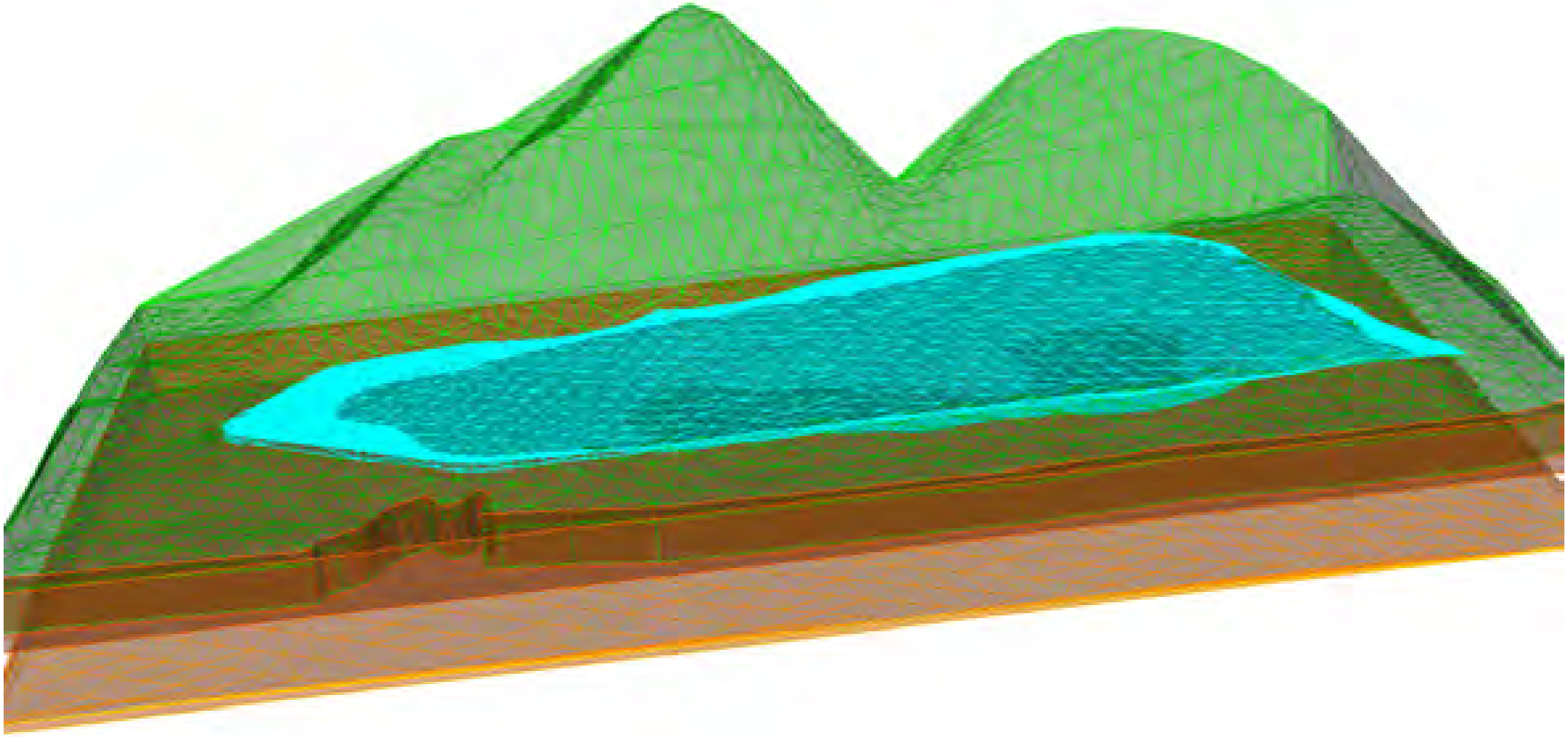
Backfilled RCPA Assumptions

1) Entire former RCPA backfilled with materials similar to the shallow alluvium onsite from dredging the Mississippi River (Lochmueller 2019). Material assumed to have a conductivity of 2.1 x 10^{-3} cm/sec (6 feet/day).

2) Recharge into the backfilled area was set equal to that estimated for the surrounding alluvial aquifer.

Phase 4 – Backfilled RCPA

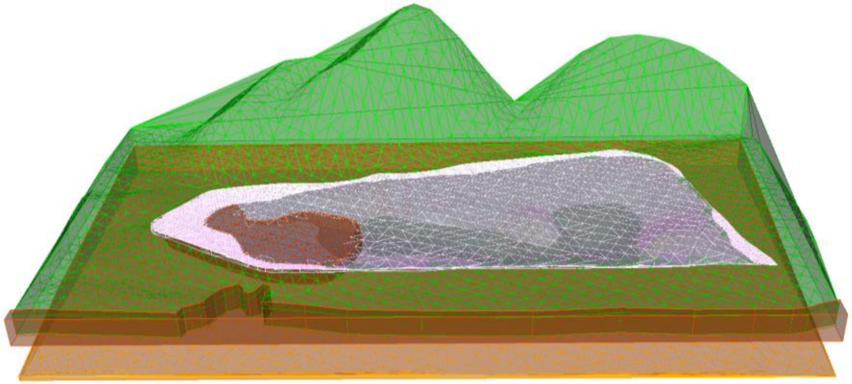
RUSH ISLAND ENERGY CENTER



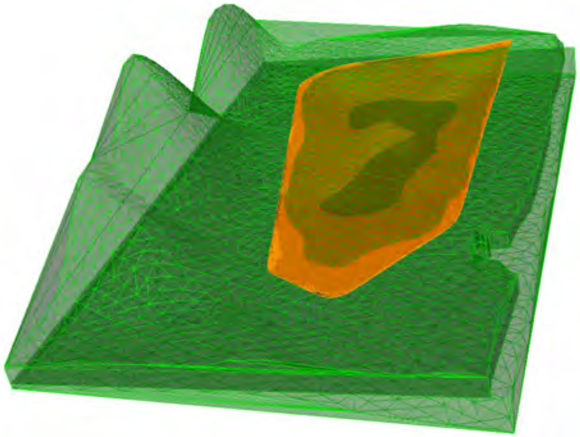
Phases of the Model

RUSH ISLAND ENERGY CENTER

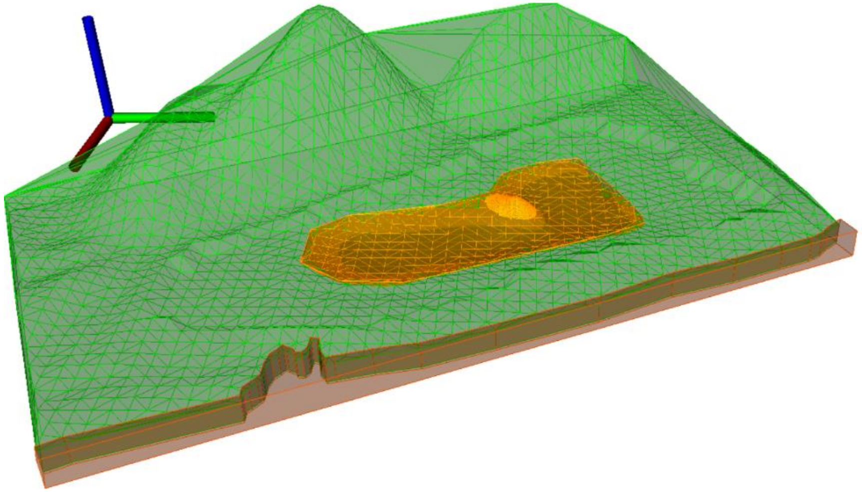
Phase 1 - Active



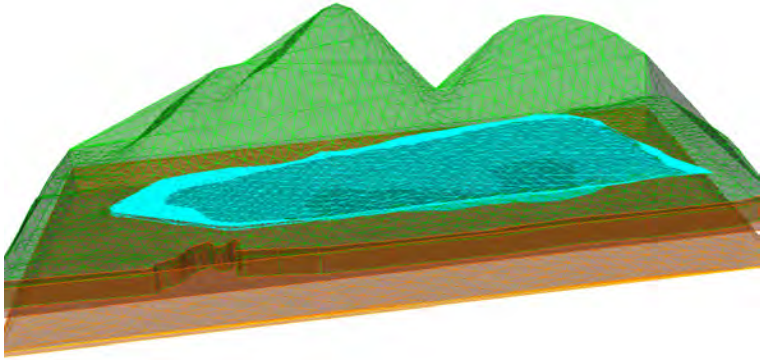
Phase 2 – Dry Removal



Phase 3 – Wet Removal

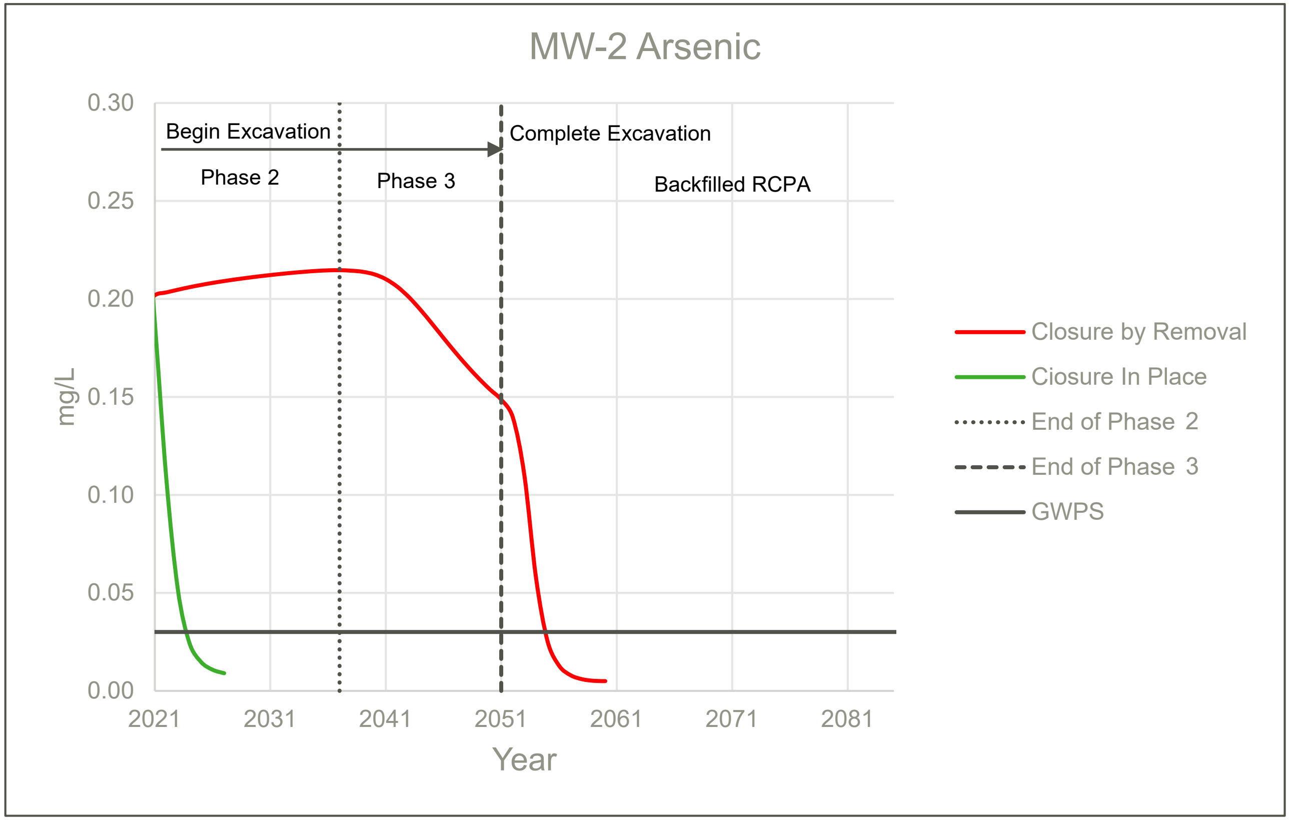


Phase 4 – Backfilled



Modeling Results Indicate Excavation Delays Groundwater Compliance

RUSH ISLAND ENERGY CENTER

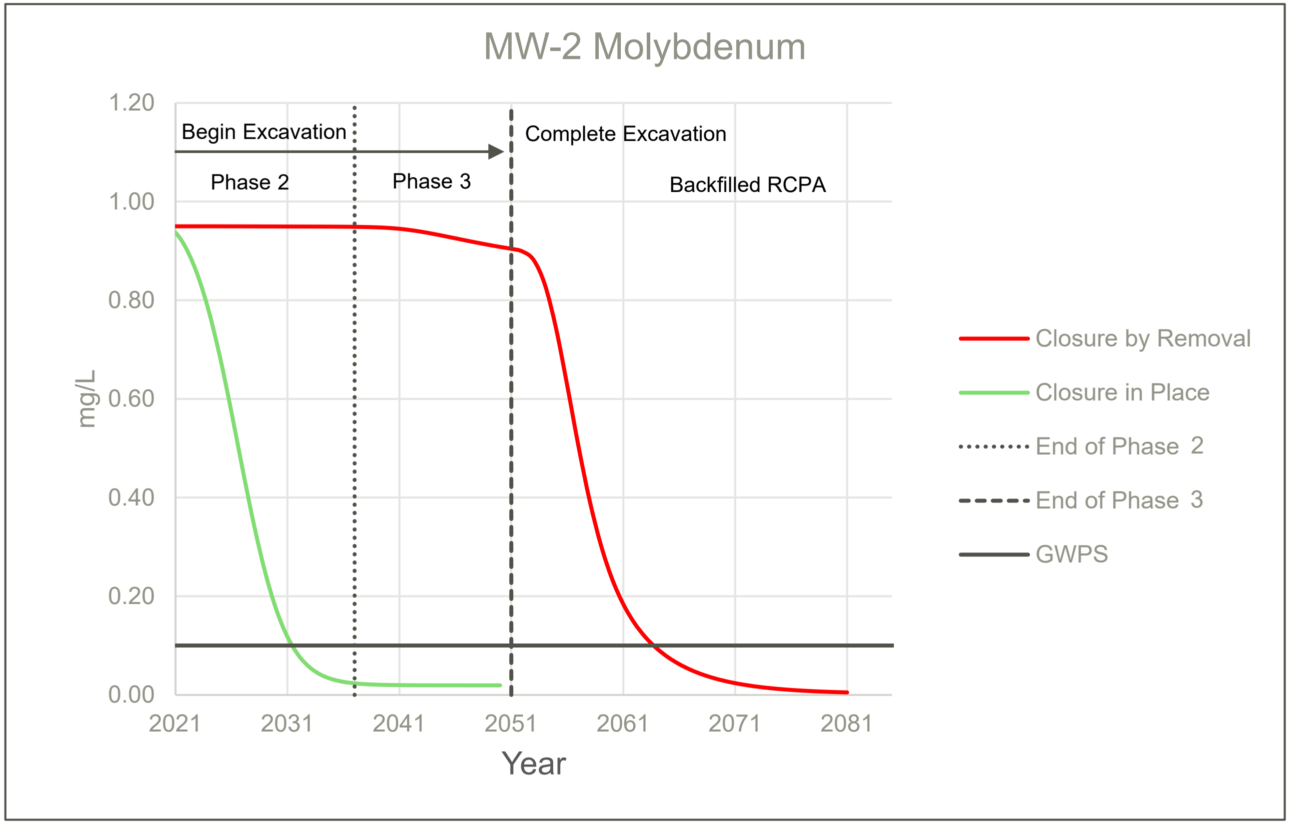


MW-2 (highest arsenic value in CCR Rule Well) is estimated to reach the GWPS 30 years sooner using closure in place vs closure by removal (Excavation)

Information on the closure by removal process is available in the Lochmueller (2019) and the Reitz & Jens (2019) reports

Modeling Results Indicate Excavation Delays Groundwater Compliance

RUSH ISLAND ENERGY CENTER



MW-2 is estimated to reach the GWPS 31 years sooner using closure in place vs closure by removal (Excavation)

GOLDER

Information on the closure by removal process is available in the Lochmueller (2019) and the Reitz & Jens (2019) reports

Explanation of Results

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Closure in Place reduces downgradient concentrations faster than Closure by Removal because:

- The 31-year time for CBR ash removal, during which rainfall drives outward migration of CCR impacts, adds contaminant loading and delays groundwater cleanup

APPENDIX B
2019 Remedy Selection Report

August 30, 2019

REMEDY SELECTION REPORT - 40 CFR § 257.97
RUSH ISLAND, LABADIE, SIOUX AND MERAMEC CCR BASINS

In May 2019, Ameren Missouri completed Corrective Measures Assessment (CMA) Reports for certain coal ash (CCR) basins located at the Rush Island, Labadie, Meramec, and Sioux energy centers. For each site, the CMAs considered a series of alternatives, all of which are protective of human health and the environment, control source material, minimize the potential for further releases and, over time, will attain site-specific groundwater protection standards. After sharing the CMAs publicly, Ameren Missouri solicited public input. In addition to the CMAs, Ameren Missouri and its consultants performed numerous technical evaluations, all of which help to inform the Company's remedy selection. Those evaluations include groundwater modeling; human health and ecological risk assessments; groundwater treatment assessments; onsite and offsite monitoring data; rail, barge and truck transportation studies; and a deep excavation study report.[1] The technical assessments, data and public input inform the evaluation of selection factors that has led to this final remedy selection.

Set forth below is a summary of Ameren Missouri's remedial plan that, when fully implemented and completed, will achieve CCR Rule requirements. As previously announced, Ameren Missouri intends to expeditiously close CCR basins at its energy centers by completing necessary steps to remove the basins from service and then installing an engineered cap system that exceeds, by more than two orders of magnitude, the federal regulatory requirements and, as modeling indicates, will minimize the limited and localized impact to groundwater observed at the CCR basins. In time, the sites will attain site-specific groundwater protection standards. As conditions stabilize after cover system installation, groundwater evaluations and monitoring will continue, and, as necessary, be modified. Ameren Missouri intends to implement the following corrective action measures in conjunction with the closure of CCR basins.

CORRECTIVE MEASURES REMEDIAL PLAN

CMA Reports Alternative 1: Source Control Through Installation of Low Permeable Cover System & Monitored Natural Attenuation

1. Source control, stabilization and containment of CCR by installation of a low-permeability geomembrane cap (a minimum 1 x 10 -7 centimeters per second (cm/sec) versus 1 x 10 -5 cm/sec required by the CCR Rule).

2. Once source control is achieved, monitor the natural attenuation (MNA) of groundwater concentrations to address limited and localized CCR-related impacts. Ongoing monitoring and modeling evaluations will document that concentrations are

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[1] Technical assessments are appended to the CMA reports and/or to Ameren Missouri's Response to Public Concerns and all have been posted to Ameren's CCR website.

decreasing as modeled. MNA occurs due to naturally occurring processes within the aquifer.

3. Annual Groundwater *Monitoring and Corrective Action Reports* for each site will address the following:

    - Demonstrate that groundwater plume(s) are stable or decreasing and not expanding;

    - Contain an ongoing summary of baseline and periodic geochemical analysis including groundwater chemistry, subsurface soils chemical composition and mineralogy;

    - Determine site-specific attenuation factors and rate of attenuation process; and

    - Design a long-term performance monitoring program based on the specific attenuation mechanism to confirm concentration reductions and document trends.

The installation of a low-permeability, geomembrane cap system satisfies both the CCR Rule's basin closure requirements and can constitute an appropriate remedial corrective measure for groundwater impacts, as recently confirmed by the Missouri Department of Natural Resources (MDNR). A properly engineered and installed cap will practically eliminate the infiltration of water into the stored ash material. As summarized in the CMA reports, concentrations will reduce once the cap system stops recharge into the ash and groundwater conditions, such as pH levels, stabilize. Ameren Missouri will establish a long-term performance monitoring plan in accordance with the CCR Rule to document and confirm such reductions. MNA encompasses a variety of physical and chemical processes (biodegradation, sorption, dilution, chemical reactions and evaporation), which, under the right conditions, can immobilize metals in aquifer sediments. In addition to capping as a remedial corrective measure, both EPA and MDNR recognize MNA as a corrective action component for addressing inorganics (metals) in groundwater. *EPA Directive 9283.1-36 (2015); Section 644.143 RSMo (1999).* As MDNR notes, <u>MNA is not a "no action" alternative and is complementary to source control measures</u>. *(<u>See</u> Fact Sheet: MNA of Groundwater at Brownfields/Voluntary Cleanup Program Sites.)*

IMPLEMENTATION OF REMEDY

Under its current schedule, Ameren Missouri will close more than 67% (428 acres) of its CCR units by the end of 2020, with the remaining 33% by December 2023. Installation of a geomembrane cap at the energy centers will practically eliminate infiltration. Site preparation activities are underway at Rush Island and Labadie, with construction of the cap/cover systems occurring over the next 12 -18 months. Closure of additional basins at Meramec will occur in 2020 and 2021, with closure of remaining basins following the retirement of the energy center in 2023. At Sioux, use of the ash basins will terminate once wastewater and dry ash handling facilities are completed in 2020. Set forth below are key milestones in the implementation of Ameren's remedial plans. Such schedule is subject to revision based upon each energy center's construction schedule, ongoing field investigations and, if needed, regulatory approvals.

Facility	Ash Basin Removed from Service	Ash Basin Cap System Completed	Performance Review: Groundwater & Cap System
Rush Island	04/2019	12/2020	Annual - Commencing 2021
Labadie	09/2019	12/2020	Annual - Commencing 2021
Sioux	12/2020	2021	Annual - Commencing 2023
Meramec	12/2022	2023	Annual - Commencing 2024

SUPPLEMENTAL CORRECTIVE MEASURES

In its laboratories, XDD, Ameren Missouri's environmental consultant, reproduced existing (i.e. pre-closure) groundwater and soil conditions so as to evaluate potential treatment methods to accelerate existing natural attenuation processes. Under appropriate conditions, metals can attenuate through precipitation, co-precipitation and/or sorption processes with subsurface soil minerals. XDD is evaluating potential treatment methods such as the use of pH adjustment, zero valent iron (ZVI), and bio-augmentation.[2] Laboratory results for arsenic and molybdenum, the primary contaminants of concern (COC) at some of Ameren's energy centers, indicate that through the adjustment of pH levels in subsurface soils and groundwater, groundwater protection standards (GWPS) can be met for each site[3] and that the use of chemical reduction (ZVI) and bioremediation may be helpful in the reduction process for these and other compounds.

Set forth below is a summary chart reflecting results from ongoing treatment studies. Boron is included for evaluation purposes even though under the Federal CCR Rule it is not currently an Appendix IV parameter.

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[2] Ameren Missouri and XDD have experience with the use of ZVI and bio-augmentation at its Huster Substation property, a groundwater remediation project supervised by USEPA and MDNR, (CERCLA-07-2017-0129). Using a drill rig, XDD injected a slurry comprised of water and ZVI into subsurface soils and groundwater forming a reactive barrier that successfully contained groundwater contaminants that had migrated from the substation. In addition, ongoing degradation of source contaminants continues to occur through a bio-augmentation process consisting of the injection of feedstock into the sands of the aquifer.

[3] The slow groundwater flow rate at the Sioux energy center has allowed for the concentration of molybdenum at levels higher than those observed at the other energy centers. Such conditions however may be particularly conducive to the use of ZVI or bioremediation.

SUMMARY OF LABORATORY TREATMENT STUDIES

	Arsenic	Molybdenum	Boron	Lithium	Attenuation Mechanism
	mg/L				
pH 10	▒	🟧 R/M5/M6	▒	🟦 M6	P,C
pH 9	🟦 R	▒	▒	▒	P,C
pH 8	🟦 R	🟧 M6	▒	▒	P,C
pH 7	🟦 R	▒	▒	▒	P,C
pH 6	🟩 R/M5*/M6*	🟦 R/M5/M6/L/S	▒	▒	P,C
CaSx	🟦 R	🟧 R/M5/M6/L	🟦 M6	🟩 M5	P,C
Dissolved Iron (Anaerobic)	🟦 R	🟦 L	▒	▒	P,C
Dissolved Iron (Aerobic)	🟦 R	🟦 L	▒	▒	P,C
ZVI Injectable	🟩 R	🟩 R/M5/M6/L/S	🟦 L/S 🟩 R/M5/M6	🟦 M5/M6	P,C
ZVI PRB	🟩 R	🟩 R/M5/M6/L	🟦 R/M5/M6	🟦 M5/M6	P,C
ZVI Injectable + Bio	🟩 R	🟩 R/M5/M6/L/S	🟩 R/M5/M6	🟦 M5/M6	P,C
ZVI Injectable pH 8 + Bio	🟩 R	🟩 R/L	🟩 R	⬜	P,C
ZVI PRB + Bio	🟩 R	🟩 M5/M6/L/S	🟦 S	🟦 M5/M6 🟩 L/S	P,C
ZVI PRB pH 8 + Bio	🟩 R	🟩 R/L	🟩 R	🟦 M6 🟩 L/S	P,C

Notes: -

▒ No Effect

🟦 Reduce

🟧 Increase

🟩 Attains Standard

⬜ Non-Detect

L = Labadie

S = Sioux

R = Rush Island

M5/M6 =Meramec monitoring wells

PRB = permeable reactive barrier

Injectable = iron particles at micro-scale; potentially applied through injection

Dissolved iron = 50 mg/L Iron(II) sulfate

CaSx = calcium polysulfide

P = Precipitation

C = Co-precipitation

* = arsenic was not detected in M5/M6 baseline despite being detected during quarterly sampling at M5. Results indicate arsenic would likely be removed under pH 6 conditions.

Additional pilot studies are needed to confirm that laboratory results can be replicated and appropriately scaled under field conditions. Assuming such confirmation, corrective action Measures may also include groundwater treatment to facilitate reductions. Field demonstrations and groundwater treatment applications could require a state-issued permit pursuant to *10 CSR 20-6.010*. Remedial actions are iterative in nature and Ameren Missouri (as part of the long-term performance monitoring program) will periodically evaluate then-existing groundwater conditions relative to GWPS and determine whether additional treatment measures are warranted.

APPENDIX C

LCPA Closure Completion Documentation

Labadie Energy Center
Notification of Intent to Close a CCR Unit and Certification for Final Cover System Design

This is Ameren Missouri's (the Owner) notification of the intent to close coal combustion residual (CCR) surface impoundment unit LCPA (Bottom Ash Pond) at the Labadie Energy Center as required by 40 C.F.R § 257.102(g). Closure of LCPA will be performed in accordance with 40 C.F.R. § 257.102(d) by leaving CCR in place.

CERTIFICATION:

As documented by this certification, I have reviewed the final cover system design for the CCR surface impoundment unit LCPA at Ameren Missouri's Labadie Energy Center. The final cover system design is prepared in accordance with accepted and good engineering practices, and the final cover system design meets the final cover system requirements of 40 C.F.R. §257.102(d)(3) and 40 C.F.R. §257.102(d)(3)(ii).

Name: Thomas R. Gredell, P.E.

Signature: Thomas R Gredell

Date: 08-28-2019

Registration Number: E-21137

State of Registration: Missouri

THOMAS R. GREDELL
08-28-19
NUMBER
PE-021137

Labadie Energy Center
Closure Plan
LCPA (Bottom Ash Pond)
CCR Surface Impoundment

Labadie Energy Center
Closure Plan
(LCPA) Bottom Ash Pond
CCR Surface Impoundment
Franklin County, Missouri

October 2016

Table of Contents

List of Appendices

Appendix A	Figures
Appendix B	Closure Schedule

Professional Engineer's Certification

By means of this certification, I have reviewed this CCR Unit Closure Plan for Surface Impoundment LCPA (Bottom Ash Pond) at Ameren Missouri's Labadie Energy Center. Such plan describes the steps necessary to close the CCR unit and such activities are in accordance with general accepted and good engineering activities, and it meets the requirements of 40 CFR §257.102(b). Such plan may be amended as authorized by 40 CFR §257.102(b)(3).

Name: Thomas R. Gredell, P.E.

Signature:

Date: 10-13-16

Registration Number: PE-02113

State of Registration: Missouri

THOMAS R. GREDELL
NUMBER PE-021137

1.0 Introduction

Pursuant to 40 CFR §257.102 (2), the owner or operator of a Coal Combustion Residual (CCR) unit must prepare a closure plan identifying the manner and timing of closure and describe such cover compliance with the designated performance criteria set forth in the CCR Rule with respect to the installation method for the final cover system.

Stormwater, CCR transport water and other low volume wastewaters discharge from the active CCR unit through NPDES permitted Outfall 002 of Missouri Operating Permit No. MO-0004812. A map showing the location of the active CCR surface impoundment is appended hereto as Figure 2.

The active CCR surface impoundment is referred to as Surface Impoundment LCPA (Bottom Ash Pond). Surface Impoundment LCPA receives CCR transport water, plant service water and other plant drainage. Stormwater currently collects on Surface Impoundment LCPB, which discharges to Surface Impoundment LCPA. The coal pile stormwater runoff is routed to LCPA via a pump station. This closure plan will focus on Surface Impoundment LCPA (Bottom Ash Pond).

2.0 Closure Plan

Pursuant to 40 CFR §257.102, a surface impoundment can be closed by leaving the CCR material in place and installing a final cover system, or through removal of the CCR. Surface impoundments at the Labadie Energy Center will be closed by capping and leaving the CCR materials in place as contemplated and authorized by the regulations. This report describes the process which Ameren Missouri will use to close Surface Impoundment LCPA at Labadie. LCPA is a 165-acre, unlined impoundment constructed in the late 1960's during the initial construction of the Labadie Energy Center. Surface Impoundment LCPA does not include a compacted soil liner or approved equivalent base liner and, therefore, does not comply with the liner performance criteria set forth in the CCR Rule.

Primary activities common to most impoundment closures are listed below. Initial project schedules are presented in Section 5 and Appendix B.

2.1 Reroute Process Water/Piping Modifications

The various piping systems to Surface Impoundment LCPA have not yet been physically removed. To preclude the probability of future impoundment of water, water systems and piping will be rerouted to prevent future discharge of plant service water systems or other drainage to the closed ash pond. A new, low volume wastewater treatment plant will be built at the Labadie Energy Center to manage non-CCR wastewaters currently discharged into Surface Impoundment LCPA. A part of this wastewater treatment plant will be a detention basin that will be built on top of a portion of the closed Surface Impoundment LCPA. Stormwater from the coal pile will be routed to the detention basin, then routed to the low volume wastewater treatment system. A portion of Surface Impoundment LCPA will continue to discharge stormwater to Outfall 002 following closure of the unit.

2.2 Dewater Surface Water

Liquid from Surface Impoundment LCPA will be removed either passively (by gravity drainage) or actively (by extraction wells, pumps or trenches). To dewater portions of the surface impoundment, the CCR material may be moved and stockpiled to allow water to drain from the ash.

2.3 Installation of Drainage and Stormwater Management

Stormwater management systems will be designed and constructed to adequately manage flow during peak discharge of the design flood event and collect and control runoff during the same design storm. The design flood event is based on the CCR unit’s flood hazard potential rating. The inflow design flood control system plan and calculations are certified by a professional engineer and updated every five years.

2.4 Stabilization and Grading

The CCR Rule requires closure systems for CCR units to preclude the probability of future impoundment of water, sediment or slurry and the stabilization of wastes within an impoundment. A CCR layer is considered stabilized when it is structurally suitable for use as a base layer and can accommodate construction activities. Stabilization techniques could include dewatering and/or compaction via tracking by earth moving equipment.

Minimum design slopes are not established within the CCR Rule. However, a slope of one percent (1%) will be used as a practical minimum for final slopes of the surface impoundments. Additional slopes will be provided, as feasible, in areas where settlement due to saturated CCR is anticipated. Ameren Missouri will optimize the use of existing onsite CCR materials to achieve final grade, reduce the overall footprint of the CCR units and enhance drainage.

The boundaries of Labadie’s CCR surface impoundments do not overlap, but they are adjacent and separated by a common berm. Therefore, they will require a coordinated approach to grading to properly manage stormwater runoff. Grading modifications related to Surface Impoundment LCPA will consider drainage from Surface Impoundment LCPB to the east and other locations of the plant. As currently anticipated, no CCR material will be removed from within the footprint of Surface Impoundment LCPA during final grading operations. An additional quantity of CCR material may be imported from other onsite CCR units at the LEC site to achieve the necessary final grades. Using conventional earth moving, this CCR material will be placed in approximate 8-inch loose lifts and compacted. A site plan for Surface Impoundment LCPA is provided as Figure 3 in Appendix A.

2.5 Closure Documentation

A construction quality assurance plan, engineering drawings, bid specifications and as-built construction drawings will be developed to demonstrate that appropriate closure activities were successfully implemented. Additional closure documentation will include the following:

- The annual progress reports summarizing closure progress and projected closure activities;
- Notification of completion of closure will be finalized within 60 days of the actual closure completion date.

The closure notices and progress reports will be placed in Labadie Energy Center's Operating Record, sent to the Director of Missouri Department of Natural Resources (MDNR) before close of business on the required compliance date and placed on Ameren's CCR public website within 30 days of placing said information in the Operating Record.

3.0 Final Cover System

Minimum standards for cover include an 18-inch infiltration layer and 6 inches of topsoil to support the growth of vegetation. The final cover is required to have permeability less than or equal to that of the bottom layer, or 1×10^{-5} centimeters per second (cm/s). Alternative cover systems are authorized provided that such design meets or exceeds the CCR Rule performance standards. As a part of the engineering design, geotechnical assessments of the CCR materials in the surface impoundment will be performed. A typical final cover system will have sufficient soil cover to support vegetative growth and minimize erosion.

A typical cross section of the final cover system is shown in Figure 1.

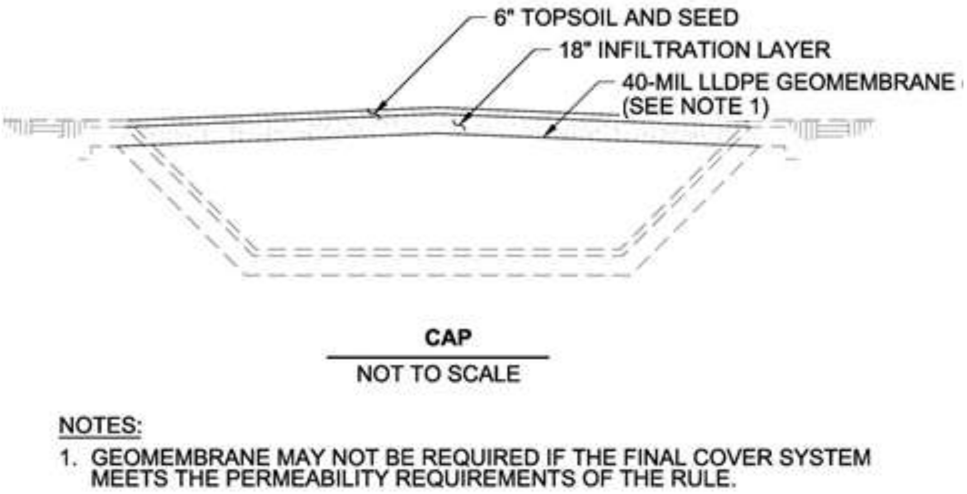
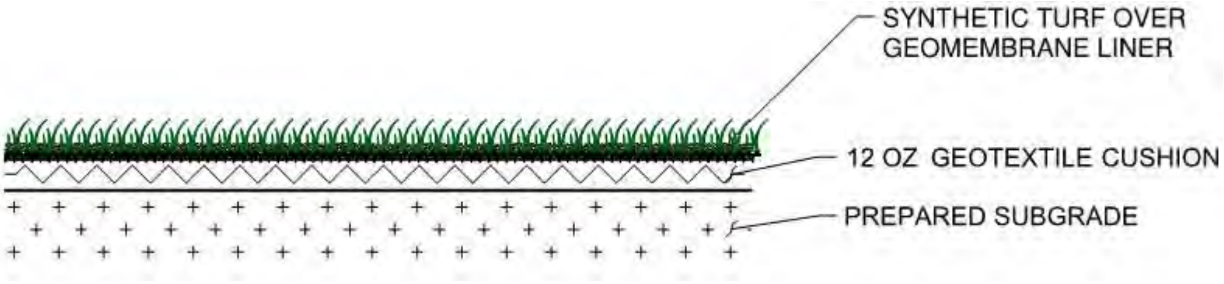


Figure 1: Typical CCR Unit Cap

3.1 Alternative Cover System

The CCR Rule authorizes the use of an alternative final cover system for closure, provided the system meets equivalent performance requirements.

A typical cross section of an alternative cover system is set forth below.



Ameren Missouri is considering using an engineered synthetic turf system at Labadie CCR unit closures, depending upon the ease of constructability and design performance experienced at LEC.

3.2 Settlement and Subsidence of Cover System

Settlement on the impoundment may occur during consolidation of the CCR material, general fill material or underlying natural subsoils under new loads from grading activities. A portion of the CCR material within the impoundment contains cemented material that may have minimal settlement. The saturated, un-cemented CCR material encountered may settle under the additional loading. This settlement may occur for the duration of grading activities and is expected to be minimal after the final cover system is installed. General fill will be installed in a controlled manner to minimize post-cover system installation settlement.

Slope stability and mass stability of the covered-in-place material will be analyzed after completion of the final design, which is currently ongoing. Instability of the cover system is not anticipated, based on the relatively flat sloping grades. The stable cover system design concept will minimize the need for extensive future maintenance.

3.3 Method of Installation

Closure construction will consist of erosion and sediment control installation, clearing and grubbing, dewatering, grading and compaction of CCR, construction of a compacted clay layer and erosion layer or alternative cover system, installation of stormwater controls and performance of final seeding and restoration.

4.0 CCR Unit Inventory and Area Estimate

Set forth below in Table 1 is Ameren Missouri's estimate of CCR materials within Surface Impoundment LCPA, along with the currently expected final cover area. Note that actual cover areas may be reduced as the footprint of various units is consolidated as part of closure.

Table 1: Estimated CCR Inventory and Cover Area

CCR Unit	Estimated Inventory (CY)	Estimated Capacity (CY)	Estimated Final Cover Area (Ac)
LCPA (Bottom Ash Pond)	12,000,000	15,836,000	165+/-

5.0 Closure Schedule

Table 3 below identifies the impoundment and anticipated closure date. This schedule is preliminary and subject to revision based upon operational needs, construction progress and budgetary constraints.

Ameren has developed preliminary work schedules based on project milestones and estimated completion dates reflected in Table 2. See the Closure Schedule in Appendix B.

Table 2: Estimated Closure Date

CCR Unit	CCR Type	Estimated Closure Date
LCPA (Bottom Ash Pond)	Bottom Ash and Fly	2023

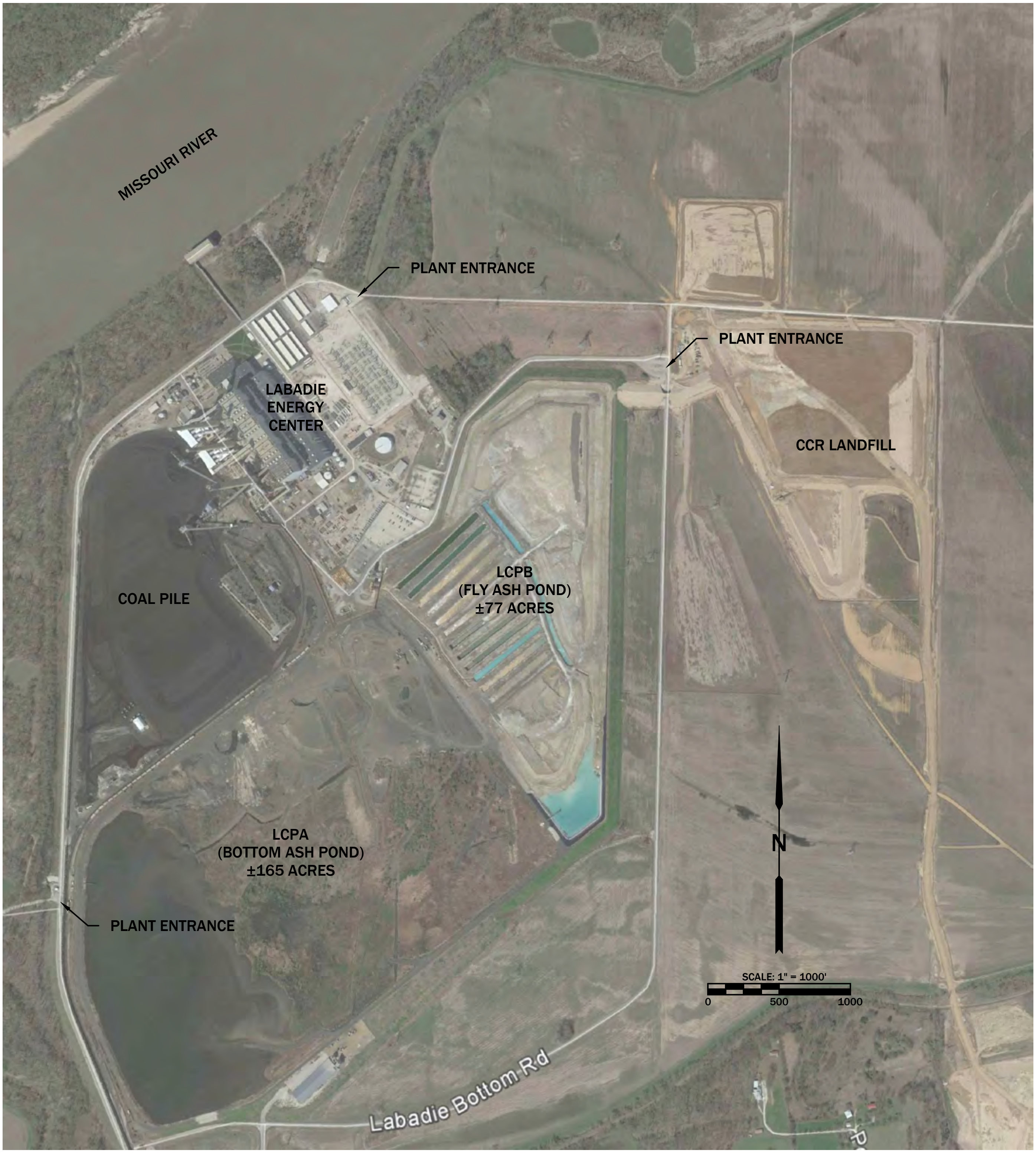
6.0 Miscellaneous Requirements

CFR §257 Section 257.102 includes other requirements that Ameren Missouri must comply with, as listed below:

- Section 257.102 (i) includes specific requirements related to *deed notations* following completion of closure.

Appendix A

Figures



M:\Share\CADDFiles\CONFIDENTIAL\SCHIFF-HARDIN 2014\ASH POND PRELI GRADING\CLOSURE PLANS.dwg, FIGURE 2 - LABADIE ENERGY CENTER, 10/13/2016 11:41:23 AM

CCR SURFACE IMPOUNDMENT CLOSURE LABADIE ENERGY CENTER

GREDELL Engineering Resources, Inc.

ENVIRONMENTAL ENGINEERING LAND - AIR - WATER

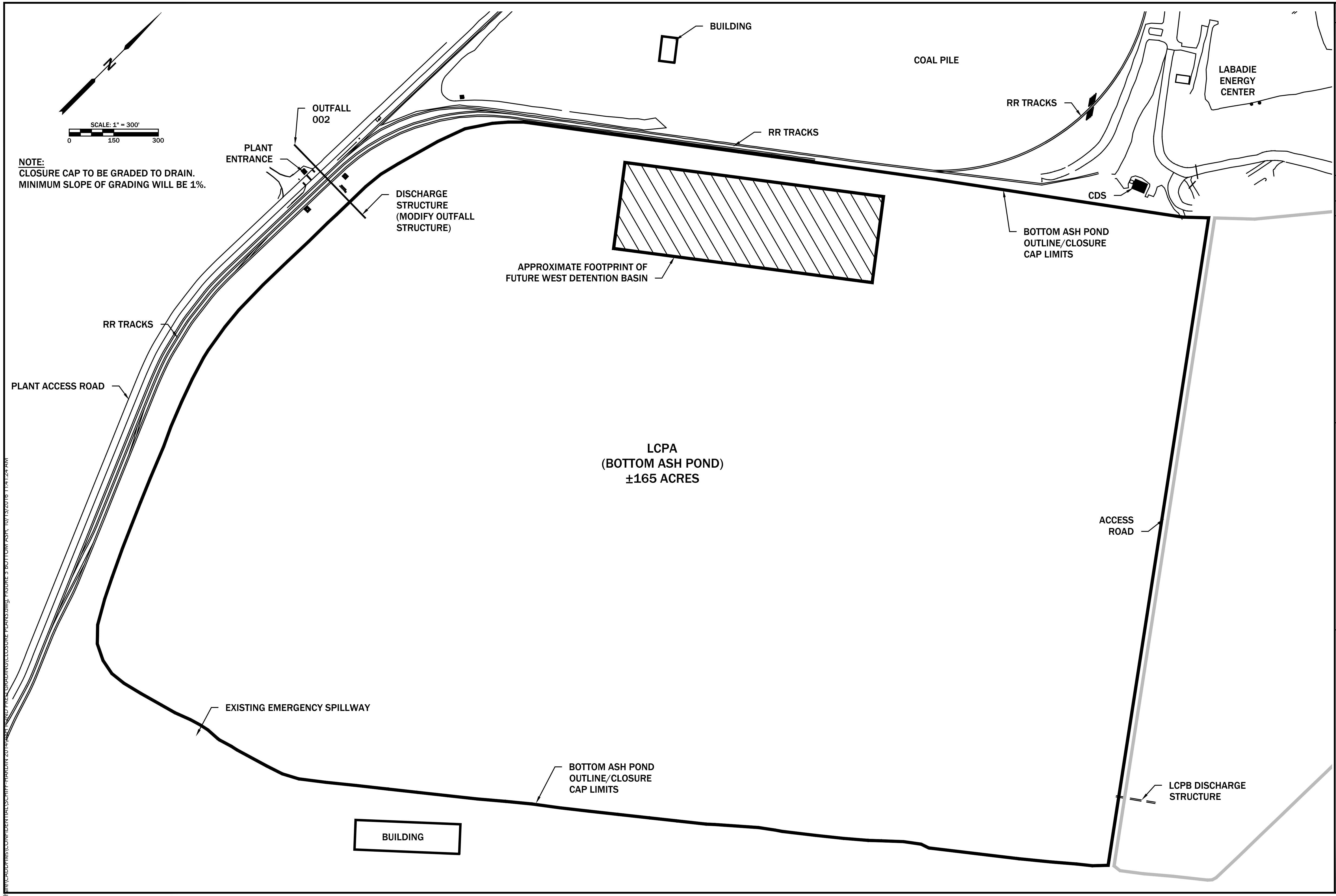
1505 East High Street
Jefferson City, Missouri

Telephone: (573) 659-9078
Facsimile: (573) 659-9079

MO CORP. ENGINEERING LICENSE NO. E-2001001669-D

FIGURE 2 - LABADIE ENERGY CENTER AERIAL VIEW

DATE	SCALE	PROJECT NAME	REVISION
10/2016	AS NOTED	ASH POND PRELIM	
DRAWN	APPROVED	FILE NAME	SHEET #
AJK	TRG	CLOSURE PLANS	1 OF 1



NOTE:
CLOSURE CAP TO BE GRADED TO DRAIN.
MINIMUM SLOPE OF GRADING WILL BE 1%.

#	DATE	REVISION DESCRIPTION	BY

FIGURE 3
LCPA (BOTTOM ASH POND)
SITE PLAN

CCR SURFACE
IMPOUNDMENT CLOSURE
LABADIE ENERGY CENTER

SURVEYED	DESIGNED	DRAWN	CHECKED	APPROVED	DATE	SCALE	PROJECT NAME	FILE NAME	SHEET #
NA	TRG	AJK	AR	TRG	10/2016	AS NOTED	ASH POND PRELIM	CLOSURE PLANS	1 OF 1

GREDELL Engineering Resources, Inc.
ENVIRONMENTAL ENGINEERING LAND - AIR - WATER
1505 East High Street Telephone: (573) 659-9078
Jefferson City, Missouri Facsimile: (573) 659-9079
MO CORP. ENGINEERING LICENSE NO. E-2001001669-D

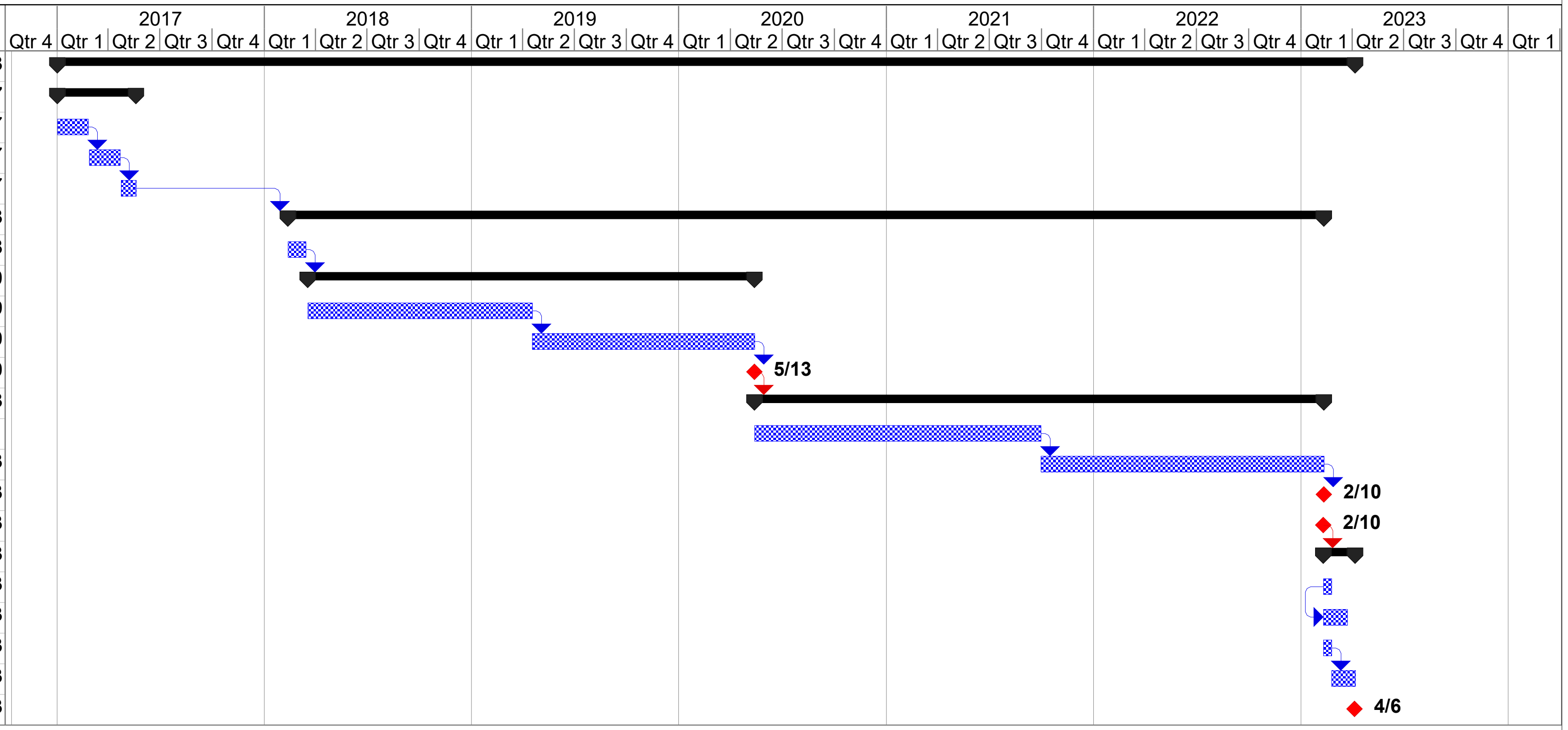
M:\Share\CADDFiles\CONFIDENTIAL\SCHIFF-HARDIN 2014\ASH POND PRELI GRADING\CLOSURE PLANS.dwg, FIGURE 3 BOTTOM ASH, 10/13/2016 11:41:24 AM

Appendix B

Closure Schedule

AMEREN MISSOURI - LABADIE ENERGY CENTER
LCPA CCR SURFACE IMPOUNDMENT (BOTTOM ASH POND)
CLOSURE SCHEDULE

ID	ⓘ	Task Name	Duration	Start	Finish
1		CCR Surface Impoundment Closure	**1634 days**	**Mon 1/2/17**	**Thu 4/6/23**
2		Prepare Construction Documents, Bid, and Contractor Selection	**100 days**	**Mon 1/2/17**	**Fri 5/19/17**
3	▦	Prepare Construction Documents and Estimate	2 mons	Mon 1/2/17	Fri 2/24/17
4	▦	Bid Process (Ameren)	2 mons	Mon 2/27/17	Fri 4/21/17
5	▦	Contractor Selection and Finalize Contract	4 wks	Mon 4/24/17	Fri 5/19/17
6		Implement CCR Surface Impoundment Closure	**1305 days**	**Mon 2/12/18**	**Fri 2/10/23**
7	▦	Prepare Notification of Intent to Close CCR Surface Impoundment	23 days	Mon 2/12/18	Wed 3/14/18
8		Dewatering & Stabilization	**563 days**	**Mon 3/19/18**	**Wed 5/13/20**
9	▦	Dewatering Surface Water	14.15 mons	Mon 3/19/18	Wed 4/17/19
10	▦	Grading and Stabilizing CCR	14 mons	Thu 4/18/19	Wed 5/13/20
11	▦	Dewatering & Stabilization Complete	0 days	Wed 5/13/20	Wed 5/13/20
12		Final Cover Construction	**717 days**	**Thu 5/14/20**	**Fri 2/10/23**
13	▦	Infiltration Layer	18 mons	Thu 5/14/20	Wed 9/29/21
14		Erosion Layer	17.85 mons	Thu 9/30/21	Fri 2/10/23
15	▦	Final Cover Construction Complete	0 days	Fri 2/10/23	Fri 2/10/23
16	▦	CCR Surface Impoundment Closure Complete	0 days	Fri 2/10/23	Fri 2/10/23
17		CCR Surface Impoundment Regulatory Closure Documentation	**40 days**	**Fri 2/10/23**	**Thu 4/6/23**
18	▦	PE Certification that Closure is Complete (Federal)	2 wks	Fri 2/10/23	Thu 2/23/23
19	▦	Prepare Notification of Closure of CCR Surface Impoundment (Federal)	30 days	Fri 2/10/23	Thu 3/23/23
20	▦	Deed Notation (Federal)	2 wks	Fri 2/10/23	Thu 2/23/23
21	▦	Notification of Deed Notation (Federal)	30 days	Fri 2/24/23	Thu 4/6/23
22	▦	Regulatory Closure Documentation Complete	0 days	Thu 4/6/23	Thu 4/6/23



Project: Ameren Missouri - Labadie Energy Center CCR Surface Impoundment Closure
Prepared by GREDELL Engineering Resources, Inc.
Date: Thu 10/13/16

Task ▨ Milestone ◆ Summary ▬

Labadie Energy Center
Post-Closure Plan
LCPA (Bottom Ash Pond)
CCR Surface Impoundment

Labadie Energy Center
Post-Closure Plan
(LCPA) Bottom Ash Pond
CCR Surface Impoundment
Franklin County, Missouri

October 2016

Table of Contents

List of Figures

Professional Engineer's Certification

I, Thomas R. Gredell, P.E., a professional engineer licensed in the State of Missouri, hereby certify in accordance with 40 CFR §257.104 that this post-closure plan for LCPA (Bottom Ash Pond) at Ameren Missouri's Labadie Energy Center has been written in accordance with applicable federal requirements promulgated under 40 CFR §257, Subpart D – Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments and good engineering and environmental practices. Such plan may be amended as authorized by 40 CFR §257.104(d)(3).

Name: Thomas R. Gredell, P.E.

Signature:

Date: 10-13-16

Registration Number: PE-021

State of Registration: Missouri

THOMAS R. GREDELL

NUMBER PE-021137

1.0 Introduction

Pursuant to 40 CFR §257.104, the owner or operator of a Coal Combustion Residual (CCR) unit must prepare a post-closure plan identifying the maintenance, monitoring, planned use, contact person, and care period with respect to the performance criteria set forth in the CCR Rule.

Stormwater, CCR transport water and other low volume wastewaters discharge from the active CCR unit through NPDES permitted Outfall 002 of Missouri Operating Permit No. MO-0004812. A map showing the location of the active CCR surface impoundment is appended hereto as Figure 1. A site plan of Surface Impoundment LCPA is appended hereto as Figure 2.

The active CCR surface impoundment is referred to as Surface Impoundment LCPA (Bottom Ash Pond). Surface Impoundment LCPA receives CCR transport water, plant service water and other plant drainage. Stormwater currently collects on Surface Impoundment LCPB, which discharges to Surface Impoundment LCPA. The coal pile stormwater runoff is routed to Surface Impoundment LCPA via a pump station. This post-closure plan will focus on Surface Impoundment LCPA (Bottom Ash Pond).

2.0 CCR Unit Information

Primary activities common to impoundment post-closures are listed below.

2.1 Post-Closure Care Contact

The Ameren Missouri contact for post-closure care will be:

Name:	Ameren Missouri
Title:	Director of Dam Safety
Address:	1901 Chouteau Avenue, St. Louis, Missouri 63103
Phone Numbers:	(800) 552-7583
Email	CCR@ameren.com

In the event the identified care contact is not available, or there is an emergency, an alternate Ameren Missouri contact that is available 24/7 can be reached at:

Name:	Ameren Missouri
Title:	Director of Dam Safety
Phone Numbers:	(800) 552-7583

2.2 Closed CCR Surface Impoundment Planned Use

The closure of Surface Impoundment LCPA will include grass turf or native grasses, or a synthetic alternative erosion layer. Ameren Missouri's current intent is to maintain the closed Surface Impoundment LCPA as a passive, open space. If Surface Impoundment LCPA includes an erosion layer that is native grasses, the open space could also be utilized for hay production, as well as open space. If Surface Impoundment LCPA includes a synthetic, alternative erosion layer, the closed Surface Impoundment will remain a passive, open area. Other potential uses of the LCPA area can be evaluated for purposes that maintain the final cover and do not increase the potential threat to human health or the environment.

2.3 Post-Closure Care Period

The care period of the closed surface impoundment will be 30 years. The post-closure period will begin when the certification from a professional engineer that Surface Impoundment LCPA is properly closed is placed in the operating record.

The post-closure period ends only when the groundwater monitoring program is in detection monitoring, in accordance with Section 257.104(c)(2) and Section 3.3 below.

2.4 Notification of Completion of the Post-Closure Care Period.

No later than 60 days following the completion of the post-closure care period, Ameren Missouri must prepare a notification that post-closure care has been completed. This notification must include the certification by a professional engineer verifying that post-closure care has been completed in accordance with the post-closure plan. The notice is complete when these documents are placed in the facility operating record, as required by Section 257.105(i)(13).

3.0 Post-Closure Care Plan

The CCR unit will be maintained during the post-closure period as outlined below.

3.1 Final Closure Cap Monitoring and Maintenance

The closed unit cap will be inspected and maintained to ensure the integrity and effectiveness of the final cover system. This maintenance will include making repairs to the final cover as necessary to correct the effects of settlement, subsidence, erosion, or other events. These repairs will also evaluate the condition of run-on and run-off from eroding or damaging the final cover.

Settlement on the impoundment may occur during consolidation of the CCR material, general fill material or underlying natural subsoils under new loads from maintenance activities. A portion of the CCR material within the impoundment contains cemented material that may have minimal settlement. The saturated, un-cemented CCR material encountered may settle under the additional loading. This settlement may occur for the duration of grading activities and is expected to be minimal after the final cover system is installed. General fill will be installed in a controlled manner to minimize post-cover system installation settlement.

The cap may be disturbed by forces of nature, maintenance equipment, or vandalism. Damage to the cap from these or other disturbances will be corrected and reseeded, if necessary. Additional vegetative soil, if necessary, will be brought to the damage area and placed in a loose lift and spread by hand tools or low impact equipment to minimize disturbance to the cap. Disturbance to the infiltration layer will be repaired in accordance with the guidance in the Closure Plan.

Routine annual inspections will be conducted by a professional engineer or designee. A report of these inspections will be placed in the operating record. Corrections recommended by the engineer will be inspected following implementation and a follow-up report will be prepared and placed in the operating record.

3.2 Stormwater Control System Maintenance

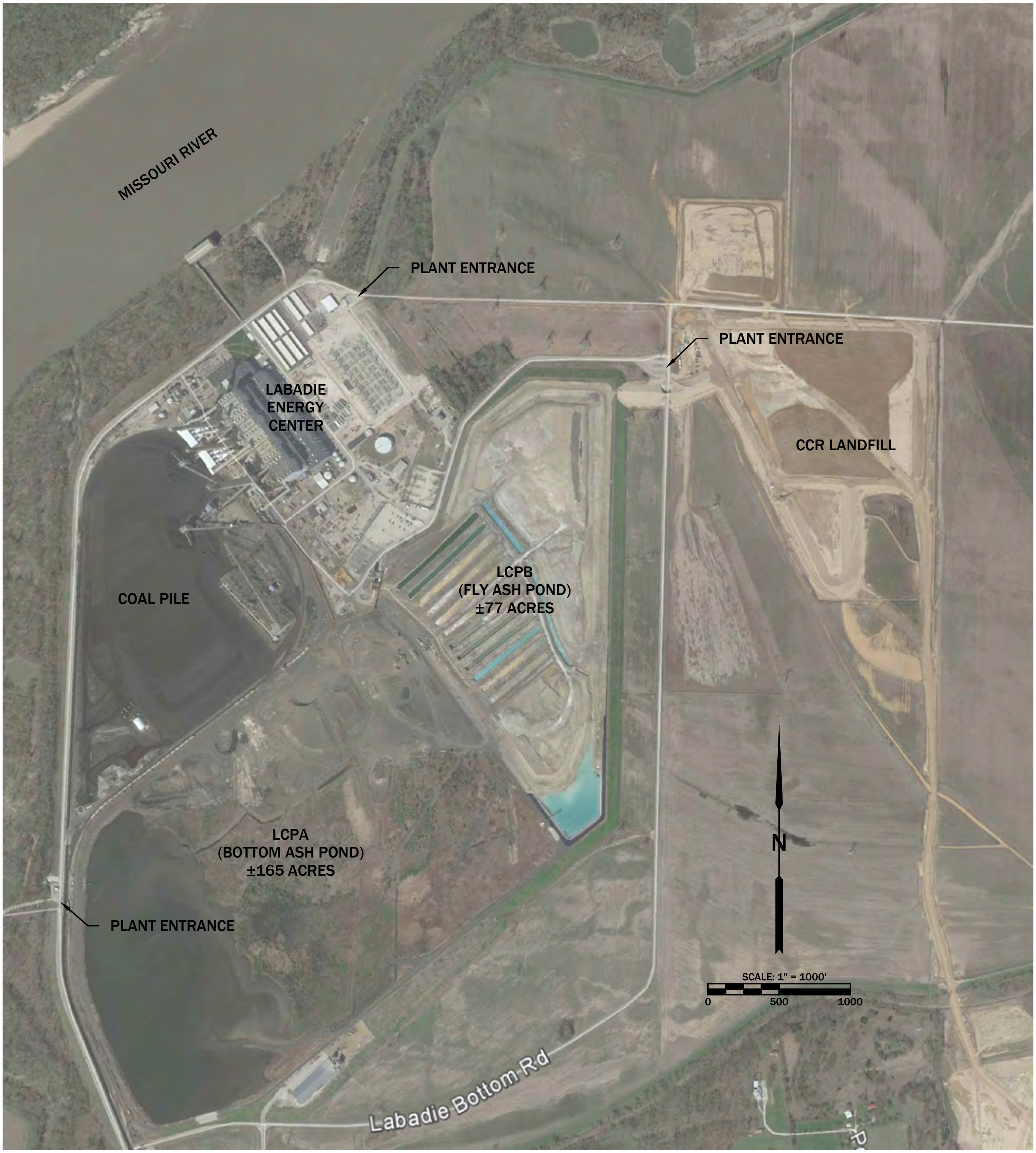
The closed unit stormwater control system will transport water from the CCR unit cap via sheet flow or to a discharge point(s). The conveyance system for the cap will be designed by a professional engineer. Observation of the constructed stormwater conveyance system will be included in the annual inspection. Corrections recommended by the engineer will be inspected following implementation and a follow-up report will be prepared and placed in the operating record.

Potential damage to the cap from stormwater run-on and stormwater run-off will be monitored by Ameren personnel. Identified damage will be corrected and reseeded, if necessary. Additional vegetative soil, if necessary, will be brought to the damage area and placed in a loose lift and spread by hand tools or low impact equipment to minimize additional disturbance to the cap.

3.3 Groundwater Monitoring and System Maintenance

The groundwater monitoring system will be maintained in accordance with the requirements of Sections 257.90 through 257.98. During sampling events and the annual inspection, repairs to the monitoring wells or system that are required will be noted in the annual report or monitoring report. The corrections will be inspected following implementation and a follow-up report will be prepared and placed in the operating record.

Figures



M:\Share\CADDFiles\CONFIDENTIAL\SCHIFF-HARDIN 2014\ASH POND PRELI GRADING\POST-CLOSURE PLANS.dwg, FIGURE 1 - LABADIE ENERGY CENTER, 10/13/2016 2:07:46 PM

CCR SURFACE IMPOUNDMENT
POST-CLOSURE MAINTENANCE
LABADIE ENERGY CENTER

GREDELL Engineering Resources, Inc.

ENVIRONMENTAL ENGINEERING LAND - AIR - WATER

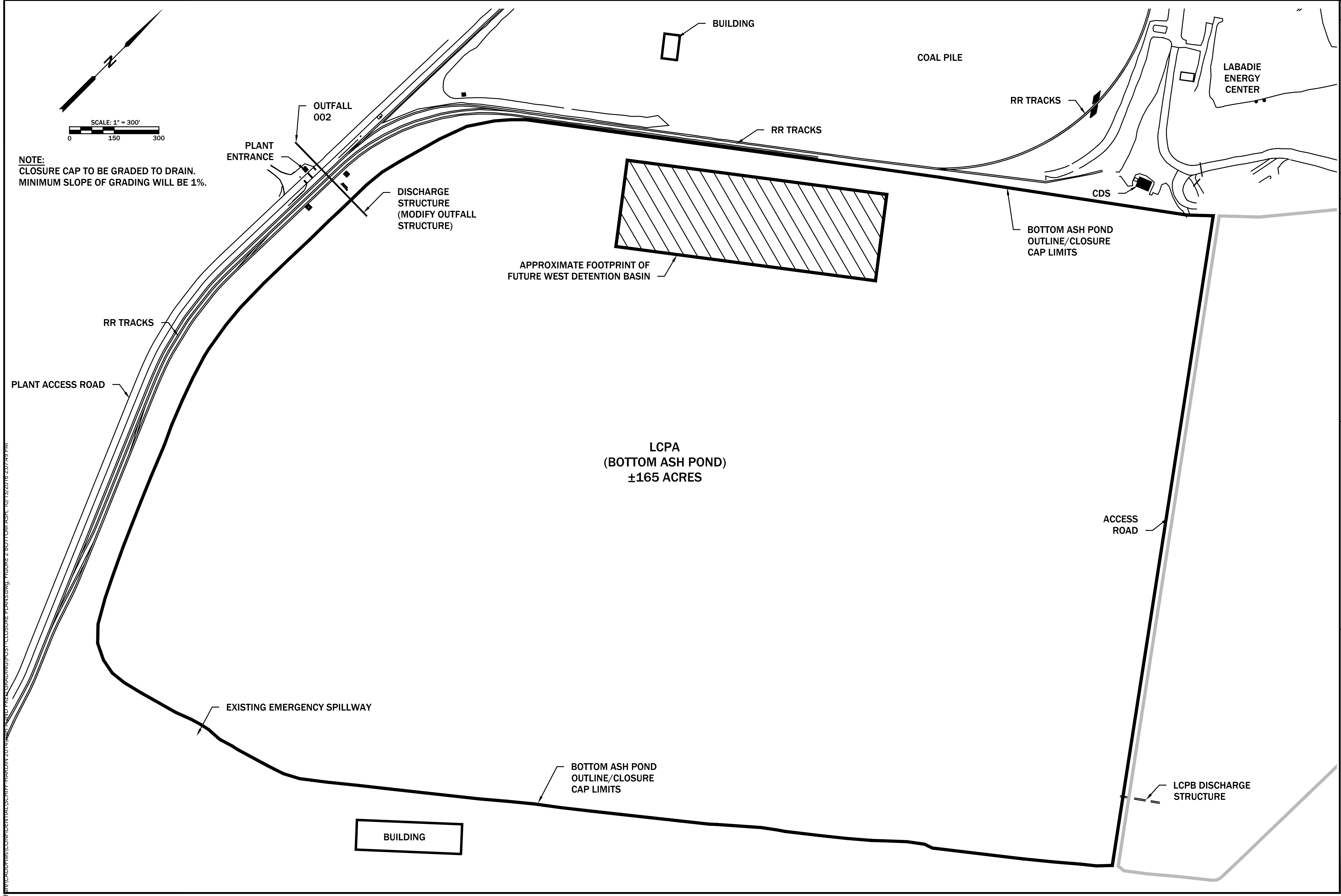
1505 East High Street
Jefferson City, Missouri

Telephone: (573) 659-9078
Facsimile: (573) 659-9079

MO CORP. ENGINEERING LICENSE NO. E-2001001669-D

FIGURE 1 - LABADIE ENERGY CENTER
AERIAL VIEW

DATE	SCALE	PROJECT NAME	REVISION
10/2016	AS NOTED	ASH POND PRELIM	
DRAWN	**APPROVED**	**FILE NAME**	**SHEET #**
AJK	TRG	POST-CLOSURE PLANS	1 OF 1



NOTE:
CLOSURE CAP TO BE GRADED TO DRAIN.
MINIMUM SLOPE OF GRADING WILL BE 1%.

#	DATE	REVISION DESCRIPTION	BY

FIGURE 2
LCPA (BOTTOM ASH POND)
SITE PLAN

CCR SURFACE IMPOUNDMENT
POST-CLOSURE MAINTENANCE
LABADIE ENERGY CENTER

SURVEYED	DESIGNED	DRAWN	CHECKED	APPROVED	DATE	SCALE	PROJECT NAME	FILE NAME	SHEET #
NA	TRG	AJK	AR	TRG	10/2016	AS NOTED	ASH POND PRELIM	POST-CLOSURE PLANS	1 OF 1

GREDELL Engineering Resources, Inc.
ENVIRONMENTAL ENGINEERING LAND - AIR - WATER
1505 East High Street Telephone: (573) 659-9078
Jefferson City, Missouri Facsimile: (573) 659-9079
MO CORP. ENGINEERING LICENSE NO. E-2001001669-D

M:\Share\CADDfiles\CONFIDENTIAL\SCHIFF-HARDIN 2014\ASH POND PRELI GRADING\POST-CLOSURE PLANS.dwg, FIGURE 2 BOTTOM ASH, 10/13/2016 2:07:49 PM

GREDELL Engineering Resources, Inc.
ENVIRONMENTAL ENGINEERING LAND - AIR - WATER
Offices in Jefferson City, Kansas City Metro and Springfield, Missouri

Professional Engineer's Certification

In accordance with §257.102(f)(3), I have prepared this certification for Ameren Missouri. By means of this certification, the undersigned documents multiple site visits were personally made to document ongoing progress and design conformance during the closure of surface impoundment LCPA (Bottom Ash Pond) at Ameren Missouri's Labadie Energy Center including recent visits in October 2022. In addition, the undersigned reviewed construction quality assurance records prepared by SCI Engineering, Inc. who provided ongoing, onsite CQA services for Ameren Missouri during the closure construction activities for surface impoundment LCPA (Bottom Ash Pond) at the Ameren Missouri Labadie Energy Center.

Based on my observations and review of CQA records, I hereby certify that closure has been completed in accordance with generally accepted and appropriate engineering practices and the Closure Plan developed for LCPA by GREDELL Engineering Resources, Inc. pursuant to 40 CFR §257.102(b). In addition, I have found the closure methods and resulting closure cap meet the final cover requirements of §257.102(d)(i)(A) through (D) and the alternative final cover requirements of §257.102(d)(1), §257.102(d)(2) and §257.102(d)(3)(ii)(A) through (C).

Name: Thomas R. Gredell, P.E.
GREDELL Engineering Resources, Inc.

THOMAS R. GREDELL
NUMBER PE-021137

Signature:

Date: 11-11-22

Registration Number: PE-021137
State of Registration: Missouri

APPENDIX D
Treatability Study Documentation

December 31, 2019 *Via e-Mail* (bmiller2@ameren.com)

Ameren Services
1901 Chouteau Avenue
PO Box 66149, MC 6
St. Louis, MO 63166-6149

RE: Ashpond Metals Treatability Study Results

XDD Project No. 19005.00, 19005.01, 19010.00, and 19011.0

XDD Environmental, LLC (XDD) appreciates the opportunity to provide Ameren Services (Ameren) with the results of the data evaluation, bench-scale treatability testing, and remedial technology evaluation to address elevated levels of arsenic (As), molybdenum (Mo), lithium (Li), boron (B), and other site metals in ashponds leachate / groundwater from the Rush Island Energy Center (RIEC), the Meramec Energy Center (MEC), the Labadie Energy Center (LEC), and the Sioux Energy Center (SEC). The bench-scale testing was performed in accordance with the scope of work described in XDD's *Proposal for Metals Treatability Study* dated February 12, 2019, *Proposal for Metals Treatability at the Labadie Energy Center* dated April 23, 2019, and *Proposal for Metals Treatability at the Sioux Energy Center* dated April 23, 2019, with modifications as noted in this report. The report herein includes preliminary results of the treatability testing for all sites with a final pilot study design approach for RIEC.

If you have any questions regarding the information presented in this report, please do not hesitate to call me at 314.609.3065.

Sincerely,

Derek Ingram

XDD Environmental

cc:

Michael Marley
Laurel Crawford
Bridget Cavanagh

ASHPOND METALS TREATABILITY STUDY RESULTS

Ameren Services

Prepared For:
AMEREN SERVICES
1901 CHOUTEAU AVENUE
PO BOX 66149, MC6
ST. LOUIS, MO 63166-6149

Prepared By:

XDD ENVIRONMENTAL

22 MARIN WAY
STRATHAM, NH 03885
TEL: (603) 778-1100
FAX: (603) 778-2121

December 31, 2019

EXECUTIVE SUMMARY

XDD Environmental (XDD) was retained by Ameren Services (Ameren) to perform metals treatability studies for the remediation of arsenic, molybdenum, lithium, boron, and other metals of concern (MOC) from ashpond leachate / groundwater. Phase 1 of the three phases of treatability studies included a review of geological conditions and existing metals in leachate from four sites [Rush Island Energy Center (RIEC), Meramec Energy Center (MEC), Labadie Energy Center (LEC), and Sioux Energy Center (SEC)]. In addition, the Phase 1 involved literature research on possible treatment trains and chemical conditions favorable for the MOC remediation. The results from the Phase 1 study identified several possible in situ treatment technologies for further evaluation, including: pH adjustment, iron precipitation / coprecipitation, zero valent iron (ZVI), metals reducing geochemical conditions, and biological stimulation as possible approaches to be tested in the Phase 2 studies.

The Phase 2 studies evaluated the Phase 1 identified treatment approaches effectiveness for MOC remediation using site groundwaters and soils, mimicking an in situ treatment application. The primary objective of the Phase 2 testing was to determine which treatment approaches / changes to geochemical conditions would promote adsorption, precipitation, or coprecipitation of the MOC, without adversely affecting the dissolved and total MOC concentrations in groundwater or other metals present at the site. The tests were carried out for periods of one to eight weeks (depending on the technology under evaluation). Of the remedial approaches tested in Phase 2, microscale ZVI and pH reduction (to pH 6) were the only methods that treated arsenic and molybdenum (the two metals of greatest regulatory concern at RIEC) to the required criteria. The other remedial approaches tested had limited to no impact on the MOC in groundwater.

The results from the Phase 2 testing were to be used to refine Phase 3 testing and to develop the pilot test design for the RIEC site. However, prior to the Phase 3 testing, boron was changed from a secondary to a primary MOC. Microscale ZVI was the only technology that had been shown to remove boron from groundwater in the Phase 2 testing; additional research identified an ion-specific resin (resin) that could treat boron to the required criteria using an ex situ remedial approach. The addition of boron as a primary MOC, along with concerns with clogging of the aquifer from precipitation of site metals, and the complexity of in situ treatment of boron, resulted in a transition from an in situ to an ex situ treatment system conceptual treatment approach for all sites MOC. The primary concern /difference in the transition from in situ to ex situ treatment is the decreased treatment time; the available in situ treatment time based on site hydraulics is weeks to a month or more; ex situ treatment requires a few minutes to hours of reaction time to permit a practical and cost-effective remedial approach.

Accordingly, for the Phase 3 treatability studies, pH adjustment, microscale ZVI, and ferric chloride addition (added due to additional literature research on the decreased available reaction timeframes for ex situ treatment) were tested for the treatment of arsenic and molybdenum in the RIEC groundwater, with polishing of the treated groundwater using resin for boron removal. The results of the Phase 3 testing identified pH adjustment, ferric chloride aided precipitation, sand filtration, and resin polishing as the most effective and reliable ex situ treatment option for RIEC groundwater.

Going forward, the results of the Phase 3 treatability testing for the RIEC groundwater will be used to guide the finalization of the treatability testing of the other sites ashpond leachate / groundwaters. Each of the individual sites unique water geochemical conditions, MOC, and hydraulics will require evaluation to ensure a reliable treatment approach design for each site.

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LIST OF TABLES

1.0 INTRODUCTION

XDD Environmental (XDD) was retained by Ameren Services (Ameren) to perform metals treatability studies on ashpond leachate / groundwater from four sites: Rush Island Energy Center (RIEC), Meramec Energy Center (MEC), Labadie Energy Center (LEC), and Sioux Energy Center (SEC). The primary objective of the studies was to evaluate potential remedial technologies for metals of concern (MOC) identified as part of the requirements of United States Environmental Protection Agency (USEPA) 40 CFR Part 257 "Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals From Electric Utilities; Final Rule" (the CCR Rule). The CCR Rule requires owners or operators of existing CCR units to produce an Annual Groundwater Monitoring and Corrective Action Report (Annual Report) each year (§§ 257.90(e)). XDD was provided, through a third party, data from the annual reports, samples from compliance wells with previously identified elevated MOC concentrations, and applicable statistically determined action levels (target goals for MOC treatment) for each site.

The treatability studies were developed and completed using a conservative approach of testing groundwaters from the areas of highest MOC concentrations, with the understanding that proposed engineered caps for each site should result in reduced MOC groundwater concentrations over time. Though the MOC and regulatory concerns are similar at each site, site-specific groundwater geochemistry's and varying MOC concentrations required XDD to approach treatment for each site separately. This approach ensures certainty in the MOC treatment effectiveness based on the differing site conditions and MOC concentrations for each site. It also provides for information needed in developing a treatment train specific to each site to address the differing geochemical conditions.

Initially, the primary MOC at the sites (though not all present at all sites) were arsenic, molybdenum, and lithium. Other potential MOC carried through the studies for each site (though again not all present at all sites) included boron, lead, cobalt, and selenium. A key component of the study was to determine if a potential MOC treatment approach would affect other metals in site groundwater and soil in either a positive (reduced concentration) or negative (increased concentration) manner. Baseline MOC / metals concentrations for all four sites (five locations; two sample sets being studied at MEC due to the presence of localized lithium) are presented in **Table 1**. The initial conceptual remedial approach was to treat the metals in situ, taking advantage of the slow moving groundwaters at the sites (allowing weeks of treatment time for MOC removal to occur), and for the potential for the most cost-effective treatment.

Around June 2019, during the performance of the treatability studies, per direction from Ameren, boron was transitioned from a potential MOC to a primary MOC, to account for an anticipated revision in the CCR Rule compliance. With this transition, any remedial option would be required to include boron treatment to below the applicable action. The complexity of in situ treatment of boron and its limited treatability options became a primary driver to change the conceptual treatment approach to ex situ treatment for the sites groundwaters.

This report focuses on the initial literature research conducted for all sites, initial treatability testing of the leachate / groundwater for all sites (for in situ treatment), then a refocus of the studies to consider ex situ treatment of the MOC (with boron added as a MOC), and finally the refinement of the treatment effectiveness and development of a MOC remedial approach for pilot testing at RIEC. The results from the additional treatability studies performed for RIEC will be used to guide refinement of the treatability studies and pilot test design for the other three sites (MEC, LEC, and SEC).

The three primary approaches for metals removal from groundwater are:

- **Precipitation:** Transformation of a dissolved species to a solid form, which can then settle out of suspension.
- **Coprecipitation with other minerals**: Transformation of a dissolved species to a solid form that combines with another material (such as iron), which can then then settle out of suspension.
- **Adsorption**: Introduction or production of a solid that will absorb the MOC from the groundwater.

The treatability studies for each site consisted of two phases; with a final / third phase conducted on RIEC only, at this time, each of the three phases of testing are described below:

- Phase 1 – Site Review and Data Evaluation for Preparation of the Treatability Study Design (**Appendix A**)
  - Compare site-specific data to each site's MOC target goals and develop a conceptual MOC remedial approach based on a summary of the site-specific geochemical and hydrological conditions.
  - Evaluate existing literature to identify potential remedial options for the MOC to be tested for each site.
- Phase 2 – Bench-Scale Treatability Study for In Situ Remediation of MOCs
  - Based on the literature review results from Phase 1, bench-scale reactors were developed, using site soil and groundwater, to evaluate promising in situ treatment technologies or treatment trains. Treatment options identified in the Phase 1 review included (**Table 2**):
    - pH adjustment

        - Addition of calcium polysulfide (CaSx)
        - Addition of dissolved iron
        - Addition of microscale zero valent iron (ZVI)
        - Addition of particle size ZVI
        - Biodegradation / biostimulation in conjunction with ZVI.
    - The focus of Phase 2 testing was to identify specific MOC removal methods from site groundwater over the course of a one month treatment period without adversely affecting other MOCs in the groundwater (e.g., mobilizing MOCs present on site soils). The one month treatment period was selected based on the groundwater flow rates from the proposed in situ treatment application area to the regulatory point of compliance; actual site-specific treatment periods will have some variance greater than this selected period.
- Phase 3 –Treatment Train Development for Ex Situ Remediation of the MOCs at RIEC
    - Per above, boron was added as a primary MOC during the Phase 2 testing timeframe. The limitation to the availability and the complexity of in situ remedial options for boron removal, along with concern for long-term aquifer clogging from MOC precipitation / coprecipitation, caused a change in the conceptual remedial approach for the sites from an in situ to an ex situ treatment train process. The primary consequence of the change was the available time for treatment of metals in an above-surface treatment train. For in situ remediation, a one month MOC treatment period was readily available for the sites; however, for practical and cost-effective ex situ MOC remediation, the treatment period would need to be reduced to minutes to a few hours, dependent upon groundwater extraction rates and storage limitations of the ex situ treatment processes.
    - Additional literature research suggested that the most reliable approach for removal of boron from groundwater was boron selective ion-exchange resins (resin)
    - Based on the RIEC Phase 2 treatability study results, ZVI and pH adjustment were identified as potential effective in situ remedial options for the initial MOCs at RIEC. One of the ZVI products tested in Phase 2 was effective on boron, though pH adjustment had no effect. Accordingly, the following column tests were conducted in the Phase 3 testing:
        - Initial groundwater pH adjustment, followed by passing groundwater through a column filled with a ZVI/sand mixture for treatment of arsenic

    and molybdenum, with evaluation of the treatment effectiveness of that system for boron

    - pH adjustment of groundwater to approximately pH 6, followed by passing the groundwater through a sand column for treatment of arsenic and molybdenum only
    - Addition of a column filled with resin after the ZVI/sand column and the pH followed by sand column tests, for additional treatment of boron

  - Based on the change to an ex situ remedial approach, requiring fast treatment periods (faster reaction kinetics), additional literature research identified the addition of ferric chloride to the groundwater as a potential approach for rapid arsenic removal through coagulation / flocculation / precipitation. The following additional tests were conducted to further evaluate ex situ treatment of arsenic and molybdenum:
    - Initial groundwater pH adjustment, followed by the addition of ferric chloride, followed by settling of the developed precipitants and filtration to remove the suspended precipitants from the groundwater
    - A resin filled column after the above filtration step for treatment of boron

Details on each of these three phases of treatment are provided in the following sections of this report.

2.0 PHASE 1 LITERATURE REVIEW

An extensive literature review was conducted for in situ treatment and general chemical behavior of the MOC prior to the selection of remedial options for consideration for the sites. The results of the literature review are presented in **Appendix A**. The literature review was necessary since the MOC precipitate, co-precipitate, or adsorb under varying geochemical conditions; however, these preferred MOC treatment geochemical conditions may result in increased mobility of other metals / MOC at the sites. The literature review identified the geochemical conditions that were either favorable for the MOC to be removed from the groundwater or would not negatively affect other MOC present. From this research, potential treatment trains were identified for remediating site MOC and for Phase 2 treatability testing.

3.0 PHASE 2 – TREATABILITY TESTING

3.1 Phase 2 Experimental Procedures

Based on the initial literature review, five mechanisms were identified as possible treatment approaches for the in situ removal of arsenic, molybdenum, and lithium from the sites groundwaters. The selection of arsenic, molybdenum, and lithium as the MOC was based on detections above the provided statistically-derived action levels for at least one of the four sites evaluated (**Table 1**). Boron was initially not on the list of primary MOC but as a metal being analyzed for since it does not have a current regulatory required action level. Boron was added as a primary MOC in the Phase 3 testing, per the request of Ameren and as a statistically-derived action level for each site was provided.

Below is a summary of each of the Phase 2 potential in situ approaches tested. A breakdown of the experimental setup for the approaches tested are presented in **Table 2**.

1. pH adjustment (7-day test)
    - For the pH adjustment, a range of pH of 6 to 10 was evaluated for RIEC to determine how the MOC concentrations would change as the pH decreased (at RIEC the initial pH in groundwater from monitoring well MW-2 was 11). Reduction and maintaining a pH of 6 resulted in arsenic and molybdenum removal after a week of treatment, without adversely affecting the concentrations of the other MOC present; therefore, this approach was maintained for testing of the other sites groundwaters.
2. Addition of calcium polysulfide (CaSx) (7-day test)
    - CaSx has been proven to reduce certain dissolved metal concentrations through forcing of reduced groundwater chemistry and subsequent metal sulfide formation. The dosage of CaSx used in these tests was based on a 1:2 mass of metals to mass of CaSx, with a 100 percent (%) safety factor (**Table 2**).
3. Addition of ferrous iron (4-week test)
    - The RIEC site groundwater samples have low concentrations of dissolved iron; dissolved iron is beneficial for the coprecipitation of certain MOC and as a sorbent for MOC. Dissolved iron (ferrous sulfate at 50 mg/L) was added to the site groundwater and soil. The test was conducted under both aerobic and anaerobic groundwater chemistries to determine if coprecipitation or sorption of the MOC can be induced.

4. Addition of ZVI (4-week test)
    - ZVI can also introduce dissolved iron, under anaerobic conditions, into groundwater for coprecipitation and possible adsorption of the MOC.
    - Two ZVI products were evaluated as potential remedial options: a microscale (7 micron) product, which is typically injected into the subsurface, and granular ZVI, which is commonly used in permeable reactive barriers (PRBs) (SR.25 particle size). Given the MOC concentrations present in site groundwater, ZVI dosages were established for the RIEC and MEC (MW-5 and MW-6) sites, based on manufacturer recommendations. While preliminary results from this approach suggested ZVI as a promising method for MOC removal, the required ZVI dosage was determined to be impractical for full-scale implementation. The ZVI dosage for the LEC and SEC site treatability tests were reduced to more practical dosage levels (see **Table 2**).
5. Biostimulation with ZVI addition (8-week test)
    - Test conditions, described in Test 4 above, were duplicated with the addition of food and nutrients, which are typically lacking in site groundwater and soils, to promote biotransformation of metals from a soluble to an insoluble form. Since biological processes are often slower than chemical processes, the biostimulated reactors were maintained for twice as long a treatment period as the ZVI only reactors (8 weeks vs. 4 weeks).

3.2 Phase 2 – Treatability Testing - Results

The results of the metals in groundwater analyses for the Phase 2 testing are presented in **Table 3** (RIEC), **Table 4** (MEC, MW-5), **Table 5** (MEC, MW-6), **Table 6** (LEC), and **Table 7** (SEC) for the in situ treatment approaches tested. The Phase 2 testing results suggest:

- A pH adjustment to 6 resulted in the reduction of arsenic and molybdenum to near action levels at all sites (Test 1).
- There was some benefit to using the granular size ZVI and a pH adjustment (reduction to 6) for the removal of arsenic and molybdenum (Test 4). Granular ZVI achieved action levels for arsenic and molybdenum for all sites, with the exception of molybdenum at SEC.
- There was minimal reduction in total metals concentrations for the tests conducted at a pH greater than 8 (Test 1).

- There was minimal reduction in MOCs as a result of treatment with CaSx, dissolved ferrous iron, or biostimulation (Tests 2, 3, and 5, respectively).
- Microscale ZVI was the only product tested that reduced boron to action levels for all sites, except for SEC.

Upon completion of the Phase 2 testing, per the request of Ameren, boron was added as a primary MOC with an action level of 4 mg/L. Of the approaches tested, microscale ZVI was the only approach that had a positive impact in reducing boron levels in groundwater. The literature research, supported by the phase 2 test results, suggests boron is most efficiently and reliably treated via ex situ filtration through a ion-selective resin. Given the addition of boron as a primary MOC and with concerns of long-term clogging of the site aquifers from metals precipitation, it was collectively decided to change the conceptual remedial approaches from an in situ to an ex situ treatment process. At this point in the testing (entering Phase 3), it was suggested by XDD and presented to Ameren, to focus on developing an ex situ remedial approach for RIEC to expedite the design and testing of a pilot scale system. The proposed Phase 3 treatability work and developed pilot test approach for RIEC would then be used to guide future Phase 3 testing and pilot test designs for the other sites (MEC, LEC, and SEC). An additional advantage of an ex situ remedial approach is the flexibility and ease of adjustment of an ex situ treatment system, given the variability in the groundwater geochemistry's and hydraulics across the four sites under evaluation. In addition, changes in site groundwater conditions are expected over time as both the consequences of the engineered cap placement and the potential ex situ treatment implementations stabilize, with respect to groundwater MOC concentrations.

4.0 PHASE 3 – TREATABILITY TESTING - RIEC

4.1 Phase 3 Experimental Procedures

The Phase 3 treatability testing focused on refining the ex situ remedial approach for RIEC and to finalize the RIEC pilot test design. The initial results from the Phase 2 testing for the in situ treatment of the MOC at RIEC, conducted in batch reactors with site groundwater and soil, supported that pH adjustment and the addition of ZVI were the most promising remedial options for treatment of arsenic and molybdenum (the primary MOC at RIEC) to action levels. The phase 3 testing consisted of a treatment train that was scaled, for the bench testing, using an ex situ conceptual pilot test design sized to fit within single or double Conex box (portable storage unit) treatment units, that could be positioned above ground at any of the sites.

The major design issue, refined in the Phase 3 testing, was the transition from the Phase 2 test results developed for an in situ treatment approach, to a reliable ex situ treatment train. For ex situ treatment to be practical and cost-effective the time of reaction (kinetics) to create precipitants needs to be on the order of minutes to a few hours. For the in situ approaches tested in Phase 2, a month-long contact time was available between amendments addition and for precipitation of metals to occur (based on the site groundwater velocity and distance from the remedial implementation area to the compliance sampling locations). For the in situ reaction timeframe, batch reactors were ideal. The required reaction timeframes for the Phase 3 testing made it necessary to use columns in the test procedures and to scale the reactor sizes and groundwater flow rates to match the conceptual field pilot and full-scale Conex box remedial systems sizing.

The Phase 3 treatability tests were also scaled for site hydraulics, assuming a 200-ft long cross-sectional treatment length, perpendicular to impacted groundwater flow, at the RIEC. Site-specific groundwater modeling was performed to determine the full-scale groundwater capture / flow rates required to permit an approximate 6 to 12-month pilot test duration to demonstrate the effectiveness of the treatment train. The pilot test treatment results need to be reflected both within the ex situ treatment process sampling points but also in existing compliance monitoring wells located within and downgradient of the treatment system hydraulic capture zone. For the RIEC site, the projected pilot test groundwater flow rate was estimated at 8 gallons per minute (gpm) (2 gpm per well) which is approximately four times the projected full-scale required groundwater flow rate.

It was also initially estimated that the ex situ treatment vessels (either filters or settling tanks) within the proposed Conex box system would have to be on the order of 750 to 1,000 gallons maximum capacity to fit in the unit, and that the Phase 3 testing would need to have reaction timeframes (kinetics) that would match the available vessel sizing. To scale the pilot test treatment train conceptual design to the Phase 3 treatability study design, the treatability study columns were made 3-inch (in) long and 1.5-in in diameter, with a groundwater flow rate of 0.7 milliliters per minute (mL/min).

Based on the results of the literature research and the Phase 2 testing, the initial Phase 3 tests were conducted with pH adjustment to pH 6 for the RIEC groundwater. The pH adjusted groundwater was then passed through a sand filter (with a residence time of 40 minutes) for arsenic and molybdenum removal. The pH adjusted groundwater was also tested by adding dissolved iron either via a ZVI/sand filter or by the addition of ferric chloride. Ferric chloride was incorporated into the Phase 3 testing due to the potential faster reactions times to create metal precipitates, per the discussion in Section 1 of this report. The ferric chloride was added to the groundwater to a concentration of 40 mg/L, the ferric chloride treated groundwater was passed into a settling vessel with a residence time of 1.25 hours, the metals were allowed to precipitate and settle, and the treated groundwater was passed through either a bag or a sand filter.

Since pH adjustment and iron addition had proved ineffective at boron removal in the Phase 2 testing, a resin filter was added to the effluent of the pH and iron addition ex situ treatment processes tested to evaluate the resins effectiveness for boron removal given the RIEC groundwater geochemistry. The resin was added post pH and ferric chloride addition as the resin is relatively expensive and focusing its use on the boron only is considered an overall more cost-effective approach for the groundwater treatment.

4.2 Phase 3 – Treatability Testing – RIEC – Results

Ferric Chloride ($FeCl_3$) Addition

The ex situ treatment method that proved most successful and reliable in the Phase 3 testing for pilot and full-scale implementation at the RIEC site is the pH adjusted, $FeCl_3$ aided flocculation / removal of arsenic and molybdenum. Preliminary testing with the ZVI and pH adjustment, discussed below, helped guide the design of the $FeCl_3$ treatment train. Understanding that the resin can be successful at removing boron at the concentrations present at the RIEC, Phase 3 testing focused on arsenic and molybdenum removal and developing a removal approach that worked effectively in the available ex situ treatment timeframes.

A preliminary Phase 3 test was performed to evaluate varying dosages of $FeCl_3$ and pH adjustment specific to the treatment of the arsenic in the RIEC groundwater. A kinetics / rate of treatment / reaction test was conducted where $FeCl_3$ was added to the groundwater and allowed to react, flocculate / precipitate and settle out of the groundwater for periods of 1 hour, 3 hours, and 6 hours, prior to flowing the groundwater through a sand filter column (**Table 8**). Since arsenic(V) is the form of arsenic that coprecipitates more readily with iron, hydrogen peroxide was tested as an oxidizer to transform any arsenic(III) in the groundwater to arsenic(V), prior to removal with the $FeCl_3$ addition. The results from the preliminary $FeCl_3$ tests suggested that:

- Both arsenic and molybdenum can be reduced to concentrations at or below action levels, using $FeCl_3$ addition.
- An initial pH of 6 (prior to the addition of $FeCl_3$) caused faster settling of the precipitants than an initial pH of 4 (also, pH 6 was determined to be a more favorable pH for RIEC groundwater treatment, based on the Phase 2 test results).
- Higher $FeCl_3$ dosage (40 mg/L vs. 20 mg/L) provided greater removal of arsenic and molybdenum. Though the difference in $FeCl_3$ dosage performance for the RIEC groundwater was not significant, based on the concentrations detected in the groundwater and the applicable action levels for the MOC at the RIEC site. The dosage evaluation results were however considered beneficial for refinement of Phase 3 testing for the other sites.

- The additional of hydrogen peroxide did not improve the arsenic removal efficiency. However, a check on the arsenic form in groundwater at RIEC showed the arsenic to be predominantly arsenic(V), so the pre-oxidation step was not needed for RIEC.

The reaction time determined for the $FeCl_3$ coagulation and flocculation / precipitation and associated removal of arsenic and molybdenum from groundwater in the preliminary testing was adequate for the conceptual ex situ treatment approach.

Following the preliminary testing it was considered beneficial to run further testing to confirm the preliminary test results, and to optimize the pilot test design. Based on additional literature research, aeration of the groundwater prior to $FeCl_3$ addition was added as a treatment step. Additional treatability tests were conducted using pH adjustment of the RIEC groundwater to approximately 6, followed by addition of 40 mg/L of $FeCl_3$, followed by settling and filtration of precipitants using either sand or bag filters. The treated groundwater was then passed through the resin filter for boron removal. Results of these additional tests are presented in **Table 9**. Key observations and conclusions from the additional $FeCl_3$ testing are:

- Aeration of the groundwater prior to the addition of $FeCl_3$ accelerates the formation of precipitants.
- Influent pH should be close to pH of 6 at RIEC for optimal precipitant settling times.
- Higher $FeCl_3$ concentrations added to the groundwater appear to provide larger precipitant particles that settle faster. However, the higher dosage of $FeCl_3$ will also increase the sludge volume that will require additional disposal and may increase maintenance needs.
- 100-micron bag filters are insufficient to remove the arsenic particles in the groundwater (and reduce total arsenic concentrations to below action levels). Though 10-micron filters work effectively to meet action levels, the 10-micron filter is likely to cause operational issues in a pilot and full-scale system and is therefore not a preferred treatment option. Also, bag filters are unlikely to remove iron in the treated groundwater to below 2 mg/L, which may negatively impact the resin filter longevity.
- The sand filter was effective as a polishing step to reduce total arsenic and molybdenum concentrations to below action levels, while also decreasing total iron concentrations to approximately 0.3 mg/L. Sand filtration is therefore recommended for the pilot scale system.
- The resin filter is needed to remove boron from the groundwater to action levels. The resin operates optimally between a pH of 4 and 10. The $FeCl_3$ addition reduces the

groundwater pH to approximately 4 so pH adjustment back to pH 6 is recommended prior to resin treatment.

- Though total lead is reported in groundwater at RIEC below action levels, the $FeCl_3$ addition reduced the total lead concentration from 0.0057 mg/L to 0.0026 mg/L or lower, suggesting that $FeCl_3$ is a potential option at other sites for treatment of total lead levels which exceed action levels.

pH Adjustment followed by Resin Column Treatment

The Phase 2 pH adjustment only bench testing had proven effective for arsenic and molybdenum removal (though not boron) over a week-long treatment period in the presence of site soils. The Phase 3 tests included an evaluation of pH adjustment followed by the resin as an alternative RIEC treatment train. Since the resin is specially designed for boron removal, the manufacturer could not provide insight into its effectiveness, performance or sustainability for arsenic or molybdenum treatment, so it was assumed that pre-treatment to remove arsenic and molybdenum was still needed.

The columns tests were conducted by decreasing the pH of the RIEC groundwater to pH 5 then passing the pH adjusted groundwater through a sand filter sized to provide a hydraulic residence time of 40 minutes. The filtered groundwater was then passed through a resin column. Groundwater exiting the resin column were collected for analysis of MOC (**Table 10**). The analysis results showed that MOC action levels were achieved after Days 1 and 3 of treatment for all MOCs; however, breakthrough of arsenic occurred by Day 7.

Groundwater samples collected between the sand filter and the resin columns showed that the pH adjustment by itself did not effectively treat the arsenic or molybdenum in the groundwater, over the short treatment period available in the scaled ex situ treatment train. Consequently, it was determined that the resin was responsible for the removal of arsenic, molybdenum, and boron in the RIEC groundwater. A further review of the data and the procedures used in this test suggests that for pH adjustment to be successful for removing arsenic and molybdenum from the RIEC groundwater, the groundwater needs to be maintained at a reduced pH for longer than 40 minutes (the residence time in the tested columns). Hence, pH adjustment alone would not be a viable ex situ treatment approach as an ex situ treatment system design.

Further, while the resin was successful at temporarily removing arsenic, molybdenum, and boron, it was not designed for arsenic and molybdenum treatment, and the arsenic concentration reduction could not be sustained below REIC action levels for up to a week. This indicates that a large resin vessel and / or frequent regeneration of the resin would be needed for resin to be considered as a stand-alone treatment approach. Also, since the resin was not designed to remove arsenic and molybdenum, it is unknown if the metals will desorb during the resin regeneration, in which case, the resin could be ineffective for further arsenic and molybdenum removal. The adsorption capacity of the resin for arsenic and molybdenum should only be considered as a safety factor in the final pilot test design, if the pretreatment for arsenic and molybdenum failed, but not as a stand-alone remedial option.

ZVI Column Testing

Since the microscale ZVI was identified in the Phase 2 tests as a possible approach for removing boron, arsenic, and molybdenum from the RIEC site groundwater, test columns were constructed using a mixture of the microscale ZVI and commercial sand (to allow the required flow through the column / ZVI, without clogging due to the ZVI microscale particle size). The columns were prepared using a 5:1 ratio of sand to microscale ZVI, and a 2:1 ratio of sand to microscale ZVI. The columns were operated for 7 days, with treated groundwater samples collected from the column effluent after 1, 3, and 7 days of treatment time (simulating groundwater treatment over a one week period through a pilot or full-scale 1,000-gallon capacity column / filter).

Table 11 presents the results of the ZVI column testing. The results show partial treatment of arsenic and molybdenum, though not to action levels. Both the 5:1 and 2:1 sand to ZVI dosed columns showed some treatment occurred the first day, but treatment effectiveness decreased by Days 3 and 7. Results for both the columns showed that concentrations did not decrease to action levels for arsenic, and results for only one column sample showed that molybdenum concentrations decreased to action levels (Day 1 of the 5:1 dose column). Boron concentrations did not change passing through the ZVI columns.

From the Phase 3 test results, it was determined that the ZVI treatment effectiveness (at the design sand to ZVI dosages) and the associated treatment longevity was questionable, and likely not reliable as a sustainable remedial option. To ensure the ZVI was being adequately evaluated, XDD had additional discussions with the ZVI vendor on the system design and effectiveness. It was determined that the recommendations by the vendor on how to use ZVI in an ex situ process was impractical for the site given the conceptual pilot test design constraints (action levels, MOC, flow rates, vessel sizing, etc.).

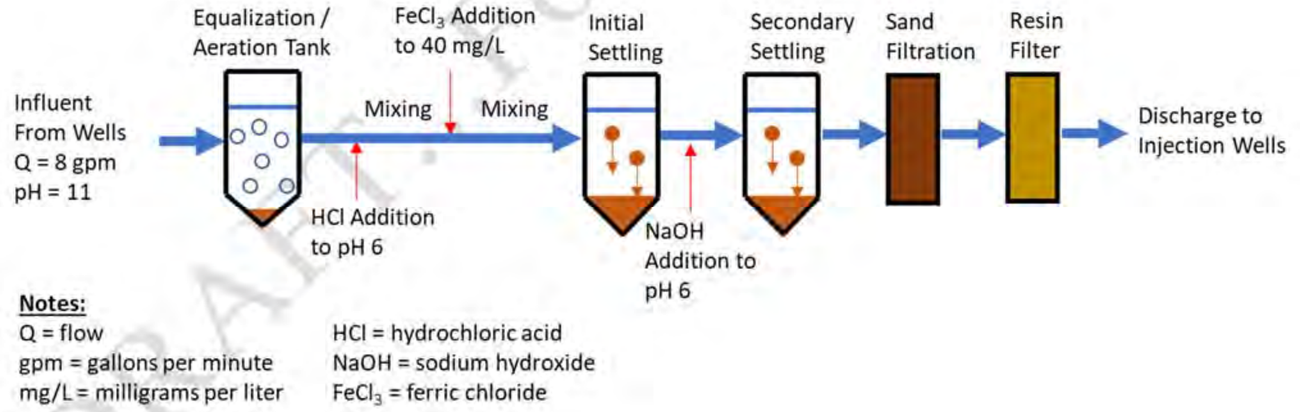
5.0 CONCLUSIONS AND RECOMMENDATIONS FROM TREATABILITY TESTING

Several potential treatment technologies were evaluated for the MOC at the sites. While ZVI and pH adjustment were the most promising remedial approaches from the Phase 2 testing for in situ treatment of the initially identified primary MOC, the subsequent addition of boron as a primary

MOC resulted in the requirement to transition to an ex situ remedial approach. Added benefits of the transition to an ex situ remedial approach are concerns with potential aquifer clogging from in situ MOC precipitation and the benefits of the flexibility in ex situ system design for varying site groundwater geochemistry's. The difference in available and practical treatment times (reaction kinetics) for in situ treatment versus ex situ treatment systems resulted in the elimination of the ZVI and pH adjustment alone technologies as viable ex situ remedial options and the evaluation of additional technologies for the MOC treatment.

Based on the results of the Phase 1 through Phase 3 treatability testing, the proposed treatment train identified for the RIEC pilot test is presented below in **Figure 1**. Modifications and optimizations to the treatment train will be evaluated during the pilot scale startup. The Phase 3 remedial approach refinement testing demonstrated that pH adjustment, followed by $FeCl_3$ aided coagulation/flocculation for arsenic and molybdenum treatment of the RIEC groundwater was effective and reliable. Boron removal requires the addition of an ion-specific resin following the $FeCl_3$ treatment. To expedite the arsenic and molybdenum removal, aeration of the groundwater prior to pH adjustment and the addition of 40 mg/L of $FeCl_3$ is required. The $FeCl_3$ reduces the groundwater pH to approximately 4 so pH adjustment back to pH 6 is recommended prior to resin treatment for boron removal.

Figure 1: Conceptual Treatment Train for Pilot Scale System at RIEC



Notes:
Q = flow
gpm = gallons per minute
mg/L = milligrams per liter
HCl = hydrochloric acid
NaOH = sodium hydroxide
$FeCl_3$ = ferric chloride

Going forward, MEC, LEC, and SEC have similar MOC to RIEC (primarily molybdenum and boron) but with a few distinct deviations from the RIEC groundwater quality. The main points of difference that need to be considered in subsequent Phase 3 testing for the individual sites are:

- At MEC (monitoring well MW-6), lithium has been detected above action levels. The literature review performed during Phase 1 (**Appendix A**) suggests ZVI is a viable remediation approach for lithium; it is suspected that $FeCl_3$ may also be effective at lithium removal.

- The boron concentration at SEC is above the manufacturer's maximum concentration recommendation for the resin (10 mg/L maximum vs. 22 to 25 mg/L measured at SEC). A recirculation method or resin vessels in series may be needed to reduce the boron concentration in SEC groundwater to meet action levels in the resin treated groundwater.
- SEC also has significantly higher molybdenum concentrations (3.05 mg/L) than RIEC (0.16 mg/L) so testing is needed to ensure $FeCl_3$ can be effective at removing molybdenum to action levels at these higher groundwater concentrations.
- Higher remediation system flow rates are likely to be encountered at some of the sites (in particular LEC) so refinement of the system hydraulics and available treatment timeframes need to be evaluated.
- The high pH at RIEC resulted in the need for an initial pH adjustment. This may not be necessary at the other locations, but confirmation tests should be performed.
- $FeCl_3$ flocculation / precipitation is facilitated with increased groundwater alkalinity. Additional alkalinity may be needed to be added to the treatment systems at the other sites to increase the rates of formation and settling of the precipitants.
- General groundwater geochemistry's are also likely to have subtle differences for the other sites. Testing is needed to provide confidence in the effectiveness of the treatment train at the other sites / locations.

The information gathered in the Phase 3 RIEC treatability testing will be used to guide the design of treatability testing and remedial approaches for the other three sites.

APPENDIX A: PHASE 1 LITERATURE REVIEW

Primary Metals of Concern

Arsenic

- Detected at 0.22 milligrams per liter (mg/L) (RIEC) and 0.02 mg/L (MEC, monitoring well MW-5). Arsenic was not detected at LEC, SEC, or at monitoring well MW-6 at MEC.
- Action levels are 0.030 mg/L (RIEC), 0.01 mg/L (MEC and SEC), and 0.0426 mg/L (LEC).
- Potential treatment methods include precipitation/coprecipitation, pH adjustment, adsorption, and ZVI/ZVI with carbon:
    - Speciation – trivalent arsenite [As (III)] is more soluble and mobile than pentavalent arsenate [As(V)].
    - Redox – arsenic is more readily mobilized under reducing conditions.
    - pH – mobility is lowest at pH 3 to 7, increases under very acidic or alkaline pH conditions.
    - Competing ions – phosphate and sulfate can limit arsenic adsorption and increase mobility.
    - Adsorption – iron oxides sorb arsenic and can greatly limit arsenic mobility.
    - Precipitation – formation of insoluble calcium arsenates can reduce leaching and mobility.
- Application of ferrous sulfate to soils has shown promise in reducing arsenic concentrations in groundwater at utility substation sites (EPRI, 2010).
    - Data review has shown that both RIEC and MEC lack iron – this indicates ZVI treatment may be promising.
- pH adjustment in trench application case study: The pH was raised from 1.93 to 7.9, leading to a reduction in groundwater arsenic concentrations from 35,000 micrograms per liter (µg/L) to <4 µg/L (EPRI, 2006).
- Summary of favorable conditions for arsenic removal:
    - pH range of 3 to 7, oxidizing conditions
    - Addition of Iron and calcium complexes
    - Low phosphate and sulfate concentrations

Molybdenum

- Detected at 0.16 mg/L (RIEC), 0.11 mg/L (MEC, monitoring well MW-5), 0.15 mg/L (MEC, monitoring well MW-6), 0.155 mg/L (LEC), and 3.05 mg/L (SEC).
- Action Level is 0.1 mg/L for all sites.
- Potential treatment methods include precipitation/coprecipitation, pH adjustment, adsorption, and ZVI/ZVI with carbon

- Molybdenum adsorption is highly pH-dependent. Peak adsorption for most sorbents (except maghemite nanoparticles) occurs at pH < 5 and limited adsorption occurs at pH > 8. In alkaline conditions, molybdenum behaves conservatively, and its dissolved concentration is controlled by precipitation, not adsorption, reactions (EPRI, 2011).
- Permeable Reactive Barrier (PRB)/ZVI/pH adjustment case study: Molybdenum was sequestered under reducing/oxidizing conditions with pH 7.3 to 10; effective for 15 months (reducing conditions sustained for 5 to 9 months) (Bellantoni, 2014).
- Summary of potential treatment options for molybdenum removal:
    - Maintaining a neutral or slightly alkaline pH with ZVI addition.

<u>Lithium</u>

- Detected at 0.12 mg/L (MEC, monitoring well MW-6), and either non-detect or below action levels at the other sites.
- Action Levels are 0.0647 mg/L (RIEC), 0.04 mg/L (MEC and SEC), and 0.055 mg/L (LEC).
- Potential treatment is limited to precipitation using ZVI PRBs.
- "Additional research is needed to evaluate, and possibly develop, in situ groundwater treatment technologies for lithium, specifically reagents for in situ injection or media for a permeable reactive barrier. Zeolites such as clinoptilolite and clays such as bentonite and kaolinite have been shown to exhibit lithium-sorbing characteristics in a laboratory setting, making these candidates for future in situ injection and PRB application studies" (EPRI, 2018).
- Summary of potential treatment options for lithium removal:
    - ZVI

<u>Boron</u>

- Detected at 3.85 mg/L (RIEC), 5.2 mg/L (MEC, monitoring well MW-5), 7.9 mg/L (MEC, monitoring well MW-6), 7.9 mg/L (LEC), 23.5 mg/L (SEC).
- Action Level is 4 mg/L for all sites.
- "Additional research is needed on the mechanisms of boron attenuation, both precipitation and adsorption, for a wider range of soil and mineral types, and in hydrogeologic environments typical of CCP management sites. While the literature suggests nonlinear sorption and some dependence on general soil type and pH, these relationships are not well understood. The same is true for competing ion effects, such as sulfate and fluoride. In addition, there are few field studies documenting boron attenuation at utility sites" (EPRI, 2005).

- "There is a need to measure boron sorption in the alkaline pH range associated with ash leachate, and to make these measurements with a wider range of soil and mineral types. Moreover, there are relatively few field-scale studies available on the fate and transport of boron derived from coal ash in groundwater. Studies based on site-specific sorption, hydrogeologic, and leaching data may yield a better understanding of the long-term impacts of boron from coal-combustion residues (EPRI, 2005)."
- Case study: pH adjustment to > 9.1 and the addition of proprietary ionizing agents resulted in 99% removal (sorption of boron complexes) (Kreinberg, 2017).
- Summary of potential treatment options for boron removal:
    - ZVI or boron specific ion-exchange resin (ex situ)

Metals of Concern Potentially Released as a Result of Treatment:

Cobalt

- Not detected in baseline samples collected at any of the sites.
- Action Level is 0.006 mg/L for all sites.
- Potential treatment methods include ZVI PRB and carbon substrate injections
    - Ontario ZVI case study: sulfate-reducing conditions (anaerobic, ORP <-250 mV), cobalt remediation achieved (reduction of ~260 parts per billion [ppb] to 40 ppb) (Pare, 2014, RPIC).

Lead

- Either reported below action levels or not detected in baseline samples collected at all sites.
- Action Level is 0.015 mg/L for all sites.
- Potential treatment methods include metal cation precipitation as sulfides, adsorption to iron corrosion products, pH adjustment using Acid-B Extra™ reagent (10%) (EPRI, 2006).
    - Success Mine PRB case study: Lead was reduced from 0.658 mg/L upgradient of the PRB to <0.002 mg/L downgradient of the PRB. The pH was buffered from 4.9 to 6.9 throughout the thickness of the barrier wall. PRB is anaerobic and creates conditions optimal for sulfate-reducing bacteria. Expected to provide treatment for 30 years (EPRI, 2006).
    - Case study at Gilt Edge Mine, SD: leachate pH was raised from 1.93 to 7.9, resulting in the following reductions in metals concentrations: arsenic from 35,000 µg/L to <4 µg/L, antimony from 500 µg/L to 10 µg/L, and lead from 390 µg/L to <10 µg/L (EPRI, 2006).

Selenium

- Not detected in baseline samples from any of the sites.
- Action Level is 0.05 mg/L for all sites.
- Potential treatment methods include reductive precipitation with oxidized iron minerals, adsorption to iron oxides, ZVI, and ZVI/carbon – many positive case studies (EPRI, 2006)
- Oxyanions (e.g., arsenic, chromium, selenium, molybdenum, vanadium, and sulfate) adsorb most strongly at low pH levels and cations (e.g., lead, cadmium, and nickel) adsorb most strongly at high pH levels.
- Like arsenic, selenium is generally present in predominantly two oxyanion forms in natural waters: Se (IV) as selenite ion SeO_3^{-2}, and Se (VI) as selenate ion SeO_4^{-2}. Selenite tends to dominate in impoundment settings when the source coal is bituminous or a mixture of bituminous and subbituminous, while selenate tends to predominate in landfill settings and when the source coal is subbituminous/lignite (EPRI, 2006). Selenate is generally soluble and mobile and is readily taken up by organisms and plants. Selenite is less soluble and mobile than selenate; therefore, reductive precipitation/coprecipitation of selenium could serve as a viable remediation approach. However, re-oxidation is a potential problem. Phytoremediation has also been reported and adsorption has been used.

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Tables

Table 1

Baseline Metal Concentrations and Action Levels

Ameren Services, Missouri

	Rush Island			Meramec MW-5			Meramec MW-6		
	Action Levels	Baseline/Baseline Dup		Action Levels	Baseline/Baseline Dup		Action Levels	Baseline/Baseline Dup	
	Total Metals (mg/L)								
Arsenic	0.03	0.22	0.22	0.01	0.020	0.020	0.01	0.005 U	0.005 U
Molybdenum	0.1	0.16	0.16	0.1	0.11	0.11	0.1	0.15	0.15
Boron	4	4.0	3.7	4	5.2	5.2	4	7.8	8.0
Lead	0.015	0.007	0.007	0.015	0.005 U	0.005 U	0.015	0.005 U	0.005 U
Cobalt	0.006	0.01 U	0.01 U	0.006	0.01 U	0.01 U	0.006	0.01 U	0.01 U
Selenium	0.05	0.01 U	0.01 U	0.05	0.01 U	0.01 U	0.05	0.01 U	0.01 U
Lithium	0.0647	0.06 U	0.06 U	0.04	0.06 U	0.06 U	0.04	0.12	0.12

	Labadie			Sioux		
	Action Levels	Baseline/Baseline Dup		Action Levels	Baseline/Baseline Dup	
	Total Metals (mg/L)					
Arsenic	0.0426	0.025 U	0.025 U	0.01	0.025 U	0.025 U
Molybdenum	0.1	0.15 J	0.16 J	0.1	3.20 J	2.90 J
Boron	4	7.7	8.1	4	25.0	22.0
Lead	0.015	0.025 U	0.025 U	0.015	0.025 U	0.025 U
Cobalt	0.006	0.05 U	0.05 U	0.006	0.05 U	0.05 U
Selenium	0.05	0.05 U	0.05 U	0.05	0.05 U	0.05 U
Lithium	0.055	0.019 J	0.016 J	0.04	0.029 J	0.020 J

Notes:

mg/L = milligrams per liter

U = not detected above the indicated reporting limit concentration

J = estimated value

🟩	Concentrations are at or below action level
⬜	Concentrations are between action level and reporting limit

Table 2
Summary of In Situ Test Conditions for Metal Treatability Study
Ameren Services, Missouri

Test Conditions				Rush Island			Meramec MW-5			Meramec MW-6		
Test condition	Soil (g)	Addition	Duration (week)	Amount	pH	Aerobic or Anaerobic	Amount	pH	Aerobic or Anaerobic	Amount	pH	Aerobic or Anaerobic
pH adjusted	48	HCl 36%	1	Varied	10, 9, 8, 7, 6	Aerobic	Varied	10, 8, 6	Aerobic	Varied	10, 8, 6	Aerobic
CaSx- No pH change	48	CaSx	1	2.1 mg		Aerobic	3.1 mg		Aerobic	5.5 mg		Aerobic
CaSx- pH adjusted	48	CaSx	1	2.1 mg	8	Aerobic	NA			NA		
Fe- anaerobic	48	Fe(II) sulfate	4	12 mg		Anaerobic	12 mg		Anaerobic	12 mg		Anaerobic
Fe -anaerobic- pH adjusted	48	Fe(II) sulfate	4	12 mg	8	Anaerobic	NA			NA		
Fe - aerobic	48	Fe(II) sulfate	4	12 mg		Aerobic	12 mg		Aerobic	12 mg		Aerobic
Fe - aerobic- pH adjusted	48	Fe(II) sulfate	4	12 mg	8	Aerobic	NA			NA		
ZVI (SR.2S)	48	SR.2S	4	96 mg		Anaerobic	96 mg		Anaerobic	96 mg		Anaerobic
ZVI (SR.2S)- pH adjusted	48	SR.2S + HCl	4	96 mg	8	Anaerobic	NA			NA		
ZVI (SR.2S)-Food	48	SR.2S + Food	8	96 mg		Anaerobic	96 mg		Anaerobic	96 mg		Anaerobic
ZVI (SR.2S)-Food- pH adjusted	48	SR.2S + Food + HCl	8	96 mg	8	Anaerobic	NA			NA		
ZVI (7 micron)	48	7 micron	4	96 mg		Anaerobic	96 mg		Anaerobic	96 mg		Anaerobic
ZVI (7 micron)- pH adjusted	48	7 micron + HCl	4	96 mg	8	Anaerobic	NA			NA		
ZVI (7 micron)- Food	48	7 micron + Food	8	96 mg		Anaerobic	96 mg		Anaerobic	96 mg		Anaerobic
ZVI (7 micron)- Food- pH adjusted	48	7 micron + Food + HCl	8	96 mg	8	Anaerobic	NA			NA		

Test Conditions				Labadie			Sioux		
Test condition	Soil (g)	Addition	Duration (week)	Amount	pH	Aerobic or Anaerobic	Amount	pH	Aerobic or Anaerobic
pH adjusted	48	HCl 36%	1	Varied	6	Aerobic	Varied	6	Aerobic
CaSx- No pH change	48	CaSx	1	0.09 mg		Aerobic	0.09 mg		Aerobic
CaSx- pH adjusted	48	CaSx	1	0.09 mg	7	Aerobic	NA		
Fe- anaerobic	48	Fe(II) sulfate	4	13.8 mg		Anaerobic	13.8 mg		Anaerobic
Fe -anaerobic- pH adjusted	48	Fe(II) sulfate	4	13.8 mg	7	Anaerobic	NA		
Fe - aerobic	48	Fe(II) sulfate	4	13.8 mg		Aerobic	13.8 mg		Aerobic
Fe - aerobic- pH adjusted	48	Fe(II) sulfate	4	13.8 mg	7	Aerobic	NA		
ZVI (SR.2S)	48	SR.2S	4	11 mg		Anaerobic	11mg		Anaerobic
ZVI (SR.2S)- pH adjusted	48	SR.2S + HCl	4	11 mg	7	Anaerobic	NA		
ZVI (SR.2S)-Food	48	SR.2S + Food	8	11 mg		Anaerobic	11mg		Anaerobic
ZVI (SR.2S)-Food- pH adjusted	48	SR.2S + Food + HCl	8	11 mg	7	Anaerobic	NA		
ZVI (7 micron)	48	7 micron	4	11 mg		Anaerobic	11mg		Anaerobic
ZVI (7 micron)- pH adjusted	48	7 micron + HCl	4	11 mg	7	Anaerobic	NA		
ZVI (7 micron)- Food	48	7 micron + Food	8	11 mg		Anaerobic	11mg		Anaerobic
ZVI (7 micron)- Food- pH adjusted	48	7 micron + Food + HCl	8	11 mg	7	Anaerobic	NA		

Notes:

SR.2S = particle size ZVI
ZVI = zero valent iron
7 micron = microscale ZVI
Food = lactate, EOL, cornsweet, and nutrients
NA = test condition not run

HCl = hydrochloric acid
CaSx = calcium polysulfide
Fe = iron (dissolved)

Table 3

Summary of Rush Island In Situ Total Metals Removal Performance

Rush Island Energy Center, Missouri

	Arsenic	Molybdenum	Boron	Lead	Cobalt	Selenium	Lithium
	mg/L						
Action Levels	0.03	0.1	4	0.015	0.006	0.05	0.065
Average of All Controls[1]	0.18	0.12	3.10	0.13	0.03 J*	0.03 J*	0.13
pH 10	0.17	0.12	3.05	0.08	0.02	0.02	0.07
pH 9	0.12	0.12	2.80	0.08	0.02	0.02	0.09
pH 8	0.10	0.13	3.15	0.05	0.01 J*	0.01 J*	0.06
pH 7	0.07	0.11	3.05	0.06	0.02	0.01	0.08
pH 6	0.02 J*	0.08	3.80	0.03 U	0.06 U	0.06 U	0.06 U
CaSx	0.23	0.12	3.60	0.08	0.07 U	0.07 U	0.07
CaSx pH7	0.05	0.14	3.75	0.03 U	0.06 U	0.06 U	0.04 J*
Dissolved Iron (Anaerobic)	0.20	0.13	3.20	0.11	0.05 U	0.05 U	0.11
Dissolved Iron pH 8 (Anaerobic)	0.11	0.14	3.20	0.08	0.05 U	0.05 U	0.06
Dissolved Iron (Aerobic)	0.19	0.13	3.05	0.13	0.05 U	0.05 U	0.10
Dissolved Iron pH 8 (Aerobic)	0.06	0.14	3.45	0.04 J*	0.05 U	0.05 U	0.13
ZVI Injectable	0.03 U	0.05 U	0.30	0.03 U	0.05 U	0.05 U	0.08 U
ZVI Injectable pH 8	0.03 U	0.05 U	0.13 J*	0.03 U	0.05 U	0.05 U	0.09 U
ZVI PRB	0.02 J*	0.39	3.60	0.03 U	0.05 U	0.05 U	0.04 U
ZVI PRB pH 8	0.03 U	0.04 J*	2.55	0.03 U	0.05 U	0.05 U	0.02 J
ZVI Injectable + Bio	0.025 U	0.05 U	0.32 J	0.025 U	0.05 U	0.05 U	0.06 U
ZVI Injectable pH 8 + Bio	0.025 U	0.05 U	0.07 J	0.025 U	0.05 U	0.05 U	NS
ZVI PRB + Bio	0.03 U	0.32 J	4.45 J	0.03 U	0.05 U	0.05 U	0.02 J
ZVI PRB pH 8 + Bio	0.03 U	0.05 U	2.20 J	0.03 U	0.05 U	0.05 U	0.04 J

Notes:

U = not detected above the indicated concentration

PRB = permeable reactive barrier

Injectable = iron particles at micro-scale; potentially applied through injection

Dissolved iron = 50 mg/L Iron(II) sulfate

NS = not sampled

CaSx = calcium polysulfide

J* = half the detection limit was used for non-detect when duplicates had a detection and a non-detect.

pH adjustment testing was conducted over a 7-day test period. The native pH in monitoring well MW-2 was pH 11.

1) Average of All Controls = average of all controls used in the Phase 2 testing for Rush Island Energy Center

🟩 At or below action level

🟦 Approaching action level

🟧 Above action level and increase relative to control

⬜ Non-detect but detection limit greater than action level

NA = no action level

mg/L = milligrams per liter

Table 4

Summary of Meramec MW-5 In Situ Total Metals Removal Performance

Meramec Energy Center, Missouri

	Arsenic	Molybdenum	Boron	Lead	Cobalt	Selenium	Lithium
	mg/L						
Action Levels	0.01	0.1	4	0.015	0.006	0.05	0.040
Average of All Controls[1]	0.034 J*	0.174	5.5	0.028 J*	0.062 U	0.062 U	0.028 J
pH 10	0.031	0.18	5.55	0.013	0.01 U	0.01 U	0.0285 J
pH 8	0.03	0.16	5.30	0.02	0.01 U	0.01 U	0.04 J
pH 6	0.029	0.11	5.6	0.027	0.01	0.01 U	0.049 J
CaSx	0.05 U	0.17	5.3	0.05 U	0.1 U	0.1 U	0.026 J
Dissolved Iron (Anaerobic)	0.039	0.18 J	4.8	0.035	0.05 U	0.05 U	0.029 J
Dissolved Iron (Aerobic)	0.031	0.17 J	4.6	0.03	0.05 U	0.05 U	0.03
ZVI Injectable	0.025 U	0.05 U	0.33	0.025 U	0.05 U	0.05 U	0.06 U
ZVI PRB	0.025 U	0.08	3.7	0.025 U	0.05 U	0.05 U	0.035 J
ZVI Injectable + Bio	0.05 U	0.1 U	0.31	0.05 U	0.1 U	0.1 U	NS
ZVI PRB + Bio	0.05 U	0.1 U	4.8 J	0.05 U	0.1 U	0.1 U	0.032 J

Notes:

U = not detected above the indicated concentration

PRB = permeable reactive barrier

Injectable = iron particles at micro-scale; potentially applied through injection

Dissolved iron = 50 mg/L Iron(II) sulfate

NS = not sampled

CaSx = calcium polysulfide

🟩 At or below action level

🟦 Approaching action level

🟧 Above action level and increase relative to control

▨ Non-detect but detection limit greater than action level

NA = no action level

mg/L = milligrams per liter

J* = half the detection limit was used for non-detect when duplicates had a detection and a non-detect.

pH adjustment testing was conducted over a 7-day test period. The native pH in monitoring well MW-6 was approximately pH 7.5.

1) Average of All Controls = average of all controls used in the Phase 2 testing for Merimec Energy Center MW-5

Table 5
Summary of Meramec MW-6 In Situ Total Metals Removal Performance
Meramec Energy Center, Missouri

	Arsenic	Molybdenum	Boron	Lead	Cobalt	Selenium	Lithium
	mg/L						
Action Levels	0.01	0.1	4	0.015	0.006	0.05	0.040
Average of All Controls[1]	0.0259 J*	0.22 J	10.24 J	0.027 J*	0.062 U	0.062 U	0.128
pH 10	0.0285	0.215	10.5	0.0135	0.01 U	0.01 U	0.12
pH 8	0.013	0.18	11	0.016	0.01 U	0.01 U	0.15
pH 6	0.03	0.14	10	0.027	0.01	0.01 U	0.16
CaSx	0.05 U	0.19	10	0.05 U	0.1 U	0.1 U	0.12
Dissolved Iron (Anaerobic)	0.032	0.26 J	8.5	0.041	0.05 U	0.05 U	0.13
Dissolved Iron (Aerobic)	0.027	0.22 J	8.6	0.033	0.05 U	0.05 U	0.13
ZVI Injectable	0.025 U	0.05 U	0.69	0.025 U	0.05 U	0.05 U	0.5 U
ZVI PRB	0.025 U	0.05	6.5	0.025 U	0.05 U	0.05 U	0.11
ZVI Injectable + Bio	0.05 U	0.1 U	0.72	0.05 U	0.1 U	0.1 U	NS
ZVI PRB + Bio	0.05 U	0.1 U	8.5 J	0.05 U	0.1 U	0.1 U	0.1

Notes:

U = not detected above the indicated concentration

PRB = permeable reactive barrier

Injectable = iron particles at micro-scale; potentially applied through injection

Dissolved iron = 50 mg/L Iron(II) sulfate

CaSx = calcium polysulfide

mg/L = milligrams per liter

half the detection limit was used for non-detect when duplicates had a detection and a non-detect.

pH adjustment testing was conducted over a 7-day test period. The native pH in monitoring well MW-6 was approximately pH 7.6.

1) Average of All Controls = average of all controls used in the Phase 2 testing for Merimec Energy Center MW-6

🟩 At or below action level

🟦 Approaching action level

🟧 Above action level and increase relative to control

⬜ Non-detect but detection limit greater than action level

NA = no action level

Table 6

Summary of Labadie In Situ Total Metals Removal Performance

Labadie Energy Center, Missouri

	Arsenic	Molybdenum	Boron	Lead	Cobalt	Selenium	Lithium
	mg/L						
Action Levels	0.0426	0.1	4	0.015	0.006	0.05	0.055
Average of All Controls[1]	0.042 U	0.162 J	9.133 J	0.042 U	0.083 U	0.083 U	0.022 J*
pH 6	0.025 U	0.13 J	7.6	0.025 U	0.05 U	0.05 U	0.018 J
CaSx	0.025 U	0.16 J	7.5	0.025 U	0.05 U	0.05 U	0.016 J
CaSx pH7	0.025 U	0.13 J	7.6	0.025 U	0.05 U	0.05 U	0.017 J
Dissolved Iron (Anaerobic)	0.05 U	0.17	9.5	0.05 U	0.1 U	0.1 U	0.06 U
Dissolved Iron (Aerobic)	0.05 U	0.17	9.6	0.05 U	0.1 U	0.1 U	0.023 J
Dissolved Iron pH 7 (Anaerobic)	0.05 U	0.15	9.5	0.05 U	0.1 U	0.1 U	0.06 U
Dissolved Iron pH 7 (Aerobic)	0.05 U	0.16	9.7	0.05 U	0.1 U	0.1 U	0.06 U
ZVI Injectable	0.05 U	0.1 U	6.5	0.05 U	0.1 U	0.1 U	0.06 U
ZVI Injectable pH 7	0.05 U	0.1 U	6.3	0.05 U	0.1 U	0.1 U	0.06 U
ZVI PRB	0.05 U	0.1	9.3	0.05 U	0.1 U	0.1 U	0.06 U
ZVI PRB pH 7	0.05 U	0.1 U	8.9	0.05 U	0.1 U	0.1 U	0.022 J
ZVI Injectable + Bio	0.05 U	0.1 U	10 J	0.05 U	0.1 U	0.1 U	0.016 J
ZVI Injectable pH 7 + Bio	0.05 U	0.1 U	8.9 J	0.05 U	0.1 U	0.1 U	0.019 J
ZVI PRB + Bio	0.05 U	0.1 U	9.9 J	0.05 U	0.1 U	0.1 U	0.063 J
ZVI PRB pH 7 + Bio	0.05 U	0.1 U	9.2 J	0.05 U	0.1 U	0.1 U	0.038 U

Notes:

U = not detected above the indicated concentration

PRB = permeable reactive barrier

Injectable = iron particles at micro-scale; potentially applied through injection

Dissolved iron = 50 mg/L Iron(II) sulfate

CaSx = calcium polysulfide

mg/L = milligrams per liter

J* = half the detection limit was used for non-detect when duplicates had a detection and a non-detect.

pH adjustment testing was conducted over a 7-day test period. The native pH at Labadie was approximately pH 8.3.

1) Average of All Controls = average of all controls used in the Phase 2 testing for Labadie Energy Center

🟩	At or below action level
🟦	Approaching action level
🟧	Above action level and increase relative to control
▨	Non-detect but detection limit greater than action level

NA = no action level

Table 7
Summary of Sioux In Situ Total Metals Removal Performance
Sioux Energy Center, Missouri

	Arsenic	Molybdenum	Boron	Lead	Cobalt	Selenium	Lithium
	mg/L						
Action Levels	0.01	0.1	4	0.015	0.006	0.05	0.040
Average of All Controls[1]	0.033 J*	2.867 J	26.7 J	0.065 J*	0.052 J*	0.083 U	0.049
pH 6	0.025 U	1.7 J	23	0.025 U	0.05 U	0.05 U	0.028 J
CaSx	0.025 U	2.7 J	21	0.025 U	0.05 U	0.05 U	0.025 J
Dissolved Iron (Anaerobic)	0.05 U	2.7	28	0.05 U	0.1 U	0.1 U	0.028 J
Dissolved Iron (Aerobic)	0.05 U	2.6	27	0.069	0.1 U	0.1 U	0.085
ZVI Injectable	0.05 U	0.1 U	23	0.05 U	0.1 U	0.1 U	0.06 U
ZVI PRB	0.05 U	0.81	26	0.05 U	0.1 U	0.1 U	0.024 J
ZVI Injectable + Bio	0.05 U	0.5 J	19 J	0.05 U	0.1 U	0.1 U	0.029 J
ZVI PRB + Bio	0.05 U	0.1 U	27 J	0.05 U	0.1 U	0.1 U	0.021 J

Notes:

U = not detected above the indicated concentration

PRB = permeable reactive barrier

Injectable = iron particles at micro-scale; potentially applied through injection

Dissolved iron = 50 mg/L Iron(II) sulfate

CaSx = calcium polysulfide

mg/L = milligrams per liter

J* = half the detection limit was used for non-detect when duplicates had a detection and a non-detect.

pH adjustment testing was conducted over a 7-day test period. The native pH at Sioux was approximately pH 7.8.

1) Average of All Controls = average of all controls used in the Phase 2 testing for Sioux Energy Center

🟩	At or below action level
🟦	Approaching action level
🟧	Above action level and increase relative to control
▨	Non-detect but detection limit greater than action level

NA = no action level

Table 8
Summary of Preliminary Ferric Chloride Treatability Testing - Rush Island
Rush Island Energy Center, Missouri

	Arsenic			Molybdenum		
	1 hour[1]	3 hour[2]	6 hour[3]	1 hour[1]	3 hour[2]	6 hour[3]
	mg/L					
Action Level	0.03			0.1		
Total Metals						
Baseline	0.224			0.146		
20 mg/L $FeCl_3$, pH 6[4]	0.0072	0.0109	0.0126	0.0205	0.0241	0.0283
40 mg/L $FeCl_3$, pH 6[4]	0.0049	0.0059	0.0062	0.01 U	0.01 U	0.01 U
40 mg/L $FeCl_3$, pH 4[5]	0.0056	0.0085	0.0105	0.01 U	0.01 U	0.01 U
40 mg/L $FeCl_3$, 3% H_2O_2, pH 6[4,6]	0.0269	NM	NM	0.188	NM	NM

Notes:

U = not detected above the indicated concentration	🟩 At or below action level
mg/L = milligrams per liter	🟦 Approaching action level
NM = not measured	🟧 Above action level and increase relative to baseline
$FeCl_3$ = ferric chloride	▨ Non-detect but detection limit greater than action level

1) 1 hour sample started collecting 1.5 hours after $FeCl_3$ added (flow through column started 0.5 hours after $FeCl_3$). Ended collection 3 hours after $FeCl_3$ added.

2) 3 hour sample started collecting 3.5 hours after $FeCl_3$ added. Ended collection 5 hours after $FeCl_3$ added.

3) 6 hour sample started collecting 5.5 hours after $FeCl_3$ added. Ended collection 7 hours after $FeCl_3$ added.

4) pH of 6 was the goal but after adding the $FeCl_3$, the 20 mg/L test was a pH of 4.65 and the 40 mg/L was a pH of 3.66. Did not measure the final pH of the H_2O_2 test.

5) pH of 4 was the goal but after adding the $FeCl_3$, the 0 mg/L test was a pH of 3.45.

6) this was the only sample that had a brownish tent to it in the effluent. The flocks had formed faster and seemed to settle out better than those without the H_2O_2. Bubbles noted in effluent of column.

Table 9
Summary of Ferric Chloride Continuous Flow Test - Rush Island
Rush Island Energy Center, Missouri

Sand Filter									
	Action Level	Influent	Intermediate			Effluent Sand Filter			
			19 hr	2 day	8 day*	Ave first 19 hr	19 hr	2 day	7 day
Total mg/L									
Arsenic	0.03	0.212	NM	NM	0.0288	0.0013	0.001	0.001 U	0.0107
Molybdenum	0.1	0.156	NM	NM	0.0267	0.01 U	0.01 U	0.01 U	0.0151
Lead	0.015	0.0057	NM	NM	0.0016	0.0026	0.0023	0.001 U	0.001 U
Lithium	0.0647	0.005 U	NM	NM	NM	0.005 U	0.005 U	0.005 U	NM
Iron	NA	0.0769	NM	NM	1.15	NM	NM	NM	0.299
Boron	4	4**	NM	NM	NM	NM	NM	NM	NM
Dissolved mg/L									
Arsenic	0.03	0.198	0.0019	0.0032	0.0219	0.001 U	0.001 U	0.001 U	0.0094
Molybdenum	0.1	0.144	0.01 U	0.01 U	0.0224	0.01 U	0.01 U	0.01 U	0.0136
Lead	0.015	0.0052	0.0022	0.0035	0.0014	0.0029	0.0027	0.001 U	0.001 U
Lithium	0.0647	0.005 U	0.005 U	0.005 U	NM	0.005 U	0.005 U	0.005 U	NM
Iron	NA	0.0552	NM	NM	0.831	NM	NM	NM	0.204
Boron	4	NM	NM	NM	NM	NM	NM	NM	NM

Filters - Mimic Resin Filtration Followed By Resin						
	Action Level	Influent	Effluent 100 micron filter - 3 Days	Effluent 10 micron filter - 3 Days	filter pH to 7.5 adjusted - 3 Days	Post Resin
Total mg/L						
Arsenic	0.03	0.212	0.0363	0.0023	NM	0.0016
Molybdenum	0.1	0.156	0.0257	0.01 U	NM	0.01 U
Lead	0.015	0.0057	NM	NM	NM	NM
Lithium	0.0647	0.005 U	NM	NM	NM	NM
Iron	NA	0.0769	4.41	2.69	NA	5.11
Boron	4	4**	NM	4**	NA	0.02 U
Dissolved mg/L						
Arsenic	0.03	0.198	0.0032	0.0016	0.001 U	0.0012
Molybdenum	0.1	0.144	0.01 U	0.01 U	0.01 U	0.01 U
Lead	0.015	0.0052	NM	NM	NM	NM
Lithium	0.0647	0.005 U	NM	NM	NM	NM
Iron	NA	0.0552	1.92	2.33	0.951	0.503
Boron	4	NM	NM	NM	NM	0.02 U

Notes:

U = not detected above the indicated concentration

mg/L = milligrams per liter

$FeCl_3$ = ferric chloride at 40 mg/L

NM = not measured

NA = not applicable. Not a metal of concern

hr = hour

Ave = average of the flow collected in the first 19 hours

Intermediate = collected after $FeCl_3$ has been added and mixed, and the flocculants are being settled

Rush Island water was adjusted to a pH of 5.8-6.0 prior to adding the $FeCl_3$ and had a final pH of 4.0-4.3.

Effluent water was adjusted to a pH of 6-8 prior to passing through the resin.

* = the total intermediate sample was passed through a 5 micron filter to simulate a bag filter.

** = results are internal XDD measurements using colorimetric Hach testing

🟩	At or below action level
🟦	Approaching action level
🟧	Above action level and increase relative to baseline
⬜	Non-detect but detection limit greater than action level

Table 10

Summary of pH Adjustment and Resin Column Testing - Rush Island

Rush Island Energy Center, Missouri

	Arsenic	**Boron**	**Molybdenum**
	mg/L		
Action Level	0.03	4	0.1
Total Metals			
Baseline	0.224	3.72	0.146
Day 1	0.0261	0.02 U	0.01 U
Day 3	0.0042	0.02 U	0.01 U
Day 7 - pH only	0.198	3.64	0.153
Day 7	0.0568	0.02 U	0.01 U
Dissolved Metals			
Baseline	0.211	3.39	0.14
Day 1	0.0242	0.02 U	0.01 U
Day 3	0.0032	0.02 U	0.01 U
Day 7 - pH only	0.189	3.27	0.142
Day 7	0.0525	0.02 U	0.01 U

Notes:

U = not detected above the indicated concentration

mg/L = milligrams per liter

pH was adjusted to 5

pH only = sample collected after pH adjustment and flowing through sand, but before the ion-specific resin

🟩	At or below action level
🟦	Approaching action level
🟧	Above action level and increase relative to baseline
▨	Non-detect but detection limit greater than action level

Table 11

Summary of Zero Valent Iron Column Metals Removal - Rush Island

Rush Island Energy Center, Missouri

	Column Construction: 5 Parts Sand per 1 Part ZVI				Column Construction: 2 Parts Sand per 1 Part ZVI			
	Arsenic	**Boron**	**Iron**	**Molybdenum**	**Arsenic**	**Boron**	**Iron**	**Molybdenum**
	mg/L							
Action Level	0.03	4	--	0.1	0.03	4	--	0.1
Total Metals								
Baseline	0.195	3.84	0.0721	0.143	0.211	3.51	0.0817	0.148
Day 1	0.034	3.48	0.357	0.0954	0.0419	3.47	0.503	0.145
Day 3	0.114	3.86	0.0959	0.15	0.082	3.4	0.166	0.134
Day 7	0.113	3.9	0.15	0.151	0.089	3.51	0.11	0.143
Dissolved Metals								
Baseline	0.18	3.71	0.0614	0.139	0.212	3.47	0.0489	0.143
Day 1	0.025 U	3.117	0.047	0.0792	0.0439	3.42	0.04 U	0.143
Day 3	0.104	3.59	0.0569	0.134	0.0836	3.36	0.0702	0.133
Day 7	0.101	3.61	0.114	0.135	0.0898	3.34	0.0805	0.138

Notes:

U = not detected above the indicated concentration

ZVI = zero valent iron - micro-scale size

mg/L = milligrams per liter

🟩 At or below action level

🟦 Approaching action level

🟧 Above action level and increase relative to baseline

⬜ Non-detect but detection limit greater than action level

MEMORANDUM

To: Barbara Miller
(Ameren Missouri)

Date: January 6, 2022

From: XDD (DRAFT)

cc: Michael Marley (XDD)

RE: **Labadie Treatability Memo**
Labadie Energy Center
226 Labadie Power Plant Rd, Labadie, MO

1.0 INTRODUCTION

XDD Environmental (XDD) was retained by Ameren Missouri (Ameren) to perform a metals treatability study for the remediation of metals of concern (MOC) from ash pond groundwater at the Labadie Energy Center (LEC) in Labadie, MO. Groundwater is currently monitored as required by the United States Environmental Protection Agency (USEPA) in 40 CFR Part 257 "Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities; Final Rule" (the CCR Rule), the facility's NPDES permit (No MO-000043), and the facilities UIC permit (UI-0000043). Groundwater is analyzed for metals via EPA Methods 200.7 and 200.8, alkalinity via SM Method 2320B, total dissolved solids via SM Method 2450C, ferric and ferrous iron via SM Method 3500, anions via EPA Method 300, and phosphorous via EPA Method 365.4. Based on statistical analysis, elevated levels of arsenic and molybdenum exceed the site-specific groundwater protection standard (GWPS) established under the CCR Rule.

While metals cannot be destroyed, they can be susceptible to treatment and undergo changes in form to become either (a) less soluble; or (b) more sorbent and bind to particle surfaces. Both methods involve the physical removal of metals from the dissolved state (a very mobile state) to either a solid state or an adsorbed state. The three primary approaches for metals removal from groundwater are:

- Precipitation: Transformation of a dissolved species to a solid form, which can then settle out of suspension.
- Co-precipitation with other minerals: Transformation of a dissolved species to a solid form that combines with another material (such as iron), which can then settle out of suspension.
- Adsorption: Introduction or production of a solid that will absorb the MOC from the groundwater.

Where multiple metals are present, there is a potential that one metal can inadvertently affect other metal(s) either positively (reduced dissolved concentration) or negatively (increased dissolved concentration). Therefore, a treatment chain consisting of a sequence of multiple technologies is often needed to address all metals of concern at a site. The focus of this study is on MOC which have regulatory action levels exceeded at LEC directly downgradient of the ash pond. Since the treated water will be injected into the extracted aquifer for hydraulic control, the treated water will be required to meet groundwater permit levels for compounds such as sulfate and boron, along with arsenic and molybdenum, which currently exceed permit discharge levels. The primary MOC at LEC are molybdenum and arsenic.

This memo will address the treatability work performed for LEC water to remove molybdenum and arsenic along with an evaluation of sulfate and boron removal to meet the discharge permit levels. The treatability lab testing for LEC was done in parallel with the treatability studies performed for Sioux Energy Center (SEC) and Rush Island Energy Center (RIEC). All three sites have overlap on treatment objectives, MOC, and similar water chemistry; therefore, promising results at one site were used to guide treatment at the other two sites.

Preliminary evaluations focused on in-situ treatment options; however, due to concerns of precipitation clogging pore space thereby affecting subsurface flow conditions, along with the lack of available in-situ options for removing or stabilizing boron, the focus transitioned to ex-situ treatment options. This memo will focus on the ex-situ treatment options only. The findings presented will focus on LEC but will include relevant results obtained from treatability tests from SEC and RIEC.

2.0 TREATABILITY OBJECTIVE

The treatment objective for LEC is to create hydraulic controls where groundwater is extracted along the flow path at the site to capture and contain the groundwater MOC plume. The water will then be treated above ground and reinjected between the extraction wells to create a hydraulic control that will minimize the extraction rate, maintain natural hydraulic flow, and prevent further migration of MOC from the ash pond groundwater. The focus of the treatability study is to remove the site MOC so that the water will meet the groundwater permit discharge levels. This will allow safe injection of the treated groundwater back into the aquifer from which it was extracted. For LEC, the proposed treatment system must address molybdenum, arsenic, sulfate, and boron. The target discharge permit levels for these compounds are:

- molybdenum = 100 micrograms per liter (µg/L)
- arsenic = 10 µg/L
- sulfate = 250,000 µg/L

- boron = 2,000 µg/L

This memo will summarize the tests performed to address each compound, conditions under which each method was tested, how successful each remedial option was shown to be, and recommendations for full scale implementation.

2.1 Molybdenum and Arsenic

At LEC, arsenic and molybdenum are the primary MOC that causes groundwater protection exceedances. The tested groundwater is almost twice the discharge permit limit for arsenic (19 µg/L with a permit limit of 10 µg/L) and molybdenum (160 µg/L with a permit limit of 100 µg/L) (**Table 1**). The primary focus of arsenic and molybdenum removal is on their lower solubility formations at low pH ranges (particularly arsenic) and both their abilities to coprecipitate with iron. The two MOC are therefore discussed in unison. Tests were performed for precipitation at a pH of 5, filtering the water through zero valent iron (ZVI) columns, pH adjustment followed by ferric chloride ($FeCl_3$) precipitation, and pH adjustment followed by $FeCl_3$ and oxidative (hydrogen peroxide) precipitation. Confirmation testing of RIEC best treatment option was performed on LEC water. It was determined that the pH adjustment using hydrochloric acid (HCl) followed by $FeCl_3$ could transform the dissolved arsenic and molybdenum to solid iron-arsenic and iron-molybdenum but that the solid particles formed would not settle within a reasonable timeframe for treatment. Additional tests were performed on LEC water to aid in the precipitation process and is discussed below in Section 2.1.4.

2.1.1 pH adjustment

The pH adjustment process involved adjusting the pH of RIEC water to 5 using HCl followed by flow through a sand filter than a SIR-150 boron resin filter (see Section 2.2 for more information on SIR-150). Since the resin is specially designed for boron removal and it is not desirable to have the resin capacity exacerbated with high concentrations of other groundwater constituents, samples were collected prior to the resin to determine the effects of the pH adjustment on molybdenum and arsenic treatment (**Table 1, Test A,M-1**).

Groundwater samples collected between the sand filter and the resin columns showed that the pH adjustment followed by sand filtration did not effectively remove the arsenic or molybdenum in the groundwater to the discharge permit levels (**Table 1, Test A,M-1**) . A further review of the data and the procedures used in this test suggests that, for pH adjustment to be successful for removing arsenic and molybdenum from RIEC groundwater, the groundwater needs to be maintained at a reduced pH for longer than 40 minutes (the residence time in the sand filter tested columns). Hence, pH adjustment alone would not be a viable ex-situ remedial approach.

2.1.2 ZVI Columns

Iron can precipitate molybdenum as a low-solubility iron-molybdenum and iron-arsenic. To test the feasibility of using a ZVI column to remove arsenic and molybdenum ex-situ, test columns were constructed using a mixture of the microscale ZVI and commercial sand. Microscale ZVI was tested due to its highly reactive surface and increased potential to remove arsenic and molybdenum. The sand was added to allow the required flow through the ZVI column without clogging due to the microscale ZVI particle size. The columns were prepared using a 5:1 and 2:1 ratios of sand to microscale ZVI. The columns were operated for 7 days, with effluent groundwater samples collected from the column after 1, 3, and 7 days of flow.

The Day 7 results are shown on **Table 1 Tests A,M-2** (5:1 sand to ZVI ratio) and **A,M-3** (2:1 sand to ZVI ratio). The results show partial removal of arsenic and molybdenum, though not to action levels. Boron concentrations did not change passing through the ZVI columns. It was concluded that the ZVI removal effectiveness (at the design sand to ZVI dosages) was questionable, and likely not reliable as a sustainable remedial option.

2.1.3 Ferric Chloride Co-Precipitation

The ex-situ remediation method that proved most successful and reliable for arsenic and molybdenum treatment of groundwater is pH adjusted with HCl followed by $FeCl_3$ aided flocculation. Preliminary testing with the ZVI and pH adjustment, discussed above, helped guide the design of the $FeCl_3$ treatment train.

$FeCl_3$ testing was performed on RIEC water to determine reaction time needed (**Table 1 Tests A,M-4** to **A,M-12**), optimal pH ranges (**Table 1 Tests A,M-7** to **A,M-12**), optimal $FeCl_3$ dosage (**Table 1 Tests A,M-4** to **A,M-9**), and if oxidation through hydrogen peroxide addition could perform better (**Table 1 Test A,M-13**). A summary of the finding are:

- Both arsenic and molybdenum can be reduced to concentrations at or below action levels, using $FeCl_3$ addition.
- An initial pH of 6 (prior to the addition of $FeCl_3$) caused faster settling of the precipitants than an initial pH of 4.
- Higher $FeCl_3$ dosage (40 mg/L vs. 20 mg/L) provided greater removal of arsenic and molybdenum.
- The additional of hydrogen peroxide did not improve the arsenic or molybdenum removal efficiency.

The reaction time determined for the $FeCl_3$ coagulation and flocculation/precipitation and associated removal of arsenic and molybdenum from groundwater in the preliminary testing using

RIEC groundwater was adequate for the conceptual ex-situ remedial approach (an hour or less).

Confirmation testing using LEC water showed that:

- 40 mg/L of $FeCl_3$ was sufficient to reach discharge limits for dissolved arsenic and molybdenum (**Table 1 Test A,M-14**)
- The dissolved concentrations of arsenic and molybdenum were significantly lower than the total arsenic and molybdenum concentrations using the pH 6 adjustment followed by $FeCl_3$ addition method established for RIEC (**Table 1 Test A,M-14**)
- Visually observations noted little to no settling of the pin flocs formed in LEC water after an hour.

The results of LEC confirmation testing suggested that, while the chemistry needed to remove dissolved arsenic and molybdenum from the groundwater was similar between RIEC and LEC, a flocculant aid is needed to remove the total arsenic and molybdenum from the suspended solid phase.

2.1.4 Coagulant Aid Testing

All coagulant aid testing was done after the water had been adjusted to a pH of 6 using HCl followed by $FeCl_3$ addition of 40 mg/L (except the testing of the alternative coagulant). There are several approaches to increase the formation of larger flocs that can help in settling of total metals and water clarity:

- Increase alkalinity
- Shifting to another coagulant (alum instead of $FeCl_3$)
- Bulking agent
- Polymers

The addition of calcium hydroxide was tested on SEC water to see if increasing the alkalinity of the water would increase the size of the flocculants (**Table 1 Tests A,M-15** to **A,M-18**). While the 2:3 molar ratio of $FeCl_3$ to calcium hydroxide (**Table 1 Tests A,M-15** and **A,M-16**) greatly increased the formation of flocculants, the calcium hydroxide increased the pH above the target range for MOC removal which resulted in the settling of the $FeCl_3$ without the molybdenum. Testing was done adding calcium hydroxide at lower dosages which would not increase the pH above the target range (target is a final pH of 4 after the $FeCl_3$ is added) (**Table 1 Tests AM-17** and **A,M-18**). This resulted in insufficient alkalinity to form flocs that would settle and the pH increases from 4 to pH of 5 or 6 decreased the removal of dissolved molybdenum compared to if no calcium hydroxide was added.

Alum is another coagulant that may remove molybdenum and arsenic from water as a lower soluble aluminum-molybdenum or aluminum-arsenic compound. Alum was added at 120 mg/L to SEC water but had little to no affect on the molybdenum removal and no significant increase in floc formation (**Table 1 Test A,M-19**).

Bulking agents are often added to water to act as a nucleus on which smaller flocs can bind to and settle out. One bulking agent that is often used in water treatment systems is bentonite. Bentonite was tested as a powder form (**Table 1 Test A,M-20**) and as a liquid slurry form (**Table 1 Test A,M-21**) on SEC water to look at alternative methods of application. The bentonite slurry test where 80 mg/L $FeCl_3$ was tested showed significant reduction in total molybdenum and had significant floc formation resulting in increased density of flocks for settling and improved water clarity. The one concern with bentonite is the difficulty in handling and maintenance of a clay in a flow through semi-automated system and dispersion of the bentonite in a water mixture.

Polymer coagulant aids are often used when flocs are too small to settle on their own. They act as a charge surface to draw solids to them and increase the density of the solids resulting in an increase rate of flocculation. Two polymers were tested on SEC water; a cationic and an anionic inorganic polymer (**Table 1 Tests A,M-22** to **A,M-25**). While both polymer formed large flocs that aided in water clarity and were capable of removing molybdenum, the cationic polymer resulted in the lowest molybdenum concentrations at an $FeCl_3$ concentration of 80 mg/L (**Table 1 Test A,M-25**).

Confirmation testing was performed on LEC water on both cationic and anionic inorganic polymers (**Table 1 Tests Final 1** and **Final 3**). While both polymers resulted in the formation of large flocks that could settle and a decreases of arsenic and molybdenum to below detection levels, less polymer was needed for the anionic than the cationic polymer. Therefore, from a dosing perspective, the anionic polymer performed more efficiently than the cationic polymer.

2.2 Boron

Resins and reverse osmosis are the primary methods used to remove boron from water sources. There is a low efficiency of treated water to wastewater using reverse osmosis, so boron treatment has focused on resins. Three commercially available boron-removal resins were identified and tested; SIR-150, IRA-743, and PWA-10.

As discussed in Section 2.1.1, a pH of 5 adjusted water followed by a column test of the SIR-150 was performed over 7 days using RIEC water. After 7 days of passing through the column, boron concentrations were still below the detection limit of 10 ug/L (**Table 1 Test B-1**). As shown in the sample collected between pH adjustment to 5 and the resin column (**Table 1 Test A,M-1**), arsenic and molybdenum were not treated sufficiently by the pH adjustment showing that arsenic and molybdenum removed to discharge levels in **Table 1 Test B-1** is from attachment to the resin.

While the resin beds in this treatability test were designed for a 15 minute residence time, when scaling the lab test to field application flow rates, the mass of resin was much larger than would be used in a site application. For RIEC test, breakthrough of arsenic after 7 days suggests that, given field-sized vessels, the resin utilization would be too high without pre-treatment for arsenic and molybdenum prior to resin filtration.

Subsequent testing was performed used the procedure discussed in Section 2.1.3 prior to filtration through the resin beds. The process involved RIEC water adjusted to a pH of 6 using HCl followed by $FeCl_3$ (40 mg/L), settling, and sand filtration. The water was then passed through one of three columns containing SIR-150 (**Table 1 Test B-2**), IRA-743 (**Table 1 Test B-3**), or PWA-10 (**Table 1 Test B-4**). While all resins were capable of removing the boron and polishing the arsenic and molybdenum, SIR-150 showed the highest performance for sulfate removal. Additional temporal testing was performed on the SIR-150 and PWA-10 resins for sulfate removal along with surfactant coated zeolite (**Table 1 Tests B,S-1** to **B,S-24**). These tests are discussed further in Section 2.3.2.

Confirmation testing of the treatment process discussed in Section 2.1.4 followed by filtration through the SIR-150 resin using LEC water was performed with results shown in **Table 1 Tests Final 2** and **Final 4** with both results showing successful treatment of arsenic, molybdenum, sulfate, and boron.

2.3 Sulfate

2.3.1 Sorption and Precipitation

Sulfate can be precipitated out at high concentrations (thousands of milligrams per liter (mg/L) concentration ranges) but is difficult to reduce at lower concentrations (hundreds of mg/L concentration ranges). The primary approaches used for the lower level concentration of sulfate are reverse osmosis and resin removal. As mentioned for boron, there is a low efficiency of treated water to wastewater using reverse osmosis. The cost, maintenance, and waste stream of resins are such that it would be preferable to not rely on a second resin bed for sulfate removal which would result in a second resin waste stream. Other literature options discussed were:

- sorption using
    - zeolite (**Table 1 Tests S-1, S-5, S-22**);
    - surfactant coated zeolite (**Table 1 Tests S-2, S-6, S-11, S-12, S-19** to **S-21**);
    - sodium chloride coated zeolite (**Table 1 Tests S-3, S-7, S-9, S-10**).
- precipitation using
    - limestone (**Table 1 Tests S-4, S-8**);
    - cement (**Table 1 Tests S-13** to **S-15**);

- calcium hydroxide (**Table 1 Tests S-16** to **S-18**);
- chitosan (**Table 1 Tests S-23** to **S-25**);
- sodium aluminate (**Table 1 Test S-26**);
- calcium aluminate (**Table 1 Test S-27**);
- calcium aluminate cement (**Table 1 Test S-28**).

Since the success of these processes are sensitive to water quality and water chemistry (alkalinity, pH, total dissolved solids, etc.), several dosages, treatment train applications, product formulations, and pH ranges were tested on RIEC and SEC water to identify if there was a method for successful.

Of the methods and conditions tested, none were shown to greatly reduce the sulfate concentration relative to the baseline value.

2.3.2 Resin

Based on the results of RIEC pilot study which was conducted in parallel with the sulfate portion of the lab treatability testing, approximately 20% of the influent sulfate can be removed through the $FeCl_3$ coagulation/flocculation process and is removed after the sand filtration. This reduction brings the sulfate concentrations at RIEC below the discharge permit levels. In addition, the pilot study showed an average of 58% reduction in sulfate between the influent and post boron resin treatment (**Table 1 Tests P1** to **P20**).

Based on the lack of success of the options in Section 2.3.1 and the ability of the current proposed treatment train to treat RIEC sulfate concentrations to below discharge permit levels (250,000 µg/L), the best option would be to use the treatment train developed for arsenic and molybdenum to decrease the sulfate concentrations and then polish the water with the boron resin.

As mentioned in Section 2.2, there were three resins identified that could remove boron and preliminary results using RIEC water suggested that sulfate coated zeolite could reduce sulfate. Temporal testing was performed to evaluate the longevity of two of the resins (SIR-150 and PWA-10) and the surfactant coated zeolite using RIEC water. Columns were constructed that were scaled to the proposed full scale vessel sizes for the lab defined flow rate and were run for 6 days. While the residence time and vessel sizing was scaled appropriately, due to water volume restraints, the surface area of vessel media to flow is an underestimate of the full scale system. Regardless, the design allowed for a comparison of the performance of the two resins and the surfactant coated zeolite using either RIEC or SEC water. Based on the results, the SIR-150 resin (**Table 1 Tests B,S-19** to **B,S-24**) outperformed the PWA-10 resin (**Table 1 Tests B,S-1** to **B,S-6** and **B,S-13** to **B,S-18**) with lower magnitudes of breakthrough. The surfactant coated zeolite (**Table 1 Tests B,S-7** to **B,S-12**) was shown to be ineffective at treatment under the design residence times.

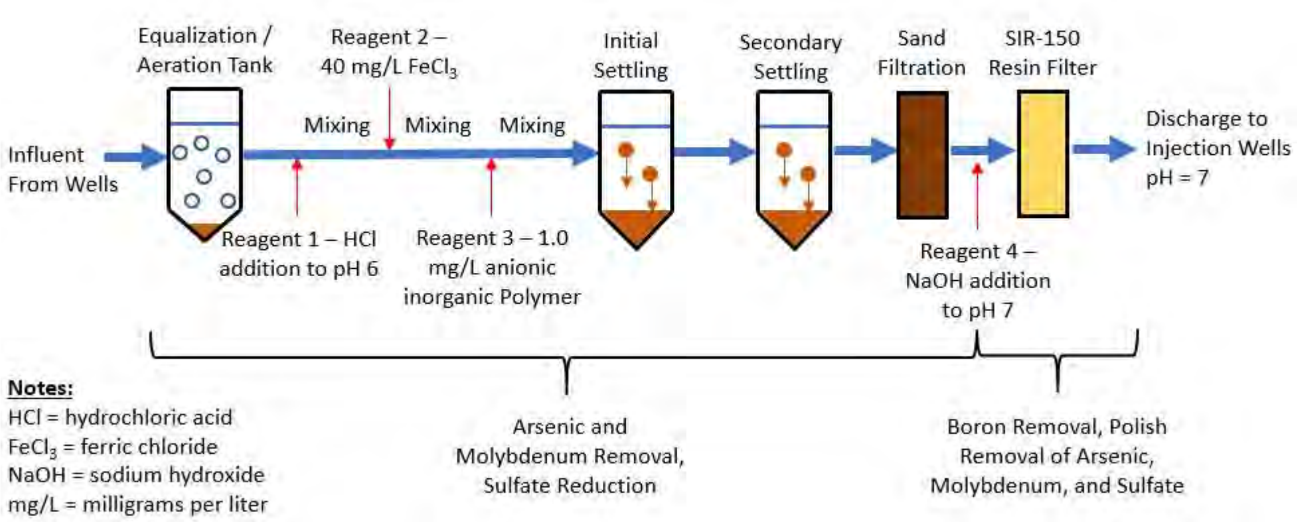
2.4 Final Design

As mentioned above, final confirmation tests were performed of LEC water to 1) confirm the treatment train process works for arsenic, molybdenum, sulfate, and boron and 2) identify if cationic or anionic polymers are more successful (**Table 1 Tests Final 1** to **4**). The final treatment train process is to aerate, adjust the pH to 6 using HCl, add $FeCl_3$ at 40 mg/L, add the anionic inorganic polymer at 1.0 mg/L, settling, sand filter, and finally SIR-150 resin filtration. Key observations and conclusions from the treatability testing, pilot study, and additional $FeCl_3$ testing are:

- Aeration of the groundwater prior to the addition of $FeCl_3$ accelerates the formation of precipitants.
- The initial adjustment pH should be close to pH of 6 at SEC for optimal arsenic and molybdenum removal.
- Higher $FeCl_3$ concentrations provided greater removal of dissolved arsenic and molybdenum.
- LEC water requires a coagulant aid to increase the density of the iron-arsenic and iron-molybdenum flocks. The anionic inorganic polymer had similar removal of arsenic and molybdenum as the cationic inorganic polymer but required a lower dose to generate flocks dense enough for settling within an hour.
- The sand filter was effective as a polishing step to reduce total arsenic and molybdenum concentrations to below action levels, while also decreasing total iron concentrations.
- The resin filter is needed to remove boron from the groundwater to action levels. The SIR-150 resin performed best of the resins tested. The SIR-150 resin operates optimally between a pH of 4 and 10.
- While removing boron from the groundwater, the resin also acts as a polishing tool for removal of residual arsenic and molybdenum and additional reduction of sulfate.

The final proposed treatment design is shown in **Figure 1** below:

Figure 1: Proposed Treatment Process



Notes:
HCl = hydrochloric acid
$FeCl_3$ = ferric chloride
$NaOH$ = sodium hydroxide
mg/L = milligrams per liter

Table 1

Summary of Labadie Energy Center Treatability Testing

Labadie Energy Center, Missouri

Test Condition Reference		Arsenic	Molybdenum	Sulfate	Boron
		ug/L			
	Permit Limits	10	100	250,000	2,000
	High Concentraiton Area Water	10.7	175	308,000	10,500
	Blended Water	19	160	290,000	9,000
	Focus on Arsenic and Molybdenum Removal - RIEC				
A,M-1	Adjust water to pH of 5 - Day 7	198	142	NM	3,270
A,M-2	Zero Valent Iron Column - 5 parts sand, 1 Part ZVI - Day 7	113	151	NM	3,900
A,M-3	Zero Valent Iron Column - 2 parts sand, 1 Part ZVI - Day 7	89	143	NM	3,510
A,M-4	Adjust water to pH 6, $FeCl_3$ (20 mg/L) - 1 hour reaction	7.2	20.5	NM	NM
A,M-5	Adjust water to pH 6, $FeCl_3$ (20 mg/L) - 3 hour reaction	10.9	24.1	NM	NM
A,M-6	Adjust water to pH 6, $FeCl_3$ (20 mg/L) - 6 hour reaction	12.6	28.3	NM	NM
A,M-7	Adjust water to pH 6, $FeCl_3$ (40 mg/L) - 1 hour reaction	4.9	<10	NM	NM
A,M-8	Adjust water to pH 6, $FeCl_3$ (40 mg/L) - 3 hour reaction	5.9	<10	NM	NM
A,M-9	Adjust water to pH 6, $FeCl_3$ (40 mg/L) - 6 hour reaction	6.2	<10	NM	NM
A,M-10	Adjust water to pH 4, $FeCl_3$ (40 mg/L) - 1 hour reaction	5.6	<10	NM	NM
A,M-11	Adjust water to pH 4, $FeCl_3$ (40 mg/L) - 3 hour reaction	8.5	<10	NM	NM
A,M-12	Adjust water to pH 4, $FeCl_3$ (40 mg/L) - 6 hour reaction	10.5	<10	NM	NM
A,M-13	Adjust water to pH 6, $FeCl_3$ (40 mg/L) and 3% H_2O_2 - 1 hour reaction	26.9	188	NM	NM
	Focus on Molybdenum Removal - LEC				
A,M-14	Adjusting water to pH of 6, $FeCl_3$ (40 mg/L), Sand Filter	8.3 Total <5 Dissolved	84 Total 72 Dissolved	NM	NM
	Focus on Molybdenum Removal and Settling Conditions - SEC				
A,M-15	Adjust water to pH 6, $FeCl_3$ (80 mg/L), 2:3 molar ratio FeCl3 to $Ca(OH)_2$, Sand Filter	NM	1,890	NM	NM
A,M-16	Adjust water to pH 6, $FeCl_3$ (40 mg/L), 2:3 molar ratio FeCl3 to $Ca(OH)_2$, Sand Filter	NM	2,560	NM	NM
A,M-17	Adjust water to pH 6, $FeCl_3$ (40 mg/L), $Ca(OH)_2$ to pH of 6, Sand Filter	NM	2,490	NM	NM
A,M-18	Adjust water to pH 6, $FeCl_3$ (40 mg/L), $Ca(OH)_2$ to pH of 5, Sand Filter	NM	1,430	NM	NM
A,M-19	Adjust water to pH 6, Alum (120 mg/L), Sand Filter	NM	2,880	NM	NM
A,M-20	Adjust water to pH 6, $FeCl_3$ (40 mg/L), Bentonite Powder, Sand Filter	NM	340	NM	NM
A,M-21	Adjust water to pH 6, $FeCl_3$ (80 mg/L), Bentonite Slurry, Sand Filter	NM	170	NM	NM
A,M-22	Adjust water to pH 6, $FeCl_3$ (40 mg/L), Anionic Polymer, Sand Filter	NM	200	NM	NM
A,M-23	Adjust water to pH 6, $FeCl_3$ (40 mg/L), Cationic Polymer, Sand Filter	NM	170	NM	NM
A,M-24	Adjust water to pH 6, $FeCl_3$ (80 mg/L), Anionic Polymer, Sand Filter	NM	120	NM	NM
A,M-25	Adjust water to pH 6, $FeCl_3$ (80 mg/L), Cationic Polymer, Sand Filter	NM	27	NM	NM
	Focus on Molybdenum Removal and Settling Conditions - LEC				
A,M-26	Adjust water to pH 6, FeCl3 (40 mg/L), Bentonite Powder, Sand Filter	<5	16	NM	NM
A,M-27	Adjust water to pH 6, FeCl3 (40 mg/L), High Dosage Anionic Polymer (3x Recomended), Adjust pH to 7, Sand Filter	NM	79	NM	NM
A,M-28	Adjust water to pH 6, FeCl3 (40 mg/L), High Dosage Anionic Polymer (3x Recomended), Adjust pH to 9, Sand Filter	NM	73	NM	NM
	Focus on Boron Removal - RIEC				
B-1	Adjust water to pH of 5, SIR 150 Resin Column - Day 7	50.8	<20	NM	<10
B-2	Adjust water to pH 6, $FeCl_3$ (40 mg/L), Sand Filter, SIR-150 Boron Resin	<5	<10	600	<10
B-3	Adjust water to pH 6, $FeCl_3$ (40 mg/L), Sand Filter, IRA-743 Boron Resin	<5	<10	17,000	<10
B-4	Adjust water to pH 6, $FeCl_3$ (40 mg/L), Sand Filter, PWA-10 Resin	<5	<10	4,400	<10
B-5	Adjusting water to pH of 6, $FeCl_3$ (40 mg/L), Sand Filter, SIR 150 Resin Column - System Operated 7 Days	1.6	<10	NM	<20

Table 1
Summary of Labadie Energy Center Treatability Testing
Labadie Energy Center, Missouri

Test Condition Reference		Arsenic	Molybdenum	Sulfate	Boron
		ug/L			
	Permit Limits	10	100	250,000	2,000
	High Concentraiton Area Water	10.7	175	308,000	10,500
	Blended Water	19	160	290,000	9,000
	Focus on Sulfate Removal - SEC				
S-1	Adjust water to pH 6, $FeCl_3$ (40 mg/L), Sand Filter, Zeolite Filter	NM	180	380,000	14,000
S-2	Adjust water to pH 6, $FeCl_3$ (40 mg/L), Sand Filter, Surfactant Coated Zeolite Filter	NM	160	360,000	15,000
S-3	Adjust water to pH 6, $FeCl_3$ (40 mg/L), Sand Filter, NaCl treated Zeolite Filter	NM	200	370,000	14,000
S-4	Adjust water to pH 6, $FeCl_3$ (40 mg/L), Sand Filter, Limestone Filter	NM	200	380,000	14,000
S-5	Adjust water to pH 6, $FeCl_3$ (40 mg/L), Sand Filter, adjust to pH 10, Zeolite Filter	NM	220	390,000	14,000
S-6	Adjust water to pH 6, $FeCl_3$ (40 mg/L), Sand Filter, adjust to pH 10, Surfactant Coated Zeolite Filter	NM	220	390,000	15,000
S-7	Adjust water to pH 6, $FeCl_3$ (40 mg/L), Sand Filter, adjust to pH 10, NaCl treated Zeolite Filter	NM	200	360,000	13,000
S-8	Adjust water to pH 6, $FeCl_3$ (40 mg/L), Sand Filter, adjust to pH 10, Limestone Filter	NM	220	390,000	14,000
S-9	Adjust water to pH6, NaCl Treated Zeolite Filter	NM	NM	430,000	1,500
S-10	NaCl Treated Zeolite Filter Only	NM	NM	420,000	1,600
S-11	Adjust water to pH 6, Surfactant Coated Zeolite Filter	NM	NM	270,000	540
S-12	Surfactant Coated Zeolite Filter Only	NM	NM	230,000	370
S-13	Adjust water to pH 6, $FeCl_3$ (80 mg/L - Bentonite to help settling), Sand Filter, 1:1 cement:sulfate molar ration (20 min mixing)	NM	NM	460,000	NM
S-14	Adjust water to pH 6, $FeCl_3$ (80 mg/L - Bentonite to help settling), Sand Filter, 1.5:1 cement:sulfate molar ration (20 min mixing)	NM	NM	470,000	NM
S-15	Adjust water to pH 6, $FeCl_3$ (80 mg/L - Bentonite to help settling), Sand Filter, 2:1 cement:sulfate molar ration (20 min mixing)	NM	NM	490,000	NM
S-16	Adjust water to pH 6, $FeCl_3$ (80 mg/L - Bentonite to help settling), Sand Filter, 1:1 $Ca(OH)_2$:sulfate molar ration (60 min mixing)	NM	NM	430,000	NM
S-17	Adjust water to pH 6, $FeCl_3$ (80 mg/L - Bentonite to help settling), Sand Filter, 3:1 $Ca(OH)_2$:sulfate molar ration (60 min mixing)	NM	NM	420,000	NM
S-18	Adjust water to pH 6, $FeCl_3$ (80 mg/L - Bentonite to help settling), Sand Filter, 5:1 $Ca(OH)_2$:sulfate molar ration (60 min mixing)	NM	NM	420,000	NM
	Focus on Sulfate Removal - RIEC				
S-19	DS-200 Zeolite Only	160	1,000	300,000	8,300
S-20	OC-300 Zeolite Only	150	1,100	360,000	9,100
S-21	HS-200 Zeolite Only	160	890	330,000	8,400
S-22	Clinoptilolite Zeolite Only	170	1,100	230,000	8,400
S-23	Adjust water to pH 6, $FeCl_3$ (40 mg/L), Sand Filter, Chitosan High MW (50 mg/L), adjust pH to 3.5, Mix for 1 hour	NM	NM	230,000	8,300
S-24	Adjust water to pH 6, $FeCl_3$ (40 mg/L), Sand Filter, Chitosan Medium MW (50 mg/L), adjust pH to 3.5, Mix for 1 hour	NM	NM	230,000	9,100
S-25	Adjust water to pH 6, $FeCl_3$ (40 mg/L), Sand Filter, Chitosan Low MW (50 mg/L), adjust pH to 3.5, Mix for 1 hour	NM	NM	230,000	9,400
S-26	Adjust water to pH 6, $FeCl_3$ (40 mg/L), Sand Filter, Sodium Aluminate at 2:1 molar ration with sulfate, adjust pH to 11.3, Mix for 1 hour	NM	NM	230,000	8,100
S-27	Adjust water to pH 6, $FeCl_3$ (40 mg/L), Sand Filter, Calcium Aluminate at 2:1 molar ration with sulfate, adjust pH to 11.3, Mix for 1 hour	NM	NM	230,000	8,200
S-28	Adjust water to pH 6, $FeCl_3$ (40 mg/L), Sand Filter, Calcium Aluminate Cement at 2:1 molar ration with sulfate, adjust pH to 11.3, Mix for 1 hour	NM	NM	230,000	8,100

Table 1

Summary of Labadie Energy Center Treatability Testing

Labadie Energy Center, Missouri

Test Condition Reference		Arsenic	Molybdenum	Sulfate	Boron
		ug/L			
	Permit Limits	10	100	250,000	2,000
	High Concentraiton Area Water	10.7	175	308,000	10,500
	Blended Water	19	160	290,000	9,000
Focus on Sulfate and Boron Resin Removal - RIEC					
B,S-1	Adjust water to pH 6, $FeCl_3$ (40 mg/L), Sand Filter, PWA-10 Boron Resin - RIEC - 1 Day	<5	14	210,000	<10
B,S-2	Adjust water to pH 6, $FeCl_3$ (40 mg/L), Sand Filter, PWA-10 Boron Resin - RIEC - 2 Day	<5	20	210,000	<10
B,S-3	Adjust water to pH 6, $FeCl_3$ (40 mg/L), Sand Filter, PWA-10 Boron Resin - RIEC - 3 Day	<5	<10	220,000	180
B,S-4	Adjust water to pH 6, $FeCl_3$ (40 mg/L), Sand Filter, PWA-10 Boron Resin - RIEC - 4 Day	<5	<10	220,000	3,400
B,S-5	Adjust water to pH 6, $FeCl_3$ (40 mg/L), Sand Filter, PWA-10 Boron Resin - RIEC - 5 Day	<5	<10	220,000	7,300
B,S-6	Adjust water to pH 6, $FeCl_3$ (40 mg/L), Sand Filter, PWA-10 Boron Resin - RIEC - 6 Day	<5	<10	220,000	9,100
B,S-7	Adjust water to pH 6, $FeCl_3$ (40 mg/L), Sand Filter, Surfactant Coated Zeolite - RIEC - 1 Day	<5	200	220,000	8,600
B,S-8	Adjust water to pH 6, $FeCl_3$ (40 mg/L), Sand Filter, Surfactant Coated Zeolite - RIEC - 2 Day	<5	200	220,000	9,100
B,S-9	Adjust water to pH 6, $FeCl_3$ (40 mg/L), Sand Filter, Surfactant Coated Zeolite - RIEC - 3 Day	<5	220	220,000	9,900
B,S-10	Adjust water to pH 6, $FeCl_3$ (40 mg/L), Sand Filter, Surfactant Coated Zeolite - RIEC - 4 Day	<5	220	220,000	9,400
B,S-11	Adjust water to pH 6, $FeCl_3$ (40 mg/L), Sand Filter, Surfactant Coated Zeolite - RIEC - 5 Day	<5	240	220,000	9,300
B,S-12	Adjust water to pH 6, $FeCl_3$ (40 mg/L), Sand Filter, Surfactant Coated Zeolite - RIEC - 6 Day	<5	240	220,000	9,500
Focus on Sulfate and Boron Resin Removal - SEC					
B,S-13	Adjust water to pH 6, $FeCl_3$ (40 mg/L), Sand Filter, PWA-10 Boron Resin - SEC - 1 Day	NM	<10	360,000	<10
B,S-14	Adjust water to pH 6, $FeCl_3$ (40 mg/L), Sand Filter, PWA-10 Boron Resin - SEC - 2 Day	NM	<10	380,000	750
B,S-15	Adjust water to pH 6, $FeCl_3$ (40 mg/L), Sand Filter, PWA-10 Boron Resin - SEC - 3 Day	NM	<10	370,000	8,600
B,S-16	Adjust water to pH 6, $FeCl_3$ (40 mg/L), Sand Filter, PWA-10 Boron Resin - SEC - 4 Day	NM	<10	370,000	16,000
B,S-17	Adjust water to pH 6, $FeCl_3$ (40 mg/L), Sand Filter, PWA-10 Boron Resin - SEC - 5 Day	NM	<10	380,000	19,000
B,S-18	Adjust water to pH 6, $FeCl_3$ (40 mg/L), Sand Filter, PWA-10 Boron Resin - SEC - 6 Day	NM	<10	360,000	17,000
B,S-19	Adjust water to pH 6, $FeCl_3$ (40 mg/L), Sand Filter, SIR-150 Boron Resin - SEC - 1 Day	NM	<10	330,000	<20
B,S-20	Adjust water to pH 6, $FeCl_3$ (40 mg/L), Sand Filter, SIR-150 Boron Resin - SEC - 2 Day	NM	<10	370,000	30
B,S-21	Adjust water to pH 6, $FeCl_3$ (40 mg/L), Sand Filter, SIR-150 Boron Resin - SEC - 3 Day	NM	<10	370,000	4,300
B,S-22	Adjust water to pH 6, $FeCl_3$ (40 mg/L), Sand Filter, SIR-150 Boron Resin - SEC - 4 Day	NM	<10	380,000	13,000
B,S-23	Adjust water to pH 6, $FeCl_3$ (40 mg/L), Sand Filter, SIR-150 Boron Resin - SEC - 5 Day	NM	<10	360,000	17,000
B,S-24	Adjust water to pH 6, $FeCl_3$ (40 mg/L), Sand Filter, SIR-150 Boron Resin - SEC - 6 Day	NM	<10	360,000	18,000
Focus on Final Design; Settling and Treatment - LEC					
Final 1	Adjust water to pH 6, $FeCl_3$ (40 mg/L), Anion Polymer (1.0 mg/L), Sand Filter	<5	<10	290,000	9,000
Final 2	Boron Resin	<5	<10	1.7	<10
Final 3	Adjust water to pH 6, $FeCl_3$ (40 mg/L), Cation Polymer (2.0 mg/L), Sand Filter	<5	<10	270,000	9,600
Final 4	Boron Resin	<5	<10	0.5	<10

Table 1
Summary of Labadie Energy Center Treatability Testing
Labadie Energy Center, Missouri

Test Condition Reference		Arsenic	Molybdenum	Sulfate	Boron
		ug/L			
	Permit Limits	10	100	250,000	2,000
	High Concentraiton Area Water	10.7	175	308,000	10,500
	Blended Water	19	160	290,000	9,000
	Pilot Study Results - RIEC				
P-1	2/10/21 RIEC Pilot Influent	169	1,070	263,000	7,510
P-2	2/10/21 RIEC Pilot Post Resin Filter	6	14	8,000	<250
P-3	2/12/21 RIEC Pilot Influent	145	852	261,000	8,110
P-4	2/12/21 RIEC Pilot Post Sand Filter	65	349	253,000	2,230
P-5	2/12/21 RIEC Pilot Post Resin Filter	0.8	0.7	7,000	20
P-6	2/15/21 RIEC Pilot Influent	167	871	280,000	1,620
P-7	2/15/21 RIEC Pilot Post Sand Filter	16	93	228,000	7,530
P-8	2/15/21 RIEC Pilot Post Resin Filter	1	<5	63,000	<10
P-9	2/25/21 RIEC Pilot Influent	163	880	265,000	7,940
P-10	2/25/21 RIEC Pilot Post Sand Filter	33	134	237,000	NM
P-11	2/25/21 RIEC Pilot Post Resin Filter	2	10	208,000	<10
P-12	3/3/21 RIEC Pilot Influent	166	1,030	255,000	8,550
P-13	3/3/21 RIEC Pilot Post Resin Filter	8	6	212,000	<10
P-14	4/9/21 RIEC Pilot Influent	188	1,060	278,000	9,940
P-15	4/9/21 RIEC Pilot Post Resin Filter	8	33	128,000	62
P-16	5/7/21 RIEC Pilot Influent	167	946	228,000	8,710
P-17	5/7/21 RIEC Pilot Post Resin Filter	47	248	100,000	2,330
P-18	5/11/21 RIEC Pilot Influent	180	1,020	235,000	9,480
P-19	5/11/21 RIEC Pilot Post Sand Filter	<10	4	186,000	6,910
P-20	5/11/21 RIEC Pilot Post Resin Filter	98	8	136,000	NM

Notes and Abreviations:

RIEC = Rush Island Energy Center
SEC = Sioux Energy Center
NM = not measured
< = concentration is less than value
Red values exceed discharge permit limits
H_2O_2 = hydrogen peroxide

mg/L = milligrams per liter
ug/L = micrograms per liter
$Ca(OH)_2$ = calcium hydroxide
ZVI = zero valent iron
NaCl = sodium chloride
$FeCl_3$ = ferric chloride

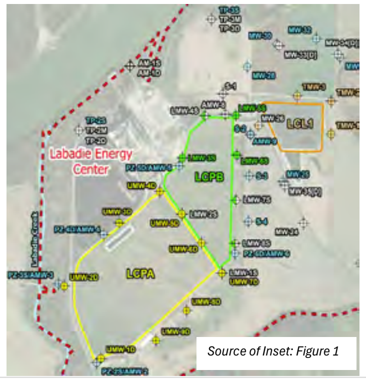
A = arsenic treatment approach
M = molybdenum treatment approach
B = boron treatment approach
S = sulfate treatment approach
MW = molecular weight

APPENDIX E

Time-Series Plots for Key Downgradient Well-Constituent Pairs

BORON TIME-SERIES PLOTS FOR KEY DOWNGRADIENT WELL-CONSTITUENT PAIRS

DETECTION AND ASSESSMENT MONITORING WELLS



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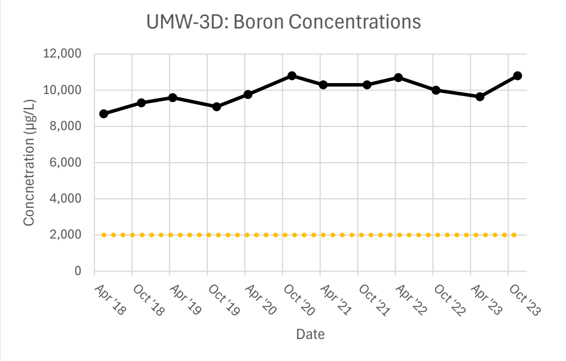
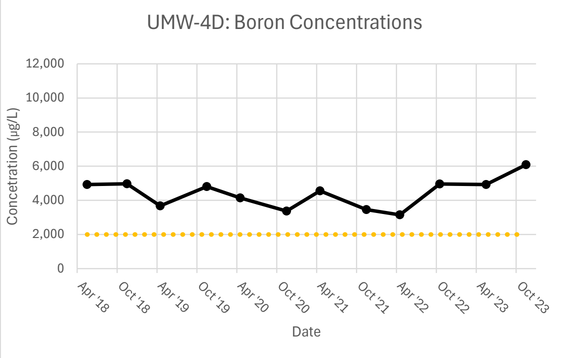

UMW-3D: Boron Concentrations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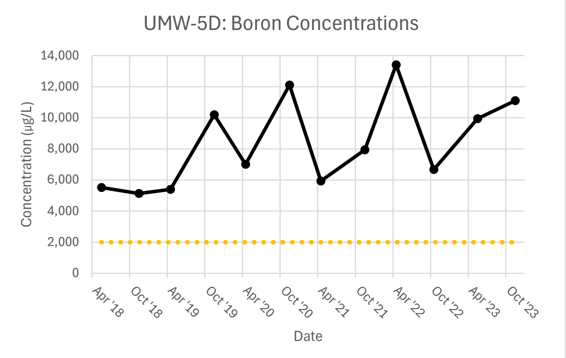
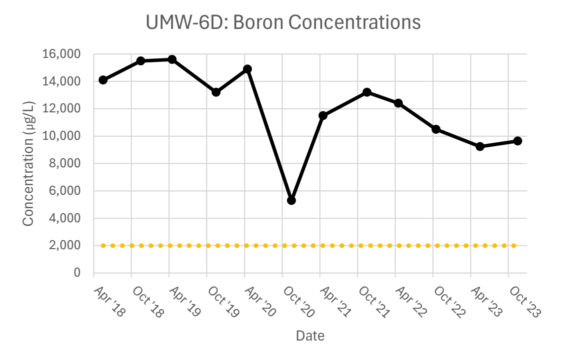
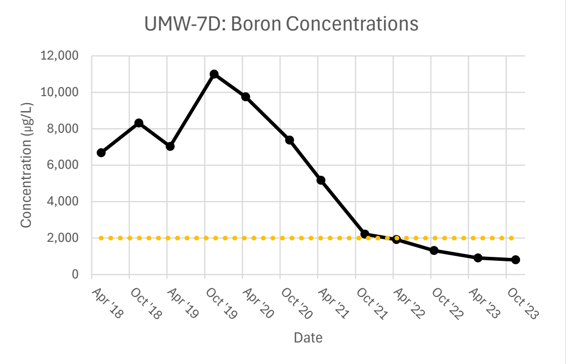

UMW-5D: Boron Concentrations


UMW-6D: Boron Concentrations


UMW-7D: Boron Concentrations

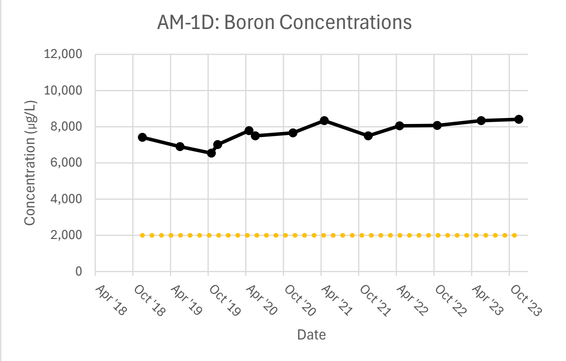
Legend:

━●━ Concentration for monitoring event

━●━ Non-detect result - value averaged from proximate event(s)

······ Comparison criterion for Appendix III constituent

CORRECTIVE ACTION MONITORING WELLS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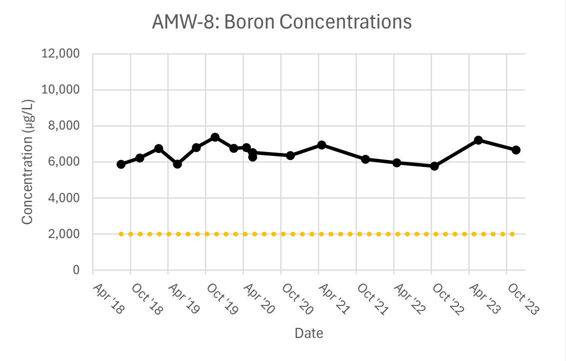
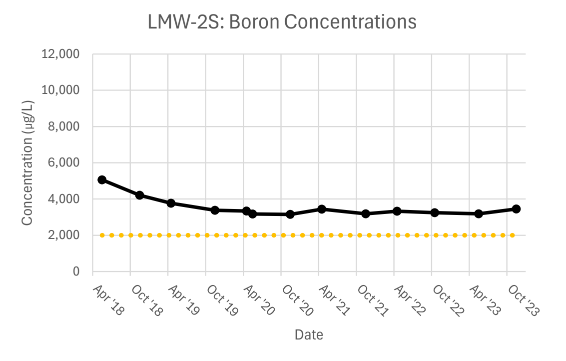
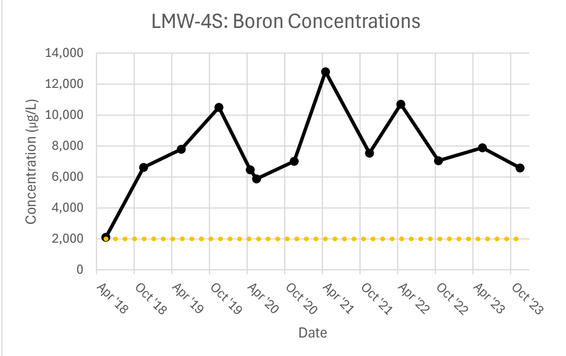

AMW-8: Boron Concentrations


LMW-2S: Boron Concentrations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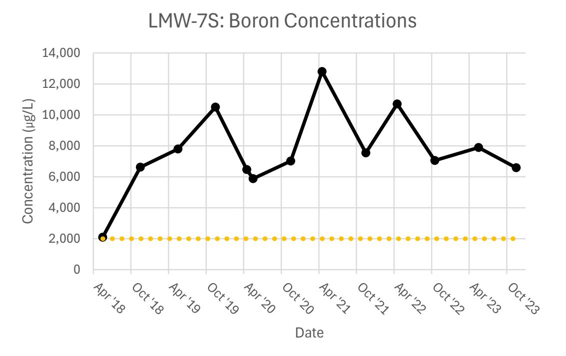
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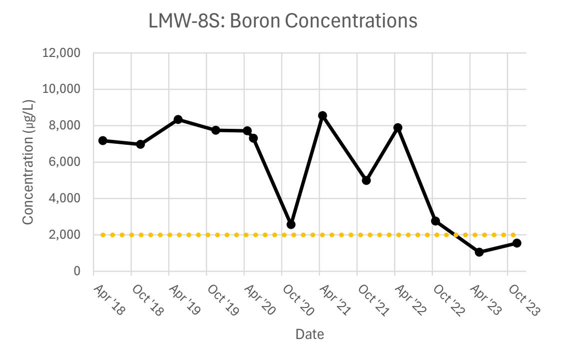
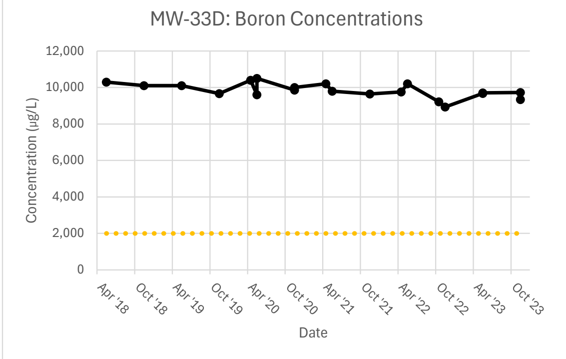

LMW-8S: Boron Concentrations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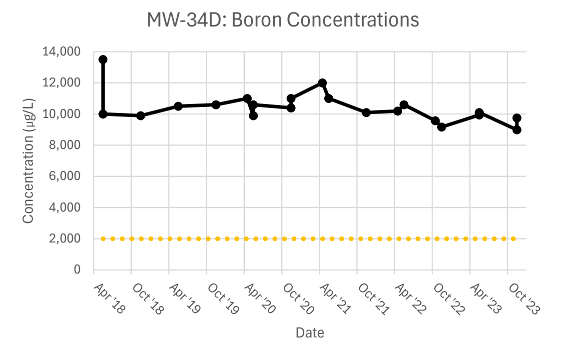
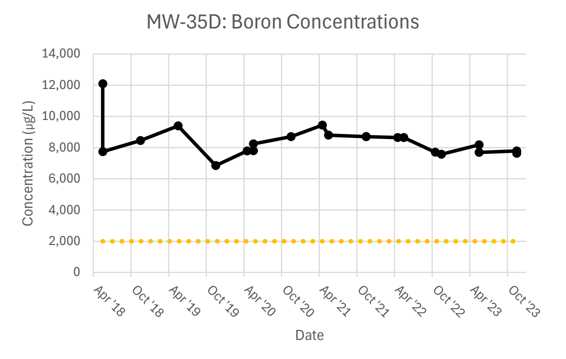
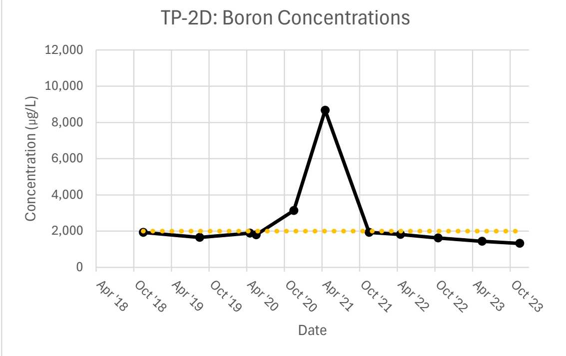
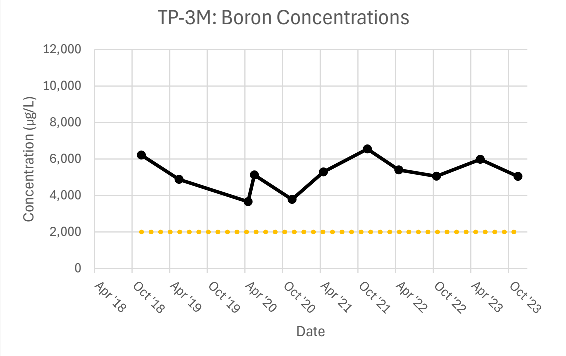
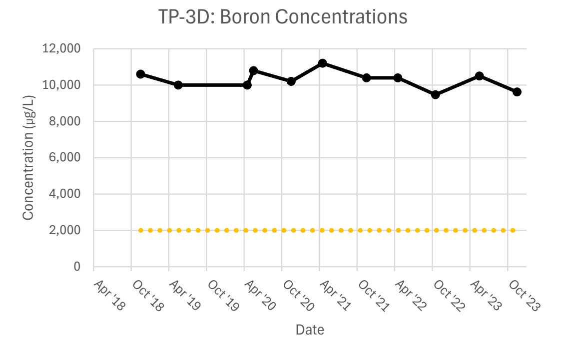

MW-34D: Boron Concentrations


MW-35D: Boron Concentrations

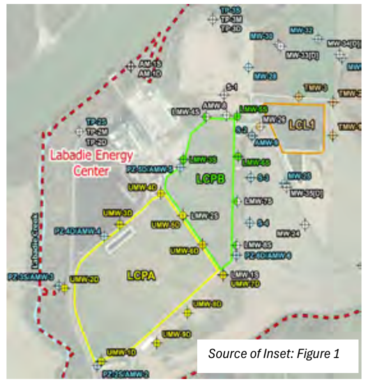

TP-2D: Boron Concentrations


TP-3M: Boron Concentrations


TP-3D: Boron Concentrations

MOLYBDENUM TIME-SERIES PLOTS FOR KEY DOWNGRADIENT WELL-CONSTITUENT PAIRS

DETECTION AND ASSESSMENT MONITORING WELLS



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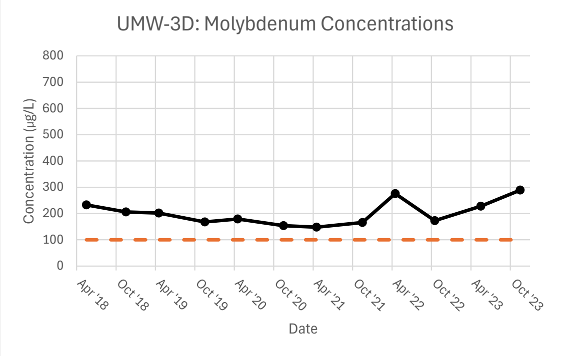
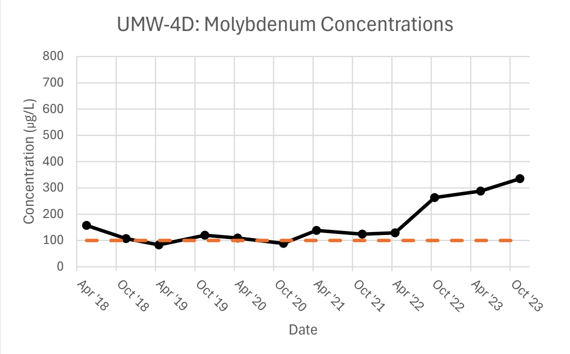

UMW-3D: Molybdenum Concentrations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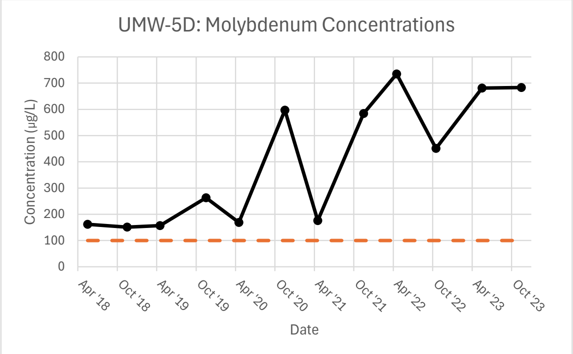
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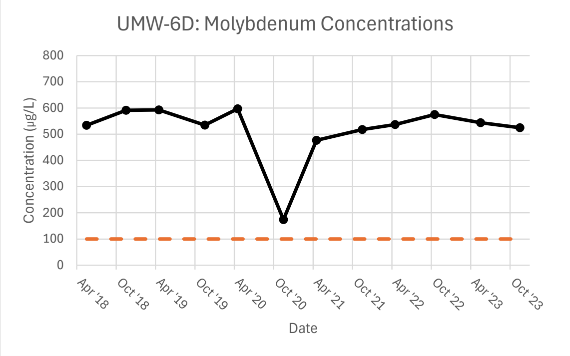
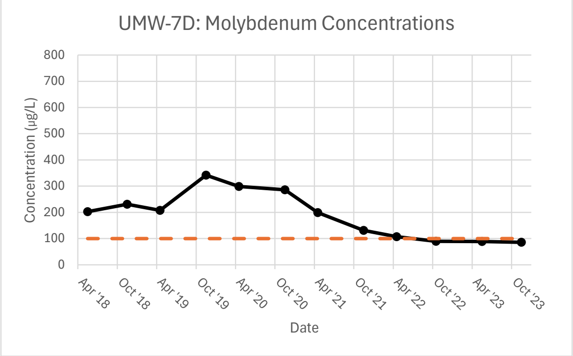
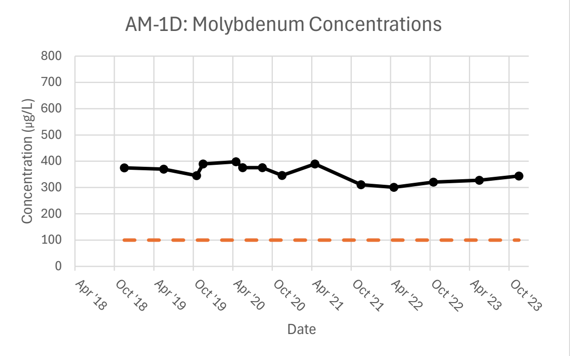
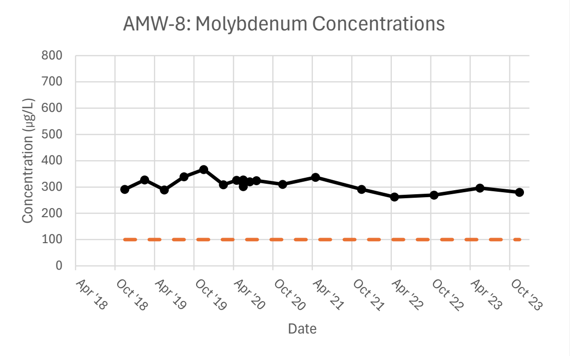

UMW-6D: Molybdenum Concentrations

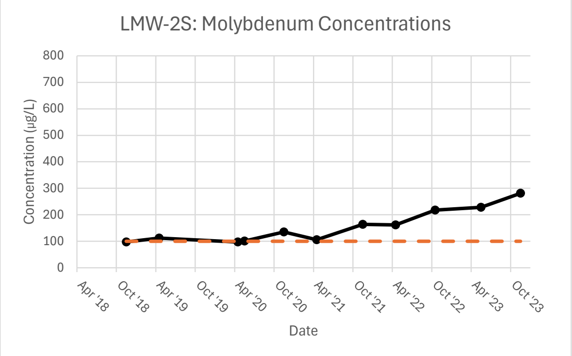

UMW-7D: Molybdenum Concentrations

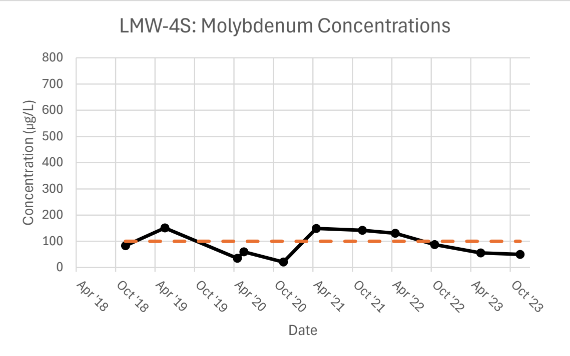
Legend:
- Concentration for monitoring event
- Non-detect result - value averaged from proximate event(s)
- GWPS for Appendix IV constituent

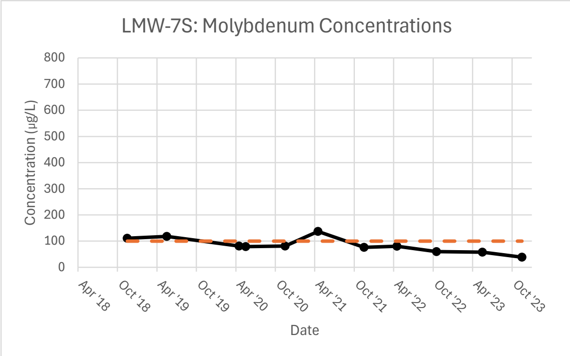
CORRECTIVE ACTION MONITORING WELLS


AM-1D: Molybdenum Concentrations


AMW-8: Molybdenum Concentrations


LMW-2S: Molybdenum Concentrations


LMW-4S: Molybdenum Concentrations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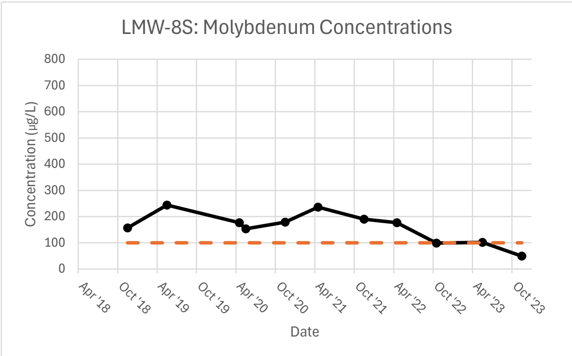
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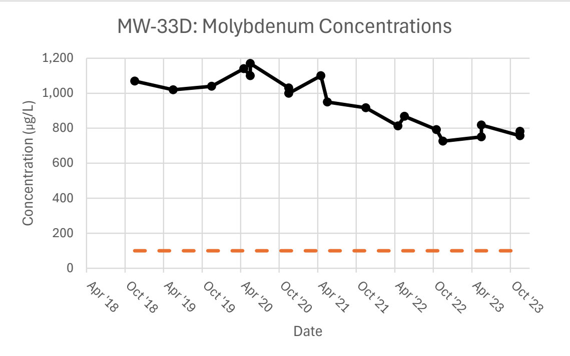
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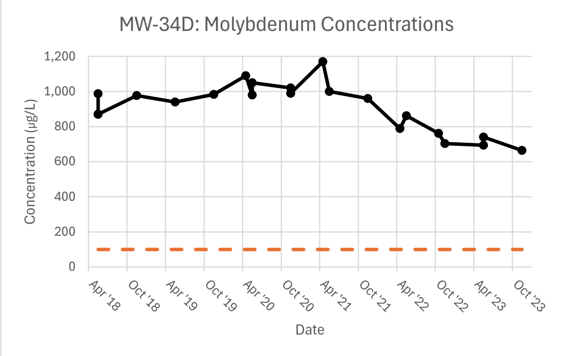
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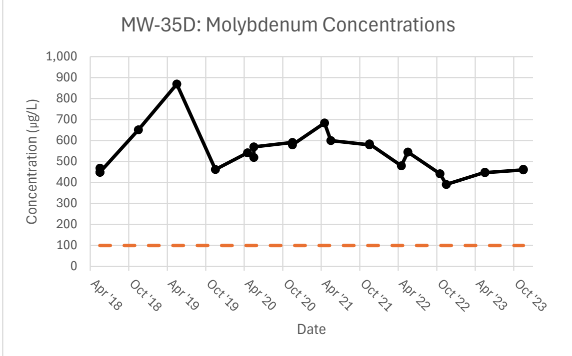
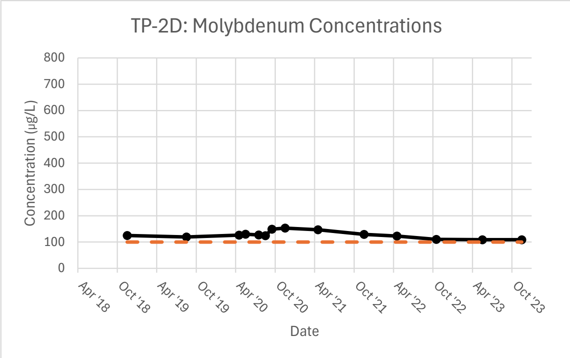
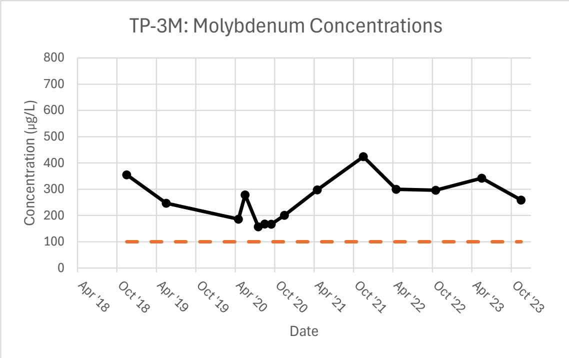
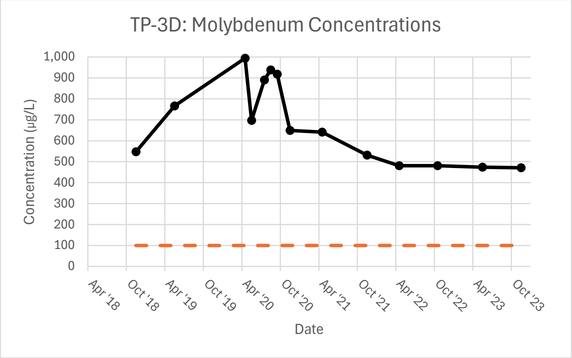

MW-35D: Molybdenum Concentrations

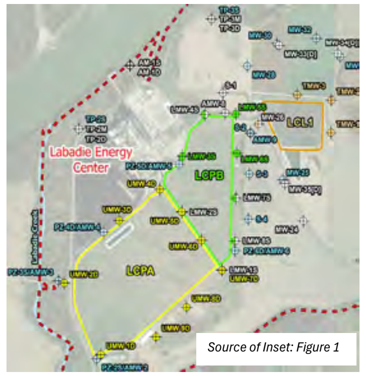

TP-2D: Molybdenum Concentrations


TP-3M: Molybdenum Concentrations


TP-3D: Molybdenum Concentrations

SULFATE TIME-SERIES PLOTS FOR KEY DOWNGRADIENT WELL-CONSTITUENT PAIRS

DETECTION AND ASSESSMENT MONITORING WELLS



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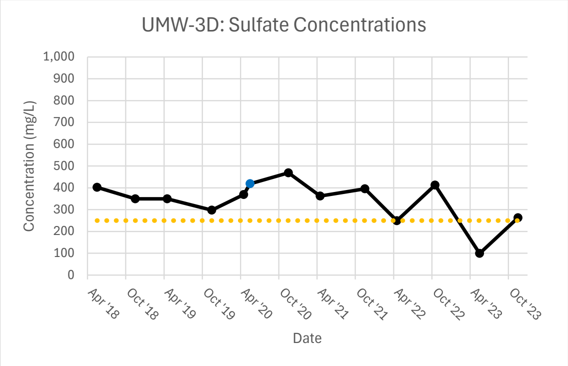
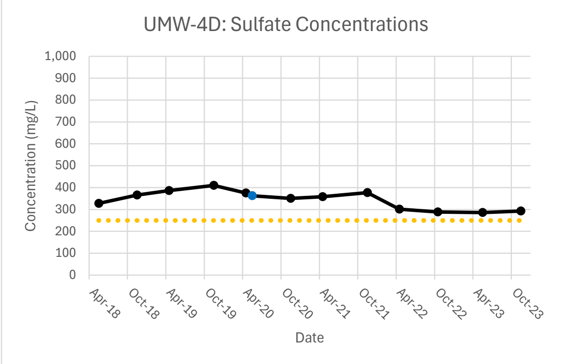
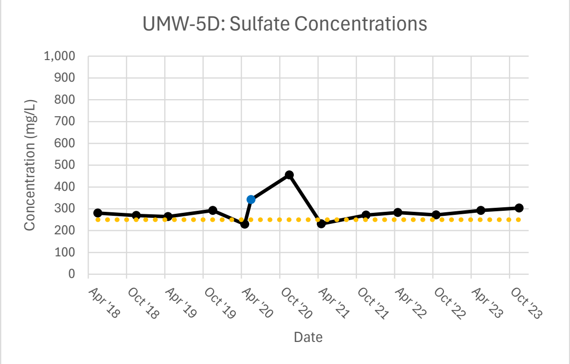
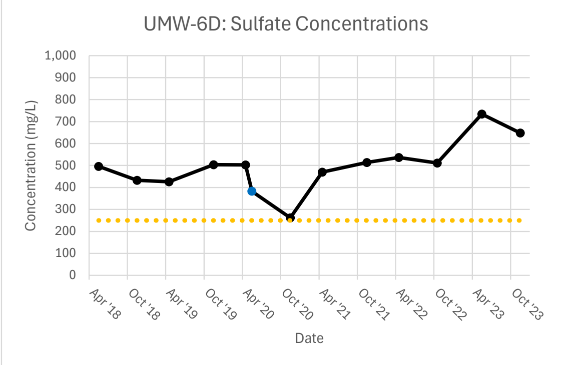
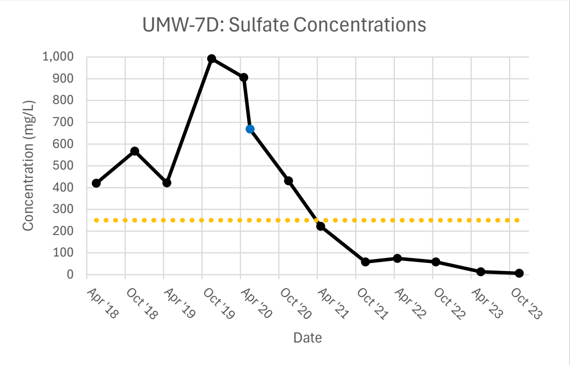




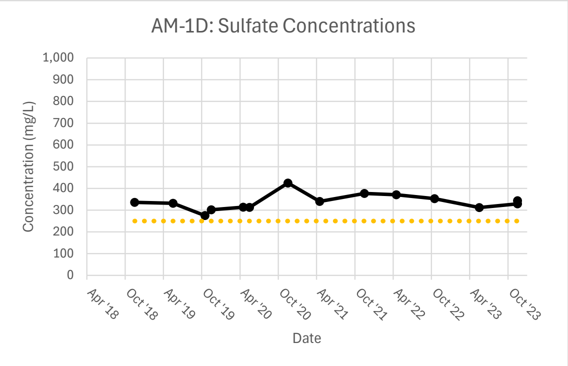


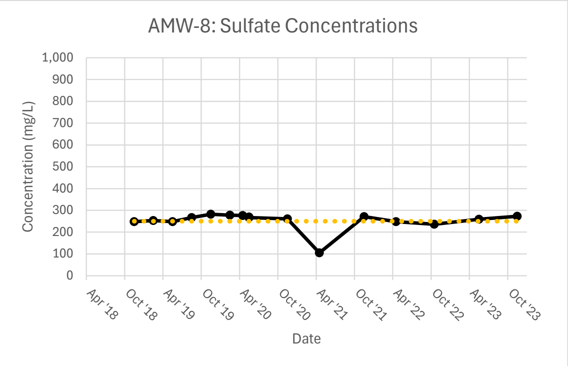


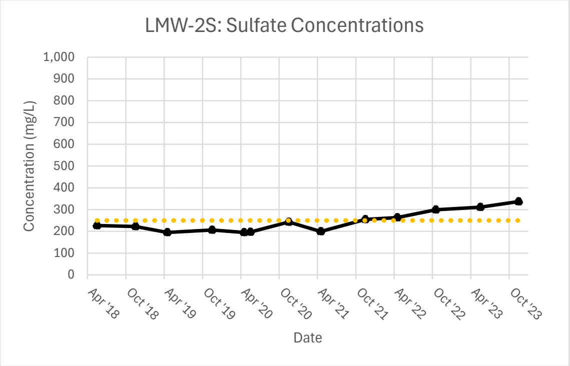


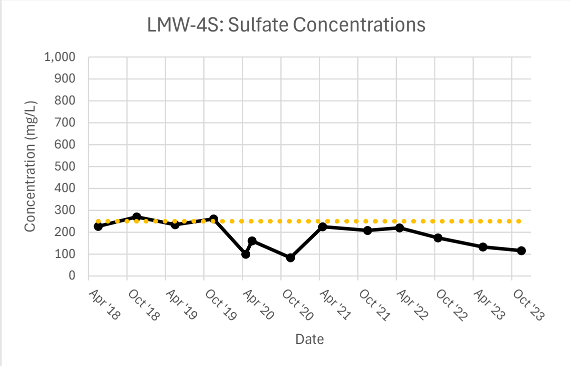
Legend:
—●— Concentration for monitoring event
—●— Non-detect result - value averaged from proximate event(s)
······ Comparison criterion for Appendix III constituent

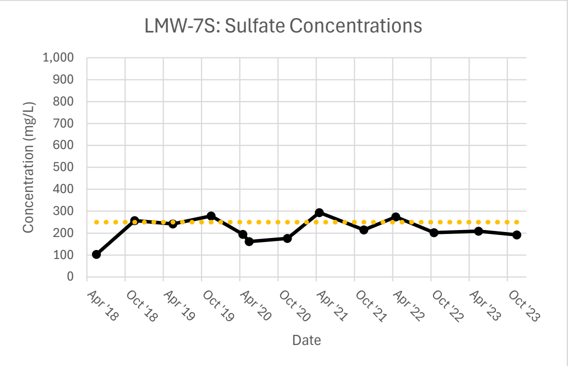
CORRECTIVE ACTION MONITORING WELLS

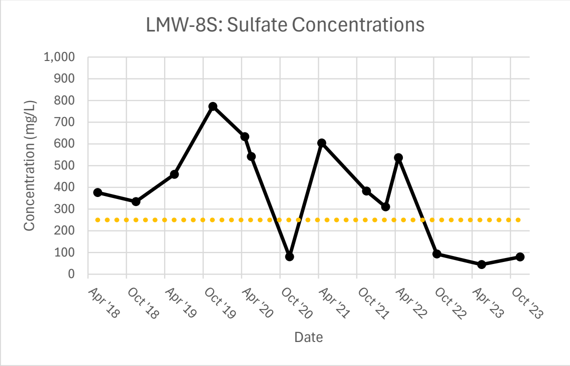


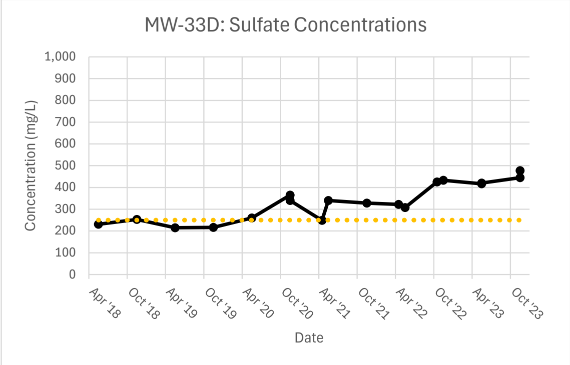


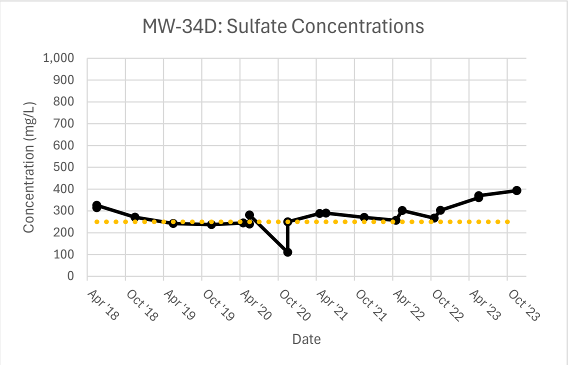


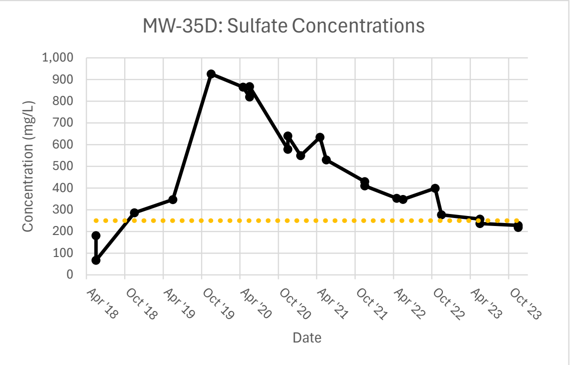


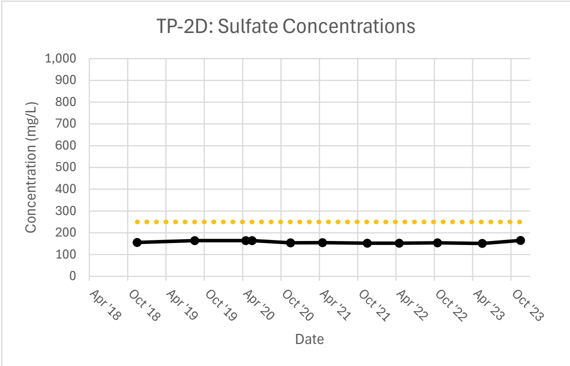


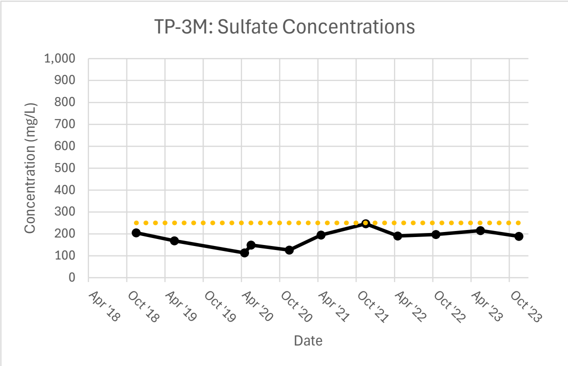


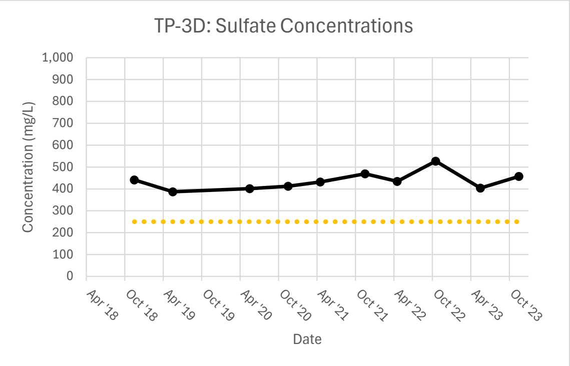












APPENDIX F

Monitored Natural Attenuation Evaluation *(produced by Golder Associates, Inc. on behalf of Ameren)*

DRAFT REPORT

Monitored Natural Attenuation Evaluation

Labadie Energy Center

Franklin County Missouri, USA

Submitted to:

Ameren Missouri
1901 Chouteau Ave
St. Louis, Missouri 63103

Submitted by:

Golder Associates Inc.
13515 Barrett Parkway Drive, Suite 260, Ballwin, Missouri, USA 63021
+1 314 984-8800

Project Number: 153140603

September 2021

MNA Checklist

Elements of MNA Evaluation	Characterization	Applicable Section(s)
Pre-Tier 1 - Site Background Information		
Site Layout	Identify potential source(s)	2.0, 2.1, 3.1
	Identify potential exposure points/receptors	2.0, 2.1, 3.1
Site History	History and Inventory of contaminants released	1.0, 2.1
	Mode of contaminant release	1.0, 2.1
	Chemistry of CCR source and release	3.1, 3.2, 4.1, 4.2
Tier 1 - Demonstrate Active Contaminant Removal from Groundwater		
Hydrogeologic Elements	Potential migration pathways identified	2.1
	Nature and extent of contaminant plume	2.1, 3.1, 5.0, 6.3
	Basic groundwater flow direction and aquifer hydrostratigraphy	5.0, App. C
General Site Chemistry	General chemistry (groundwater, surface water, and/or aquifer solids) for preliminary evaluation of contaminant degradation	3.1, 3.2, 4.1, 4.2
	Trend evaluation of groundwater data	3.1, 3.2, 4.1
	Distribution of contaminants between aqueous and solid phases	4.1, 4.2
Tier 2 - Determine Mechanisms and Rate of Attenuation		
Define Contaminant/Aquifer Solid Interactions	Identify aquifer mineralogy, attenuation mechanisms, and microbiological processes (if applicable)	4.1, 4.2, 6.1, 6.2, 6.3
Chemistry and Spatial Distribution of Contaminants	Groundwater characteristics for source(s) and contaminant plume, including field parameters, Appendix III parameters, Appendix IV parameters, major cations and anions, and speciation data (if applicable)	3.1, 3.2, 4.1, 5.0
Detailed Hydrogeology	Groundwater flow regime, including direction, velocity, potentiometric surface, gradients, etc.	2.1, 5.0, App. C
Tier 3 – Determine System Capacity and Stability of Attenuation		
Measurement of Attenuation Capacity	Determination of contaminant and dissolved reactant fluxes (concentration data and water flux)	6.1, 6.2, 6.3
	Determination of mass of available solid phase reactant(s)	4.2, 6.2, 6.3
Stability of Attenuated Contaminated Mass	Laboratory testing of immobilized contaminant stability	4.2, 6.2
	Model analyses to characterize aquifer capacity and evaluation of immobilized contaminant stability	6.2, 6.3
Tier 4 - Design of Performance Monitoring Program and Identify Alternative Remedy		
Long-Term Monitoring Program	Selection of monitoring locations and sampling frequency based on site conditions	Not applicable - provided in separate report.
	Selection of key monitoring parameters used to assess effectiveness of the remedy	
	Selection of monitoring criteria that would trigger re-evaluation of adequacy of the monitoring program and the remedy selected	

Note: Table based on summaries provided in United States Environmental Protection Agency (USEPA) *Monitored Natural Attenuation of Inorganic Contaminants in Ground Water* (USEPA 2007a, b), and Interstate Technology & Regulatory Council (ITRC) *A Decision Framework for Applying Monitoring Natural Attenuation Processes to Metals and Radionuclides in Groundwater* (ITRC 2010).

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1.0 INTRODUCTION

Based on the results of the corrective measures assessment conducted under 40 CFR § 257.91, groundwater (USEPA 2016) and Coal Combustion Residual (CCR) porewater and solid materials were characterized and evaluated to determine the effectiveness and help predict the attenuation rate of Monitored Natural Attenuation (MNA) as a component of remedial strategy for Ameren Missouri's (hereafter, "Ameren") LCPA bottom ash surface impoundment (hereafter, "LCPA" or "CCR Unit") located at Labadie Energy Center (LEC) in Franklin County, Missouri (hereafter, the "Site", "LEC" or "Labadie"). The structure of this evaluation closely follows the United States Environmental Protection Agency (USEPA) guidance on using MNA as a remedial strategy (USEPA 2007a, b) and considers best practices from the Interstate Technology Regulatory Council (ITRC) document: "A Decision Framework for Applying Monitored Natural Attenuation Processes to Metals and Radionuclides in Groundwater" (ITRC 2010). This MNA evaluation was completed using the following tiers (USEPA 2007a, b):

1) Demonstrate active constituent removal from groundwater and dissolved plume stability (Tier I)
2) Determine the mechanism(s) and rate(s) of the operative attenuation processes (Tier II)
3) Determine the long-term capacity for attenuation and the stability of immobilized constituents (Tier III)

Following the completion of this multi-tier evaluation, the fourth and final tier of an MNA program, which involves the design of a performance monitoring program and the development of contingency plan, will be updated as needed, based on the findings of this evaluation if needed.

2.0 SITE BACKGROUND

The LEC is located approximately 35 miles west of downtown St. Louis in Franklin, County, Missouri (Figure 1). The Facility encompasses approximately 2,400 acres and is situated within the Missouri River Valley. The Facility is bounded to the north by the Missouri River, to the west by Labadie Creek, to the northeast and east by agricultural land and to the south by a railroad line and bedrock bluffs. Figure 2 shows the CCR Unit, along with site monitoring wells and the Missouri River.

The detection and assessment monitoring well network for the Site includes two background and nine compliance monitoring wells. There is also a corrective action monitoring well network for the LCPA, consisting of 22 monitoring wells. The well networks are summarized in Table 1 and shown on Figure 2.

Table 1: LCPA Monitoring Well Network

Monitoring Well Networks	Well ID
Detection and Assessment Background Monitoring Wells	BMW-1D, BMW-2D
Detection and Assessment (Compliance) Monitoring Wells	UMW-1D, UMW-2D, UMW-3D, UMW-4D, UMW-5D, UMW-6D, UMW-7D, UMW-8D, UMW-9D
Corrective Action Monitoring Wells	BMW-1S, BMW-2S, LMW-1S, LMW-2S, LMW-4S, LMW-7S, LMW-8S, MW-24, MW-26, S-1, AM-1S, AM-1D, TP-1D, TP-2M, TP-2D, TP-3M, TP-3D, TP-4D, MW-33(D), MW-34(D), MW-35(D), AMW-8

Historically, sampling and statistical analysis of the detection monitoring network has identified the following statistically significant increases (SSIs) of Appendix III constituents over background:

- **Boron** – UMW-3D, UMW-4D, UMW-5D, UMW-6D
- **Calcium** – UMW-1D, UMW-2D, UMW-3D, UMW-4D, UMW-5D, UMW-6D, UMW-7D, UMW-8D

- **Chloride** – UMW-2D, UMW-3D, UMW-4D, UMW-5D, UMW-6D, UMW-9D
- **Fluoride** – UMW-2D, UMW-4D,
- **pH** – UMW-3D, UMW-4D, UMW-5D, UMW-6D
- **Sulfate** - UMW-2D, UMW-3D, UMW-4D, UMW-5D, UMW-6D, UMW-7D, UMW-8D
- **Total Dissolved Solids** – UMW-1D, UMW-2D, UMW-3D, UMW-6D, UMW-7D, UMW-8D

Assessment monitoring in accordance with §257.95 was initiated on April 15th, 2018. Assessment monitoring identified statistically significant levels (SSLs) as follows:

- **Molybdenum** – UMW-3D, UMW-4D, UMW-5D, UMW-6D, and UMW-7D

On January 9, 2019, Ameren initiated its Corrective Measures Assessment (CMA) and completed and posted the CMA report on May 20, 2019. A public meeting was held on May 29, 2019 and responses to public comments were posted on Ameren's CCR website (https://www.ameren.com/company/environment-and-sustainability/managing-coal-combustion). On August 30, 2019, Ameren published its "Remedy Selection Report – 40 CFR §257.97 Rush Island, Labadie, Sioux, and Meramec CCR Basins" (Ameren 2019) that identified source control through installation of a low-permeability cover system and use of MNA as its chosen corrective action remedial plan.

Since the issuance of the Remedy Selection Report, Ameren has completed a pilot groundwater treatment investigation at the Rush Island Energy Center. The results of the pilot study successfully demonstrated reductions in concentrations of parameters typically associated with CCRs (including boron and molybdenum). Based on these results, Ameren is planning on installing a groundwater treatment system for the LEC on the downgradient side of the LCPA by the end of 2022. This MNA report has been prepared to further evaluate the effectiveness of MNA as a groundwater remedy at the LEC for molybdenum concentrations.

2.1 Summary of Site Hydrogeologic Conditions

A detailed discussion of the Site Hydrogeology is presented in the Groundwater Monitoring Plan (GMP, Golder 2017), the Corrective Action Groundwater Monitoring Plan (CAGMP, Golder 2020b) and the initial 2019 modeling report (Gredell 2019). In summary, geological and hydrogeological units exposed at the Site include two different geologic terrains: (1) floodplain deposits of the Missouri River Valley and (2) older sedimentary bedrock formations. The alluvial floodplain deposits are typically comprised of sands and gravels with lesser amounts of silts and clays, generally resulting in an overall fining-upward sequence. The bedrock formations are comprised of relatively flat-lying Ordovician-aged limestones, sandstones, and dolomites.

The alluvial deposits represent the primary aquifer at the Site and are influenced by the nearby Missouri River. Water flows into and out of the alluvial aquifer because of fluctuating river water levels that produce "bank recharge" and "bank discharge" conditions. Under typical aquifer conditions, groundwater in the alluvial aquifer flows towards the river and away from the bedrock bluffs, with a net flow direction generally to the north or northeast.

Horizontal and vertical groundwater flow within the uppermost aquifer have been locally influenced by operation of the LCPA surface impoundment prior to commencing closure. Prior to closure, ponding of water in the LCPA at elevations higher than the static water levels in the underlying alluvial aquifer groundwater created a localized mounding effect, resulting in localized downward gradients and localized radial groundwater flow outward from the impoundment. Since closure, these artificial downward gradients have been eliminated and alluvial aquifer flow has returned to more natural flow conditions.

3.0 TIER I EVALUATION

This evaluation was performed to further evaluate the mechanisms, rates, and stability of MNA as a remedy for groundwater impacts for the LCPA. To conduct this evaluation, a review of groundwater, CCR porewater, and soil samples that have been collected since 2011 was completed. Supplemental data collection and evaluation in support of MNA included:

- Groundwater characterization (including major cations and anions) to identify water types and temporal and geographical trends, where present.
- Mineralogical analysis of aquifer soil materials to identify and quantify the major mineral components.
- Chemical analysis of aquifer soil materials to quantify the total metal content and identify the environmentally available fraction of metals.
- Geochemical modeling to identify the major aqueous species and evaluate saturation indices of minerals relevant to attenuation of molybdenum.

The results generated by this supplemental assessment were used by Golder to complete the Tier I, Tier II, and Tier III evaluations in accordance with USEPA (2007a, b). The results of the Tier I, Tier II, and Tier III are summarized in the subsequent sections.

3.1 Groundwater and Porewater Sampling

Numerous groundwater samples have been collected at the Site as a part of CCR Rule and State Utility Waste Landfill (UWL) monitoring programs. For this evaluation, monitoring wells from the compliance and corrective action networks as well as porewater from the CCR Unit piezometers were evaluated. The network sampling locations and designations are presented on Figure 2 and in Table 2.

Table 2: Sampling Locations Used for the MNA Assessment

Detection and Assessment (Compliance) Monitoring Network Wells	Corrective Action Monitoring Network Wells	CCR Unit Porewater Piezometers
BMW-1D*, BMW-2D*, UMW-1D, UMW-2D, UMW-3D, UMW-4D, UMW-5D, UMW-6D, UMW-7D, UMW-8D, UMW-9D	BMW-1S*, BMW-2S*, LMW-1S, LMW-2S, LMW-4S, LMW-7S, LMW-8S, MW-24, MW-26, S-1, AM-1S, AM-1D, TP-1D, TP-2M, TP-2D, TP-3M, TP-3D, TP-4D, MW-33(D), MW-34(D), MW-35(D), AMW-8	LCPA-1D, LCPA-1S, LCPA-2D, LCPA-2S, LCPA-3D, LCPA-3S

Note: * - Denotes background well.

3.1.1 Groundwater and Porewater Analysis

Geochemical analysis of groundwater and porewater samples included the determination of field parameters and the concentrations of total metals and major cations and anions. The rationale and methods used were as follows:

- **Field Parameters:** Parameters measured in the field included pH, dissolved oxygen, oxidation reduction potential (ORP), conductivity, and temperature. These parameters were used to determine general geochemical conditions in the groundwater and support geochemical modeling.
- **Metals:** Analysis of Appendix III and IV metals concentrations was conducted to understand the geochemical composition of groundwater and CCR Unit porewater. Metals analysis allows for the

delineation of a potential plume, evaluation of mineral saturation indices through geochemical modeling, development of partitioning coefficients (in conjunction with solid material analyses), and evaluation of contributions from natural or anthropogenic sources.

- **Major Cations and Anions:** Geochemical modeling of mineral solubility, metals attenuation, and background contributions requires analysis of major cations and anions because they affect and participate in sorption and mineral dissolution or precipitation reactions.

The groundwater and porewater samples were analyzed and the results and methods are provided in the Annual Reports for the LCPA, LCPB, and LCL1 from 2017 to 2020.

3.2 Soil Sampling and Analysis

3.2.1 Sample Collection

In May 2021, nine soil samples were collected from three boreholes to evaluate geochemical properties of the alluvial aquifer materials at the Site. Samples were obtained from a boring (L-BH-01) at a background location as well as at L-BH-02 and L-BH-03 (Figure 2) located near the LCPA. Three depth intervals were selected in each boring: shallow, intermediate, and deep. Sample intervals are shown in Table 3 and soil sample analyses are described in Section 3.2.2.

Table 3: Boring Sample ID and Descriptions

Boring ID	Sample ID (Depth in Feet Below Ground Surface)	Geologic Material
L-BH-01 **(Background)**	L-BH-01S (23 – 30)	(SP) Poorly graded sand
	L-BH-01M (65 – 70)	(SP) Poorly graded sand
	L-BH-01D (100 – 114)	(SW) Well graded sand and gravel
L-BH-02 **(Upgradient)**	L-BH-02S (40 – 50)	(SW) Well graded sand
	L-BH-02M (67.5 – 70)	(SM) Silty sand
	L-BH-02D (80 – 87)	(SP) Poorly graded fine sand
L-BH-03 **(Downgradient)**	L-BH-03S (22.5 – 30)	(SP) Poorly graded fine sand
	L-BH-03M (70 – 80)	(SW) Well graded sand
	L-BH-03D (108 – 114)	(SW) Well graded sand and gravel

3.2.2 Soil Analyses

Multiple geochemical analytical methods were used to assess the mineralogical and chemical composition of the shallow, intermediate, and deep intervals at the three alluvial aquifer borehole locations across the Site. The selected geochemical test methods included:

- **Mineralogical composition**: The purpose of the mineralogical analysis was to identify and quantify the crystalline mineral phases in each sample. This information is required for geochemical modeling as the release or attenuation of molybdenum is influenced by the mineral phase(s) present in the aquifer (Hem

1985). The mineralogical analysis was performed using quantitative (Rietveld) X-ray diffraction (XRD) (ME-LR-MIN-MET-MN-DO5) and a Bruker AXS D8 Advance Diffractometer.

- **Total metals:** This test was used to quantify the chemical composition of aquifer materials. The total mass of metals, in combination with the results of sequential extraction testing, can be used to determine the provenance of metals and verify sequential extraction results. This extraction method is based on USEPA Method SW846 3050B, sometimes called an "aqua regia" or near total extraction. Target metals were analyzed using USEPA Method SW846 6010C "Inductively Coupled Plasma-Atomic Emission Spectrometry", Revision 3, November 2000.
- **Sequential extraction (SEP):** This test consists of a seven-step total metals extraction from solids as per Tessier et al. (1979) to identify the provenance of molybdenum (i.e., the operationally defined fraction that contains the metal)[1] and determine their potential environmental mobility. For instance, metals bound in the carbonate fraction, or that are exchangeable, are much more likely to become mobile due to changes in groundwater conditions than metals bound within a sulfide or silicate fraction. The total concentration of a metal measured from all seven steps can be compared to the concentration determined from the total metal analysis for compositional accountability. The metals content of the extracted samples was determined using USEPA Method SW846 6020B "Inductively Coupled Plasma-Mass Spectrometry", Revision 2, July 2014.
- **Cation exchange capacity (CEC):** The CEC represents the total number of negative charge sites in a given amount of solid at which reversible cation adsorption and desorption can occur (Hem 1985). Although CEC was determined, the results are not included in this report as the MNA only included evaluation of the attenuation of molybdenum, and molybdenum does not occur as a cationic species in groundwater.

4.0 GROUNDWATER, POREWATER, AND SOIL CHARACTERIZATION

4.1 Geochemical Evaluation

The water quality monitoring data used for the geochemical evaluation were obtained from Site monitoring wells and CCR Unit piezometers. The results discussed in this section apply to both the CCR rule monitoring wells and the Corrective Action Monitoring wells. Data used are provided in the Annual Reports produced by Golder from 2017 through 2020.

On September 28th, 2019, Ameren commenced Phase 1 of Corrective Action by initiating closure at the LCPA and completed Phase I with the installation of a geomembrane liner system by December 30th, 2020. As such, the discussion of water quality results addresses the periods before and after closure. The following is noted with respect to groundwater quality:

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[1] Sequential extraction of metals from soil samples consisted of seven discrete steps for this investigation:

Step 1 - Exchangeable Fraction: This extraction includes trace elements that are reversibly adsorbed to overburden minerals, amorphous solids, and/or organic material by electrostatic forces.

Step 2 - Carbonate Fraction: This extraction targets trace elements that are adsorbed or otherwise bound to carbonate minerals.

Step 3 - Non-Crystalline Materials Fraction: This extraction targets trace elements that are complexed by amorphous minerals (e.g., iron).

Step 4 - Metal Hydroxide Fraction: Trace elements bound to hydroxides of iron, manganese, and/or aluminum.

Step 5 - Organic Fraction: This extraction targets trace elements strongly bound via chemisorption to organic material.

Step 6 - Acid/Sulfide Fraction: The extraction is used to identify trace elements precipitated as sulfide minerals.

Step 7 - Residual Fraction: Trace elements remaining in the overburden after the previous extractions will be distributed between silicates, phosphates, and refractory oxides.

- **pH:** The pH of groundwater samples collected from CCR monitoring network wells after closure (between January and June 2021) ranged from 6.8 to 9.4 (Figure 3a). Historically, the pH in the CCR monitoring well network has ranged from 6.2 to 9.6, with most values falling between 7.1 and 8.1. Pre-closure groundwater samples collected from the corrective action well network reported pH values ranging from 5.8 to 9.8. Samples collected from the corrective action network since the closure of the LCPA display pH values ranging from 6.6 to 9.4 (Figure 3b). In 2018, the pH of porewater ranged from 8.9 to 10.8 within the LCPA.
- **ORP (Redox):** The ORP of groundwater samples collected from CCR monitoring wells after closure ranged from -181 to +53 millivolts (mV) (Figure 4a). Historically, the ORP in the CCR monitoring well network has ranged from –242 to +159 mV, with most values falling between -136 and -44 mV. The corrective action monitoring wells redox values ranged from -183 to +94 mV after closure. Pre-closure redox values within the corrective action monitoring network were variable, ranging from -297 to +311 mV (Figure 4b). In 2018, the ORP of porewater ranged from -90 to +170 mV.
- **Total Dissolved Solids (TDS):** Groundwater TDS concentrations in the CCR monitoring well network were variable after the LCPA closure and ranged from 324 milligrams per liter (mg/L) to 1050 mg/L. The lowest TDS concentration (324 mg/L) was observed in CCR monitoring well L-UMW-4D (where there is an SSL of molybdenum) and the highest TDS concentration (1,050 mg/L) was reported from CCR monitoring well L-UMW-8D. Groundwater in CCR monitoring well L-UMW-8D, while having the highest TDS, does not have an SSL for molybdenum as of January 2021. In 2018, the TDS of porewater ranged from 528 to 642 mg/L.
- **Major ion chemistry:** A Piper plot was generated for groundwater and porewater samples to facilitate the identification of water types and source contributions (Figure 5a, 5b). All background water samples, and most CCR monitoring well network downgradient water samples were water type Ca-HCO_3. The remainder of the downgradient wells had a water type of Ca-SO_4 or Na-SO_4 and demonstrated a similar major ion relative abundance to porewater (water type Ca-SO_4). The overall geochemical characteristics of the corrective action network samples were similar, whereas most downgradient water samples were water type Ca-HCO_3. However, some of the downgradient wells reported a water type of Ca-SO_4 or Na-SO_4, similar to that of porewater.
- **Iron:** Total oxidized iron (Fe^{+3}) concentrations were variable within the CCR network after closure and ranged from 0.03 mg/L (L-UMW-5D) to 25.5 mg/L (L-UMW-8D) between February and April 2021. Reduced iron (Fe^{+2}) ranged from 0.05 to 1.1 mg/L during this period. Total iron concentrations in porewater ranged from 0.03 to 0.18 mg/L during 2018.
- **Molybdenum:** Historically, molybdenum concentrations in groundwater surrounding the LCPA CCR Unit have ranged from non-detect (<0.005 mg/L) to 0.67 mg/L (Figure 6a). Molybdenum concentrations have exceeded the Groundwater Protection Standard (GWPS) at monitoring wells L-UMW-3D, L-UMW-4D, L-UMW-5D, L-UMW-6D, and L-UMW-7D since March 2016. Based on a Mann-Kendall test, molybdenum concentrations at only L-UMW-5D show a statistically significant increasing trend. However, since the initial closure activities began (September 2019), molybdenum concentrations at well L-UMW-5D have declined by 33%, indicating the SSL of molybdenum at L-UMW-5D is decreasing. All other wells with an SSL of molybdenum also indicate a decreasing or stable trend.

  It is anticipated that molybdenum concentrations at L-UMW-5D will continue to decrease due to the completion of LCPA closure. The elevated pH (9.23) at L-UMW-5D is likely partially responsible for the elevated molybdenum concentrations in groundwater since alkaline conditions cause desorption of molybdenum from soil. It is expected that as circumneutral Site groundwater mixes with groundwater at

L-UMW-5D, a decrease in pH is likely to occur, resulting in a continued decline in molybdenum concentrations at L-UMW-5D due to mixing and increased sorption efficiency. Molybdenum in groundwater in the corrective action monitoring network was higher in some wells, up to 1.4 mg/L historically (Figure 6b) than present in the compliance network, however, all wells also show a stable or decreasing trend statistically and both closure and corrective actions are expected to improve groundwater quality at the wells. Molybdenum levels in the porewater samples ranged from 0.084 mg/L to 1.43 mg/L within the LCPA, with a mean molybdenum concentration of 0.26 mg/L. Molybdenum is expected to be predominately present in the form of the divalent anionic molybdate (MoO_4^{-2}) species under the pH and redox conditions present in groundwater (Figure 7a, b).

4.1.1 Mineralogical Controls in Groundwater and Porewater

The results of saturation index modeling for relevant minerals for groundwater and porewater at upgradient, downgradient, and corrective action wells are presented in Table 4. Mineral saturation can play an important role in attenuation of metals, either directly by their removal through mineral precipitation, or indirectly by providing sorptive surfaces or opportunities for co- precipitation.

- Iron-bearing minerals: Ferrihydrite was indicated to be at equilibrium with groundwater or oversaturated in all of the monitoring well and porewater samples, indicating a strong potential for ongoing precipitation of solid-phase iron oxides. Thus, it is assumed that iron (hydr)oxides are ubiquitous in the Site aquifer.
- Other minerals: All groundwater and porewater samples were simulated to be in equilibrium or oversaturated with respect to calcite ($CaCO_3$). Other carbonate minerals, i.e., rhodochrosite ($MnCO_3$) and siderite ($FeCO_3$), were oversaturated or in equilibrium in most groundwater and some porewater samples. Barite ($BaSO_4$) was simulated to be in equilibrium or oversaturated in all porewater samples and nearly all groundwater samples (except for UMW-9D).

In summary, several mineral phases likely control groundwater composition at some or all wells: barite, calcite, ferrihydrite, rhodochrosite, and siderite. In the case of ferrihydrite (or calcite to a lesser degree), the dissolved concentrations of molybdenum can be reduced through their ability to act as a substrate for adsorption/co-precipitation.

4.2 Compositional Analysis of Alluvial Aquifer Soil

4.2.1 Mineralogical Composition

Quantitative X-ray diffraction (XRD) with Rietveld refinement was used to identify and quantify minerals in nine soil samples collected during the drilling activities - three samples from three depths (shallow, middle, and deep) from each of the soil borings (L-BH-01, L-BH-02, and LB-BH-03), as described in Section 3.2. These samples were obtained to determine the mineralogical composition of the aquifer system and identify any minerals that would potentially influence attenuation of molybdenum. In contrast, the presence of certain minerals could also indicate a potential for naturally occurring release of molybdenum into groundwater, for instance due to oxidation of sulfide minerals.

The mineralogical analysis identified the aquifer materials to predominately consist of quartz, with varying amounts of the silicate minerals albite, muscovite, chlorite, and montmorillonite (Table 5). Laboratory analytical reports for the XRD samples, including the XRD patterns, are provided in Appendix A.

4.2.2 Chemical Composition and Sequential Extraction

Chemical analysis and sequential extractions were used to determine the chemical composition of the alluvial aquifer soils and the distribution of molybdenum over various operationally defined fractions. As described in

Section 3.2, this testing was conducted on soil samples from three borehole locations. Select results are presented in Table 6 and the laboratory data are included in Appendix B.

A description of the individual fractions determined by sequential extraction is presented in Footnote 1, Section 3.2.2. Metals extracted in steps 1 through 5 are considered environmentally available, whereas metals extracted in steps 6 and 7 are present in refractory fractions and are not expected to be released under conditions typically encountered in aquifers (Tessier et al. 1979). Total metal quantities from the sequential extraction are expressed as "SEP Total" in Table 6. The sum of the sequential extraction steps is also presented for comparison, but does not represent an analytically determined value.

The results from the chemical analysis and sequential extraction can be summarized as follows:

General Chemistry Parameters

- Aluminum: Aluminum is not a constituent of interest (COI) at the Site, but it has been well studied as a potential sorbing medium in soils (e.g., Karamalidis and Dzombak 2010). Total aluminum in soils ranged from 34,800 to 64,000 mg/kg, and the environmentally available fraction ranged from 240 (L-BH-03M) to 1,369 mg/kg (L-BH-02M; Figure 8). Aluminum in the soil at the site is, therefore, largely (> 90%) present in the residual, or silicate-bound fraction. The environmentally available fraction is likely partially represented by hydrous aluminum phyllosilicate minerals or clays intermixed in the silica sand matrix. Clays can represent an important sorptive reservoir for numerous trace metals and metalloids, including molybdenum at this site (Uddin 2017).
- Iron: While not a COI, iron and its minerals commonly represent one of most abundant reservoirs for metal/metalloid attenuation in soils (Dzombak and Morel 1990; Smith 1999). Iron was present in all nine core samples analyzed, varying from 3,900 (BH-03M) to 19,000 mg/kg (L-BH-02M). In all nine soil borings, the non-environmentally available (sulfide and residual) fractions accounted for the largest proportion of total iron (61 to 74%) and, as such, most of the iron is not environmentally available (Figure 9). The remainder of iron in the samples is present in either the amorphous or metal hydroxide fractions. These phases, part of the labile fraction in steps 1 through 5, can generally be considered representative of the amount of iron in soil that may be available as a sorbing medium and can, therefore, be important for attenuation of molybdenum under certain conditions.

Metals identified as an SSL

- Molybdenum: Total molybdenum in soil ranged from 0.21 to 3.2 mg/kg, of which up to 100% (L-BH-01D and L-BH-03D) was present in the environmentally available fraction (Figure 10). Environmentally available molybdenum was contained in the amorphous and metal hydroxide fractions. In three borings (L-BH-01S, L-BH-01M and L-BH-02D), of the small amount of molybdenum identified, all was present in the residual fraction. These results indicate that attenuation of molybdenum by amorphous and metal hydroxide minerals is occurring at the Site.

The results of the SEP analysis confirm both the natural occurrence of molybdenum in the aquifer materials and that attenuation of molybdenum is occurring by aquifer materials through adsorption/co-precipitation onto/with amorphous and metal hydroxide minerals.

5.0 GROUNDWATER MODELING

In 2019, a groundwater model and draft report was prepared by Gredell Engineering, Inc (Gredell 2019), to provide a predictive analysis for groundwater flow at the LEC for the Corrective Measures Assessment. In 2021, this groundwater model was updated by XDD Environmental, LLC (XDD), to provide predictive analysis for groundwater flow at the LEC for the design of a pump, treat, and re-injection system for LCPA Corrective

Action. For this evaluation, Golder updated the XDD model to evaluate the fate and transport of key metals under different corrective action scenarios and a Technical Memorandum summarizing the groundwater model is provided in Appendix C.

The numerical computer code MODFLOW – developed by the United States Geological Survey (USGS) – was selected for the groundwater modeling because it is well suited to represent a wide range of hydrologic and hydrogeologic conditions, has been widely tested and accepted in the professional hydrology community and by regulatory agencies, and has been scrutinized closely in a number of legal proceedings over the past 20 years. In total, five software packages were used for the groundwater investigation:

- Groundwater flow: USGS software package MODFLOW (McDonald and Harbaugh 1988, Harbaugh and McDonald 1996, Harbaugh et al. 2000, Harbaugh 2005). MODFLOW-2005 was the version used in the analyses presented here.
- Groundwater transport: USGS software package MT3DMS (Zheng and Wang, 1999).
- Particle tracking: USGS software package MODPATH (Pollock 2012)
- Parameter estimation: PEST (Doherty 2010 and 2016)
- Graphical user interface: Groundwater Vistas (Environmental Simulations 2020, Rumbaugh and Rumbaugh 2011).

The groundwater model simulates steady-state and transient flow conditions for the site area. The groundwater model was developed and updated based on the following:

- Natural hydrologic boundaries wherever possible.
- Ground surface topography and CCR unit geometries.
- Geologic layers with representative hydrogeological properties based on boring logs.
- Hydraulic properties of geologic layers based on historical aquifer tests conducted at the site.
- Historical groundwater elevation measurements.

Details of the flow model development and results are presented in Appendix C. The results of the model were used to for the geochemical evaluation as discussed in Section 6.

6.0 GEOCHEMICAL ANALYSIS AND MODELING

6.1 Empirical Attenuation Rates

To evaluate the attenuation of molybdenum in groundwater at the Site and to assess the rate of attenuation, Golder applied the point decay method (Newell et al. 2002). The point decay method is used to determine the rate at which a constituent's concentrations are increasing or decreasing in groundwater at a single well between sampling events and this method can thus be used to predict when the constituent's concentrations will fall back below regulatory limits.

Equation 1 describes first-order decay for a constituent:

$$\mathrm{Ln}(Ct) = kt + \mathrm{Ln}(C0) \qquad \text{(Equation 1)}$$

where C0 is the initial constituent concentration, Ct is the constituent concentration at time t, t is the amount of time in years that has passed since the initial concentration measurement, and k is the first-order decay rate constant (1 per year). Equation 2 shows Equation 1 reorganized to solve for the decay rate constant:

$$k = (\ln(Ct) - \ln(C0))/t \quad \text{(Equation 2)}$$

Groundwater water quality data from the background and downgradient wells collected between March 2016 and April 2021 were used to determine the mean first-order decay rate for each constituent of interest. A first-order decay rate was also calculated using data collected from April 2020 to April 2021 to evaluate the effect of changing conditions at the Unit due to capping and closure. Due to variable detection limits, results that were reported as below detection limits were not used in the point decay analysis. Using Equation 1 and the mean first-order decay rate, Golder calculated the approximate number of years that it would take for molybdenum concentrations higher than their respective GWPS to decline below these values and these results are provided in Section 6.3.

6.2 Geochemical Modeling

Geochemical modeling was conducted to evaluate general groundwater and porewater quality, determine the potential for precipitation of sorbent media, evaluate the potential for mineral precipitation or adsorption in the aquifer, and determine the speciation of metals of interest. The geochemical computer code developed by the USGS, PHREEQC, was used for these simulations (Parkhurst and Appelo 2013). PHREEQC version 3.6 is a general-purpose geochemical modeling code used to simulate reactions in water and between water and solid mineral phases (e.g., rocks and sediments). Reactions include aqueous equilibria, mineral dissolution and precipitation, ion exchange, surface complexation, solid solutions, gas-water equilibrium, and kinetic biogeochemical reactions. The widely accepted thermodynamic database Minteq.v4, 2017 edition (USEPA 1998d1998c, as amended), was used as a basis for the thermodynamic constants required for modeling, with additions and modifications from recent literature as required.

The Geochemist's Workbench (Release 15; Bethke et al. 2021) was used to generate graphical representations of geochemical modeling outputs in the form of predominance, or Pourbaix diagrams (also known as Eh-pH diagrams) for the species of interest (i.e., molybdenum) and trilinear plots (also known as Piper plots) displaying the relative abundance of major ions. The Minteq.v4 database was used as the basis for the Pourbaix diagrams.

A Kd value (partitioning coefficient) was calculated using the average groundwater molybdenum concentration across the site and the results of sequential extraction of molybdenum from soils (Section 4.2.2; Steps 1-5), using equation 3.

$$\text{Kd (mL/g)} = \text{Mass of Adsorbate Sorbed} / \text{Mass of Adsorbate in Solution} \quad \text{(Equation 3)}$$

The resulting Kd ranged from 1 (or non-detect molybdenum adsorbed) to 38 mL/g for the site. The results of the Kd calculation are in agreement with published Kd values of 0 to 40 mL/g for materials that contain <10% clay, organic matter, or metal iron and aluminum oxyhydroxides at a pH range of >9 or between 5 to 9 (Stenge and Peterson 1989). The Kd approach was used in combination with groundwater modeling to develop a fate and transport model for determination of the attenuation rate of molybdenum at the site in response to a combination of closure, natural attenuation, and corrective actions.

6.2.1 Surface Complexation Modeling

Adsorption is an important mechanism by which constituents in groundwater can be attenuated. The adsorptive partitioning between dissolved and solid phases was simulated using a two-layer surface complexation model (SCM). The SCM approach is described in Davis and Kent (1990), with additional parameterization based on Dzombak and Morel (1990) and Karamalidis and Dzombak (2010) utilizing iron (hydrous ferric oxide [Hfo]) as ferrihydrite [$Fe(OH)_{3(am)}$], and aluminum (hydrous aluminum oxide [Hao]) as gibbsite [$Al(OH)_{3(am)}$], as adsorbing surfaces.

The amounts of Hfo and Hao available at the site for attenuation were based on the amorphous and metal hydroxide phase iron and aluminum concentrations measured in the SEP as described in Section 4.2.2. The minimum, mean, and maximum concentrations in soil borings were used in the adsorption models to capture the range of expected site concentrations. The Hfo and Hao surface properties (i.e., surface area, site density, and types of sites) from Dzombak and Morel (1990) and Karamalidis and Dzombak (2010) were used to quantify the iron and aluminum adsorption sites per mole of mineral.

The calculation methodology of Appelo and Postma (2010) was used to determine the specific quantity of sites on each mineral surface type as a function of the amount of mineral available to participate in these reactions. The methodology assumes the number of surface sites (sites) equals the product of the moles of iron ([Fe]) and the moles of surface sites per mole of iron ([sites]/[Fe]= 0.2 moles of sites per mole of iron). For the amount of ferrihydrite available for sorption, the Appelo and Postma methodology further assumes the mass of ferrihydrite (m_{Hfo}) in grams (g) available equals the product of the [Fe] and the molecular weight of ferrihydrite (m_{wHfo} = 88.85 g/mole). The same approach was used to calculate the number of sites from gibbsite, assuming the [sites]/[Al] is 0.41 moles of sites per mole of aluminum and the molecular weight of gibbsite is 78.003 g/mole.

The geochemical thermodynamic database Minteq V.4 was used to conduct adsorption modeling. However, new and updated thermodynamic data have been released in scientific literature. These new data are important to include in the geochemical modeling exercises for certain elements or minerals as they allow further refinement of potential reactions, or for correction of previous data that may have been less accurate or more broadly defined. For groundwater modeling at the Site, Golder made numerous updates to the Minteq V.4 database, including the addition of data relating to partitioning coefficients for metals on gibbsite, developed by Karamalidis and Dzombak (2010).

To quantify current levels of adsorption of molybdenum, its adsorbed concentration (as milligram (mg) of constituent/kilogram (kg) of soil) was modeled for the minimum, maximum, and mean Hfo and Hao contents when equilibrated with the range of groundwater qualities observed at the Site. To quantify the capacity of soil to adsorb additional molybdenum, a stepwise increase in molybdenum concentrations was simulated, similar in concept to a titration. This was accomplished using the mean concentration of molybdenum observed in porewater, as well as the concentrations of other constituents present in porewater, allowing for site competition. This simulated “titration” took place into the range of observed groundwater qualities while allowing equilibration with the sorption surfaces in soils as shown in Table 7 (minimum, maximum and mean Hfo and Hao). The model was then used to predict the quantity of each constituent that would adsorb due to this titration of additional molybdenum and other porewater constituents.

Table 7: Calculation of Ferrihydrite and Gibbsite Surface Parameters for Geochemical Modeling

Parameter	Unit	Ferrihydrite			Gibbsite		
		Minimum	Mean	Maximum	Minimum	Mean	Maximum
Geometric Mean of Aquifer Solids Composition	mg/kg X	1220	1997	6200	187	399	1290
	mol X	2.2E-02	3.6E-02	1.1E-01	6.9E-03	1.5E-02	4.8E-02
Surface Site Concentration	mol weak sites / mol X	0.2	0.2	0.2	0.41	0.41	0.41
	mol strong sites / mol X	0.005	0.005	0.005	---		

Parameter	Unit	Ferrihydrite			Gibbsite		
Surface Sites	mol weak	4.4E-03	7.2E-03	2.2E-02	2.8E-03	6.1E-03	2E-02
	mol strong	1.1E-04	1.8E-04	5.6E-04	---		
Mass of Ferrihydrite or Gibbsite	grams	1.94	3.18	9.86	0.54	1.15	3.73

Note: Gibbsite only has one site type

6.2.2 Mineral Precipitation and Co-precipitation

The potential for mineral precipitation was assessed in PHREEQC using a saturation index (SI) calculated according to Equation 4.

$$SI = \log (IAP/Ksp) \quad \text{(Equation 4)}$$

The saturation index is the ratio of the ion activity product (IAP) of a mineral to the solubility product (Ksp). An SI value greater than zero indicates that the solution is supersaturated with respect to a particular mineral phase and, therefore, precipitation of this mineral may occur. An evaluation of precipitation kinetics is then required to determine whether the supersaturated mineral will indeed form. An SI value less than zero indicates the solution is undersaturated with respect to a particular mineral phase. An SI value close to zero indicates equilibrium conditions exist between the mineral and the solution. SI values between -0.5 and 0.5 are considered to represent 'equilibrium' in this report to account for the uncertainties inherent in the analytical methods and geochemical modeling.

In addition to adsorption, co-precipitation, or the direct incorporation of trace metals such as molybdenum into precipitated iron oxide-oxyhydroxides, has been previously identified as a process of potential importance in trace metal sequestration (e.g., Butt et al. 2000; Dzombak and Morel 1990; Smith 1999). Molybdenum may also be attenuated during the formation of ferrihydrite in addition to following its formation (Tebo et al. 2004).

6.2.3 Long-Term Stability of Attenuated Constituents

Three sensitivity analyses were performed to assess the long-term stability of attenuated molybdenum under variable pH, redox, and ionic strength conditions. Variations in pH, redox, and ionic strength are the most likely types of changes that will occur in an aquifer over time, thereby potentially affecting the stability of the constituents of interest (ITRC 2010). The sensitivity analyses were conducted applying the minimum, mean, and maximum Hfo and Hao contents determined for the Site soils, equilibrated with the groundwater qualities observed at the Site at the measured pH and redox conditions. For each sensitivity analysis, a single parameter was varied:

- pH - Hydrochloric acid or sodium hydroxide addition was used in the modeling simulations to vary the pH between 4 and 12. A pH range of 4 to 10 is the typical range considered for evaluating metal speciation, but at a pH lower than 5, Hfo tends to become unstable, limiting attenuation/adsorption, which causes an observed decrease in modeled attenuation at lower pH values. Hao remains stable until a pH range of approximately 3.5 and, as such, may provide attenuation capacity under more acidic conditions.
- Redox – Addition of dissolved oxygen (DO) was simulated to adjust redox (Eh) values between -200 and +700 millivolts (mV) based on the historical and anticipated range of Eh in the region.
- Ionic Strength - Total dissolved solids (TDS) concentrations were increased by titrating in calcium, magnesium, sodium, potassium, chloride, and sulfate in the proportions observed in porewater. TDS

concentrations up to 3,700 mg/L were evaluated, which is approximately five to six times higher than the highest TDS concentration observed in groundwater at the CCR Unit.

6.2.4 Geochemical Modeling Assumptions and Data Handling

Geochemical modeling assumptions and data handling included the following:

- **Groundwater continuity:** Groundwater quality samples were collected from each well during sampling events conducted between January and April 2021. Samples from this period were selected for the geochemical modeling because all wells within the compliance and corrective action monitoring well networks were sampled and analyzed for the full suite of parameters required and the resulting data are assumed to provide a comprehensive overview of groundwater conditions. Temporal trend analysis for molybdenum made use of all available sampling events between March 2016 and April 2021.
- **Porewater chemistry:** Porewater samples collected from L-LCPA-1D, L-LCPA-1S, L-LCPA-2D, LC-LCPA-2S, L-LCPA-3D, and L-LCPA-3S in February 2018 were assumed to be representative of porewater found in the CCR Unit.
- **Redox values:** ORP values measured in the field were converted to Eh by adding 200 mV to the field-measured values as per YSI Tech Note (YSI 2015).
- **Non-detect values:** Constituents with concentrations less than their respective method reporting limits were assumed to have a concentration equal to half the reporting limit in model simulations.
- **Total recoverable concentrations:** Total recoverable fraction results were used for geochemical modeling.
- **Charge balance:** Groundwater and porewater compositions with charge balance errors less than 10% were considered valid. Compositions with charge balance errors greater than 10% were flagged as potentially less reliable, but still included in the geochemical modeling effort.

6.3 Results

6.3.1 Empirical Attenuation Rate

The results of the point decay analysis (Section 6.1) for groundwater at background and downgradient wells between March 2016 and April 2021 are provided in Tables 8. Results are presented as mean, site-wide attenuation rates.

This evaluation demonstrates that, in the compliance monitoring network, a net decrease in the concentration of molybdenum at downgradient monitoring wells has been occurring, as indicated by negative point decay constants. A second point decay analysis for data collected between April 2020 and April 2021 was conducted to represent molybdenum concentration trends throughout and following recent Site closure activities. In this dataset, molybdenum concentrations reported a stronger decreasing trend (i.e., a more negative point decay constant), shortening the expected time to compliance.

Table 8: Empirical Attenuation Rate of Molybdenum in the Compliance Monitoring Network

Constituents	Units	Average Point Decay Rates		
		Background Wells	Compliance Monitoring Network Wells	Time to Compliance (years)
March 2016 to April 2021				
Molybdenum	yr^{-1}	-0.01	-0.04	40
April 2020 to April 2021				
Molybdenum	yr^{-1}	0.14	-0.16	10

The mean downgradient decay rates can be used to estimate the number of years it would take for elevated groundwater molybdenum concentrations to decrease to its GWPS for the compliance monitoring network. At the maximum concentration of molybdenum observed in downgradient wells in 2021 (0.48 mg/L), this would require approximately 10 years based on the site decay rate that has been observed since April 2020. This estimation is conservative, as it does not account for various attenuation processes (e.g., dilution, dispersion, or sorption).

6.3.2 Model Predicted Attenuation Rate

Attenuation rates for molybdenum in groundwater were modeled using fate and transport modeling techniques as discussed in section 5.0 and Appendix C. Groundwater concentrations were modeled to decrease in concentration in wells both adjacent to the LCPA (Detection and Assessment Network) and within the molybdenum plume (Corrective Action Network).

As displayed in Figure 11, monitoring wells within the detection and assessment (compliance) monitoring well network that are present at a SSL, including UMW-3D, UMW-4D, UMW-5D, UMW-6D, and UMW-7D are predicted to be below the GWPS within 2 – 13 years of the treatment system start of operation. The model calculated attenuation rate from these wells is approximately 10 to 162 micrograms (µg/L) per year, with an average decrease in concentration of approximately 80 µg/L per year.

Figure 12 displays the model predicted decrease in molybdenum concentrations in the corrective action well network that are currently at concentrations above the GWPS (LMW-8S, AM-1D, TP-2D, TP-2M, TP-3D, TP-3M, AMW-8, MW-33D, MW-34D, MW-35D). These monitoring wells are located outside of the treatment capture zone and are predicted to reach concentrations below the GWPS within 2 - 39 years. The model calculated attenuation rate from these wells is approximately 4.5 to 24.2 µg/L per year, with an average decrease in concentration of approximately 14 µg/L per year.

6.3.3 Capacity of Attenuation Mechanisms

Attenuation modeling was conducted in PHREEQC as a function of the amount of attenuating substrate present (minimum, mean and maximum from soil analyses). The modeling revealed a large range of attenuation capacities for molybdenum. Figures 13a and 13b display the predicted trajectories of aqueous molybdenum concentrations in the compliance monitoring and corrective action monitoring networks, respectively, before and after attenuation, as additional molybdenum is titrated into solution. The bold lines display the geometric means for all groundwater scenarios within each soil scenario and the grey area represents the range for the 5th to 95th percentile of all soil scenarios.

The predicted trajectories are compared against the GWPS and porewater concentrations. On the plots, the further the predicted trajectories are to the right of the diagonal 1:1 line, the larger the amount of molybdenum that is attenuated in soils and is no longer predicted to reside in the aqueous phase.

For the minimum adsorption cases, the trajectories run nearly parallel to the 1:1 line, indicating that sorption capacity is directly proportional to the concentration before adsorption as sites become filled. The modeling results suggest that adsorption has the capacity to reduce molybdenum concentrations below approximately 0.3 mg/L down to the GWPS of 0.1 mg/L in the compliance monitoring network. The corrective action monitoring network currently shows less capacity for additional molybdenum attenuation as evidenced by molybdenum concentrations in multiple wells that are currently above the GWPS. In this case, the capping and closure of LCPA is expected to result in a reduced contribution from porewater at a given well, which will increase aquifer capacity in the future. The increase in capacity is demonstrated by the fate and transport modeling that displays decreasing molybdenum concentrations in response to closure of the LCPA (Section 6.3.2).

6.3.4 Long-Term Stability of Attenuated Constituents

To determine the long-term stability of sequestered molybdenum, simulations were conducted varying three variables known to affect its attenuation: pH, redox, and TDS. The modeled variations in dissolved molybdenum concentration as a function of changes in pH, Eh, and TDS are shown in Figures 14, 15, and 16 respectively. The compliance monitoring and corrective action monitoring networks were evaluated independently and are denoted as “a” and “b”, respectively. Results are presented along with the GWPS value and the range of pH, Eh, or TDS values (5th percentile to 95th percentile) observed at the Site.

The results of the attenuation stability modeling for molybdenum as a function of changes in pH, Eh and TDS can be summarized as follows:

- **Molybdenum:** Lower pH values (more acidic conditions) are generally more favorable for adsorption (Figure 14a and b). Under alkaline conditions (pH greater than 10), nearly all molybdenum is desorbed and present in the dissolved phase in concentrations exceeding the GWPS. It is expected that pH values across the Site will decrease post closure, benefiting molybdenum attenuation. Over the range of Eh values at the Site (Figure 15a and b), molybdenum sorption is stable. Even highly reducing and oxidizing conditions are predicted to have minimal impact on molybdenum concentrations, which remain below the GWPS. Molybdenum adsorption is moderately affected by increases in TDS concentrations (Figure 16a and b). Molybdenum is modeled to desorb at TDS concentrations comparable to the maximum observed porewater concentration (642 mg/L). However, these simulations do not account for decreases in porewater flux that will likely result from capping and closure measures, so it is not expected that TDS levels will increase after closure.

7.0 TIER I EVALUATION

The evaluation of natural attenuation of molybdenum was completed in accordance with recommended practices and guidance promulgated by the USEPA and the ITRC (USEPA 2007a, b; ITRC 2010). According to USEPA (USEPA 2007a), the purpose of the Tier 1 evaluation is to “Demonstrate that the groundwater plume is not expanding and that sorption of the contaminant onto aquifer solids is occurring where immobilization is the predominant attenuation process.” Based on this definition, the following observations support further MNA for the CCR Unit in coordination with other closure and corrective measure efforts (treatment) that are currently being undertaken:

- **Plume Stability:** Based on the water quality monitoring data presented in this assessment, groundwater concentrations of molybdenum outside of the CCR Unit appear to be stable or decreasing. Molybdenum at L-UMW-5D displays a statistically significant increasing trend since March 2016. However, since the initiation of closure (September 2019) and capping of LCPA (December 2020), the molybdenum concentration at well L-UMW-5D has decreased by 33%. The alkaline conditions (pH > 9) at well L-UMW-5D, which result in desorption of molybdenum from solids, also likely contribute to molybdenum levels above the GWPS at the Site. The pH in this well is expected to decrease due to the implementation of the engineering controls and, consequently, molybdenum concentrations are anticipated to decline as well. This should be further improved with the installation of the treatment system. In combination, these observations indicate that concentrations of molybdenum in the aquifer are stable or decreasing across the site.

- **Magnitude of Exceedances:** The highest molybdenum concentration (since monitoring began) in the compliance monitoring network was observed at downgradient well L-UMW-6D in March 2016 at 0.67 mg/L. However, results from the most recent sampling have indicated that the concentration in this well has decreased to 0.48 mg/L. Additionally, declines have been observed in four of five downgradient wells, with no new wells demonstrating a molybdenum GWPS exceedances since closure efforts began in September 2019. The corrective action monitoring network, while being located substantially farther from the CCR Units, has historically reported higher molybdenum levels, up to 1.4 mg/L in March 2016. But, similar to the compliance monitoring networks, a recent decline in molybdenum concentrations in nearly every well in the network has occurred since closure of the LCPA.
- **Porewater:** Historical records are not available for ash additions or porewater concentrations over the lifespan of the LCPA surface impoundment. However, based on 2018 porewater data, molybdenum concentrations in porewater ranged from 0.084 mg/L to 1.43 mg/L. This indicates variable concentrations of molybdenum in the CCR Unit. While the LCPA may have been a source for molybdenum in groundwater in the past, due to the leaching characteristics of CCR, and groundwater predominantly flowing around instead of into the LCPA after closure, it is currently not considered to be an active source of molybdenum, as demonstrated by decreasing site-wide molybdenum concentrations in the compliance monitoring network that is immediately adjacent to the LCPA.
- **Groundwater Chemistry:** The groundwater monitoring results and the findings of the geochemical modeling support the potential for natural attenuation of molybdenum. Groundwater was modeled to be in equilibrium with the mineral phase ferrihydrite for all monitoring wells included in this assessment. This is consistent with the results from the sequential extraction analysis that indicate amorphous and metal hydroxide fractions sequester molybdenum.
- **Confirmation of Attenuation/Immobilization:** Based on both mineralogical and chemical analysis, it is demonstrated that attenuation of molybdenum by aquifer materials is occurring. Iron and aluminum, capable of forming (hydr)oxide phases that facilitate metals attenuation (Dzombak and Morel 1990), was identified in all samples. This indicates that it is likely aquifer solids have been and are actively attenuating molybdenum. Additional attenuation is expected after closure due to a reduced contribution from porewater and an accompanying decrease in groundwater pH around the LCPA, which will only be further aided by the installation of a groundwater treatment system. As discussed previously, molybdenum attenuation by soils is enhanced under moderately acidic conditions.

Based on these findings, molybdenum is confirmed to be viable for an MNA remedy application due to the aquifer response observed from closure activities and is, therefore, deemed to meet the criteria for Tier I MNA in accordance with USEPA guidance (USEPA 2007a, b).

8.0 TIER II EVALUATION

The purpose of the Tier II evaluation is to "Identify mechanisms and rates of the operative attenuation process." Based on this definition, the following modeling results and observations support MNA as a viable corrective measure for the CCR Unit:

- **Attenuation Mechanisms:** PHREEQC modeling results (supported by results of SEP analysis) show that adsorption is attenuating molybdenum downgradient of the CCR Unit. This is concluded based on equilibration of site-specific groundwater compositions with the range of Hfo and Hao concentrations observed in SEP results of Site soils. The attenuation capacity of Hfo and Hao surface sites is partially dependent on the concentrations of molybdenum in groundwater. The titration modeling (Figure 13a and b) demonstrates the soil's capacity to attenuate molybdenum if concentrations of molybdenum were to increase above current levels. The compliance monitoring network (located immediately adjacent to the LCPA) shows significant additional attenuation capacity based on modeling. The corrective action network, which is more distant from the LCPA, currently shows less capacity for additional attenuation of molybdenum. However, additional capacity will likely be created as the porewater flux decreases due to closure activities and conditions become more acidic. In addition to metal oxyhydroxides, clay minerals and/or particulate organics can also act as a substrate for attenuation (Goldberg and Forster 1996), but these mechanisms were not directly addressed in the current evaluation.
- **Estimated Site Attenuation Rates:** Concentrations of molybdenum are decreasing at downgradient compliance monitoring network wells, resulting in negative calculated point decay rates. Using the mean empirical decay rate, the maximum 2021 concentrations of molybdenum observed in downgradient monitoring wells would take approximate 10 years to attenuate to below GWPS (based on the trend since April 2020) without further corrective measures. Modeled attenuation rates determined by fate and transport modeling, taking into account dilution, sorption, and possible changes in geochemical conditions, are estimated to be under the GWPS in the detection and assessment monitoring well network within 2-13 years after installation of the treatment system. Monitoring wells within the corrective action well network are estimated to be under the GWPS in 2 to 39 years, depending on well location.

Based on these findings, molybdenum is viable as an MNA remedy application in combination with closure activities and deemed to meet the criteria for Tier II MNA in accordance with USEPA guidance (USEPA 2007a, b).

9.0 TIER III EVALUATION

According to USEPA (USEPA 2007a), the purpose of the Tier III evaluation is to eliminate sites for an MNA remedy where (1) "Capacity of the aquifer is insufficient to attenuate the COC mass to regulatory standards" and/or (2) "Stability of the immobilized COC is insufficient to prevent remobilization due to future changes in groundwater chemistry". Based on this definition, the following observations support MNA as a viable corrective measure for the CCR Unit:

- **Adsorption Capacity Modeling:** Predictive modeling has demonstrated that source water concentrations of molybdenum could increase to 0.3 mg/L and yet result in concentrations at downgradient monitoring wells of the compliance monitoring network below the molybdenum GWPS in a reasonable time frame. The time frame is defined here as "reasonable" when it is comparable to time frames associated with other active remediation options described in an assessment of corrective measures (Golder 2019; ITRC 2010). The 95th percentiles of modeled trajectories show that a majority of pH and redox conditions at site are favorable for attenuating molybdenum and will become more conducive to attenuation as the groundwater pH reverts to natural background levels post closure. In addition to aluminum oxides and iron oxyhydroxides, molybdenum is known to adsorb to manganese oxides, clay minerals, and particulate organic matter, providing additional opportunity for sequestration. The same response, albeit delayed due to groundwater transport times, is expected to occur in the corrective action monitoring network as supported by fate and transport modeling.

- **Stability Modeling for Adsorbed Constituents:** Stability modeling indicates that over the ranges of pH, Eh, and TDS observed in groundwater at the Site, the adsorbed molybdenum is relatively stable and will likely remain attenuated. The modeling results further suggest that the adsorption of molybdenum can be reversed if conditions become sufficiently alkaline, but there is no historical basis to expect such an occurrence and, in fact, the opposite (decreasing pH at wells) is expected to continue post closure. Generally, site groundwater is circumneutral or alkaline and has remained stable across the sampling period which supports continued molybdenum attenuation or increased attenuation as pH decreases at some wells. Changes in redox conditions are modeled to have little to no impact on aqueous molybdenum concentrations and molybdenum attenuation efficiency. Modeling results also indicate that increasing TDS concentrations could result in a very slight increase in aqueous concentrations of molybdenum due to competition for sorption sites. However, this effect is predicted to be minor over the range of TDS concentrations observed at the Site and the risk will be lessened over time as closure causes a decrease in porewater flux and greater mixing of ambient groundwater in the aquifer.

Based on these findings, molybdenum is viable as an MNA remedy application in combination with closure activities and deemed to meet the criteria for Tier III MNA in accordance with USEPA guidance (USEPA 2007a, b).

10.0 CONCLUSIONS

This evaluation has been completed in accordance with guidance and best practices promulgated by the USEPA (USEPA 2007a, b) and the ITRC (ITRC 2010). Based on the results of this evaluation, the following is concluded for molybdenum in Site groundwater:

- Physical and chemical attenuation is occurring, and concentrations are stable or declining across the site.
- Modeling indicates that molybdenum attenuation will be efficient and stable in the long term.
- Molybdenum concentrations in corrective action wells outside of the treatment capture zone are predicted by Golder's modeling to decrease below the GWPS within 2 - 39 years.
- Molybdenum meets the UESPA requirements (Tiers I, II, and III) to be viable as an MNA remedy application in combination with the capping and closure of the LCPA. This conclusion is further supported by fate and transport modeling that also considered the effects of the proposed groundwater treatment system, and the predicted future molybdenum concentrations at the site.

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TABLES

Table 4
Geochemical Modeling
Relevant Mineral Phases- Saturation Indices
Labadie Energy Center, Franklin County, MO

MINERAL PHASES - Saturation Indices		L-LCPA-1D	L-LCPA-1S	L-LCPA-2D	L-LCPA-2S	L-LCPA-3D	L-LCPA-3S	L-BMW-1D	L-BMW-2D	L-UMW-1D	L-UMW-2D	L-UMW-3D	L-UMW-4D	L-UMW-5D	L-UMW-6D	L-UMW-7D	L-UMW-8D	L-UMW-9D
Ferrihydrite	Fe(OH)3	**3.36**	**1.51**	**2.33**	**2.21**	**2.43**	**1.83**	**1.60**	**2.48**	**3.71**	**3.37**	**3.27**	**1.91**	**2.37**	**3.74**	**3.43**	**4.48**	**3.95**
Siderite	FeCO3	-4.51	-9.92	-5.56	-7.27	-6.47	-11.70	**0.49**	**0.62**	**0.96**	**0.43**	-2.26	-0.90	-3.90	-1.10	**0.68**	**0.45**	**0.92**
Melanterite	FeSO4: 7H2O	-10.63	-16.77	-11.98	-13.65	-13.12	-18.48	-5.45	-5.67	-5.91	-5.56	-8.40	-6.01	-10.38	-6.28	-4.82	-4.75	-7.09
Anglesite	PbSO4	-4.87	-7.71	-5.56	-5.45	-6.02	-6.81	-4.82	-5.03	-5.63	-4.39	-4.64	-3.82	-5.27	-3.92	-3.99	-3.76	-6.51
Rhodochrosite	MnCO3	-1.35	-0.90		**0.02**	-1.14		**-0.32**	**-0.35**	**-0.16**	**0.02**	**0.21**	**-0.42**	-0.79	**-0.13**	**0.43**	**-0.01**	**-0.30**
Birnessite	MnO2	-8.53	-4.08		-2.97	-8.00		-17.95	-16.91	-14.75	-14.69	-11.17	-16.88	-11.90	-12.60	-14.31	-12.18	-14.39
Manganite	MnOOH	-2.36	**1.62**		**1.20**	-1.30		-7.91	-7.20	-6.28	-5.94	-3.31	-6.58	-3.49	-4.06	-5.56	-4.76	-6.06
Gypsum	CaSO4:2H2O	-1.19	-1.14	-1.05	-1.26	-1.13	-1.21	-1.94	-1.93	-2.46	-1.44	-0.91	-1.12	-1.31	-0.93	-1.01	-0.99	-3.82
Calcite	CaCO3	**0.93**	**1.70**	**1.43**	**1.28**	**1.46**	**1.54**	**0.04**	**0.40**	**0.41**	**0.54**	**1.18**	**-0.04**	**1.13**	**0.27**	**0.51**	**0.23**	**0.21**
Magnesite	MgCO3	-0.94	-1.66	**-0.42**	**0.59**	-0.96	-1.33	-1.19	-0.93	-0.81	-0.76	-0.89	-1.61	-2.81	-1.64	-0.96	-0.96	-0.95
Barite	BaSO4	**0.63**	**0.60**	**0.89**	**0.97**	**0.63**	**0.53**	**1.00**	**0.46**	**0.07**	**0.61**	**1.03**	**1.03**	**0.71**	**1.16**	**0.66**	**1.10**	-1.18

MINERAL PHASES - Saturation Indices		L-BMW-1S	L-BMW-2S	L-LMW-1S	L-LMW-2S	L-LMW-4S	L-LMW-7S	L-LMW-8S	L-MW-24	L-MW-26	L-S-1	L-AM-1S	L-AM-1D	L-TP-1D	L-TP-2M	L-TP-2D	L-TP-3M	L-TP-3D
Ferrihydrite	Fe(OH)3	**3.99**	**1.42**	**1.60**	**2.15**	**2.64**	**1.46**	**2.61**	**0.64**	**1.01**	**2.02**	**1.45**	**1.56**	**1.22**	**1.62**	**2.50**	**2.99**	**4.11**
Siderite	FeCO3	**0.44**	-2.12	**0.31**	-5.54	**0.43**	**-0.11**	**0.24**	-2.37	-2.29	-1.27	**0.19**	**0.27**	**0.66**	**0.35**	**0.78**	**0.28**	**-0.42**
Melanterite	FeSO4: 7H2O	-5.22	-7.95	-5.44	-11.77	-4.72	-4.89	-4.44	-8.27	-8.46	-7.50	-6.29	-4.81	-6.02	-5.32	-4.83	-4.78	-5.26
Anglesite	PbSO4	-4.62	-4.60	-4.58	-5.13	-3.98	-3.44	-3.53	-4.79	-4.81	-5.00	-5.17	-3.61	-5.46	-4.31	-4.32	-3.77	-3.62
Rhodochrosite	MnCO3	**0.24**	-2.86	**0.04**	-1.50	**0.19**	**-0.23**	**0.14**	-2.27	**0.07**	**-0.36**	**0.18**	-0.53	**-0.44**	**-0.04**	**0.53**	**-0.02**	-0.91
Birnessite	MnO2	-12.20	-16.04		-10.04	-15.61		-15.44	-16.06	-13.32	-13.66	-17.01	-19.02	-19.37	-18.32	-16.79	-14.89	-12.94
Manganite	MnOOH	-4.95	-8.10		-2.78	-6.40		-6.26	-7.93	-5.34	-5.86	-7.41	-8.10	-8.65	-7.54	-6.49	-6.17	-5.22
Gypsum	CaSO4:2H2O	-1.49	-1.61	-1.68	-1.40	-1.17	-1.03	-0.61	-1.94	-2.01	-2.17	-2.23	-1.02	-2.34	-1.35	-1.29	-1.20	-0.97
Calcite	CaCO3	**0.20**	**0.25**	**0.10**	**0.81**	**0.00**	**-0.24**	**0.08**	**0.02**	**0.20**	**0.08**	**0.25**	**0.07**	**0.37**	**0.34**	**0.35**	**-0.14**	**-0.12**
Magnesite	MgCO3	-1.08	-1.18	-1.24	-2.61	-1.25	-1.48	-1.25	-1.25	-1.09	-1.32	-1.04	-1.43	-0.82	-1.08	-0.91	-1.43	-1.37
Barite	BaSO4	**0.75**	**0.66**	**0.29**	**0.37**	**1.02**	**1.28**	**1.32**	**0.24**	**0.16**	**0.22**	**0.25**	**0.88**	**0.69**	**0.80**	**0.88**	**1.18**	**0.99**

MINERAL PHASES - Saturation Indices		L-TP-4D	L-MW-33[D]	L-MW-34[D]	L-MW-35[D]	L-AMW-8
Ferrihydrite	Fe(OH)3	**4.02**	**3.38**	**3.46**	**1.29**	**3.88**
Siderite	FeCO3	-0.79	**-0.04**	**0.02**	**-0.04**	-0.56
Melanterite	FeSO4: 7H2O	-6.17	-5.06	-4.92	-4.59	-6.09
Anglesite	PbSO4	-3.99	-3.79		-3.42	-4.25
Rhodochrosite	MnCO3	**-0.46**	-0.76		-0.69	**-0.40**
Birnessite	MnO2	-11.14	-14.80		-18.85	-13.03
Manganite	MnOOH	-4.46	-6.14	-6.11	-8.15	-4.74
Gypsum	CaSO4:2H2O	-1.24	-1.25	-1.11	-0.73	-1.58
Calcite	CaCO3	**0.16**	**-0.23**	**-0.16**	**-0.16**	**-0.03**
Magnesite	MgCO3	-1.01	-1.48	-1.37	-1.40	-1.52
Barite	BaSO4	**1.33**	**0.91**	**0.97**	**0.91**	**0.66**

Notes:

Saturation indices >-0.5 identified by red bold type and grey shading

(b) pCO2(g) values presented at 10^^{value} atm

Table 5
Monitored Natural Attenuation Evaluation
Summary of Rietveld Quantitative Analysis X-Ray Diffraction Results
Labadie Energy Center, Franklin County, MO

Mineral	Mineral Formula	Sample Location								
		L-BH-01S	L-BH-01M	L-BH-01D	L-BH-02S	L-BH-02M	L-BH-02D	L-BH-03S	L-BH-03M	L-BH-03D
		Sample Interval (FT BGS)								
		23-30	65-70	100-114	40-50	67.5-70	80-87	22.5-30	70-80	108-114
Actinolite	$Ca_2(Mg,Fe)_5Si_8O_{22}(OH)_2$	-	-	-	-	0.2	-	-	-	-
Albite	$NaAlSi_3O_8$	17.7	16.8	21.0	17.6	16.4	16.0	18.9	18.9	16.8
Chlorite	(Fe,(Mg,Mn)5,Al)(Si3Al)O10(OH)8	1.5	1.2	0.9	1.0	2.3	1.3	1.0	0.1	-
Calcite	CaCO3							1.2		
Diopside	$CaMgSi_2O_6$	-	-	-	2.3	2.2	2.2	-	2.2	2.1
Dolomite	$CaMg(CO_3)_2$	0.5	0.5	0.5	0.3	3.1	0.5	0.4	1.2	-
Heulandite	$CaAl_2Si_7O_{18}\cdot 6H_2O$	-	-	-	-	1.8	-	-	-	-
Hornblende	$(Ca,Na)_2{}^{-}3(Mg,Fe,Al)_5Si_6(Si,Al)_2O_{22}(OH)_2$	-	0.6	0.7	-	-	1.0	-	1.4	-
Kutnohorite	$CaMn(CO_3)_2$	2.1	-	-	-	0.3	-	-	-	-
Magnetite	$CaMgSi_2O_6$	-	-	-	-	0.3	-	-	-	-
Microcline	$KAlSi_3O_8$	8.5	12.5	19.6	12.3	7.5	7.8	11.0	13.7	13.5
Montmorillonite	$(Na,Ca)_{0.3}(Al,Mg)_2Si_4O_{10}(OH)_2\cdot nH_2O$	-	-	-	-	6.5	-	-	-	-
Muscovite	$KAl_2(AlSi_3O_{10})(OH)_2$	5.8	6.3	4.3	3.9	10.1	4.6	4.8	2.8	3.1
Quartz	SiO_2	63.9	62.1	53.0	62.6	49.1	66.2	62.6	59.7	64.5
Rhodochrosite	$MnCO_3$	-	-	-	-	0.2	0.4	-	-	-
TOTAL		100	100	100	100	100	100	100	100	100

Notes:

1.) Results provided in wt% - percent by weight of each mineral.

2.) ft bgs - feet below ground surface.

3.) Non-detect minerals within a sample are represented by "-".

4.) Zero values indicate that the mineral was included in the refinement, but the calculated concentration is below a measurable value.

5.) Samples were collected by Golder Associates between May 24, 2021 and May 26, 2021.

Table 6
Monitored Natural Attenuation Evaluation
SEP Analysis Summary
Labadie Energy Center, Franklin County, MO

Analyte	SEP Step	Sample Location								
		L-BH-01S	L-BH-01M	L-BH-01D	L-BH-02S	L-BH-02M	L-BH-02D	L-BH-03S	L-BH-03M	L-BH-03D
		Sample Interval (FT BGS)								
		(23-30)	(65-70)	(100-114)	(40-50)	(67.5-70)	(80-87)	(22.5-30)	(70-80)	(108-114)
Aluminum	SEP Step 1	< 52 U	< 46 U	< 45 U	< 51 U	< 54 U	< 49 U	< 50 U	< 44 U	< 47 U
Aluminum	SEP Step 2	6.6 J	6.5 J	6.0 J	9.1 J	17 J	11 J	< 37 U	< 33 U	10 J
Aluminum	SEP Step 3	36	32	16	43	190	47	31	17	39
Aluminum	SEP Step 4	410	350	220	430	1,100	360	410	170	270
Aluminum	SEP Step 5	130 J	84 J	31 J	91 J	62 J	74 J	100 J	53 J	61 J
Aluminum	SEP Step 6	740	590	450	700	3,100	720	720	500	410
Aluminum	SEP Step 7	41,000	31,000	43,000	41,000	36,000	37,000	43,000	35,000	24,000
Aluminum	SEP SUM	42,000	32,000	44,000	43,000	40,000	39,000	44,000	36,000	25,000
Aluminum	SEP Total	1,800	1,300	840	2,200	6,500	1,700	1,700	1,200	800
Aluminum	SEP Total	42,000	38,000	40,000	54,000	64,000	41,000	41,000	37,000	34,000
Antimony	SEP Step 1	< 16 U	< 14 U	< 14 U	< 15 U	< 16 U	< 15 U	< 15 U	< 13 U	< 14 U
Antimony	SEP Step 2	< 12 U	< 10 U	< 10 U	< 11 U	< 12 U	< 11 U	< 11 U	< 9.9 U	< 10 U
Antimony	SEP Step 3	< 3.9 U	< 3.5 U	< 3.4 U	< 3.8 U	< 4.0 U	< 3.7 U	< 3.7 U	< 3.3 U	< 3.5 U
Antimony	SEP Step 4	< 3.9 U	< 3.5 U	< 3.4 U	< 3.8 U	< 4.0 U	< 3.7 U	< 3.7 U	< 3.3 U	< 3.5 U
Antimony	SEP Step 5	< 59 U	< 52 U	< 51 U	< 57 U	< 60 U	< 55 U	< 56 U	< 49 U	< 52 U
Antimony	SEP Step 6	< 3.9 U	< 3.5 U	< 3.4 U	< 3.8 U	< 4.0 U	< 3.7 U	< 3.7 U	< 3.3 U	< 3.5 U
Antimony	SEP Step 7	0.43 J	0.39 J	0.16 J	< 3.8 U	1.1 J	0.45 J	0.46 J	0.49 J	0.25 J
Antimony	SEP SUM	0.43 J	0.39 J	0.16 J	< 3.0 U	1.1 J	0.45 J	0.46 J	0.49 J	0.25 J
Antimony	SEP Total	< 7.4 U	< 6.5 U	< 6.3 U	< 7.2 U	< 7.9 U	< 7.1 U	< 7.0 U	< 6.2 U	< 6.6 U
Antimony	SEP Total	0.47 J	0.41 J	0.34 J	0.63 J	1.1 J	0.41 J	0.35 J	0.42 J	0.48 J
Arsenic	SEP Step 1	< 2.6 U	< 2.3 U	< 2.3 U	< 2.6 U	< 2.7 U	< 2.4 U	< 2.5 U	< 2.2 U	< 2.3 U
Arsenic	SEP Step 2	< 2.0 U	< 1.7 U	< 1.7 U	< 1.9 U	< 2.0 U	< 1.8 U	< 1.9 U	< 1.6 U	< 1.7 U
Arsenic	SEP Step 3	1.6	0.48 J	< 0.57 U	0.93	3.4	0.47 J	0.44 J	< 0.55 U	< 0.58 U
Arsenic	SEP Step 4	1.1	0.64	0.31 J	0.92	1.4	0.50 J	0.80	0.34 J	0.61
Arsenic	SEP Step 5	< 9.8 U	< 8.7 U	< 8.5 U	< 9.6 U	< 10 U	< 9.2 U	< 9.3 U	< 8.2 U	< 8.7 U
Arsenic	SEP Step 6	0.80	0.88	0.54 J	1.0	1.0	0.86	0.75	0.67	1.1
Arsenic	SEP Step 7	1.9	0.79 J	1.1	1.6	2.0	1.5	1.8	< 1.1 U	< 1.2 U
Arsenic	SEP SUM	5.3	2.8	2.0	4.5	7.7	3.4	3.8	1.0	1.7
Arsenic	SEP Total	4.2	2.9	0.87 J	3.0	6.1	2.1 J	2.3	0.87 J	1.6 J
Arsenic	SEP Total	7.9 B	4.1 B	2.4 B	4.8 B	9.6 B	4.4 B	4.5 B	2.1 B	3.0 B
Calcium	SEP Step 1	740 J B	340 J B	270 J B	450 J B	2,200 B	320 J B	430 J B	210 J B	170 J B
Calcium	SEP Step 2	1,800	1,400	2,700	1,500	6,800	1,300	1,400	990	220 J
Calcium	SEP Step 3	6.4 J	5.0 J	5.9 J	5.5 J	7.3 J	5.2 J	5.8 J	5.8 J	4.8 J
Calcium	SEP Step 4	1,200	1,500	1,300	1,200	3,800	1,400	1,200	1,000	410
Calcium	SEP Step 5	480 J B	510 J B	990 J B	370 J B	3,600 J B	850 J B	360 J B	710 J B	98 J B
Calcium	SEP Step 6	150 J	380	690	200 J	1,300	250 J	160 J	390	110 J
Calcium	SEP Step 7	5,400	4,400	4,600	5,000	4,000	6,600	6,200	5,600	2,200
Calcium	SEP SUM	9,800	8,500	11,000	8,800	22,000	11,000	9,800	8,900	3,200
Calcium	SEP Total	3,900	4,200	4,800	3,800	14,000	3,800	3,400	15,000	2,000
Calcium	SEP Total	12,000	9,900	8,400	12,000	30,000	13,000	9,400	7,800	5,100

Notes:

1.) All Results displayed in milligram per kilogram (mg/kg).

2.) ft bgs - feet below ground surface.

3.) SEP: Sequential Extraction Procedure.
Step 1 - Exchangeable Phase: This extraction includes trace elements that are reversibly adsorbed to soil minerals, amorphous solids, and organic material by electrostatic forces.

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Step 7 - Residual Fraction: Trace elements remaining in the soil aftrer the previous extractions will be distributed between silicates, phosphates, and refractory oxides.

4.) U= The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit.

5.) UJ= The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit, the quantitation limit is considered estimated.

6.) J= The analyte was positively identified. The associated numerical value is the approximate concentration.

7.) J+= The analyte was positively identified. The associated numerical value is the approximate concentration of the analyte in the sample and biased high.

8.) B= Compound was found in the blank and sample.

Table 6
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SEP Analysis Summary
Labadie Energy Center, Franklin County, MO

Analyte	SEP Step	Sample Location								
		L-BH-01S	L-BH-01M	L-BH-01D	L-BH-02S	L-BH-02M	L-BH-02D	L-BH-03S	L-BH-03M	L-BH-03D
		Sample Interval (FT BGS)								
		(23-30)	(65-70)	(100-114)	(40-50)	(67.5-70)	(80-87)	(22.5-30)	(70-80)	(108-114)
Cobalt	SEP Step 1	< 13 U	< 12 U	< 11 U	< 13 U	< 13 U	< 12 U	< 12 U	< 11 U	< 12 U
Cobalt	SEP Step 2	0.46 J	< 8.7 U	< 8.5 U	0.30 J	1.2 J	< 9.2 U	< 9.3 U	< 8.2 U	0.42 J
Cobalt	SEP Step 3	0.91 J	0.51 J	0.21 J	0.54 J	1.0 J	0.39 J	0.49 J	0.14 J	0.74 J
Cobalt	SEP Step 4	1.3 J	0.94 J	1.3 J	1.0 J	1.3 J	0.63 J	0.89 J	1.2 J	1.6 J
Cobalt	SEP Step 5	< 49 U	< 43 U	< 43 U	< 48 U	< 50 U	< 46 U	< 46 U	< 41 U	< 44 U
Cobalt	SEP Step 6	0.62 J	0.65 J	0.71 J	0.72 J	1.2 J	0.53 J	0.56 J	0.80 J	1.4 J
Cobalt	SEP Step 7	0.44 J	< 2.9 U	< 2.8 U	0.28 J	1.2 J	0.30 J	0.20 J	< 2.7 U	< 2.9 U
Cobalt	SEP SUM	3.7	2.1 J	2.2 J	2.9	5.8	1.8 J	2.1 J	2.1 J	4.2
Cobalt	SEP Total	4.6 J	2.3 J	2.1 J	3.6 J	5.0 J	1.8 J	2.4 J	2.7 J	3.1 J
Cobalt	SEP Total	4.8	2.8 J	2.1 J	3.9	8.1	2.6 J	2.7 J	2.2 J	4.0
Iron	SEP Step 1	< 26 U	< 23 U	< 23 U	< 26 U	< 27 U	< 24 U	< 25 U	< 22 U	< 23 U
Iron	SEP Step 2	14 J	75	100	120	860	190	13 J	34	44
Iron	SEP Step 3	560	400	310	500	3,400	600	310	220	220
Iron	SEP Step 4	1,700	1,300	1,100	1,500	2,800	1,000	1,600	1,000	1,800
Iron	SEP Step 5	< 98 U	< 87 U	< 85 U	< 96 U	< 100 U	< 92 U	< 93 U	< 82 U	< 87 U
Iron	SEP Step 6	2,300	1,900	1,300	2,000	4,400	1,700	2,000	2,300	2,900
Iron	SEP Step 7	2,600	1,400	1,400	2,300	6,500	2,400	2,100	1,300	1,300
Iron	SEP SUM	7,200	5,100	4,200	6,400	18,000	5,900	6,000	4,900	6,300
Iron	SEP Total	4,500	3,400	2,100	4,800	10,000	3,400	4,200	3,500	3,900
Iron	SEP Total	7,400	5,700	6,100	8,000	19,000	6,800	6,200	3,900	6,300
Lithium	SEP Step 1	< 13 U	< 12 U	< 11 U	< 13 U	< 13 U	< 12 U	< 12 U	< 11 U	< 12 U
Lithium	SEP Step 2	< 9.8 U	< 8.7 U	< 8.5 U	< 9.6 U	< 10 U	< 9.2 U	< 9.3 U	< 8.2 U	< 8.7 U
Lithium	SEP Step 3	< 3.3 U	< 2.9 U	< 2.8 U	< 3.2 U	< 3.4 U	< 3.1 U	< 3.1 U	< 2.7 U	< 2.9 U
Lithium	SEP Step 4	0.80 J	0.68 J	0.36 J	0.81 J	2.8 J	0.71 J	0.75 J	0.28 J	0.33 J
Lithium	SEP Step 5	< 49 U	< 43 U	< 43 U	< 48 U	< 50 U	< 46 U	< 46 U	< 41 U	< 44 U
Lithium	SEP Step 6	0.97 J	0.72 J	0.58 J	0.80 J	3.4	0.89 J	0.84 J	0.63 J	0.47 J
Lithium	SEP Step 7	5.4	2.7 J	2.2 J	3.5	10	4.4	3.8	2.4 J	2.0 J
Lithium	SEP SUM	7.2	4.1	3.1	5.2	16	6.0	5.4	3.3	2.8
Lithium	SEP Total	2.3 J	1.7 J	1.6 J	2.7 J	8.0	2.0 J	2.0 J	2.1 J	0.94 J
Lithium	SEP Total	6.6	5.3	3.6	7.2	21	6.7	6.1	3.6	3.5
Manganese	SEP Step 1	0.55 J	1.4 J	3.4	0.65 J	7.3	0.91 J	0.67 J	2.8 J	3.7
Manganese	SEP Step 2	16	33	68	19	160	23	16	48	36
Manganese	SEP Step 3	4.6 B	15 B	48 B	5.1 B	53 B	15 B	8.5 B	16 B	8.6 B
Manganese	SEP Step 4	16	17	100	15	35	13	15	21	19
Manganese	SEP Step 5	< 15 U	2.1 J	5.2 J	< 14 U	9.9 J	< 14 U	< 14 U	3.2 J	< 13 U
Manganese	SEP Step 6	18	14	17	15	33	14	15	17	22
Manganese	SEP Step 7	39	25	38	42	67	47	34	35	14
Manganese	SEP SUM	94	110	280	96	370	110	89	140	100
Manganese	SEP Total	50	95	99	64	230	63	58	420	87
Manganese	SEP Total	100	140	250	140	410	150	96	160	160

Notes:

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		Sample Interval (FT BGS)								
		(23-30)	(65-70)	(100-114)	(40-50)	(67.5-70)	(80-87)	(22.5-30)	(70-80)	(108-114)
Molybdenum	SEP Step 1	< 10 U	< 9.3 U	< 9.1 U	< 10 U	< 11 U	< 9.8 U	< 9.9 U	< 8.8 U	< 9.3 U
Molybdenum	SEP Step 2	< 7.9 U	< 6.9 U	< 6.8 U	< 7.7 U	< 8.0 U	< 7.3 U	< 7.4 U	< 6.6 U	< 7.0 U
Molybdenum	SEP Step 3	< 2.6 U	< 2.3 U	0.14 J	< 2.6 U	0.25 J	< 2.4 U	< 2.5 U	< 2.2 U	0.15 J
Molybdenum	SEP Step 4	< 2.6 U	< 2.3 U	< 2.3 U	< 2.6 U	0.12 J	< 2.4 U	< 2.5 U	< 2.2 U	0.12 J
Molybdenum	SEP Step 5	< 39 U	< 35 U	< 34 U	< 38 U	< 40 U	< 37 U	< 37 U	< 33 U	< 35 U
Molybdenum	SEP Step 6	< 2.6 U	< 2.3 U	< 2.3 U	< 2.6 U	< 2.7 U	< 2.4 U	< 2.5 U	< 2.2 U	< 2.3 U
Molybdenum	SEP Step 7	0.12 J	0.11 J	< 2.3 U	< 2.6 U	0.22 J	0.10 J	< 2.5 U	< 2.2 U	< 2.3 U
Molybdenum	SEP SUM	0.12 J	0.11 J	0.14 J	< 2.0 U	0.59 J	0.10 J	< 2.0 U	< 2.0 U	0.26 J
Molybdenum	SEP Total	< 4.9 U	0.16 J	0.60 J	< 4.8 U	0.35 J	< 4.7 U	< 4.7 U	0.15 J	0.29 J
Molybdenum	SEP Total	0.26 J	0.26 J	3.2	0.21 J	0.82 J	0.29 J	0.23 J	0.33 J	1.3 J
Potassium	SEP Step 1	< 1,300 U	< 1,200 U	< 1,100 U	< 1,300 U	< 1,300 U	< 1,200 U	< 1,200 U	< 1,100 U	< 1,200 U
Potassium	SEP Step 2	110 J	93 J	90 J	120 J	180 J	100 J	110 J	< 820 U	99 J
Potassium	SEP Step 3	< 330 U	< 290 U	< 280 U	< 320 U	75 J	< 310 U	< 310 U	< 270 U	< 290 U
Potassium	SEP Step 4	39 J	36 J	< 280 U	50 J	120 J	42 J	43 J	< 270 U	< 290 U
Potassium	SEP Step 5	3,300 J B	2,900 J B	2,900 J B	3,200 J B	3,200 J B	3,100 J B	3,200 J B	2,800 J B	3,000 J B
Potassium	SEP Step 6	240 J	180 J	130 J	240 J	940	250 J	230 J	120 J	130 J
Potassium	SEP Step 7	26,000	18,000	26,000	26,000	17,000	19,000	24,000	21,000	18,000
Potassium	SEP SUM	30,000	22,000	30,000	29,000	22,000	22,000	27,000	24,000	21,000
Potassium	SEP Total	390 J	280 J	200 J	450 J	1,600	380 J	380 J	230 J	190 J
Potassium	SEP Total	19,000	18,000	27,000	29,000	25,000	18,000	21,000	25,000	22,000
Selenium	SEP Step 1	< 2.6 U	< 2.3 U	< 2.3 U	< 2.6 U	< 2.7 U	< 2.4 U	< 2.5 U	< 2.2 U	< 2.3 U
Selenium	SEP Step 2	< 2.0 U	< 1.7 U	< 1.7 U	< 1.9 U	< 2.0 U	< 1.8 U	< 1.9 U	< 1.6 U	< 1.7 U
Selenium	SEP Step 3	< 0.65 U	< 0.58 U	< 0.57 U	< 0.64 U	< 0.67 U	< 0.61 U	< 0.62 U	< 0.55 U	< 0.58 U
Selenium	SEP Step 4	< 0.65 U	< 0.58 U	< 0.57 U	< 0.64 U	< 0.67 U	< 0.61 U	< 0.62 U	< 0.55 U	< 0.58 U
Selenium	SEP Step 5	< 9.8 U	< 8.7 U	< 8.5 U	< 9.6 U	< 10 U	< 9.2 U	< 9.3 U	< 8.2 U	< 8.7 U
Selenium	SEP Step 6	< 0.65 U	< 0.58 U	< 0.57 U	< 0.64 U	< 0.67 U	< 0.61 U	< 0.62 U	< 0.55 U	< 0.58 U
Selenium	SEP Step 7	< 0.65 U	< 1.2 U	< 0.57 U	< 0.64 U	0.28 J	< 1.2 U	< 0.62 U	< 1.1 U	< 1.2 U
Selenium	SEP SUM	< 0.50 U	< 0.50 U	< 0.50 U	< 0.50 U	0.28 J	< 0.50 U	< 0.50 U	< 0.50 U	< 0.50 U
Selenium	SEP Total	< 1.8 U	< 1.6 U	< 1.6 U	< 1.8 U	< 2.0 U	< 1.8 U	< 1.7 U	< 1.5 U	< 1.7 U
Selenium	SEP Total	0.54 J	< 0.58 U	0.38 J	< 0.64 U	< 0.67 U	< 0.61 U	< 0.62 U	< 0.55 U	< 0.58 U
Sodium	SEP Step 1	< 1,300 U	< 1,200 U	< 1,100 U	< 1,300 U	< 1,300 U	< 1,200 U	< 1,200 U	< 1,100 U	< 1,200 U
Sodium	SEP Step 3	7,100	5,800	6,000	6,700	11,000	6,700	6,700	5,800	6,200
Sodium	SEP Step 4	420	330	360	380	1,200	390	370	330	360
Sodium	SEP Step 6	23,000	18,000	20,000	21,000	34,000	23,000	21,000	17,000	18,000
Sodium	SEP Step 7	8,900	8,800	18,000	8,800	10,000	9,500	8,700	7,600	6,400
Sodium	SEP SUM	40,000	33,000	45,000	37,000	56,000	40,000	37,000	31,000	31,000
Sodium	SEP Total	51 J	46 J	39 J	71 J	160 J	71 J	59 J	60 J	57 J
Sodium	SEP Total	12,000	11,000	12,000	17,000	11,000	11,000	11,000	12,000	11,000

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Step 5 - Organic Phase: This extraction targets trace elements strongly bound via chemisorption to organic material.

Step 6 - Acid/Sulfide Fraction: The extraction is used to identify trace elements precipitated as sulfide minerals.

Step 7 - Residual Fraction: Trace elements remaining in the soil aftrer the previous extractions will be distributed between silicates, phosphates, and refractory oxides.

4.) U= The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit.

5.) UJ= The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit, the quantitation limit is considered estimated.

6.) J= The analyte was positively identified. The associated numerical value is the approximate concentration.

7.) J+= The analyte was positively identified. The associated numerical value is the approximate concentration of the analyte in the sample and biased high.

8.) B= Compound was found in the blank and sample.

FIGURES

LEGEND

- ⇗ River Flow Direction
- ● Location of Importance

0 5
Miles

NOTE(S)
1.) ALL LOCATIONS AND BOUNDARIES ARE APPROXIMATE.
2.) MNA - MONITORED NATURAL ATTENUATION.

REFERENCE(S)
1.) COORDINATE SYSTEM: NAD 1983 STATEPLANE MISSOURI EAST FIPS 2,401 FEET.

CLIENT
AMEREN MISSOURI
LCPA SURFACE IMPOUNDMENT, LABADIE ENERGY CENTER

PROJECT
TIER I - TIER III MNA GEOCHEMICAL EVALUATION

Ameren

TITLE
SITE LOCATION MAP

CONSULTANT

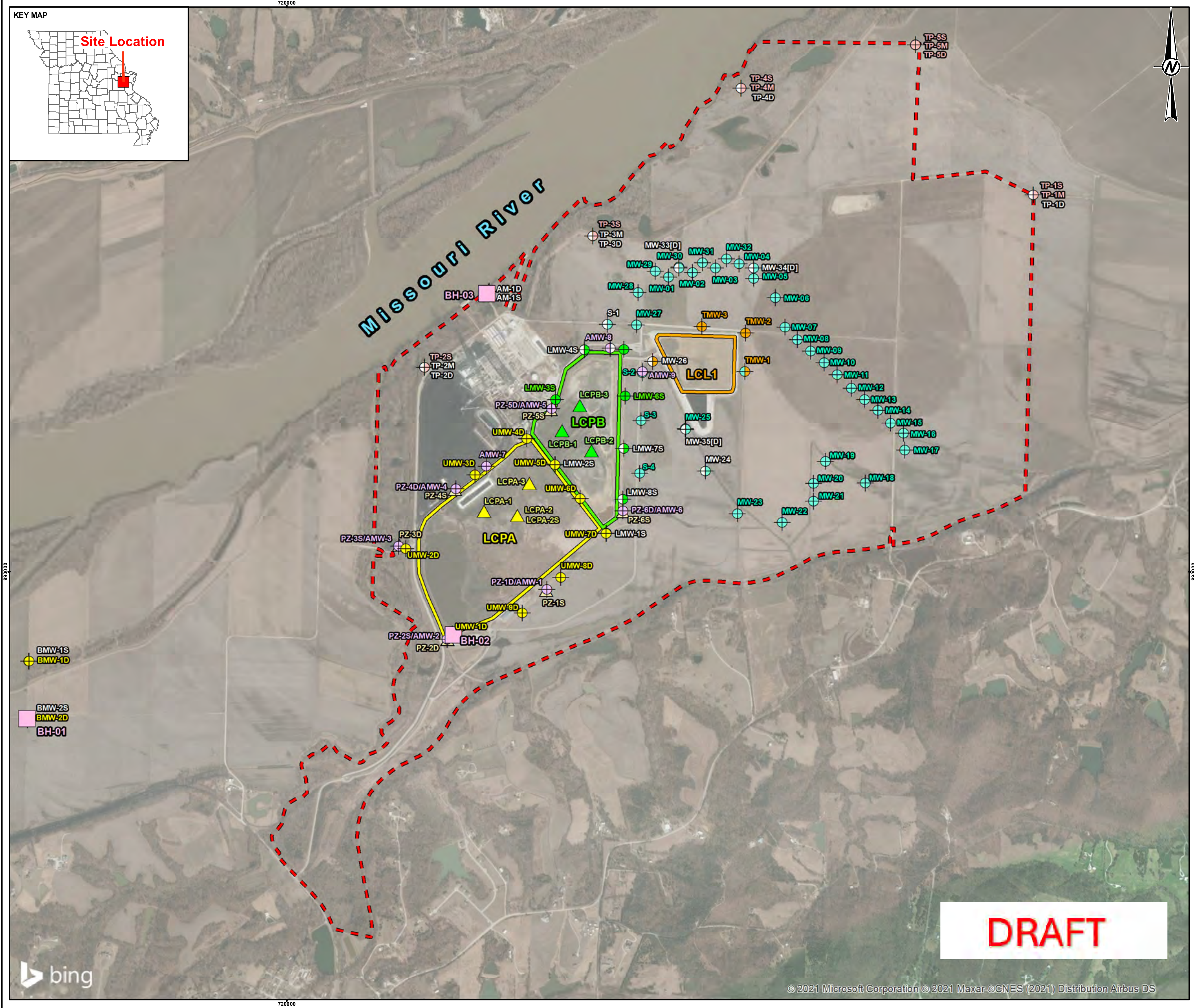
YYYY-MM-DD	2021-09-24
DESIGNED	JSI
PREPARED	BTT
REVIEWED	JS
APPROVED	MNH

PROJECT NO.	CONTROL	REV.	FIGURE
153140603	1240	0.0	1

PATH: C:\Users\jingram\Golder Associates\153140601,02 - Ameren CCR GW Monitoring Program 2020 - APF\5 Technical Work\0001-LEC\5.5-Figures-Drawings\PRODUCTION\20210210-LECMNA-MAP\20210924-Figure1-MNA Overview.mxd PRINTED ON: 2021-09-29 AT: 6:30:42 PM

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

0 1 in



DRAFT

LEGEND

🟥 Approximate Property Boundary

🟪 MNA Borehole Locations

Labadie Energy Center CCR Units

🟨 LCPA - Bottom Ash Surface Impoundment

🟩 LCPB - Fly Ash Surface Impoundment

🟧 LCL1 - Utility Waste Landfill Cell 1

Groundwater and Porewater Sampling Locations

⊕ LCPA Monitoring Well

⊕ LCPB Monitoring Well

⊕ LCPB and Corrective Action Monitoring Well

⊕ LCL1 Monitoring Well

⊕ State UWL, LCL1, and Corrective Action Monitoring Well

⊕ NPDES Monitoring Well

⊕ NPDES and Corrective Action Monitoring Well

⊕ State UWL Monitoring Well

⊕ State UWL and Corrective Action Monitoring Well

⊕ Nature and Extent Monitoring Well

⊕ Nature and Extent and Corrective Action Monitoring Well

⊕ State UWL and LCL1 Monitoring Well

▲ LCPA Direct-push Porewater Sample

▲ LCPB Direct-push Porewater Sample

▲ Abandoned NPDES Monitoring Well

0 1,000 2,000 3,000 4,000
Feet

NOTE(S)

1.) ALL LOCATIONS AND BOUNDARIES ARE APPROXIMATE.
2.) MNA - MONITORED NATURAL ATTENUATION.

REFERENCE(S)

1.) ZAHNER AND ASSOCIATES, INC. 2016. LOT CONSOLIDATION PLAT OF "LABADIE ENERGY CENTER" - PREPARED FOR AMEREN MISSOURI. REVISED JUNE 15, 2016.
2.) COORDINATE SYSTEM: NAD 1983 STATEPLANE MISSOURI EAST FIPS 2,401 FEET.

CLIENT
AMEREN MISSOURI
LCPA SURFACE IMPOUNDMENT, LABADIE ENERGY CENTER

PROJECT
TIER I - TIER III MNA GEOCHEMICAL EVALUATION

Ameren

TITLE
MNA BORING AND EXISTING GROUNDWATER AND POREWATER SAMPLING LOCATIONS

CONSULTANT

GOLDER
MEMBER OF WSP

YYYY-MM-DD	2021-09-22
DESIGNED	JSI
PREPARED	EMS/BTT
REVIEWED	JS
APPROVED	MNH

PROJECT NO.	CONTROL	REV.	FIGURE
153140603	1240	1.0	2

PATH: C:\Users\BTalbert\Golder Associates\153140601.02 - Ameren CCR GW Monitoring Program 2020 - 15314106 - All Project Files\5 Technical Work\0001-LEC\5.5-Figures-Drawings\PRODUCTION\2021020-LECMNA-MAP\20210924-Figure2-WellNetwork.mxd PRINTED ON: 2021-09-28 AT: 3:39:16 PM

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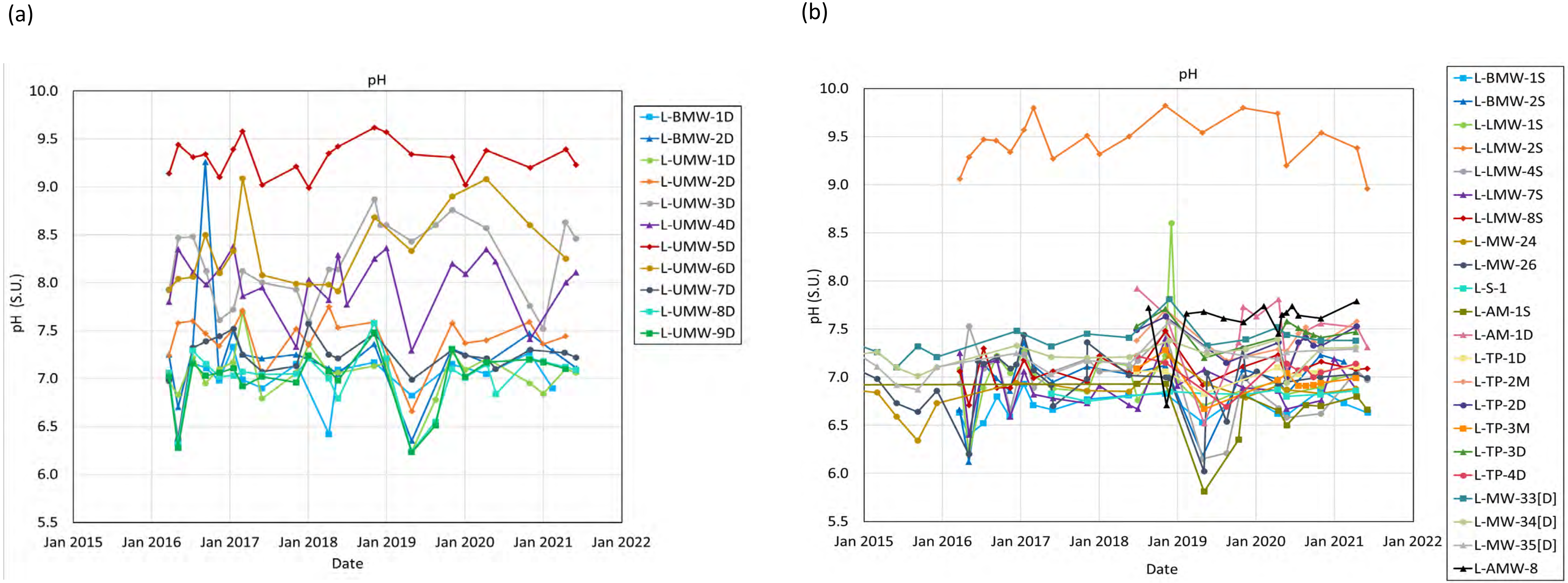
0 1 in



CLIENT
AMEREN MISSOURI
LCPA SURFACE IMPOUNDMENT, LABADIE ENERGY CENTER

PROJECT
TIER I – TIER III MNA GEOCHEMICAL
EVALUATION

CONSULTANT
GOLDER
MEMBER OF WSP

TITLE
Historical pH Values of Groundwater in
(a) Compliance Monitoring and (b) Corrective Action Wells

PROJECT NO.	PHASE	REV.	FIGURE
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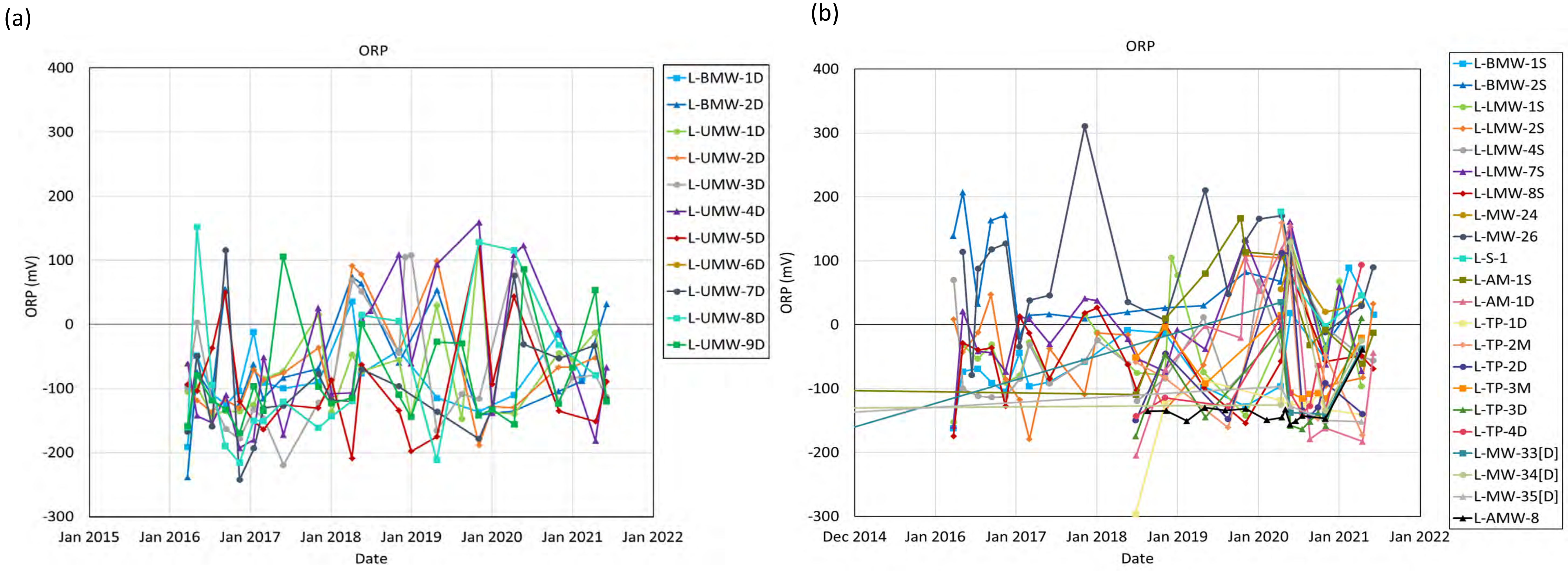

CLIENT
AMEREN MISSOURI
LCPA SURFACE IMPOUNDMENT, LABADIE ENERGY CENTER

PROJECT
TIER I – TIER III MNA GEOCHEMICAL
EVALUATION

CONSULTANT
GOLDER
MEMBER OF WSP

TITLE
Historical Redox Values of Groundwater in
(a) Compliance Monitoring and (b) Corrective Action Wells

PROJECT NO.	PHASE	REV.	FIGURE
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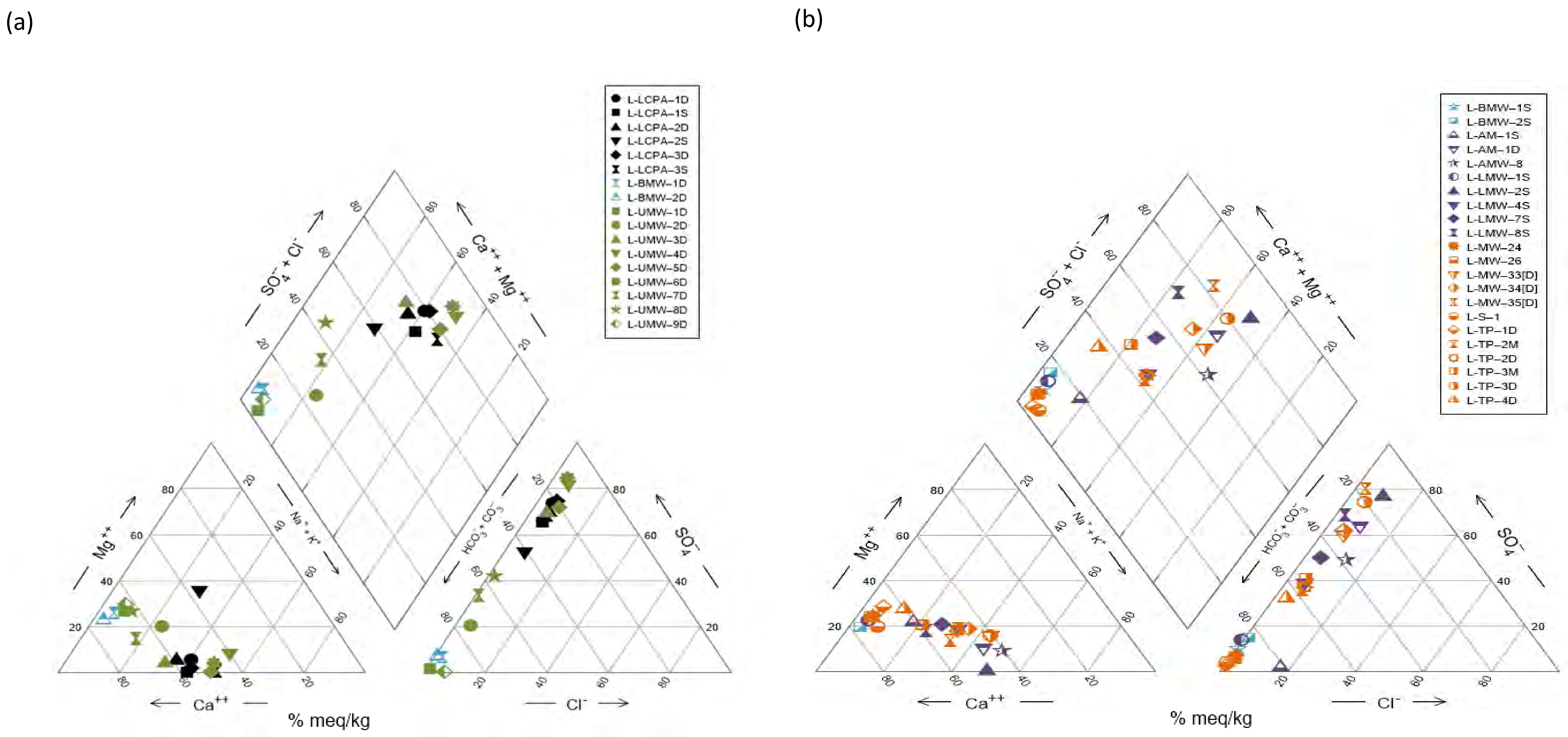


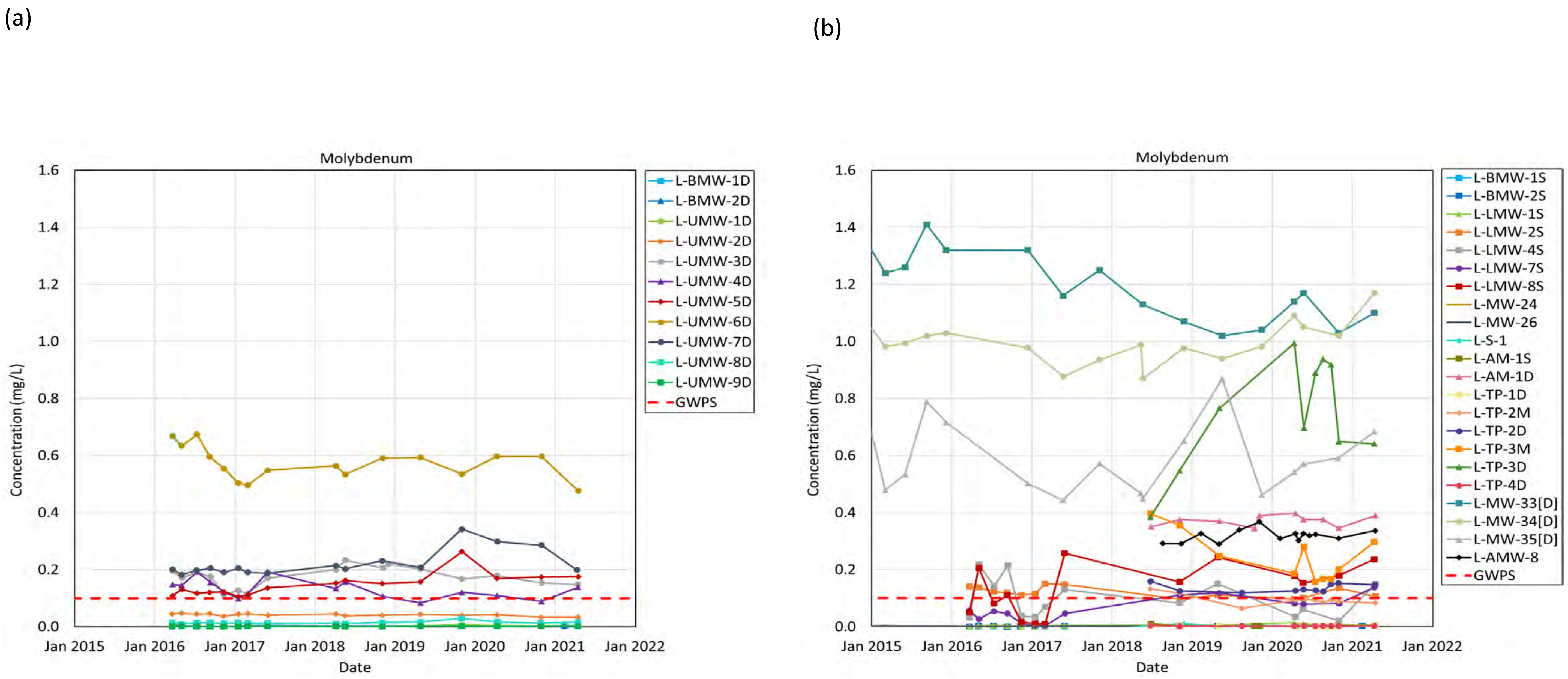
CLIENT
AMEREN MISSOURI
LCPA SURFACE IMPOUNDMENT, LABADIE ENERGY CENTER

PROJECT
TIER I – TIER III MNA GEOCHEMICAL
EVALUATION

CONSULTANT
GOLDER
MEMBER OF WSP

TITLE
Trilinear Diagrams - Groundwater Characterization
of (a) Compliance Monitoring and (b) Corrective Action Wells

PROJECT NO.	PHASE	REV.	FIGURE
153140603	0001D	A	5



CLIENT
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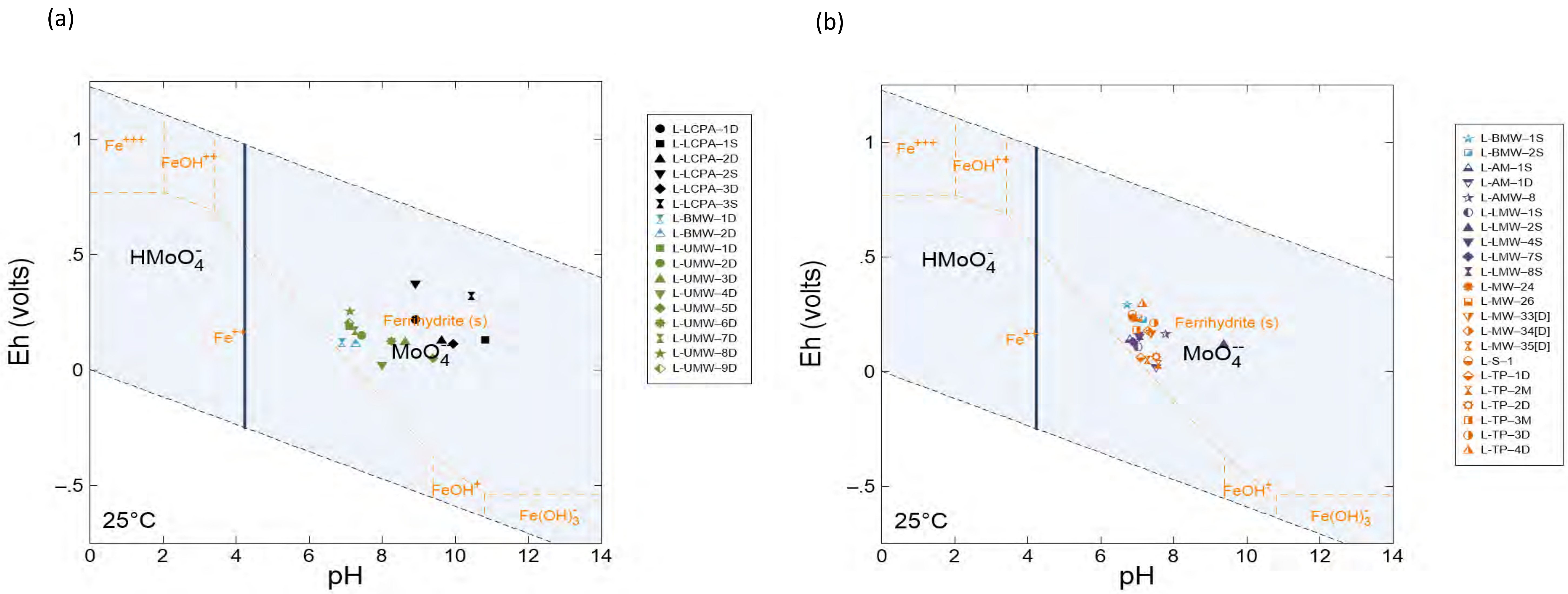
LCPA SURFACE IMPOUNDMENT, LABADIE ENERGY CENTER

CONSULTANT
GOLDER
MEMBER OF WSP

PROJECT
TIER I – TIER III MNA GEOCHEMICAL EVALUATION

TITLE
Historical Molybdenum Concentrations of Groundwater in (a) Compliance Monitoring and (b) Corrective Action Wells

PROJECT NO.	PHASE	REV.	FIGURE
153140603	0001D	A	6



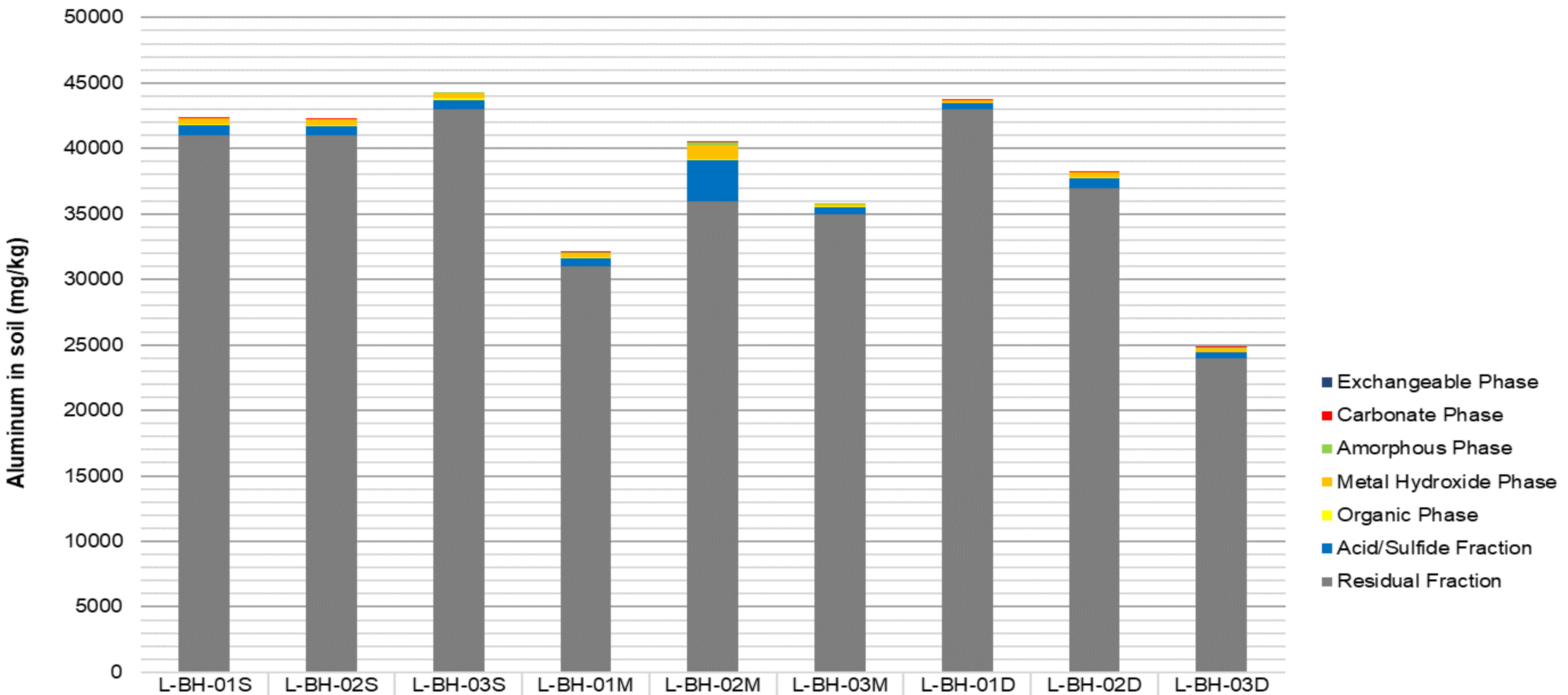
CLIENT
AMEREN MISSOURI
LCPA SURFACE IMPOUNDMENT, LABADIE ENERGY CENTER

PROJECT
TIER I – TIER III MNA GEOCHEMICAL
EVALUATION

CONSULTANT
GOLDER
MEMBER OF WSP

TITLE
Speciation of Molybdenum in Groundwater
at (a) Compliance Monitoring and (b) Corrective Action Wells

PROJECT NO.	PHASE	REV.	FIGURE
153140603	0001D	A	7



	L-BH-01S (23-30)	L-BH-02S (40-50)	L-BH-03S (22.5-30)	L-BH-01M (65-70)	L-BH-02M (67.5-70)	L-BH-03M (70-80)	L-BH-01D (100-114)	L-BH-02D (80-87)	L-BH-03D (108-114)
Exchangeable Phase	0	0	0	0	0	0	0	0	0
Carbonate Phase	6.6	9.1	0	6.5	17	0	6	11	10
Amorphous Phase	36	43	31	32	190	17	16	47	39
Metal Hydroxide Phase	410	430	410	350	1100	170	220	360	270
Organic Phase	130	91	100	84	62	53	31	74	61
Acid/Sulfide Fraction	740	700	720	590	3100	500	450	720	410
Residual Fraction	41000	41000	43000	31000	36000	35000	43000	37000	24000

Borehole and depth below ground surface

CLIENT
AMEREN MISSOURI
LCPA SURFACE IMPOUNDMENT, LABADIE ENERGY CENTER

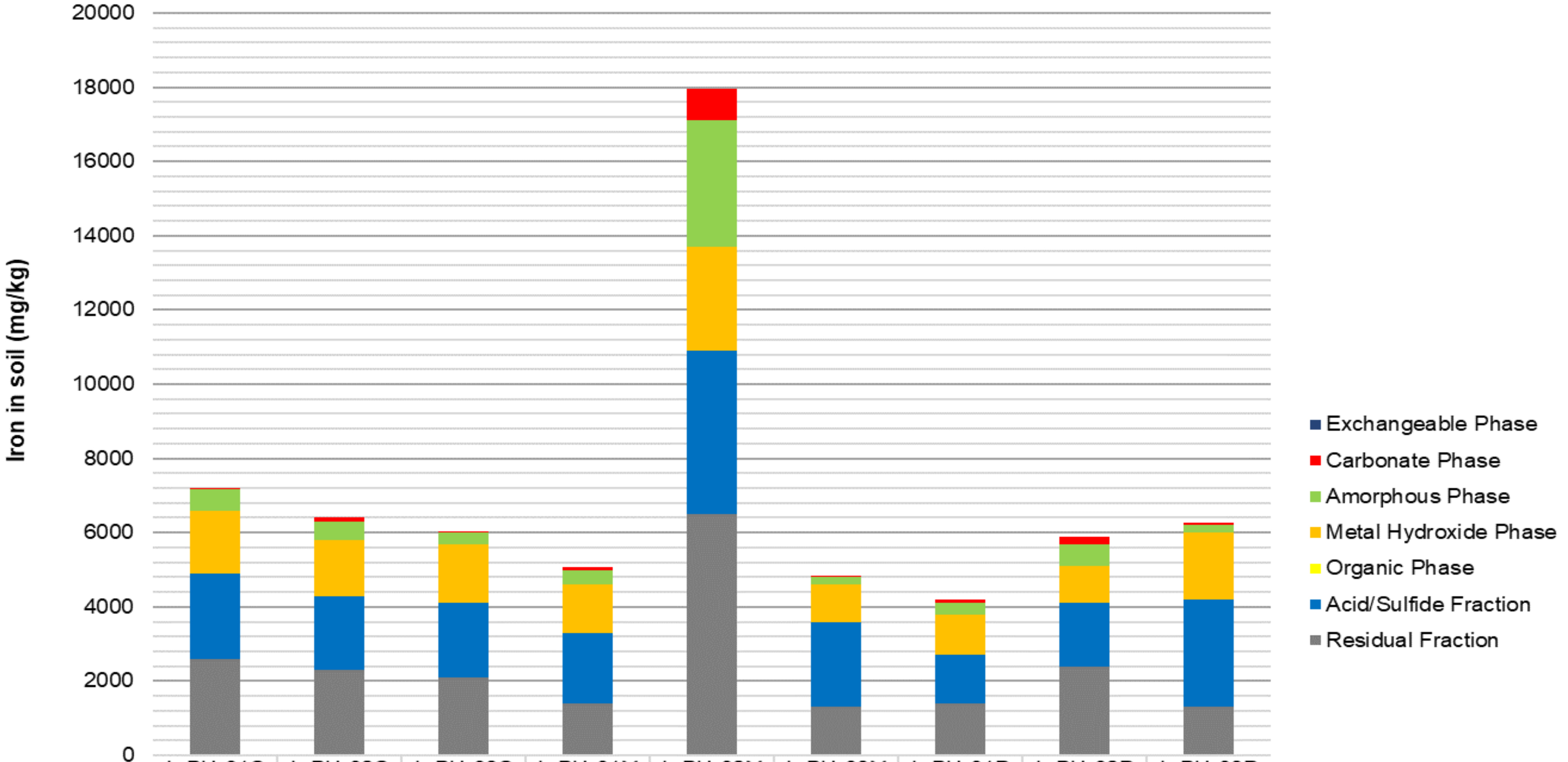
PROJECT
TIER I – TIER III MNA GEOCHEMICAL
EVALUATION

CONSULTANT
GOLDER
MEMBER OF WSP

TITLE
Sequential Extraction of Aluminum from Soil Borings

PROJECT NO.	PHASE	REV.	FIGURE
153140603	0001D	A	8

PATH: https://golderassociates.sharepoint.com/sites/123667/Project Files/APF/6 Deliverables/153-1406-03/Phase 0001 - Labadie/202109-MNA-Evaluations/Figures | FILE NAME: DRAFT_MNA Figures_3_16_T4 Labadie_v3CWK.xlsx



	L-BH-01S (23-30)	L-BH-02S (40-50)	L-BH-03S (22.5-30)	L-BH-01M (65-70)	L-BH-02M (67.5-70)	L-BH-03M (70-80)	L-BH-01D (100-114)	L-BH-02D (80-87)	L-BH-03D (108-114)
Exchangeable Phase	0	0	0	0	0	0	0	0	0
Carbonate Phase	14	120	13	75	860	34	100	190	44
Amorphous Phase	560	500	310	400	3400	220	310	600	220
Metal Hydroxide Phase	1700	1500	1600	1300	2800	1000	1100	1000	1800
Organic Phase	0	0	0	0	0	0	0	0	0
Acid/Sulfide Fraction	2300	2000	2000	1900	4400	2300	1300	1700	2900
Residual Fraction	2600	2300	2100	1400	6500	1300	1400	2400	1300

Borehole and depth below ground surface

CLIENT
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LCPA SURFACE IMPOUNDMENT, LABADIE ENERGY CENTER

PROJECT
TIER I – TIER III MNA GEOCHEMICAL
EVALUATION

CONSULTANT
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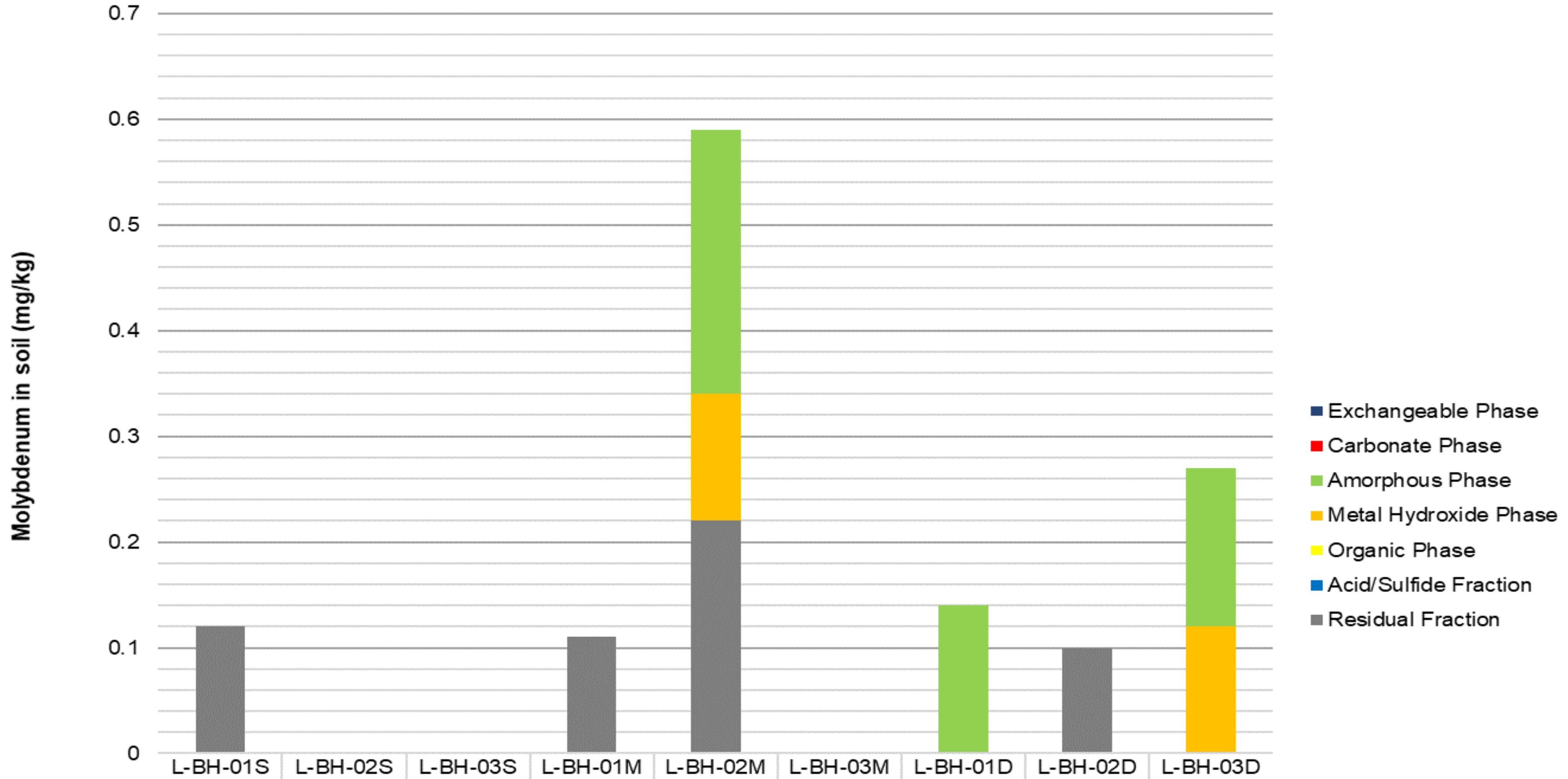
MEMBER OF WSP

TITLE
Sequential Extraction of Iron from Soil Borings

PROJECT NO.	PHASE	REV.	FIGURE
153140603	0001D	A	9



	L-BH-01S	L-BH-02S	L-BH-03S	L-BH-01M	L-BH-02M	L-BH-03M	L-BH-01D	L-BH-02D	L-BH-03D
Exchangeable Phase	0	0	0	0	0	0	0	0	0
Carbonate Phase	0	0	0	0	0	0	0	0	0
Amorphous Phase	0	0	0	0	0.25	0	0.14	0	0.15
Metal Hydroxide Phase	0	0	0	0	0.12	0	0	0	0.12
Organic Phase	0	0	0	0	0	0	0	0	0
Acid/Sulfide Fraction	0	0	0	0	0	0	0	0	0
Residual Fraction	0.12	0	0	0.11	0.22	0	0	0.1	0

Borehole and depth below ground surface

CLIENT
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PROJECT
TIER I – TIER III MNA GEOCHEMICAL
EVALUATION

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TITLE
Sequential Extraction of Molybdenum from Soil Borings

PROJECT NO.	PHASE	REV.	FIGURE
153140603	0001D	A	10

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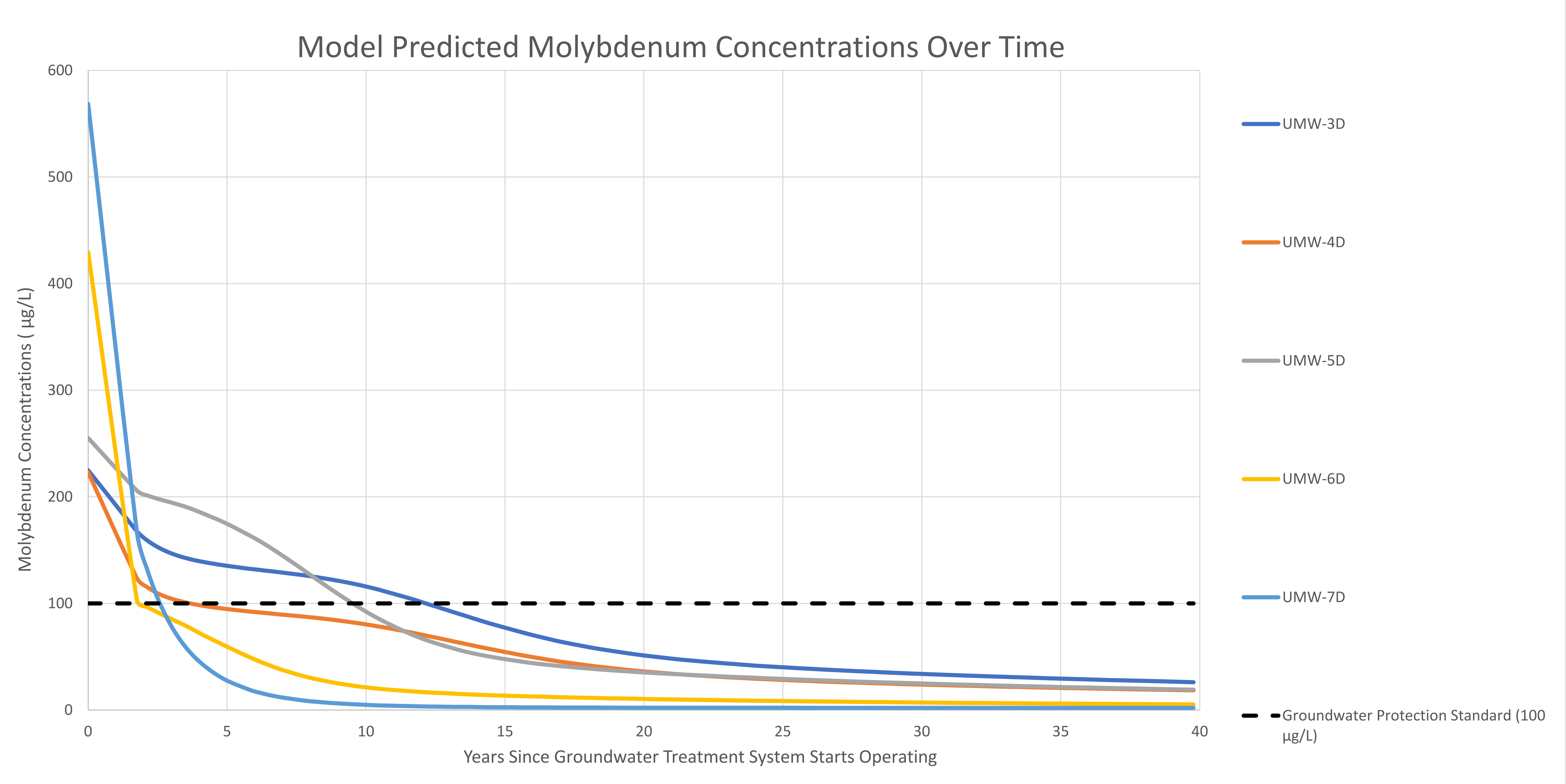

Notes:
1) µg/L - Micrograms per liter.

CLIENT
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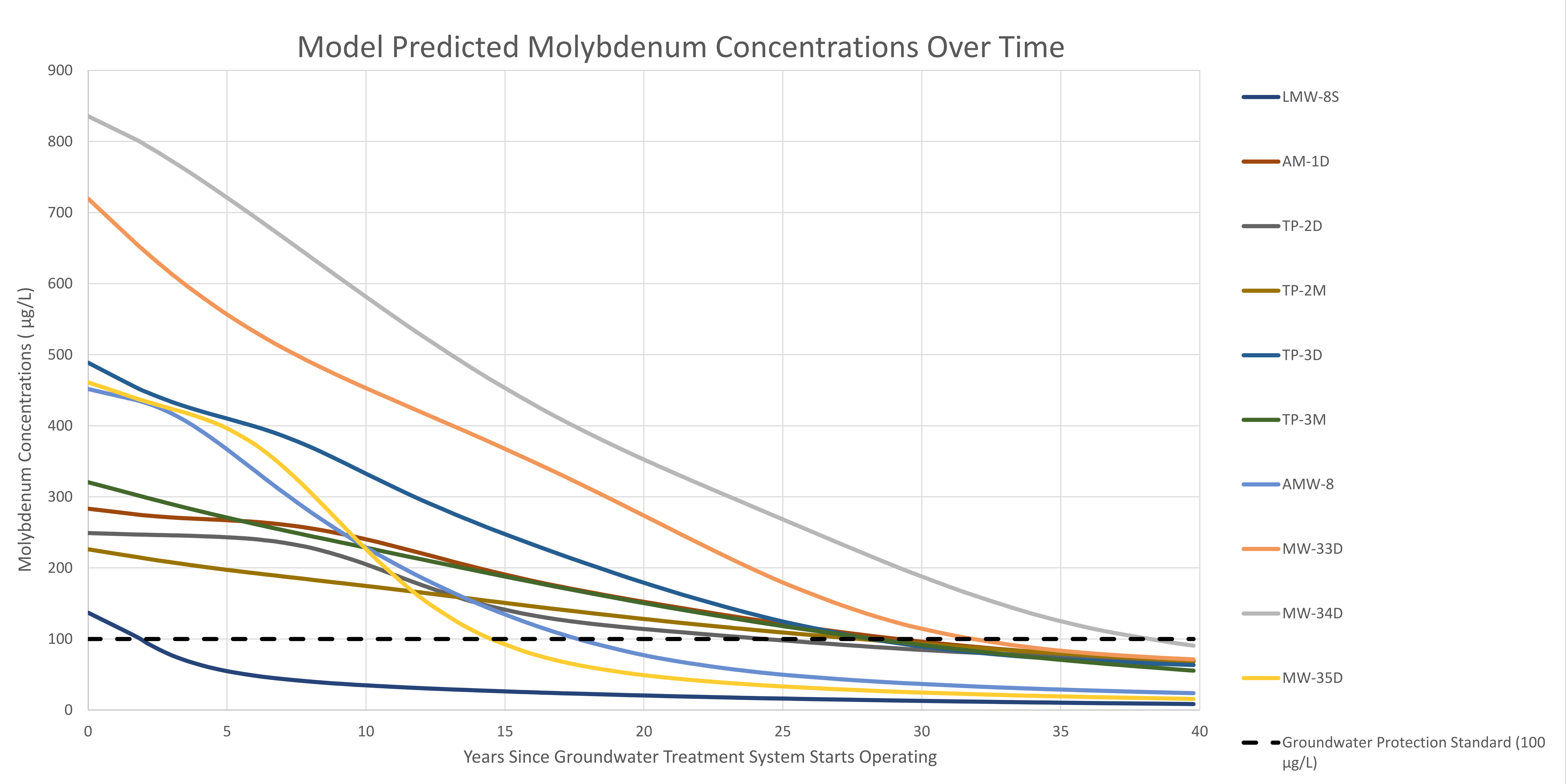
PROJECT
TIER I – TIER III MNA GEOCHEMICAL EVALUATION

TITLE
Model Predicted Molybdenum Concentrations Over Time
Detection and Assessment Monitoring Well Network

PROJECT NO.	PHASE	REV.	FIGURE
153140603	0001D	A	11

PATH: https://golderassociates.sharepoint.com/sites/123667/Project Files/APF/6 Deliverables/153-1406-03/Phase 0001 - Labadie/202109-MNA-Evaluations/Figures | FILE NAME: DRAFT_MNA Figures_3_16_T4 Labadie_v3CWK.xlsx



Notes:
1) µg/L - Micrograms per liter.

CLIENT
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LCPA SURFACE IMPOUNDMENT, LABADIE ENERGY CENTER

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GOLDER
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PROJECT
TIER I – TIER III MNA GEOCHEMICAL EVALUATION

TITLE
Model Predicted Molybdenum Concentrations Over Time
Corrective Action Monitoring Well Network

PROJECT NO.	PHASE	REV.	FIGURE
153140603	0001D	A	12

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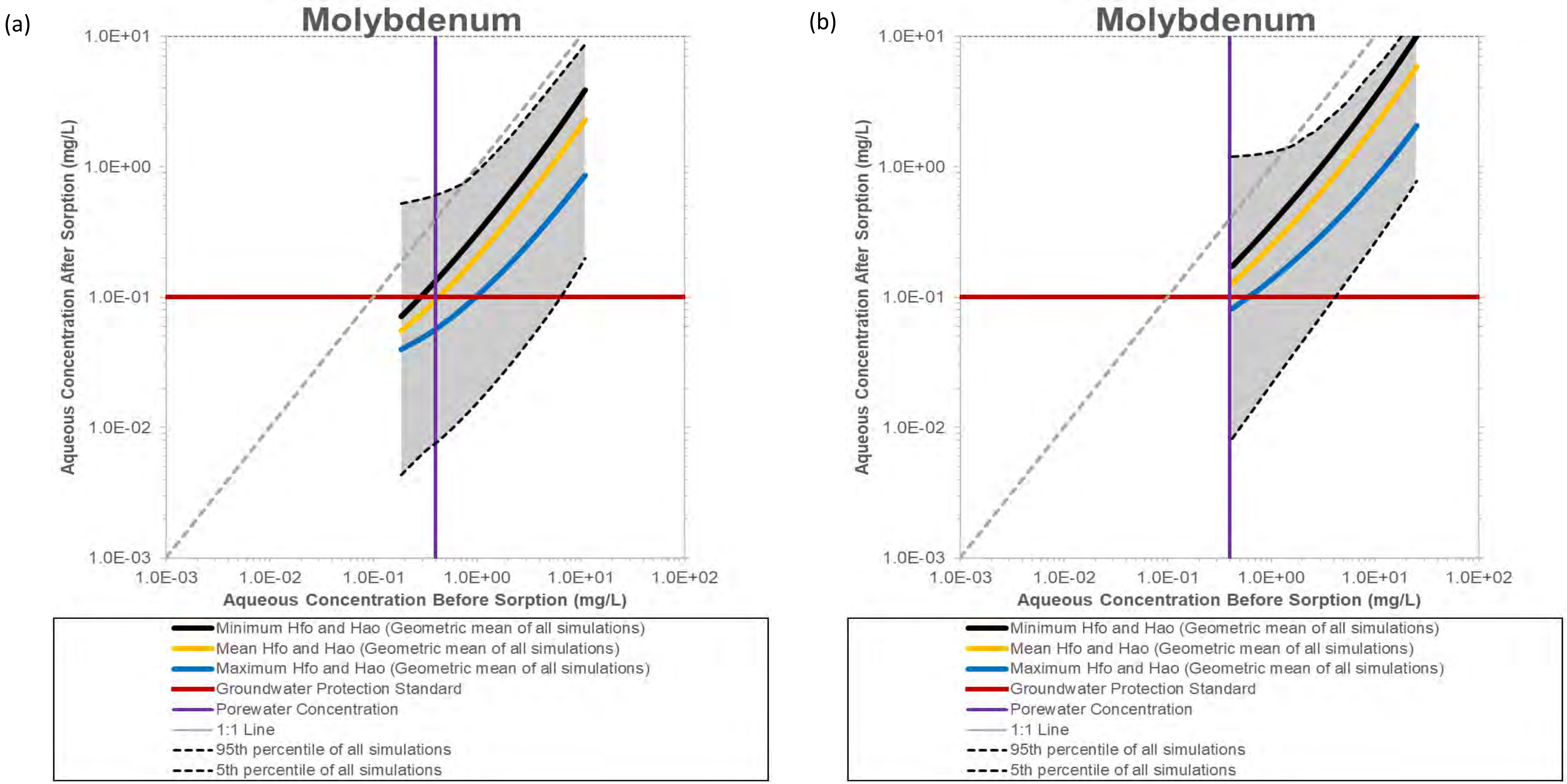

CLIENT
AMEREN MISSOURI
LCPA SURFACE IMPOUNDMENT, LABADIE ENERGY CENTER

PROJECT
TIER I – TIER III MNA GEOCHEMICAL
EVALUATION

CONSULTANT
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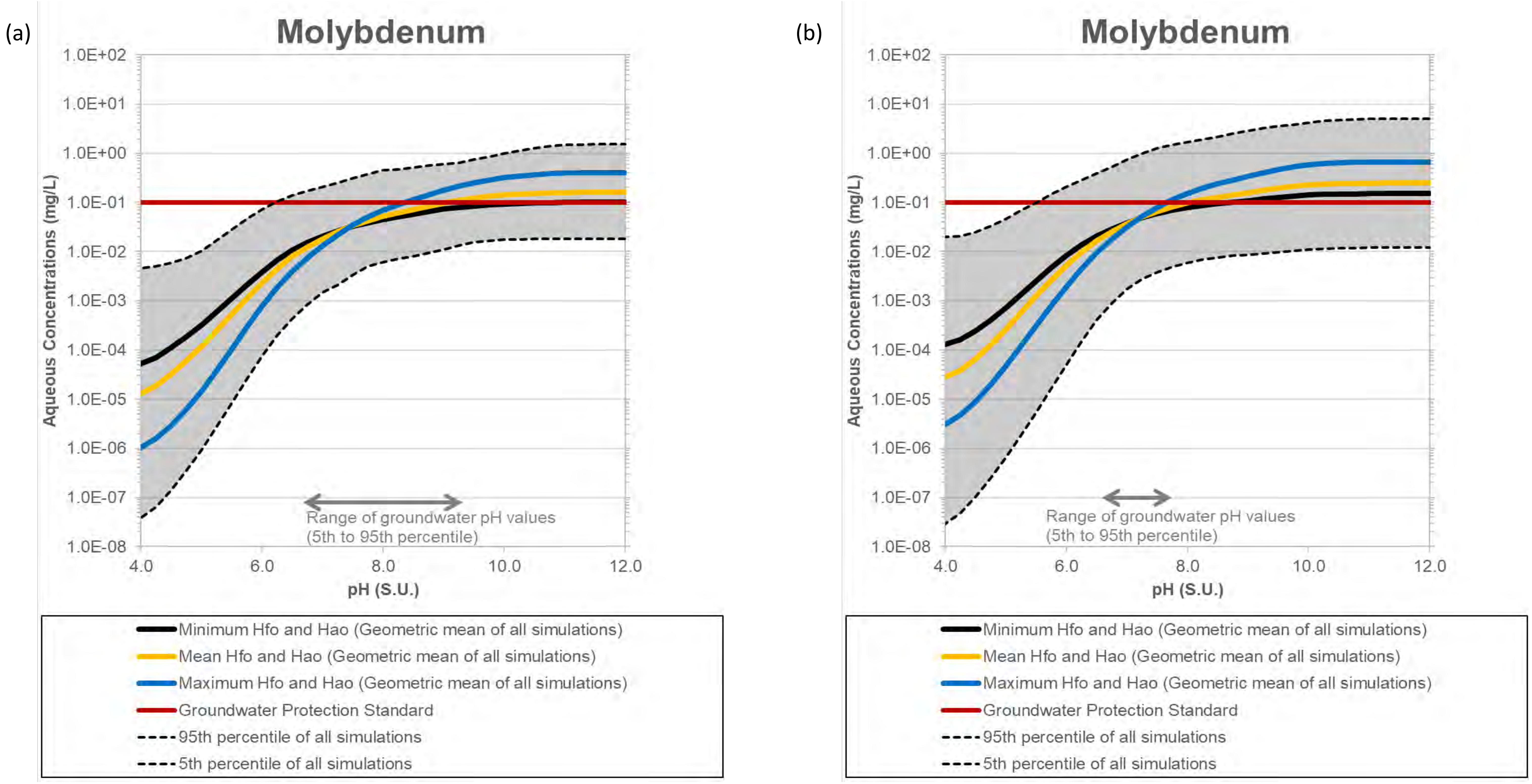
MEMBER OF WSP

TITLE
Attenuation Capacity Model for Molybdenum in
(a) Compliance Monitoring and (b) Corrective Action Wells

PROJECT NO.	PHASE	REV.	FIGURE
153140603	0001D	A	13

PATH: https://golderassociates.sharepoint.com/sites/123667/Project Files/APF/6 Deliverables/153-1406-03/Phase 0001 - Labadie/202109-MNA-Evaluations/Figures | FILE NAME: DRAFT_MNA Figures_3_16_T4 Labadie_v3CWK.xlsx



CLIENT
AMEREN MISSOURI
LCPA SURFACE IMPOUNDMENT, LABADIE ENERGY CENTER

CONSULTANT
GOLDER
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PROJECT
TIER I – TIER III MNA GEOCHEMICAL
EVALUATION

TITLE
Stability of Adsorbed Molybdenum in Response to pH
in (a) Compliance Monitoring and (b) Corrective Action Wells

PROJECT NO.	PHASE	REV.	FIGURE
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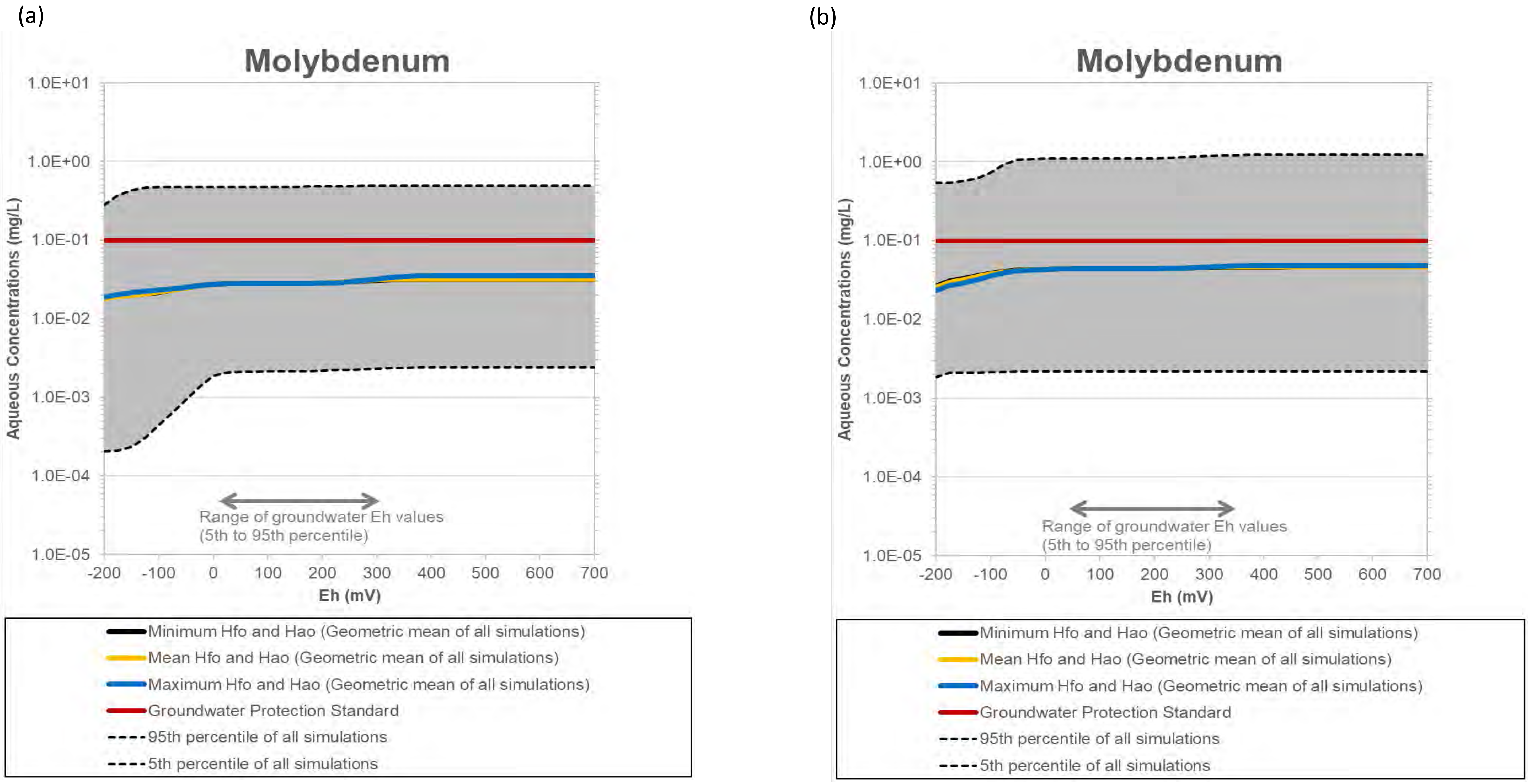

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AMEREN MISSOURI
LCPA SURFACE IMPOUNDMENT, LABADIE ENERGY CENTER

CONSULTANT
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MEMBER OF WSP

PROJECT
TIER I – TIER III MNA GEOCHEMICAL
EVALUATION

TITLE
Stability of Adsorbed Molybdenum in Response to Eh
in (a) Compliance Monitoring and (b) Corrective Action Wells

PROJECT NO.	PHASE	REV.	FIGURE
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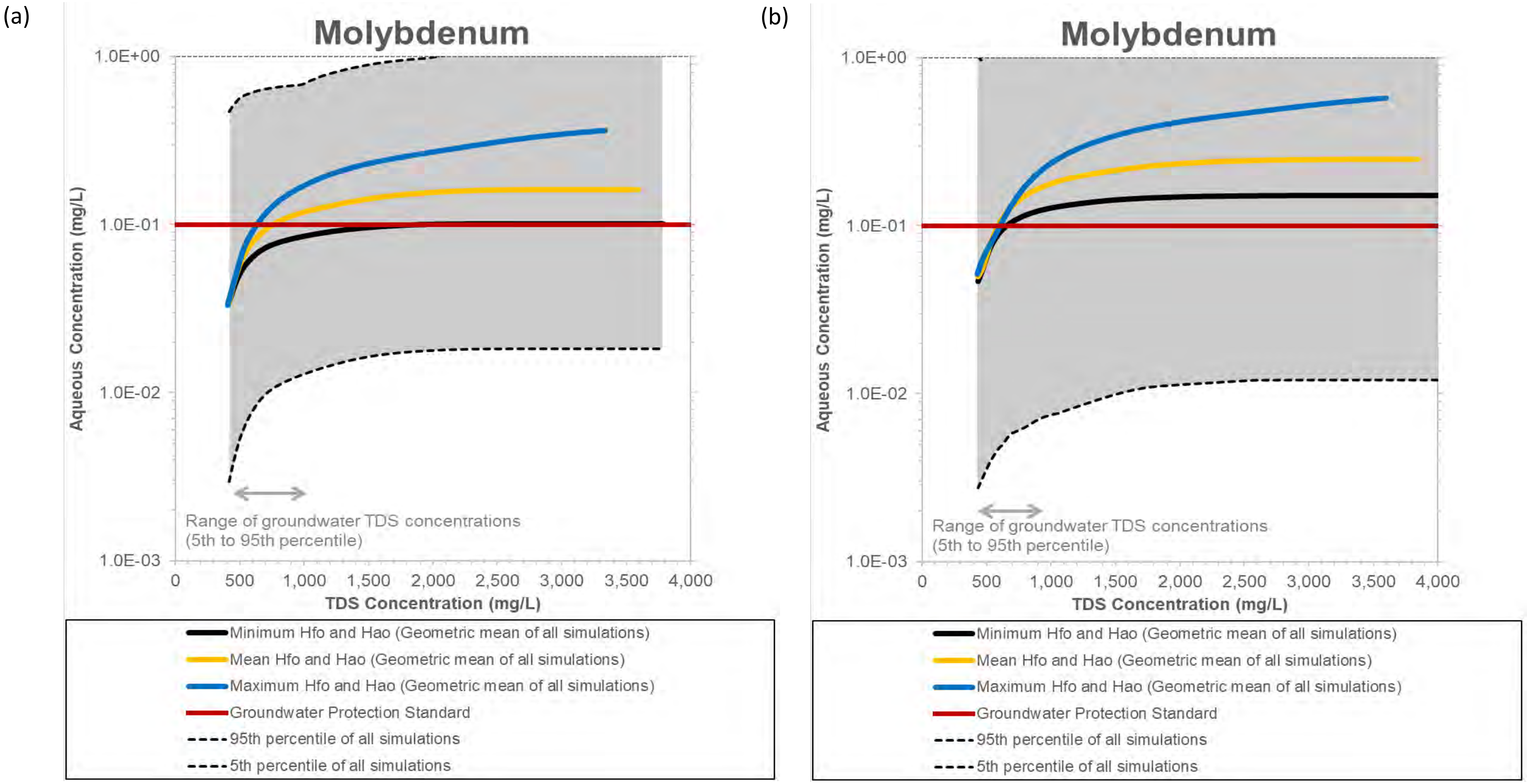

CLIENT
AMEREN MISSOURI
LCPA SURFACE IMPOUNDMENT, LABADIE ENERGY CENTER

PROJECT
TIER I – TIER III MNA GEOCHEMICAL
EVALUATION

CONSULTANT
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MEMBER OF WSP

TITLE
Stability of Adsorbed Molybdenum in Response to TDS
in (a) Compliance Monitoring and (b) Corrective Action Wells

PROJECT NO.	PHASE	REV.	FIGURE
153140603	0001D	A	16

APPENDIX A

Mineralogical Analysis Laboratory Report

Quantitative X-Ray Diffraction by Rietveld Refinement

Report Prepared for: *Golder Associates USA*

Project Number/ LIMS No. *18502-03/ MI7019-MAY21*

Sample Receipt: *May 28, 2021*

Sample Analysis: *June 9, 2021*

Reporting Date: *July 15, 2021*

Instrument: Panalytical X'pert Pro Diffractometer

Test Conditions: Co radiation, 40 kV, 45 mA
Regular Scanning: Step: 0.033°, Step time:0.15s, 2θ range: 6-70°

Interpretations : PDF2/PDF4 powder diffraction databases issued by the International Center for Diffraction Data (ICDD). DiffracPlus Eva and Topas software.

Detection Limit : 0.5-2%. Strongly dependent on crystallinity.

Contents:
1) Method Summary
2) Quantitative XRD Results
3) XRD Pattern(s)

BEaton

Ben Eaton, B.Sc.
Junior Mineralogist

Huyun Zhou

Huyun Zhou, Ph.D., P.Geo.
Senior Mineralogist

SGS Minerals
a division of SGS Canada Inc.
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Tel: (604) 638-2349 Fax: (604) 444-5486 www.sgs.com www.sgs.com/met
Member of the SGS Group (SGS SA)

Method Summary

Mineral Identification and Interpretation:

Mineral identification and interpretation involves matching the diffraction pattern of an unknown material to patterns of single-phase reference materials. The reference patterns are compiled by the Joint Committee on Powder Diffraction Standards - International Center for Diffraction Data (JCPDS-ICDD) database and released on software as Powder Diffraction Files (PDF).

Interpretations do not reflect the presence of non-crystalline and/or amorphous compounds, except when internal standards have been added by request. Mineral proportions may be strongly influenced by crystallinity, crystal structure and preferred orientations. Mineral or compound identification and quantitative analysis results should be accompanied by supporting chemical assay data or other additional tests.

Quantitative Rietveld Analysis:

Quantitative Rietveld Analysis is performed by using Topas 4.2 (Bruker AXS), a graphics based profile analysis program built around a non-linear least squares fitting system, to determine the amount of different phases present in a multicomponent sample. Whole pattern analyses are predicated by the fact that the X-ray diffraction pattern is a total sum of both instrumental and specimen factors. Unlike other peak intensity-based methods, the Rietveld method uses a least squares approach to refine a theoretical line profile until it matches the obtained experimental patterns.

Rietveld refinement is completed with a set of minerals specifically identified for the sample. Zero values indicate that the mineral was included in the refinement calculations, but the calculated concentration was less than 0.05wt%. Minerals not identified by the analyst are not included in refinement calculations for specific samples and are indicated with a dash.

Summary of Rietveld Quantitative Analysis X-Ray Diffraction Results

Mineral/Compound	L-BH-03S MAY7019-01 (wt %)	L-BH-03M MAY7019-02 (wt %)	L-BH-03D MAY7019-03 (wt %)	L-BH-02S MAY7019-04 (wt %)	L-BH-02M MAY7019-05 (wt %)	L-BH-02D MAY7019-06 (wt %)	L-BH-01S MAY7019-07 (wt %)	L-BH-01M MAY7019-08 (wt %)	L-BH-01D MAY7019-09 (wt %)
Actinolite	-	-	-	-	0.2	-	-	-	-
Albite	18.9	18.9	16.8	17.6	16.4	16.0	17.7	16.8	21.0
Chlorite	1.0	0.1	-	1.0	2.3	1.3	1.5	1.2	0.9
Calcite	1.2								
Diopside	-	2.2	2.1	2.3	2.2	2.2	-	-	-
Dolomite	0.4	1.2	-	0.3	3.1	0.5	0.5	0.5	0.5
Heulandite	-	-	-	-	1.8	-	-	-	-
Hornblende	-	1.4	-	-	-	1.0	-	0.6	0.7
Kutnohorite	-	-	-	-	0.3	-	2.1	-	-
Magnetite	-	-	-	-	0.3	-	-	-	-
Microcline	11.0	13.7	13.5	12.3	7.5	7.8	8.5	12.5	19.6
Montmorillonite	-	-	-	-	6.5	-	-	-	-
Muscovite	4.8	2.8	3.1	3.9	10.1	4.6	5.8	6.3	4.3
Quartz	62.6	59.7	64.5	62.6	49.1	66.2	63.9	62.1	53.0
Rhodochrosite	-	-	-	-	0.2	0.4	-	-	-
TOTAL	100	100	100	100	100	100	100	100	100

Zero values indicate that the mineral was included in the refinement, but the calculated concentration is below a measurable value.

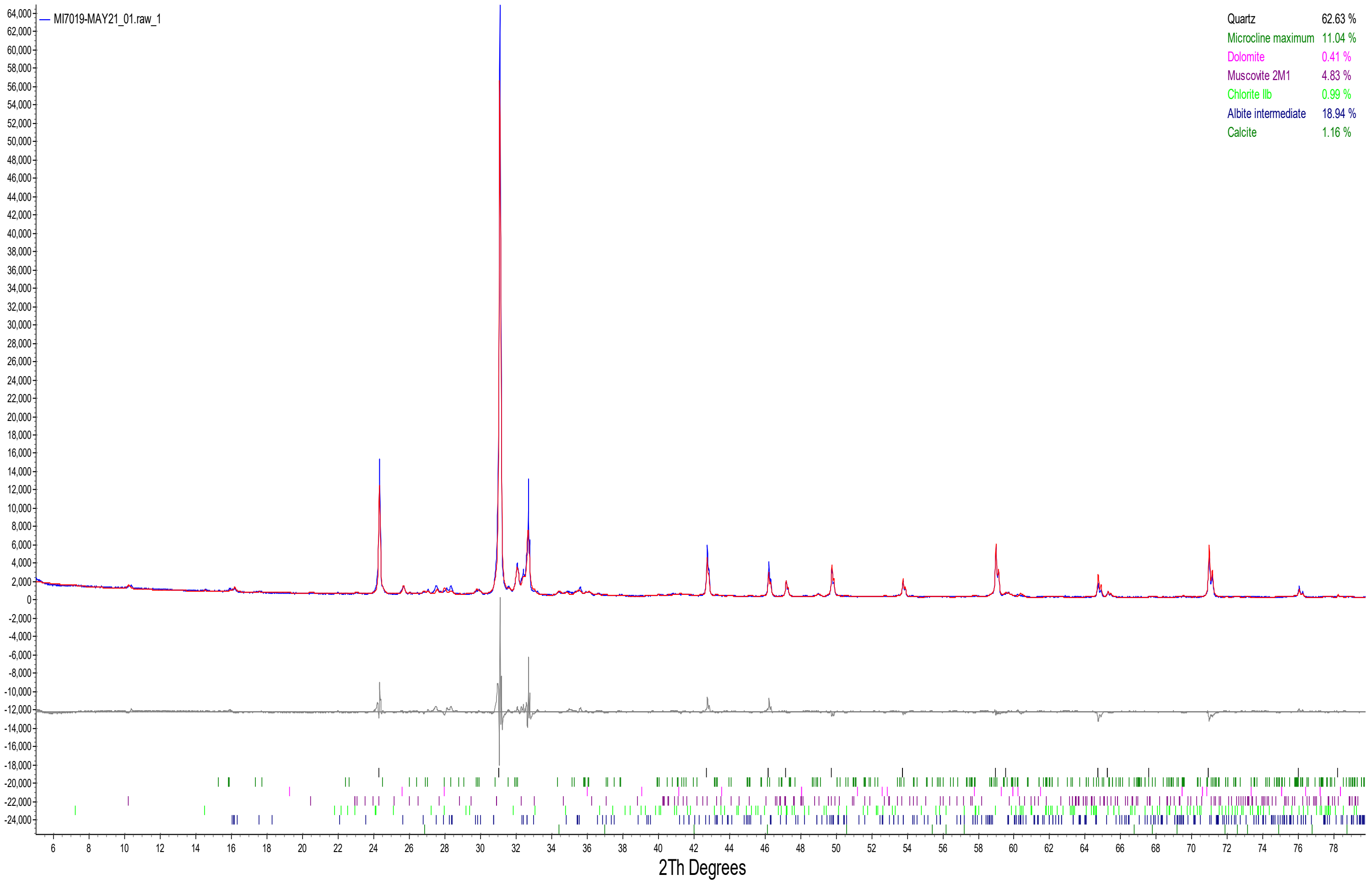
Dashes indicate that the mineral was not identified by the analyst and not included in the refinement calculation for the sample.

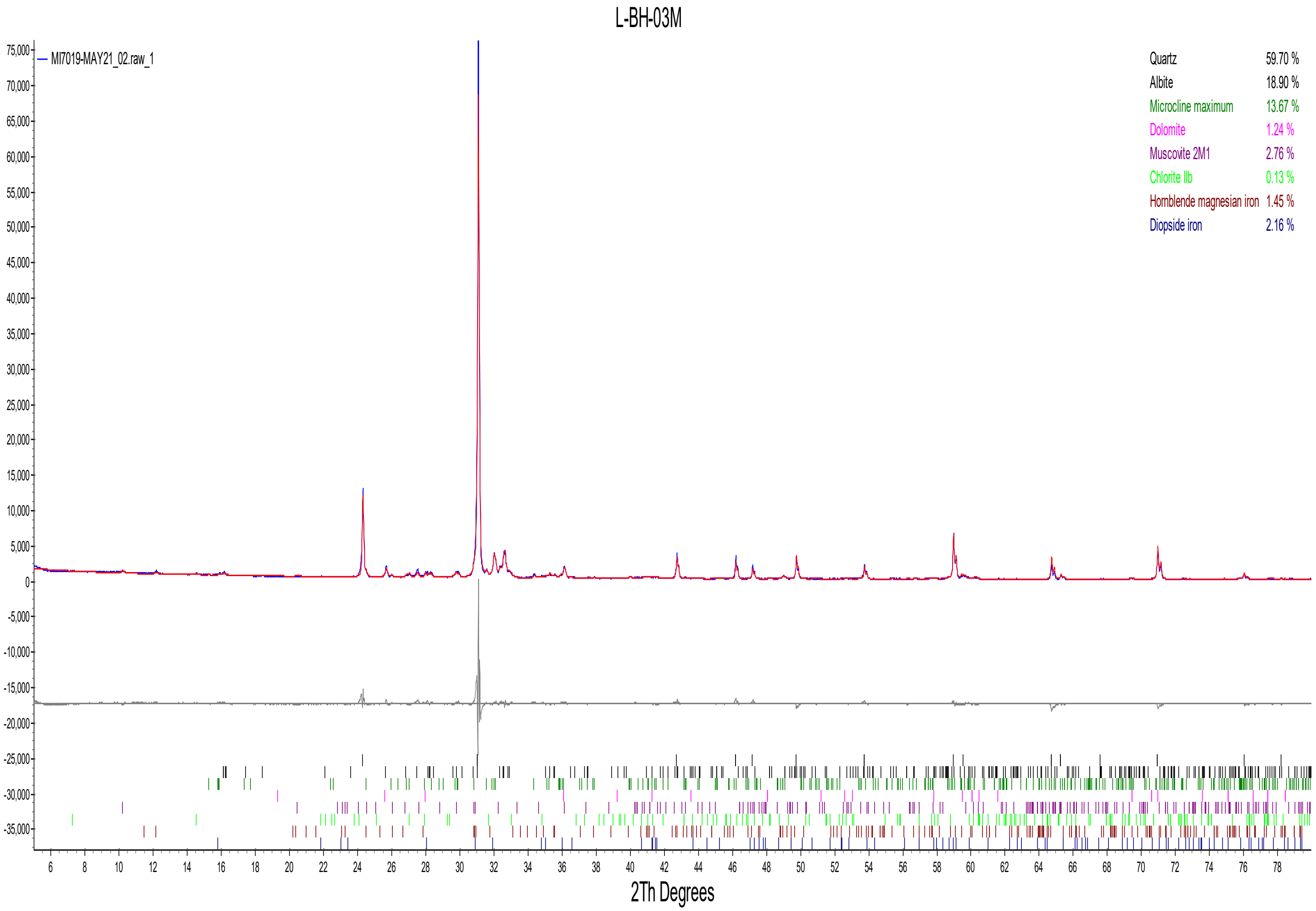
The weight percent quantities indicated have been normalized to a sum of 100%. The quantity of amorphous material has not been determined.

Mineral/Compound	Formula
Actinolite	$Ca_2(Mg,Fe)_5Si_8O_{22}(OH)_2$
Albite	$NaAlSi_3O_8$
Calcite	$CaCO_3$
Chlorite	$(Fe,(Mg,Mn)_5,Al)(Si_3Al)O_{10}(OH)_8$
Diopside	$CaMgSi_2O_6$
Dolomite	$CaMg(CO_3)_2$
Heulandite	$CaAl_2Si_7O_{18}\cdot 6H_2O$
Hornblende	$(Ca,Na)_2^{-}3(Mg,Fe,Al)_5Si_6(Si,Al)_2O_{22}(OH)_2$
Kutnohorite	$CaMn(CO_3)_2$
Magnetite	$CaMgSi_2O_6$
Microcline	$KAlSi_3O_8$
Montmorillonite	$(Na,Ca)_{0.3}(Al,Mg)_2Si_4O_{10}(OH)_2\cdot nH_2O$
Muscovite	$KAl_2(AlSi_3O_{10})(OH)_2$
Quartz	SiO_2
Rhodochrosite	$MnCO_3$

Golder Associates USA
18502-03/MI7019-MAY21
7/15/2021

L-BH-03S




L-BH-03M
MI7019-MAY21_02.raw_1
Quartz 59.70 %
Albite 18.90 %
Microcline maximum 13.67 %
Dolomite 1.24 %
Muscovite 2M1 2.76 %
Chlorite IIb 0.13 %
Hornblende magnesian iron 1.45 %
Diopside iron 2.16 %
75,000
70,000
65,000
60,000
55,000
50,000
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
-5,000
-10,000
-15,000
-20,000
-25,000
-30,000
-35,000
6
8
10
12
14
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38
40
42
44
46
48
50
52
54
56
58
60
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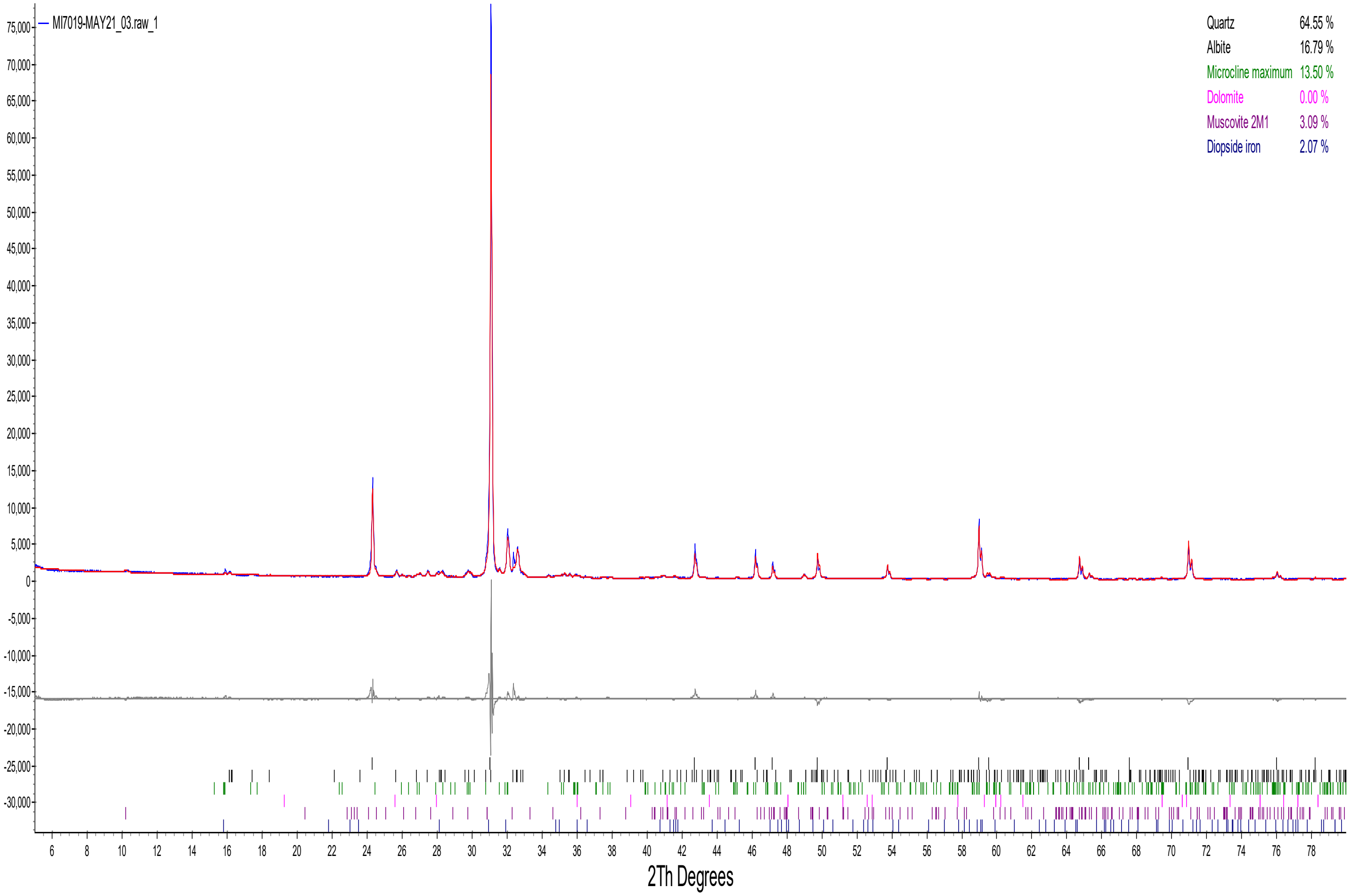
64
66
68
70
72
74
76
78
2Th Degrees

L-BH-03D


MI7019-MAY21_03.raw_1
Quartz 64.55 %
Albite 16.79 %
Microcline maximum 13.50 %
Dolomite 0.00 %
Muscovite 2M1 3.09 %
Diopside iron 2.07 %
75,000
70,000
65,000
60,000
55,000
50,000
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
-5,000
-10,000
-15,000
-20,000
-25,000
-30,000
6
8
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28
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32
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46
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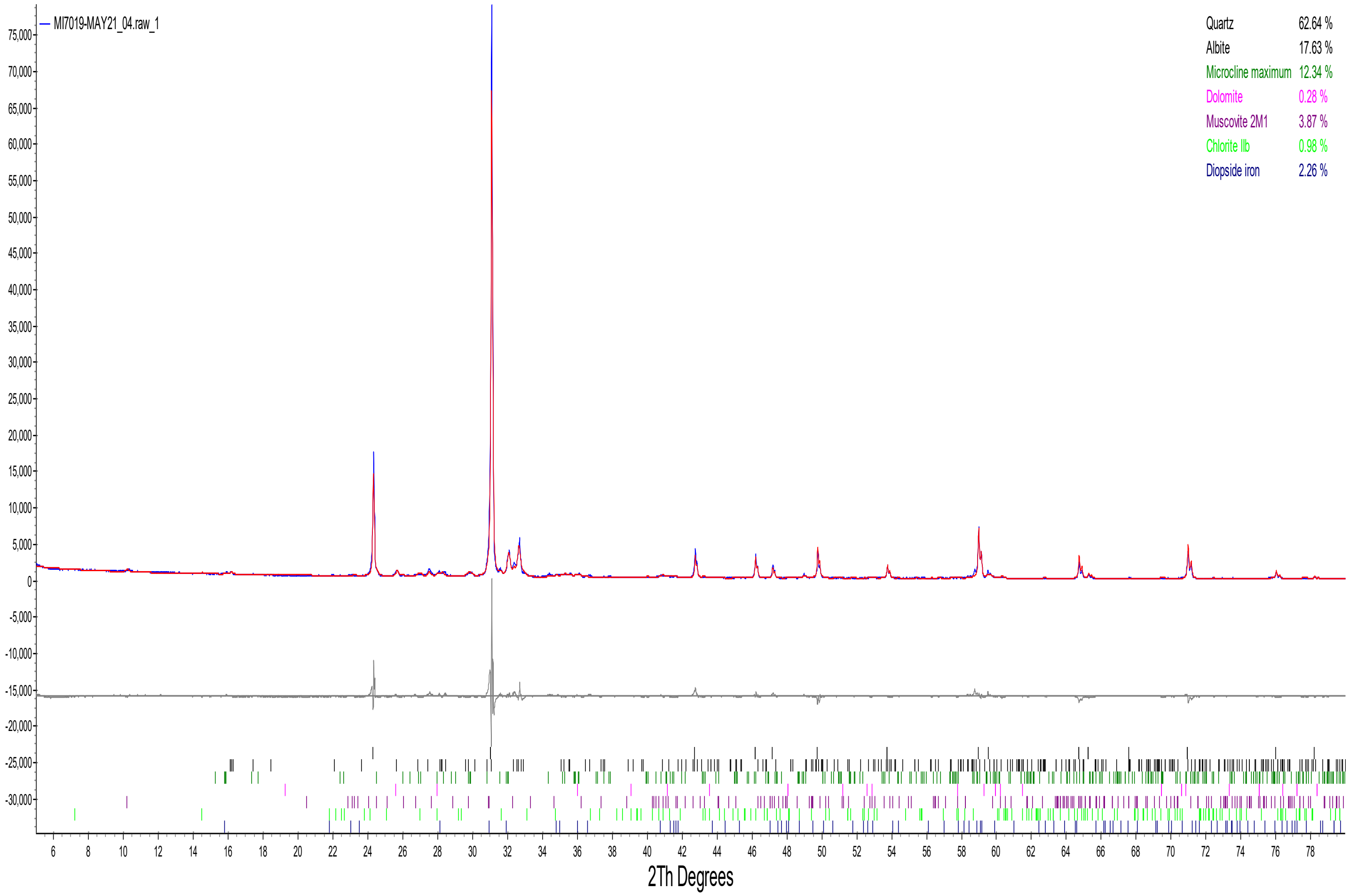
58
60
62
64
66
68
70
72
74
76
78
2Th Degrees

L-BH-02S


MI7019-MAY21_04.raw_1
Quartz 62.64 %
Albite 17.63 %
Microcline maximum 12.34 %
Dolomite 0.28 %
Muscovite 2M1 3.87 %
Chlorite IIb 0.98 %
Diopside iron 2.26 %
75,000
70,000
65,000
60,000
55,000
50,000
45,000
40,000
35,000
30,000
25,000
20,000
15,000
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-5,000
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-20,000
-25,000
-30,000
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38
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74
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2Th Degrees

Golder Associates USA
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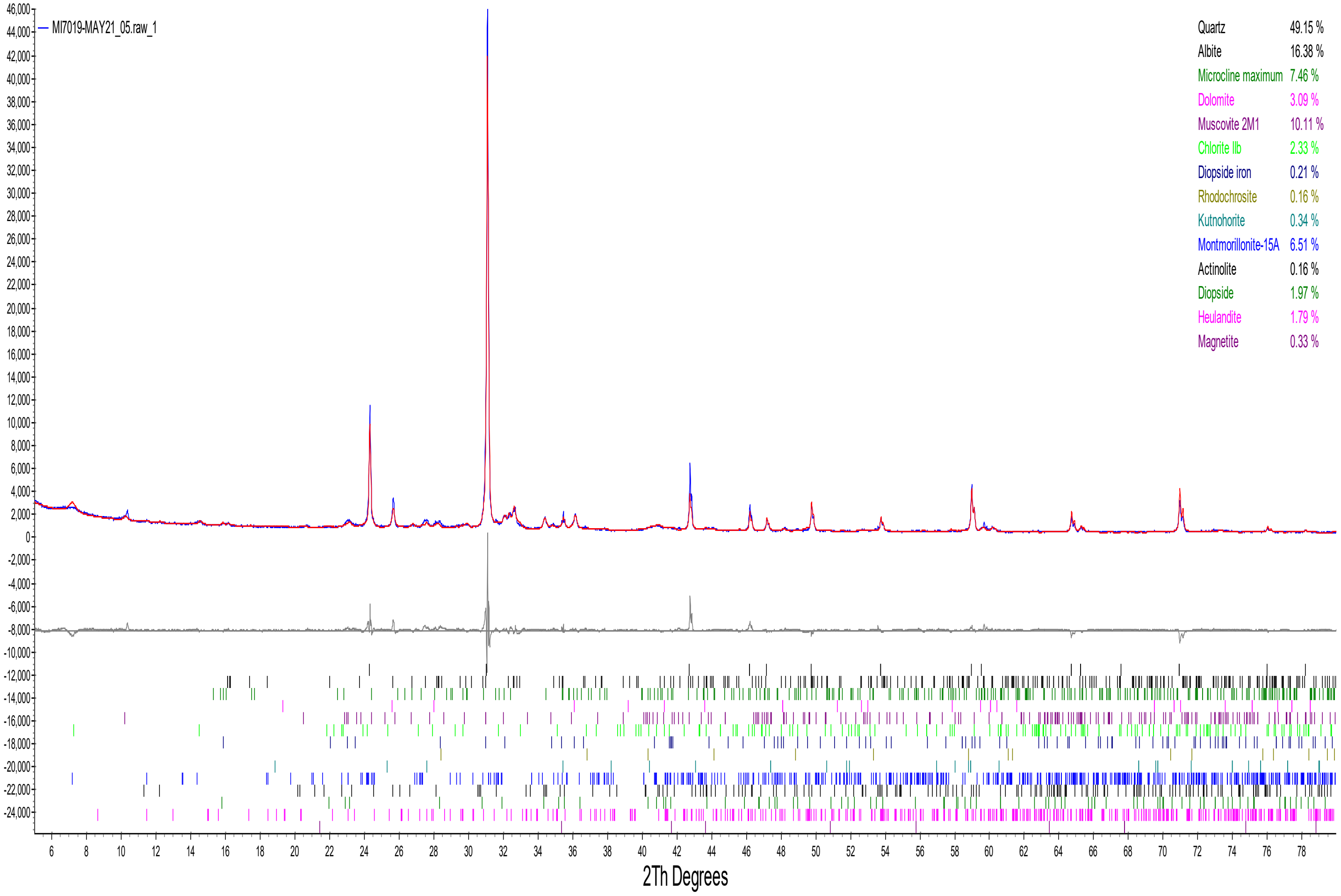
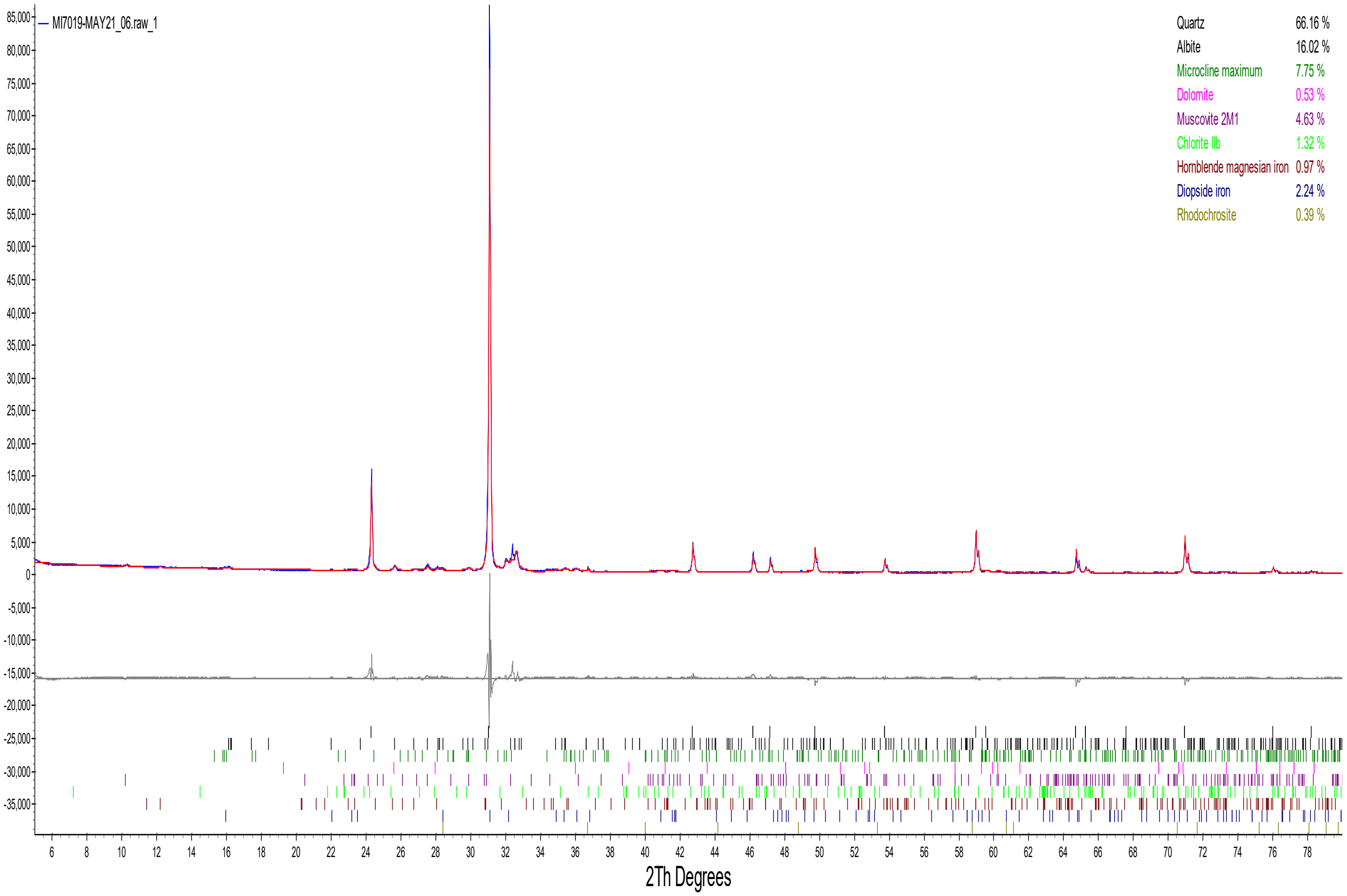
L-BH-02M



L-BH-02D


MI7019-MAY21_06.raw_1
Quartz 66.16 %
Albite 16.02 %
Microcline maximum 7.75 %
Dolomite 0.53 %
Muscovite 2M1 4.63 %
Chlorite IIb 1.32 %
Hornblende magnesian iron 0.97 %
Diopside iron 2.24 %
Rhodochrosite 0.39 %
85,000
80,000
75,000
70,000
65,000
60,000
55,000
50,000
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
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-5,000
-10,000
-15,000
-20,000
-25,000
-30,000
-35,000
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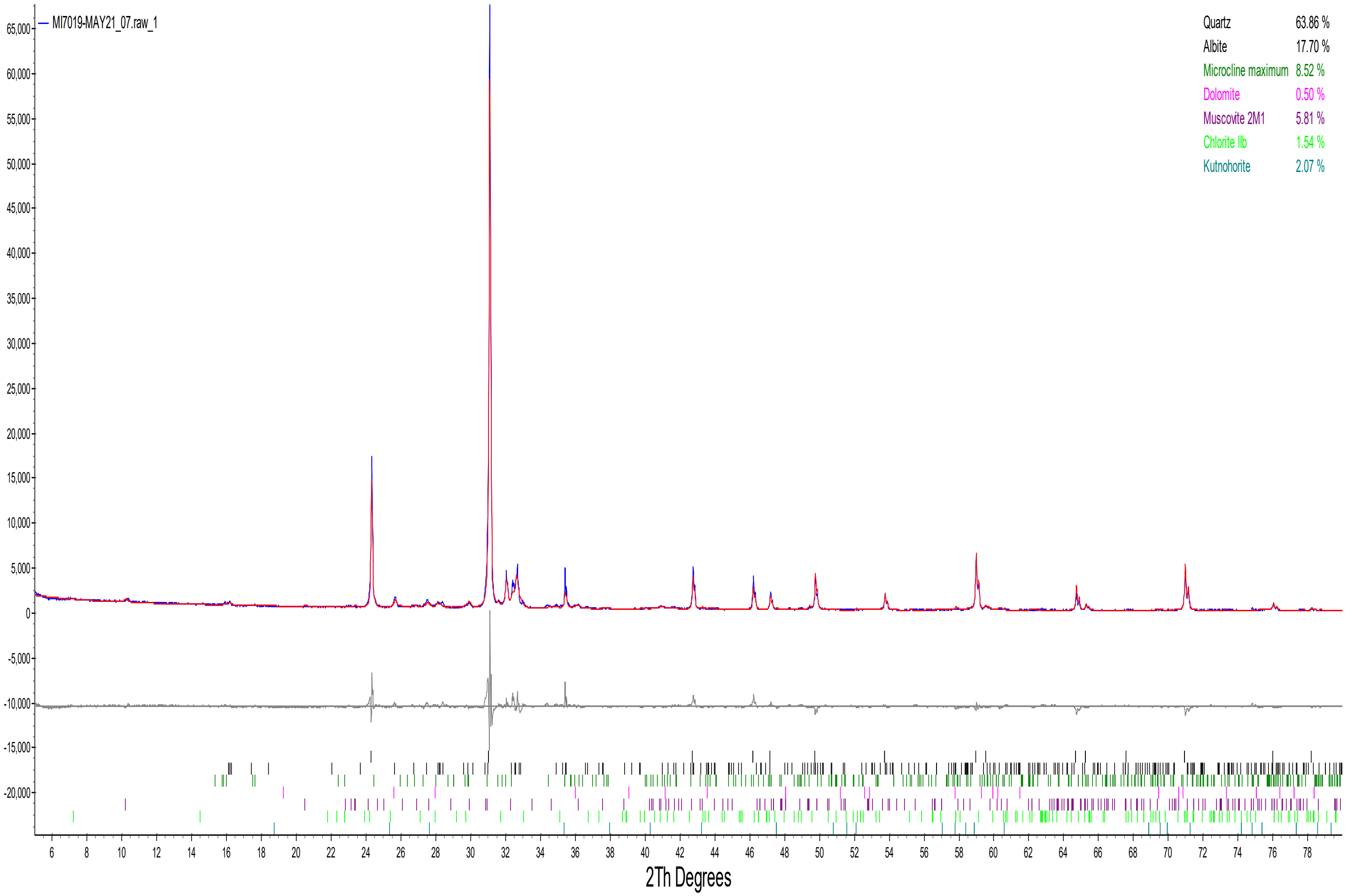
72
74
76
78
2Th Degrees

L-BH-01S


MI7019-MAY21_07.raw_1
Quartz 63.86 %
Albite 17.70 %
Microcline maximum 8.52 %
Dolomite 0.50 %
Muscovite 2M1 5.81 %
Chlorite IIb 1.54 %
Kutnohorite 2.07 %
65,000
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-20,000
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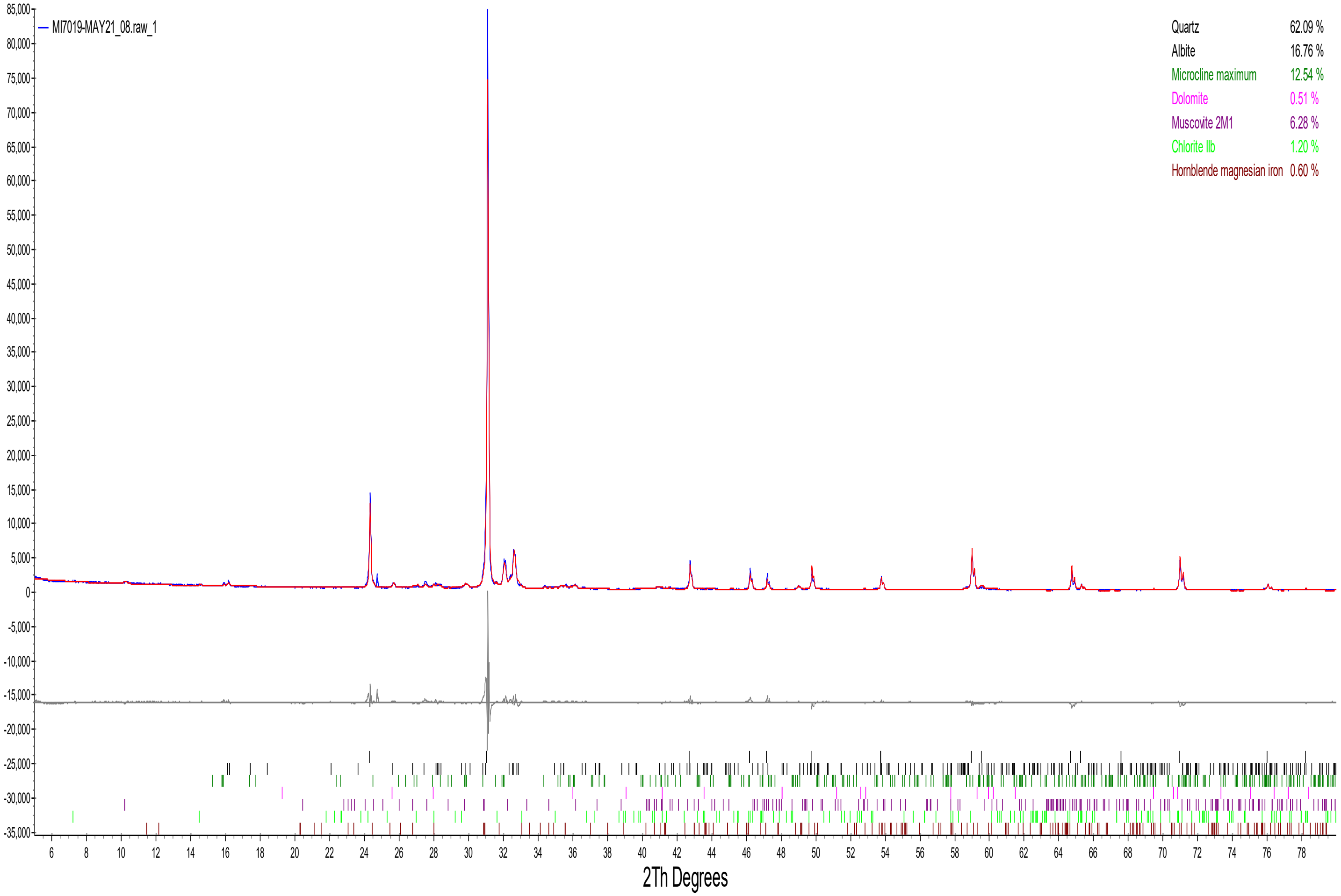
2Th Degrees

L-BH-01M


MI7019-MAY21_08.raw_1
Quartz 62.09 %
Albite 16.76 %
Microcline maximum 12.54 %
Dolomite 0.51 %
Muscovite 2M1 6.28 %
Chlorite llb 1.20 %
Hornblende magnesian iron 0.60 %
85,000
80,000
75,000
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60,000
55,000
50,000
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35,000
30,000
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20,000
15,000
10,000
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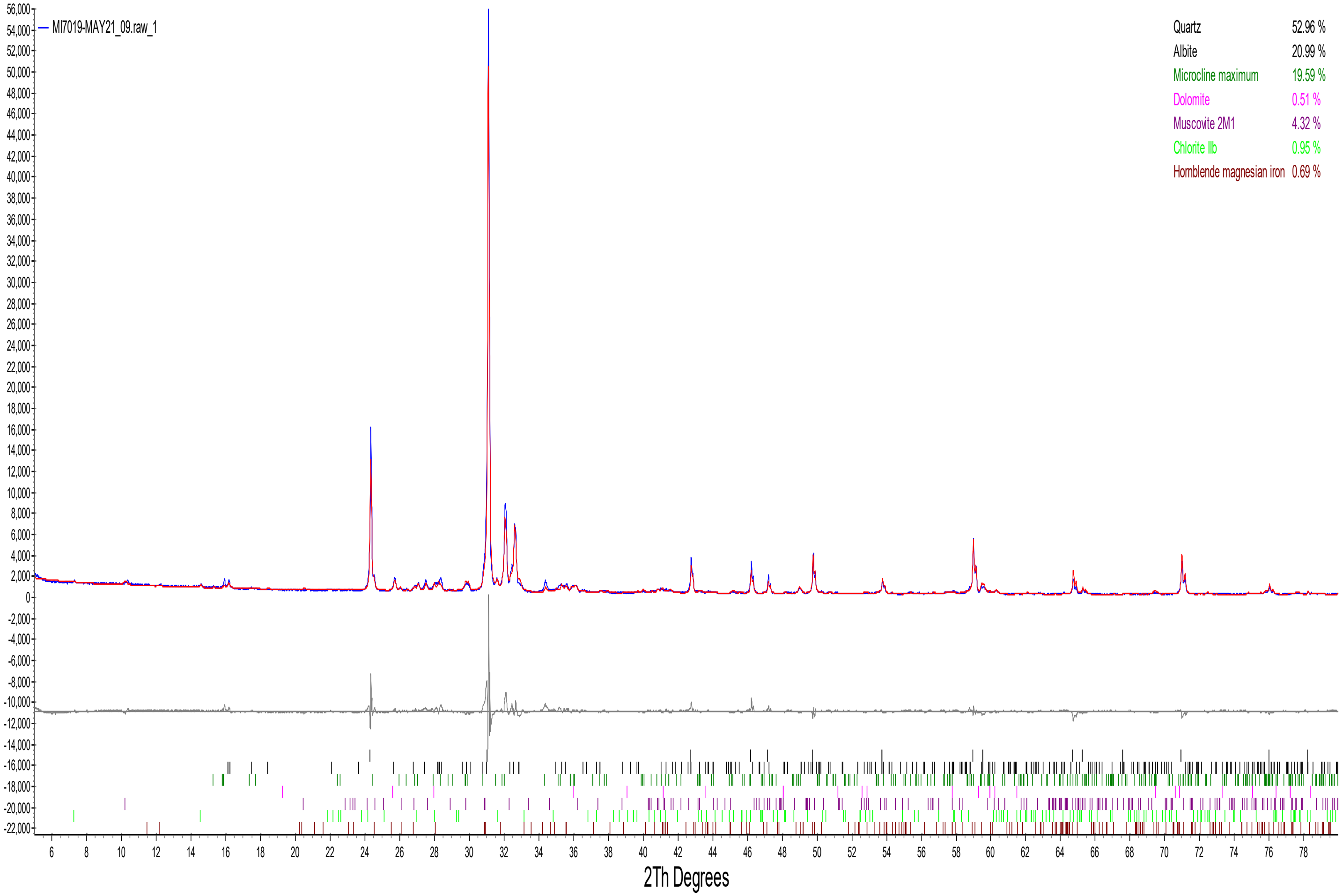
2Th Degrees

Golder Associates USA
18502-03/MI7019-MAY21
7/15/2021

L-BH-01D



APPENDIX B

Sequential Extraction Laboratory Report

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ANALYTICAL REPORT

Eurofins TestAmerica, Knoxville
5815 Middlebrook Pike
Knoxville, TN 37921
Tel: (865)291-3000

Laboratory Job ID: 140-23290-1
Client Project/Site: Labadie Energy Center - Missouri

For:
Golder Associates Inc.
13515 Barrett Parkway Drive
Suite 260
Ballwin, Missouri 63021

Attn: Jeffrey Ingram

Ryan Henry

Authorized for release by:
7/30/2021 10:20:24 AM

Ryan Henry, Project Manager I
(865)291-3000
williamr.henry@eurofinset.com

This report has been electronically signed and authorized by the signatory. Electronic signature is intended to be the legally binding equivalent of a traditionally handwritten signature.

Results relate only to the items tested and the sample(s) as received by the laboratory.

Table of Contents

Definitions/Glossary

Qualifiers

Metals

Qualifier	Qualifier Description
4	MS, MSD: The analyte present in the original sample is greater than 4 times the matrix spike concentration; therefore, control limits are not applicable.
B	Compound was found in the blank and sample.
J	Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
¤	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
CFL	Contains Free Liquid
CFU	Colony Forming Unit
CNF	Contains No Free Liquid
DER	Duplicate Error Ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL	Detection Limit (DoD/DOE)
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision Level Concentration (Radiochemistry)
EDL	Estimated Detection Limit (Dioxin)
LOD	Limit of Detection (DoD/DOE)
LOQ	Limit of Quantitation (DoD/DOE)
MCL	EPA recommended "Maximum Contaminant Level"
MDA	Minimum Detectable Activity (Radiochemistry)
MDC	Minimum Detectable Concentration (Radiochemistry)
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
MPN	Most Probable Number
MQL	Method Quantitation Limit
NC	Not Calculated
ND	Not Detected at the reporting limit (or MDL or EDL if shown)
NEG	Negative / Absent
POS	Positive / Present
PQL	Practical Quantitation Limit
PRES	Presumptive
QC	Quality Control
RER	Relative Error Ratio (Radiochemistry)
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)
TNTC	Too Numerous To Count

Job ID: 140-23290-1

Laboratory: Eurofins TestAmerica, Knoxville

Narrative

Job Narrative
140-23290-1

Receipt
The samples were received on 5/28/2021 at 10:00am and arrived in good condition, and where required, properly preserved and on ice. The temperature of the cooler at receipt was 0.5º C.

Metals
7 Step Sequential Extraction Procedure

These soil samples were prepared and analyzed using Eurofins TestAmerica Knoxville standard operating procedure KNOX-MT-0008, “7 Step Sequential Extraction Procedure”. SW-846 Method 6010B as incorporated in Eurofins TestAmerica Knoxville standard operating procedure KNOX-MT-0007 was used to perform the final instrument analyses.

An aliquot of each sample was sequentially extracted using the steps listed below:

- Step 1 - Exchangeable Fraction: A 5 gram aliquot of sample was extracted with 25 mL of 1M magnesium sulfate (MgSO4), centrifuged and filtered. 5 mL of the resulting leachate was digested using method 3010A and analyzed by method 6010B. Results are reported in mg/kg on a dry weight basis.
- Step 2 - Carbonate Fraction: The sample residue from step 1 was extracted with 25 mL of 1M sodium acetate/acetic acid (NaOAc/HOAc) at pH 5, centrifuged and filtered. 5 mL of the resulting leachate was digested using method 3010A and analyzed by method 6010B. Results are reported in mg/kg on a dry weight basis.
- Step 3 - Non-crystalline Materials Fraction: The sample residue from step 2 was extracted with 25 mL of 0.2M ammonium oxalate (pH 3), centrifuged and filtered. 5 mL of the resulting leachate was digested using method 3010A and analyzed by method 6010B. Results are reported in mg/kg on a dry weight basis.
- Step 4 - Metal Hydroxide Fraction: The sample residue from step 3 was extracted with 25 mL of 1M hydroxylamine hydrochloride solution in 25% v/v acetic acid, centrifuged and filtered. 5 mL of the resulting leachate was digested using method 3010A and analyzed by method 6010B. Results are reported in mg/kg on a dry weight basis.
- Step 5 - Organic-bound Fraction: The sample residue from step 4 was extracted three times with 25 mL of 5% sodium hypochlorite (NaClO) at pH 9.5, centrifuged and filtered. The resulting leachates were combined and 5 mL were digested using method 3010A and analyzed by method 6010B. Results are reported in mg/kg on a dry weight basis.
- Step 6 - Acid/Sulfide Fraction: The sample residue from step 5 was extracted with 25 mL of a 3:1:2 v/v solution of HCl-HNO3-H2O, centrifuged and filtered. 5 mL of the resulting leachate was diluted to 50 mL with reagent water and analyzed by method 6010B. Results are reported in mg/kg on a dry weight basis.
- Step 7 - Residual Fraction: A 1.0 g aliquot of the sample residue from step 6 was digested using HF, HNO3, HCl and H3BO3. The digestate was analyzed by ICP using method 6010B. Results are reported in mg/kg on a dry weight basis.

In addition, a 1.0 g aliquot of the original sample was digested using HF, HNO3, HCl and H3BO3. The digestate was analyzed by ICP using method 6010B. Total metal results are reported in mg/kg on a dry weight basis.

Results were calculated using the following equation:

$$\text{Result, µg/g or mg/Kg, dry weight} = (C \times V \times V1 \times D) / (W \times S \times V2)$$

Where:
C = Concentration from instrument readout, µg/mL
V = Final volume of digestate, mL
D = Instrument dilution factor
V1 = Total volume of leachate, mL
V2 = Volume of leachate digested, mL
W = Wet weight of sample, g
S = Percent solids/100

A method blank, laboratory control sample and laboratory control sample duplicate were prepared and analyzed with each SEP step in

Job ID: 140-23290-1 (Continued)

Laboratory: Eurofins TestAmerica, Knoxville (Continued)

order to provide information about both the presence of elements of interest in the extraction solutions, and the recovery of elements of interest from the extraction solutions. Results outside of laboratory QC limits do not reflect out of control performance, but rather the effect of the extraction solution upon the analyte.

A laboratory sample duplicate was prepared and analyzed with each batch of samples in order to provide information regarding the reproducibility of the procedure.

SEP Report Notes:

The final report lists the results for each step, the result for the total digestion of the sample, and a sum of the results of steps 1 through 7 by element.

Magnesium was not reported for step 1 because the extraction solution for this step (magnesium sulfate) contains high levels of magnesium. Sodium was not reported for steps 2 and 5 since the extraction solutions for these steps contain high levels of sodium. The sum of steps 1 through 7 is much higher than the total result for sodium and magnesium due to the magnesium and sodium introduced by the extraction solutions.

The digestates for steps 1, 2 and 5 were analyzed at a dilution due to instrument problems caused by the high solids content of the digestates. The reporting limits were adjusted accordingly.

Method 6010B: The following samples were diluted due to the nature of the sample matrix: L-BH-03S (140-23290-1), L-BH-03M (140-23290-2), L-BH-03D (140-23290-3), L-BH-02S (140-23290-4), L-BH-02M (140-23290-5), L-BH-02D (140-23290-6), L-BH-01S (140-23290-7), L-BH-01M (140-23290-8) and L-BH-01D (140-23290-9). Elevated reporting limits (RLs) are provided for aluminum and calcium.

Method 6010B: The following sample was diluted due to the presence of titanium which interferes with Cobalt: L-BH-02M (140-23290-5). Elevated reporting limits (RLs) are provided.

Method 6010B: The following samples were diluted to bring the concentration of target analyte, potassium, within the calibration range: L-BH-03S (140-23290-1), L-BH-03M (140-23290-2), L-BH-03D (140-23290-3), L-BH-02S (140-23290-4), L-BH-02M (140-23290-5), L-BH-02D (140-23290-6), L-BH-01S (140-23290-7), L-BH-01M (140-23290-8) and L-BH-01D (140-23290-9). Elevated reporting limits (RLs) are provided.

Method 6010B: The following samples were diluted to bring the concentration of target analyte, sodium, within the calibration range: L-BH-03M (140-23290-2), L-BH-02S (140-23290-4) and L-BH-01D (140-23290-9). Elevated reporting limits (RLs) are provided.

Method 6010B SEP: The following samples were diluted to bring the concentration of target analyte, sodium, within the calibration range: L-BH-03S (140-23290-1), L-BH-03M (140-23290-2), L-BH-03D (140-23290-3), L-BH-02S (140-23290-4), L-BH-02M (140-23290-5), L-BH-02D (140-23290-6), L-BH-01S (140-23290-7), L-BH-01M (140-23290-8) and L-BH-01D (140-23290-9). Elevated reporting limits (RLs) are provided.

Method 6010B SEP: The following samples were diluted to bring the concentration of target analyte, potassium, within the calibration range: L-BH-03S (140-23290-1), L-BH-03M (140-23290-2), L-BH-03D (140-23290-3), L-BH-02S (140-23290-4), L-BH-02M (140-23290-5), L-BH-02D (140-23290-6), L-BH-01S (140-23290-7), L-BH-01M (140-23290-8) and L-BH-01D (140-23290-9). Elevated reporting limits (RLs) are provided.

Method 6010B SEP: The following sample was diluted to bring the concentration of target analyte, sodium, within the calibration range: L-BH-01D (140-23290-9). Elevated reporting limits (RLs) are provided.

Method 6010B SEP: The following samples were diluted due to the presence of silicon which interferes with Arsenic and Selenium: L-BH-03M (140-23290-2), L-BH-03D (140-23290-3), L-BH-02D (140-23290-6) and L-BH-01M (140-23290-8). Elevated reporting limits (RLs) are provided.

Job ID: 140-23290-1 (Continued)

Laboratory: Eurofins TestAmerica, Knoxville (Continued)

Method 6010B SEP: The following sample was diluted due to the presence of titanium which interferes with Cobalt: L-BH-02M (140-23290-5). Elevated reporting limits (RLs) are provided.

Method 6010B SEP: The following samples were diluted due to the nature of the sample matrix: L-BH-03S (140-23290-1), L-BH-03M (140-23290-2), L-BH-03D (140-23290-3), L-BH-02S (140-23290-4), L-BH-02M (140-23290-5), L-BH-02D (140-23290-6), L-BH-01S (140-23290-7), L-BH-01M (140-23290-8) and L-BH-01D (140-23290-9). Elevated reporting limits (RLs) are provided for aluminum and calcium.

Method 6010B SEP: The following samples were diluted to bring the concentration of target analyte, potassium, within the calibration range: L-BH-03M (140-23290-2), L-BH-03D (140-23290-3), L-BH-02M (140-23290-5), L-BH-02D (140-23290-6) and L-BH-01M (140-23290-8). Elevated reporting limits (RLs) are provided.

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

General Chemistry
No analytical or quality issues were noted, other than those described in the Definitions/Glossary page.

Sample Summary

Client: Golder Associates Inc.
Project/Site: Labadie Energy Center - Missouri

Job ID: 140-23290-1

Lab Sample ID	Client Sample ID	Matrix	Collected	Received
140-23290-1	L-BH-03S	Solid	05/24/21 08:45	05/28/21 10:00
140-23290-2	L-BH-03M	Solid	05/24/21 10:00	05/28/21 10:00
140-23290-3	L-BH-03D	Solid	05/24/21 11:45	05/28/21 10:00
140-23290-4	L-BH-02S	Solid	05/25/21 09:00	05/28/21 10:00
140-23290-5	L-BH-02M	Solid	05/25/21 10:25	05/28/21 10:00
140-23290-6	L-BH-02D	Solid	05/25/21 10:25	05/28/21 10:00
140-23290-7	L-BH-01S	Solid	05/26/21 08:10	05/28/21 10:00
140-23290-8	L-BH-01M	Solid	05/26/21 09:25	05/28/21 10:00
140-23290-9	L-BH-01D	Solid	05/26/21 11:05	05/28/21 10:00

Client Sample Results

Client: Golder Associates Inc. Job ID: 140-23290-1
Project/Site: Labadie Energy Center - Missouri

Client Sample ID: L-BH-03S Lab Sample ID: 140-23290-1

Date Collected: 05/24/21 08:45 **Matrix: Solid**
Date Received: 05/28/21 10:00 **Percent Solids: 80.7**

Method: 6010B SEP - SEP Metals (ICP) - Step 1

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	ND		50	7.9	mg/Kg	☼	07/13/21 08:00	07/21/21 12:47	4
Antimony	ND		15	1.4	mg/Kg	☼	07/13/21 08:00	07/21/21 12:47	4
Arsenic	ND		2.5	0.64	mg/Kg	☼	07/13/21 08:00	07/21/21 12:47	4
Calcium	**430**	**J B**	1200	9.4	mg/Kg	☼	07/13/21 08:00	07/21/21 12:47	4
Cobalt	ND		12	0.22	mg/Kg	☼	07/13/21 08:00	07/21/21 12:47	4
Iron	ND		25	14	mg/Kg	☼	07/13/21 08:00	07/21/21 12:47	4
Lithium	ND		12	0.74	mg/Kg	☼	07/13/21 08:00	07/21/21 12:47	4
Manganese	**0.67**	**J**	3.7	0.15	mg/Kg	☼	07/13/21 08:00	07/21/21 12:47	4
Molybdenum	ND		9.9	0.41	mg/Kg	☼	07/13/21 08:00	07/21/21 12:47	4
Potassium	ND		1200	130	mg/Kg	☼	07/13/21 08:00	07/21/21 12:47	4
Selenium	ND		2.5	0.84	mg/Kg	☼	07/13/21 08:00	07/21/21 12:47	4
Sodium	ND		1200	640	mg/Kg	☼	07/13/21 08:00	07/21/21 12:47	4

Method: 6010B SEP - SEP Metals (ICP) - Step 2

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	ND		37	5.9	mg/Kg	☼	07/13/21 08:00	07/21/21 14:36	3
Antimony	ND		11	1.0	mg/Kg	☼	07/13/21 08:00	07/21/21 14:36	3
Arsenic	ND		1.9	0.48	mg/Kg	☼	07/13/21 08:00	07/21/21 14:36	3
Calcium	**1400**		930	8.2	mg/Kg	☼	07/13/21 08:00	07/21/21 14:36	3
Cobalt	ND		9.3	0.23	mg/Kg	☼	07/13/21 08:00	07/21/21 14:36	3
Iron	**13**	**J**	19	11	mg/Kg	☼	07/13/21 08:00	07/21/21 14:36	3
Lithium	ND		9.3	0.56	mg/Kg	☼	07/13/21 08:00	07/21/21 14:36	3
Manganese	**16**		2.8	1.0	mg/Kg	☼	07/13/21 08:00	07/21/21 14:36	3
Molybdenum	ND		7.4	0.30	mg/Kg	☼	07/13/21 08:00	07/21/21 14:36	3
Potassium	**110**	**J**	930	97	mg/Kg	☼	07/13/21 08:00	07/21/21 14:36	3
Selenium	ND		1.9	0.63	mg/Kg	☼	07/13/21 08:00	07/21/21 14:36	3

Method: 6010B SEP - SEP Metals (ICP) - Step 3

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**31**		12	2.6	mg/Kg	☼	07/14/21 08:00	07/21/21 16:37	1
Antimony	ND		3.7	0.35	mg/Kg	☼	07/14/21 08:00	07/21/21 16:37	1
Arsenic	**0.44**	**J**	0.62	0.16	mg/Kg	☼	07/14/21 08:00	07/21/21 16:37	1
Calcium	**5.8**	**J**	310	1.9	mg/Kg	☼	07/14/21 08:00	07/21/21 16:37	1
Cobalt	**0.49**	**J**	3.1	0.056	mg/Kg	☼	07/14/21 08:00	07/21/21 16:37	1
Iron	**310**		6.2	3.6	mg/Kg	☼	07/14/21 08:00	07/21/21 16:37	1
Lithium	ND		3.1	0.19	mg/Kg	☼	07/14/21 08:00	07/21/21 16:37	1
Manganese	**8.5**	**B**	0.93	0.033	mg/Kg	☼	07/14/21 08:00	07/21/21 16:37	1
Molybdenum	ND		2.5	0.10	mg/Kg	☼	07/14/21 08:00	07/21/21 16:37	1
Potassium	ND		310	32	mg/Kg	☼	07/14/21 08:00	07/21/21 16:37	1
Selenium	ND		0.62	0.21	mg/Kg	☼	07/14/21 08:00	07/21/21 16:37	1
Sodium	**6700**		310	160	mg/Kg	☼	07/14/21 08:00	07/21/21 16:37	1

Method: 6010B SEP - SEP Metals (ICP) - Step 4

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**410**		12	2.0	mg/Kg	☼	07/15/21 08:00	07/22/21 14:03	1
Antimony	ND		3.7	0.56	mg/Kg	☼	07/15/21 08:00	07/22/21 14:03	1
Arsenic	**0.80**		0.62	0.27	mg/Kg	☼	07/15/21 08:00	07/22/21 14:03	1
Calcium	**1200**		310	2.7	mg/Kg	☼	07/15/21 08:00	07/22/21 14:03	1
Cobalt	**0.89**	**J**	3.1	0.066	mg/Kg	☼	07/15/21 08:00	07/22/21 14:03	1
Iron	**1600**		6.2	3.6	mg/Kg	☼	07/15/21 08:00	07/22/21 14:03	1

Client Sample Results

Client Sample ID: L-BH-03S

Lab Sample ID: 140-23290-1

Date Collected: 05/24/21 08:45
Matrix: Solid
Date Received: 05/28/21 10:00
Percent Solids: 80.7

Method: 6010B SEP - SEP Metals (ICP) - Step 4 (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Lithium	**0.75**	**J**	3.1	0.19	mg/Kg	☼	07/15/21 08:00	07/22/21 14:03	1
Manganese	**15**		0.93	0.16	mg/Kg	☼	07/15/21 08:00	07/22/21 14:03	1
Molybdenum	ND		2.5	0.10	mg/Kg	☼	07/15/21 08:00	07/22/21 14:03	1
Potassium	**43**	**J**	310	32	mg/Kg	☼	07/15/21 08:00	07/22/21 14:03	1
Selenium	ND		0.62	0.58	mg/Kg	☼	07/15/21 08:00	07/22/21 14:03	1
Sodium	**370**		310	160	mg/Kg	☼	07/15/21 08:00	07/22/21 14:03	1

Method: 6010B SEP - SEP Metals (ICP) - Step 5

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**100**	**J**	190	29	mg/Kg	☼	07/17/21 08:14	07/22/21 15:51	5
Antimony	ND		56	5.2	mg/Kg	☼	07/17/21 08:14	07/22/21 15:51	5
Arsenic	ND		9.3	2.4	mg/Kg	☼	07/17/21 08:14	07/22/21 15:51	5
Calcium	**360**	**J B**	4600	14	mg/Kg	☼	07/17/21 08:14	07/22/21 15:51	5
Cobalt	ND		46	0.74	mg/Kg	☼	07/17/21 08:14	07/22/21 15:51	5
Iron	ND		93	55	mg/Kg	☼	07/17/21 08:14	07/22/21 15:51	5
Lithium	ND		46	2.7	mg/Kg	☼	07/17/21 08:14	07/22/21 15:51	5
Manganese	ND		14	2.3	mg/Kg	☼	07/17/21 08:14	07/22/21 15:51	5
Molybdenum	ND		37	1.5	mg/Kg	☼	07/17/21 08:14	07/22/21 15:51	5
Potassium	**3200**	**J B**	4600	530	mg/Kg	☼	07/17/21 08:14	07/22/21 15:51	5
Selenium	ND		9.3	3.2	mg/Kg	☼	07/17/21 08:14	07/22/21 15:51	5

Method: 6010B SEP - SEP Metals (ICP) - Step 6

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**720**		12	2.0	mg/Kg	☼	07/16/21 12:00	07/22/21 17:39	1
Antimony	ND		3.7	0.35	mg/Kg	☼	07/16/21 12:00	07/22/21 17:39	1
Arsenic	**0.75**		0.62	0.19	mg/Kg	☼	07/16/21 12:00	07/22/21 17:39	1
Calcium	**160**	**J**	310	2.6	mg/Kg	☼	07/16/21 12:00	07/22/21 17:39	1
Cobalt	**0.56**	**J**	3.1	0.057	mg/Kg	☼	07/16/21 12:00	07/22/21 17:39	1
Iron	**2000**		6.2	3.6	mg/Kg	☼	07/16/21 12:00	07/22/21 17:39	1
Lithium	**0.84**	**J**	3.1	0.19	mg/Kg	☼	07/16/21 12:00	07/22/21 17:39	1
Manganese	**15**		0.93	0.31	mg/Kg	☼	07/16/21 12:00	07/22/21 17:39	1
Molybdenum	ND		2.5	0.12	mg/Kg	☼	07/16/21 12:00	07/22/21 17:39	1
Potassium	**230**	**J**	310	32	mg/Kg	☼	07/16/21 12:00	07/22/21 17:39	1
Selenium	ND		0.62	0.21	mg/Kg	☼	07/16/21 12:00	07/22/21 17:39	1
Sodium	**21000**		1500	810	mg/Kg	☼	07/16/21 12:00	07/22/21 19:14	5

Method: 6010B SEP - SEP Metals (ICP) - Step 7

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**43000**		120	20	mg/Kg	☼	07/20/21 08:00	07/23/21 13:57	10
Antimony	**0.46**	**J**	3.7	0.17	mg/Kg	☼	07/20/21 08:00	07/23/21 15:15	1
Arsenic	**1.8**		0.62	0.16	mg/Kg	☼	07/20/21 08:00	07/23/21 15:15	1
Calcium	**6200**		3100	32	mg/Kg	☼	07/20/21 08:00	07/23/21 13:57	10
Cobalt	**0.20**	**J**	3.1	0.032	mg/Kg	☼	07/20/21 08:00	07/23/21 15:15	1
Iron	**2100**		6.2	5.1	mg/Kg	☼	07/20/21 08:00	07/23/21 15:15	1
Lithium	**3.8**		3.1	0.19	mg/Kg	☼	07/20/21 08:00	07/23/21 15:15	1
Manganese	**34**		0.93	0.14	mg/Kg	☼	07/20/21 08:00	07/23/21 15:15	1
Molybdenum	ND		2.5	0.10	mg/Kg	☼	07/20/21 08:00	07/23/21 15:15	1
Potassium	**24000**		1500	62	mg/Kg	☼	07/20/21 08:00	07/28/21 14:55	5
Selenium	ND		0.62	0.21	mg/Kg	☼	07/20/21 08:00	07/23/21 15:15	1
Sodium	**8700**		310	53	mg/Kg	☼	07/20/21 08:00	07/23/21 15:15	1

Client Sample Results

Client: Golder Associates Inc.
Job ID: 140-23290-1
Project/Site: Labadie Energy Center - Missouri

Client Sample ID: L-BH-03S
Lab Sample ID: 140-23290-1
Date Collected: 05/24/21 08:45
Matrix: Solid
Date Received: 05/28/21 10:00
Percent Solids: 80.7

Method: 6010B SEP - SEP Metals (ICP) - Sum of Steps 1-7

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**44000**		10	1.6	mg/Kg			07/29/21 21:07	1
Antimony	**0.46**	**J**	3.0	0.14	mg/Kg			07/29/21 21:07	1
Arsenic	**3.8**		0.50	0.13	mg/Kg			07/29/21 21:07	1
Calcium	**9800**		250	0.74	mg/Kg			07/29/21 21:07	1
Cobalt	**2.1**	**J**	2.5	0.023	mg/Kg			07/29/21 21:07	1
Iron	**6000**		5.0	4.1	mg/Kg			07/29/21 21:07	1
Lithium	**5.4**		2.5	0.15	mg/Kg			07/29/21 21:07	1
Manganese	**89**		0.75	0.052	mg/Kg			07/29/21 21:07	1
Molybdenum	ND		2.0	0.082	mg/Kg			07/29/21 21:07	1
Potassium	**27000**		250	26	mg/Kg			07/29/21 21:07	1
Selenium	ND		0.50	0.17	mg/Kg			07/29/21 21:07	1
Sodium	**37000**		250	130	mg/Kg			07/29/21 21:07	1

Method: 6010B - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**1700**		47	5.8	mg/Kg	☼	06/28/21 08:00	07/07/21 15:29	1
Antimony	ND		7.0	0.40	mg/Kg	☼	06/28/21 08:00	07/07/21 15:29	1
Arsenic	**2.3**		2.3	0.34	mg/Kg	☼	06/28/21 08:00	07/07/21 15:29	1
Calcium	**3400**		580	100	mg/Kg	☼	06/28/21 08:00	07/07/21 15:29	1
Cobalt	**2.4**	**J**	5.8	0.056	mg/Kg	☼	06/28/21 08:00	07/07/21 15:29	1
Iron	**4200**		23	9.2	mg/Kg	☼	06/28/21 08:00	07/07/21 15:29	1
Lithium	**2.0**	**J**	5.8	0.35	mg/Kg	☼	06/28/21 08:00	07/07/21 15:29	1
Manganese	**58**		1.7	0.72	mg/Kg	☼	06/28/21 08:00	07/07/21 15:29	1
Molybdenum	ND		4.7	0.13	mg/Kg	☼	06/28/21 08:00	07/07/21 15:29	1
Potassium	**380**	**J**	580	28	mg/Kg	☼	06/28/21 08:00	07/07/21 15:29	1
Selenium	ND		1.7	0.51	mg/Kg	☼	06/28/21 08:00	07/07/21 15:29	1
Sodium	**59**	**J**	580	42	mg/Kg	☼	06/28/21 08:00	07/07/21 15:29	1

Method: 6010B - SEP Metals (ICP) - Total

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**41000**		120	20	mg/Kg	☼	07/12/21 08:00	07/28/21 17:42	10
Antimony	**0.35**	**J**	3.7	0.17	mg/Kg	☼	07/12/21 08:00	07/29/21 11:53	1
Arsenic	**4.5**	**B**	0.62	0.16	mg/Kg	☼	07/12/21 08:00	07/29/21 11:53	1
Calcium	**9400**		3100	32	mg/Kg	☼	07/12/21 08:00	07/28/21 17:42	10
Cobalt	**2.7**	**J**	3.1	0.032	mg/Kg	☼	07/12/21 08:00	07/29/21 11:53	1
Iron	**6200**		6.2	5.1	mg/Kg	☼	07/12/21 08:00	07/29/21 11:53	1
Lithium	**6.1**		3.1	0.19	mg/Kg	☼	07/12/21 08:00	07/29/21 11:53	1
Manganese	**96**		0.93	0.14	mg/Kg	☼	07/12/21 08:00	07/29/21 11:53	1
Molybdenum	**0.23**	**J**	2.5	0.10	mg/Kg	☼	07/12/21 08:00	07/29/21 11:53	1
Potassium	**21000**		1500	62	mg/Kg	☼	07/12/21 08:00	07/29/21 13:25	5
Selenium	ND		0.62	0.21	mg/Kg	☼	07/12/21 08:00	07/29/21 11:53	1
Sodium	**11000**		310	53	mg/Kg	☼	07/12/21 08:00	07/29/21 11:53	1

Client Sample Results

Client: Golder Associates Inc.
Job ID: 140-23290-1
Project/Site: Labadie Energy Center - Missouri

Client Sample ID: L-BH-03M

Lab Sample ID: 140-23290-2
Date Collected: 05/24/21 10:00
Matrix: Solid
Date Received: 05/28/21 10:00
Percent Solids: 91.1

Method: 6010B SEP - SEP Metals (ICP) - Step 1

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	ND		44	7.0	mg/Kg	☼	07/13/21 08:00	07/21/21 13:06	4
Antimony	ND		13	1.2	mg/Kg	☼	07/13/21 08:00	07/21/21 13:06	4
Arsenic	ND		2.2	0.57	mg/Kg	☼	07/13/21 08:00	07/21/21 13:06	4
Calcium	**210**	**J B**	1100	8.3	mg/Kg	☼	07/13/21 08:00	07/21/21 13:06	4
Cobalt	ND		11	0.20	mg/Kg	☼	07/13/21 08:00	07/21/21 13:06	4
Iron	ND		22	13	mg/Kg	☼	07/13/21 08:00	07/21/21 13:06	4
Lithium	ND		11	0.66	mg/Kg	☼	07/13/21 08:00	07/21/21 13:06	4
Manganese	**2.8**	**J**	3.3	0.14	mg/Kg	☼	07/13/21 08:00	07/21/21 13:06	4
Molybdenum	ND		8.8	0.36	mg/Kg	☼	07/13/21 08:00	07/21/21 13:06	4
Potassium	ND		1100	110	mg/Kg	☼	07/13/21 08:00	07/21/21 13:06	4
Selenium	ND		2.2	0.75	mg/Kg	☼	07/13/21 08:00	07/21/21 13:06	4
Sodium	ND		1100	570	mg/Kg	☼	07/13/21 08:00	07/21/21 13:06	4

Method: 6010B SEP - SEP Metals (ICP) - Step 2

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	ND		33	5.3	mg/Kg	☼	07/13/21 08:00	07/21/21 14:56	3
Antimony	ND		9.9	0.92	mg/Kg	☼	07/13/21 08:00	07/21/21 14:56	3
Arsenic	ND		1.6	0.43	mg/Kg	☼	07/13/21 08:00	07/21/21 14:56	3
Calcium	**990**		820	7.2	mg/Kg	☼	07/13/21 08:00	07/21/21 14:56	3
Cobalt	ND		8.2	0.21	mg/Kg	☼	07/13/21 08:00	07/21/21 14:56	3
Iron	**34**		16	9.5	mg/Kg	☼	07/13/21 08:00	07/21/21 14:56	3
Lithium	ND		8.2	0.49	mg/Kg	☼	07/13/21 08:00	07/21/21 14:56	3
Manganese	**48**		2.5	0.92	mg/Kg	☼	07/13/21 08:00	07/21/21 14:56	3
Molybdenum	ND		6.6	0.27	mg/Kg	☼	07/13/21 08:00	07/21/21 14:56	3
Potassium	ND		820	86	mg/Kg	☼	07/13/21 08:00	07/21/21 14:56	3
Selenium	ND		1.6	0.56	mg/Kg	☼	07/13/21 08:00	07/21/21 14:56	3

Method: 6010B SEP - SEP Metals (ICP) - Step 3

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**17**		11	2.3	mg/Kg	☼	07/14/21 08:00	07/21/21 16:56	1
Antimony	ND		3.3	0.31	mg/Kg	☼	07/14/21 08:00	07/21/21 16:56	1
Arsenic	ND		0.55	0.14	mg/Kg	☼	07/14/21 08:00	07/21/21 16:56	1
Calcium	**5.8**	**J**	270	1.6	mg/Kg	☼	07/14/21 08:00	07/21/21 16:56	1
Cobalt	**0.14**	**J**	2.7	0.049	mg/Kg	☼	07/14/21 08:00	07/21/21 16:56	1
Iron	**220**		5.5	3.2	mg/Kg	☼	07/14/21 08:00	07/21/21 16:56	1
Lithium	ND		2.7	0.16	mg/Kg	☼	07/14/21 08:00	07/21/21 16:56	1
Manganese	**16**	**B**	0.82	0.030	mg/Kg	☼	07/14/21 08:00	07/21/21 16:56	1
Molybdenum	ND		2.2	0.090	mg/Kg	☼	07/14/21 08:00	07/21/21 16:56	1
Potassium	ND		270	29	mg/Kg	☼	07/14/21 08:00	07/21/21 16:56	1
Selenium	ND		0.55	0.19	mg/Kg	☼	07/14/21 08:00	07/21/21 16:56	1
Sodium	**5800**		270	140	mg/Kg	☼	07/14/21 08:00	07/21/21 16:56	1

Method: 6010B SEP - SEP Metals (ICP) - Step 4

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**170**		11	1.8	mg/Kg	☼	07/15/21 08:00	07/22/21 14:23	1
Antimony	ND		3.3	0.49	mg/Kg	☼	07/15/21 08:00	07/22/21 14:23	1
Arsenic	**0.34**	**J**	0.55	0.24	mg/Kg	☼	07/15/21 08:00	07/22/21 14:23	1
Calcium	**1000**		270	2.4	mg/Kg	☼	07/15/21 08:00	07/22/21 14:23	1
Cobalt	**1.2**	**J**	2.7	0.058	mg/Kg	☼	07/15/21 08:00	07/22/21 14:23	1
Iron	**1000**		5.5	3.2	mg/Kg	☼	07/15/21 08:00	07/22/21 14:23	1

Client Sample Results

Client Sample ID: L-BH-03M

Lab Sample ID: 140-23290-2
Date Collected: 05/24/21 10:00
Matrix: Solid
Date Received: 05/28/21 10:00
Percent Solids: 91.1

Method: 6010B SEP - SEP Metals (ICP) - Step 4 (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Lithium	**0.28**	**J**	2.7	0.16	mg/Kg	☼	07/15/21 08:00	07/22/21 14:23	1
Manganese	**21**		0.82	0.14	mg/Kg	☼	07/15/21 08:00	07/22/21 14:23	1
Molybdenum	ND		2.2	0.090	mg/Kg	☼	07/15/21 08:00	07/22/21 14:23	1
Potassium	ND		270	29	mg/Kg	☼	07/15/21 08:00	07/22/21 14:23	1
Selenium	ND		0.55	0.52	mg/Kg	☼	07/15/21 08:00	07/22/21 14:23	1
Sodium	**330**		270	140	mg/Kg	☼	07/15/21 08:00	07/22/21 14:23	1

Method: 6010B SEP - SEP Metals (ICP) - Step 5

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**53**	**J**	160	26	mg/Kg	☼	07/17/21 08:14	07/22/21 16:11	5
Antimony	ND		49	4.6	mg/Kg	☼	07/17/21 08:14	07/22/21 16:11	5
Arsenic	ND		8.2	2.1	mg/Kg	☼	07/17/21 08:14	07/22/21 16:11	5
Calcium	**710**	**J B**	4100	12	mg/Kg	☼	07/17/21 08:14	07/22/21 16:11	5
Cobalt	ND		41	0.66	mg/Kg	☼	07/17/21 08:14	07/22/21 16:11	5
Iron	ND		82	48	mg/Kg	☼	07/17/21 08:14	07/22/21 16:11	5
Lithium	ND		41	2.4	mg/Kg	☼	07/17/21 08:14	07/22/21 16:11	5
Manganese	**3.2**	**J**	12	2.0	mg/Kg	☼	07/17/21 08:14	07/22/21 16:11	5
Molybdenum	ND		33	1.4	mg/Kg	☼	07/17/21 08:14	07/22/21 16:11	5
Potassium	**2800**	**J B**	4100	470	mg/Kg	☼	07/17/21 08:14	07/22/21 16:11	5
Selenium	ND		8.2	2.9	mg/Kg	☼	07/17/21 08:14	07/22/21 16:11	5

Method: 6010B SEP - SEP Metals (ICP) - Step 6

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**500**		11	1.8	mg/Kg	☼	07/16/21 12:00	07/22/21 17:59	1
Antimony	ND		3.3	0.31	mg/Kg	☼	07/16/21 12:00	07/22/21 17:59	1
Arsenic	**0.67**		0.55	0.16	mg/Kg	☼	07/16/21 12:00	07/22/21 17:59	1
Calcium	**390**		270	2.3	mg/Kg	☼	07/16/21 12:00	07/22/21 17:59	1
Cobalt	**0.80**	**J**	2.7	0.050	mg/Kg	☼	07/16/21 12:00	07/22/21 17:59	1
Iron	**2300**		5.5	3.2	mg/Kg	☼	07/16/21 12:00	07/22/21 17:59	1
Lithium	**0.63**	**J**	2.7	0.16	mg/Kg	☼	07/16/21 12:00	07/22/21 17:59	1
Manganese	**17**		0.82	0.27	mg/Kg	☼	07/16/21 12:00	07/22/21 17:59	1
Molybdenum	ND		2.2	0.11	mg/Kg	☼	07/16/21 12:00	07/22/21 17:59	1
Potassium	**120**	**J**	270	29	mg/Kg	☼	07/16/21 12:00	07/22/21 17:59	1
Selenium	ND		0.55	0.19	mg/Kg	☼	07/16/21 12:00	07/22/21 17:59	1
Sodium	**17000**		1400	710	mg/Kg	☼	07/16/21 12:00	07/22/21 19:19	5

Method: 6010B SEP - SEP Metals (ICP) - Step 7

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**35000**		110	18	mg/Kg	☼	07/20/21 08:00	07/23/21 14:01	10
Antimony	**0.49**	**J**	3.3	0.15	mg/Kg	☼	07/20/21 08:00	07/23/21 15:20	1
Arsenic	ND		1.1	0.29	mg/Kg	☼	07/20/21 08:00	07/28/21 15:00	2
Calcium	**5600**		2700	29	mg/Kg	☼	07/20/21 08:00	07/23/21 14:01	10
Cobalt	ND		2.7	0.029	mg/Kg	☼	07/20/21 08:00	07/23/21 15:20	1
Iron	**1300**		5.5	4.5	mg/Kg	☼	07/20/21 08:00	07/23/21 15:20	1
Lithium	**2.4**	**J**	2.7	0.16	mg/Kg	☼	07/20/21 08:00	07/23/21 15:20	1
Manganese	**35**		0.82	0.12	mg/Kg	☼	07/20/21 08:00	07/23/21 15:20	1
Molybdenum	ND		2.2	0.090	mg/Kg	☼	07/20/21 08:00	07/23/21 15:20	1
Potassium	**21000**		1400	55	mg/Kg	☼	07/20/21 08:00	07/28/21 15:05	5
Selenium	ND		1.1	0.37	mg/Kg	☼	07/20/21 08:00	07/28/21 15:00	2
Sodium	**7600**		270	47	mg/Kg	☼	07/20/21 08:00	07/23/21 15:20	1

Client Sample Results

Client: Golder Associates Inc. Job ID: 140-23290-1
Project/Site: Labadie Energy Center - Missouri

Client Sample ID: L-BH-03M

Lab Sample ID: 140-23290-2
Date Collected: 05/24/21 10:00
Matrix: Solid
Date Received: 05/28/21 10:00
Percent Solids: 91.1

Method: 6010B SEP - SEP Metals (ICP) - Sum of Steps 1-7

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**36000**		10	1.6	mg/Kg			07/29/21 21:07	1
Antimony	**0.49**	**J**	3.0	0.14	mg/Kg			07/29/21 21:07	1
Arsenic	**1.0**		0.50	0.13	mg/Kg			07/29/21 21:07	1
Calcium	**8900**		250	0.74	mg/Kg			07/29/21 21:07	1
Cobalt	**2.1**	**J**	2.5	0.023	mg/Kg			07/29/21 21:07	1
Iron	**4900**		5.0	4.1	mg/Kg			07/29/21 21:07	1
Lithium	**3.3**		2.5	0.15	mg/Kg			07/29/21 21:07	1
Manganese	**140**		0.75	0.052	mg/Kg			07/29/21 21:07	1
Molybdenum	ND		2.0	0.082	mg/Kg			07/29/21 21:07	1
Potassium	**24000**		250	26	mg/Kg			07/29/21 21:07	1
Selenium	ND		0.50	0.17	mg/Kg			07/29/21 21:07	1
Sodium	**31000**		250	130	mg/Kg			07/29/21 21:07	1

Method: 6010B - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**1200**		41	5.2	mg/Kg	☼	06/28/21 08:00	07/07/21 15:50	1
Antimony	ND		6.2	0.35	mg/Kg	☼	06/28/21 08:00	07/07/21 15:50	1
Arsenic	**0.87**	**J**	2.1	0.30	mg/Kg	☼	06/28/21 08:00	07/07/21 15:50	1
Calcium	**15000**		520	91	mg/Kg	☼	06/28/21 08:00	07/07/21 15:50	1
Cobalt	**2.7**	**J**	5.2	0.050	mg/Kg	☼	06/28/21 08:00	07/07/21 15:50	1
Iron	**3500**		21	8.2	mg/Kg	☼	06/28/21 08:00	07/07/21 15:50	1
Lithium	**2.1**	**J**	5.2	0.31	mg/Kg	☼	06/28/21 08:00	07/07/21 15:50	1
Manganese	**420**		1.5	0.64	mg/Kg	☼	06/28/21 08:00	07/07/21 15:50	1
Molybdenum	**0.15**	**J**	4.1	0.11	mg/Kg	☼	06/28/21 08:00	07/07/21 15:50	1
Potassium	**230**	**J**	520	25	mg/Kg	☼	06/28/21 08:00	07/07/21 15:50	1
Selenium	ND		1.5	0.45	mg/Kg	☼	06/28/21 08:00	07/07/21 15:50	1
Sodium	**60**	**J**	520	37	mg/Kg	☼	06/28/21 08:00	07/07/21 15:50	1

Method: 6010B - SEP Metals (ICP) - Total

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**37000**		110	18	mg/Kg	☼	07/12/21 08:00	07/28/21 17:47	10
Antimony	**0.42**	**J**	3.3	0.15	mg/Kg	☼	07/12/21 08:00	07/29/21 11:59	1
Arsenic	**2.1**	**B**	0.55	0.14	mg/Kg	☼	07/12/21 08:00	07/29/21 11:59	1
Calcium	**7800**		2700	29	mg/Kg	☼	07/12/21 08:00	07/28/21 17:47	10
Cobalt	**2.2**	**J**	2.7	0.029	mg/Kg	☼	07/12/21 08:00	07/29/21 11:59	1
Iron	**3900**		5.5	4.5	mg/Kg	☼	07/12/21 08:00	07/29/21 11:59	1
Lithium	**3.6**		2.7	0.16	mg/Kg	☼	07/12/21 08:00	07/29/21 11:59	1
Manganese	**160**		0.82	0.12	mg/Kg	☼	07/12/21 08:00	07/29/21 11:59	1
Molybdenum	**0.33**	**J**	2.2	0.090	mg/Kg	☼	07/12/21 08:00	07/29/21 11:59	1
Potassium	**25000**		1400	55	mg/Kg	☼	07/12/21 08:00	07/29/21 13:30	5
Selenium	ND		0.55	0.19	mg/Kg	☼	07/12/21 08:00	07/29/21 11:59	1
Sodium	**12000**		1400	240	mg/Kg	☼	07/12/21 08:00	07/29/21 13:30	5

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Client Sample ID: L-BH-03D

Lab Sample ID: 140-23290-3

Date Collected: 05/24/21 11:45

Matrix: Solid

Date Received: 05/28/21 10:00

Percent Solids: 85.7

Method: 6010B SEP - SEP Metals (ICP) - Step 1

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	ND		47	7.5	mg/Kg	☼	07/13/21 08:00	07/21/21 13:11	4
Antimony	ND		14	1.3	mg/Kg	☼	07/13/21 08:00	07/21/21 13:11	4
Arsenic	ND		2.3	0.61	mg/Kg	☼	07/13/21 08:00	07/21/21 13:11	4
Calcium	**170**	**J B**	1200	8.9	mg/Kg	☼	07/13/21 08:00	07/21/21 13:11	4
Cobalt	ND		12	0.21	mg/Kg	☼	07/13/21 08:00	07/21/21 13:11	4
Iron	ND		23	14	mg/Kg	☼	07/13/21 08:00	07/21/21 13:11	4
Lithium	ND		12	0.70	mg/Kg	☼	07/13/21 08:00	07/21/21 13:11	4
Manganese	**3.7**		3.5	0.14	mg/Kg	☼	07/13/21 08:00	07/21/21 13:11	4
Molybdenum	ND		9.3	0.38	mg/Kg	☼	07/13/21 08:00	07/21/21 13:11	4
Potassium	ND		1200	120	mg/Kg	☼	07/13/21 08:00	07/21/21 13:11	4
Selenium	ND		2.3	0.79	mg/Kg	☼	07/13/21 08:00	07/21/21 13:11	4
Sodium	ND		1200	610	mg/Kg	☼	07/13/21 08:00	07/21/21 13:11	4

Method: 6010B SEP - SEP Metals (ICP) - Step 2

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**10**	**J**	35	5.6	mg/Kg	☼	07/13/21 08:00	07/21/21 15:01	3
Antimony	ND		10	0.98	mg/Kg	☼	07/13/21 08:00	07/21/21 15:01	3
Arsenic	ND		1.7	0.45	mg/Kg	☼	07/13/21 08:00	07/21/21 15:01	3
Calcium	**220**	**J**	870	7.7	mg/Kg	☼	07/13/21 08:00	07/21/21 15:01	3
Cobalt	**0.42**	**J**	8.7	0.22	mg/Kg	☼	07/13/21 08:00	07/21/21 15:01	3
Iron	**44**		17	10	mg/Kg	☼	07/13/21 08:00	07/21/21 15:01	3
Lithium	ND		8.7	0.52	mg/Kg	☼	07/13/21 08:00	07/21/21 15:01	3
Manganese	**36**		2.6	0.98	mg/Kg	☼	07/13/21 08:00	07/21/21 15:01	3
Molybdenum	ND		7.0	0.29	mg/Kg	☼	07/13/21 08:00	07/21/21 15:01	3
Potassium	**99**	**J**	870	91	mg/Kg	☼	07/13/21 08:00	07/21/21 15:01	3
Selenium	ND		1.7	0.59	mg/Kg	☼	07/13/21 08:00	07/21/21 15:01	3

Method: 6010B SEP - SEP Metals (ICP) - Step 3

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**39**		12	2.4	mg/Kg	☼	07/14/21 08:00	07/21/21 17:01	1
Antimony	ND		3.5	0.33	mg/Kg	☼	07/14/21 08:00	07/21/21 17:01	1
Arsenic	ND		0.58	0.15	mg/Kg	☼	07/14/21 08:00	07/21/21 17:01	1
Calcium	**4.8**	**J**	290	1.7	mg/Kg	☼	07/14/21 08:00	07/21/21 17:01	1
Cobalt	**0.74**	**J**	2.9	0.052	mg/Kg	☼	07/14/21 08:00	07/21/21 17:01	1
Iron	**220**		5.8	3.4	mg/Kg	☼	07/14/21 08:00	07/21/21 17:01	1
Lithium	ND		2.9	0.17	mg/Kg	☼	07/14/21 08:00	07/21/21 17:01	1
Manganese	**8.6**	**B**	0.87	0.031	mg/Kg	☼	07/14/21 08:00	07/21/21 17:01	1
Molybdenum	**0.15**	**J**	2.3	0.096	mg/Kg	☼	07/14/21 08:00	07/21/21 17:01	1
Potassium	ND		290	30	mg/Kg	☼	07/14/21 08:00	07/21/21 17:01	1
Selenium	ND		0.58	0.20	mg/Kg	☼	07/14/21 08:00	07/21/21 17:01	1
Sodium	**6200**		290	150	mg/Kg	☼	07/14/21 08:00	07/21/21 17:01	1

Method: 6010B SEP - SEP Metals (ICP) - Step 4

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**270**		12	1.9	mg/Kg	☼	07/15/21 08:00	07/22/21 14:28	1
Antimony	ND		3.5	0.52	mg/Kg	☼	07/15/21 08:00	07/22/21 14:28	1
Arsenic	**0.61**		0.58	0.26	mg/Kg	☼	07/15/21 08:00	07/22/21 14:28	1
Calcium	**410**		290	2.6	mg/Kg	☼	07/15/21 08:00	07/22/21 14:28	1
Cobalt	**1.6**	**J**	2.9	0.062	mg/Kg	☼	07/15/21 08:00	07/22/21 14:28	1
Iron	**1800**		5.8	3.4	mg/Kg	☼	07/15/21 08:00	07/22/21 14:28	1

Client Sample ID: L-BH-03D
Lab Sample ID: 140-23290-3
Date Collected: 05/24/21 11:45
Matrix: Solid
Date Received: 05/28/21 10:00
Percent Solids: 85.7

Method: 6010B SEP - SEP Metals (ICP) - Step 4 (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Lithium	**0.33**	**J**	2.9	0.17	mg/Kg	☼	07/15/21 08:00	07/22/21 14:28	1
Manganese	**19**		0.87	0.15	mg/Kg	☼	07/15/21 08:00	07/22/21 14:28	1
Molybdenum	**0.12**	**J**	2.3	0.096	mg/Kg	☼	07/15/21 08:00	07/22/21 14:28	1
Potassium	ND		290	30	mg/Kg	☼	07/15/21 08:00	07/22/21 14:28	1
Selenium	ND		0.58	0.55	mg/Kg	☼	07/15/21 08:00	07/22/21 14:28	1
Sodium	**360**		290	150	mg/Kg	☼	07/15/21 08:00	07/22/21 14:28	1

Method: 6010B SEP - SEP Metals (ICP) - Step 5

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**61**	**J**	170	27	mg/Kg	☼	07/17/21 08:14	07/22/21 16:16	5
Antimony	ND		52	4.9	mg/Kg	☼	07/17/21 08:14	07/22/21 16:16	5
Arsenic	ND		8.7	2.2	mg/Kg	☼	07/17/21 08:14	07/22/21 16:16	5
Calcium	**98**	**J B**	4400	13	mg/Kg	☼	07/17/21 08:14	07/22/21 16:16	5
Cobalt	ND		44	0.70	mg/Kg	☼	07/17/21 08:14	07/22/21 16:16	5
Iron	ND		87	51	mg/Kg	☼	07/17/21 08:14	07/22/21 16:16	5
Lithium	ND		44	2.6	mg/Kg	☼	07/17/21 08:14	07/22/21 16:16	5
Manganese	ND		13	2.2	mg/Kg	☼	07/17/21 08:14	07/22/21 16:16	5
Molybdenum	ND		35	1.5	mg/Kg	☼	07/17/21 08:14	07/22/21 16:16	5
Potassium	**3000**	**J B**	4400	500	mg/Kg	☼	07/17/21 08:14	07/22/21 16:16	5
Selenium	ND		8.7	3.0	mg/Kg	☼	07/17/21 08:14	07/22/21 16:16	5

Method: 6010B SEP - SEP Metals (ICP) - Step 6

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**410**		12	1.9	mg/Kg	☼	07/16/21 12:00	07/22/21 18:04	1
Antimony	ND		3.5	0.33	mg/Kg	☼	07/16/21 12:00	07/22/21 18:04	1
Arsenic	**1.1**		0.58	0.17	mg/Kg	☼	07/16/21 12:00	07/22/21 18:04	1
Calcium	**110**	**J**	290	2.4	mg/Kg	☼	07/16/21 12:00	07/22/21 18:04	1
Cobalt	**1.4**	**J**	2.9	0.054	mg/Kg	☼	07/16/21 12:00	07/22/21 18:04	1
Iron	**2900**		5.8	3.4	mg/Kg	☼	07/16/21 12:00	07/22/21 18:04	1
Lithium	**0.47**	**J**	2.9	0.17	mg/Kg	☼	07/16/21 12:00	07/22/21 18:04	1
Manganese	**22**		0.87	0.29	mg/Kg	☼	07/16/21 12:00	07/22/21 18:04	1
Molybdenum	ND		2.3	0.12	mg/Kg	☼	07/16/21 12:00	07/22/21 18:04	1
Potassium	**130**	**J**	290	30	mg/Kg	☼	07/16/21 12:00	07/22/21 18:04	1
Selenium	ND		0.58	0.20	mg/Kg	☼	07/16/21 12:00	07/22/21 18:04	1
Sodium	**18000**		1500	760	mg/Kg	☼	07/16/21 12:00	07/22/21 19:24	5

Method: 6010B SEP - SEP Metals (ICP) - Step 7

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**24000**		120	19	mg/Kg	☼	07/20/21 08:00	07/23/21 14:06	10
Antimony	**0.25**	**J**	3.5	0.16	mg/Kg	☼	07/20/21 08:00	07/23/21 15:25	1
Arsenic	ND		1.2	0.30	mg/Kg	☼	07/20/21 08:00	07/28/21 15:24	2
Calcium	**2200**		290	3.0	mg/Kg	☼	07/20/21 08:00	07/23/21 15:25	1
Cobalt	ND		2.9	0.030	mg/Kg	☼	07/20/21 08:00	07/23/21 15:25	1
Iron	**1300**		5.8	4.8	mg/Kg	☼	07/20/21 08:00	07/23/21 15:25	1
Lithium	**2.0**	**J**	2.9	0.17	mg/Kg	☼	07/20/21 08:00	07/23/21 15:25	1
Manganese	**14**		0.87	0.13	mg/Kg	☼	07/20/21 08:00	07/23/21 15:25	1
Molybdenum	ND		2.3	0.096	mg/Kg	☼	07/20/21 08:00	07/23/21 15:25	1
Potassium	**18000**		1500	58	mg/Kg	☼	07/20/21 08:00	07/28/21 15:29	5
Selenium	ND		1.2	0.40	mg/Kg	☼	07/20/21 08:00	07/28/21 15:24	2
Sodium	**6400**		290	50	mg/Kg	☼	07/20/21 08:00	07/23/21 15:25	1

Client Sample Results

Client: Golder Associates Inc. Job ID: 140-23290-1
Project/Site: Labadie Energy Center - Missouri

Client Sample ID: L-BH-03D Lab Sample ID: 140-23290-3

Date Collected: 05/24/21 11:45 **Matrix: Solid**
Date Received: 05/28/21 10:00 **Percent Solids: 85.7**

Method: 6010B SEP - SEP Metals (ICP) - Sum of Steps 1-7

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**25000**		10	1.6	mg/Kg			07/29/21 21:07	1
Antimony	**0.25**	**J**	3.0	0.14	mg/Kg			07/29/21 21:07	1
Arsenic	**1.7**		0.50	0.13	mg/Kg			07/29/21 21:07	1
Calcium	**3200**		250	0.74	mg/Kg			07/29/21 21:07	1
Cobalt	**4.2**		2.5	0.023	mg/Kg			07/29/21 21:07	1
Iron	**6300**		5.0	4.1	mg/Kg			07/29/21 21:07	1
Lithium	**2.8**		2.5	0.15	mg/Kg			07/29/21 21:07	1
Manganese	**100**		0.75	0.052	mg/Kg			07/29/21 21:07	1
Molybdenum	**0.26**	**J**	2.0	0.082	mg/Kg			07/29/21 21:07	1
Potassium	**21000**		250	26	mg/Kg			07/29/21 21:07	1
Selenium	ND		0.50	0.17	mg/Kg			07/29/21 21:07	1
Sodium	**31000**		250	130	mg/Kg			07/29/21 21:07	1

Method: 6010B - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**800**		44	5.5	mg/Kg	☼	06/28/21 08:00	07/07/21 15:55	1
Antimony	ND		6.6	0.38	mg/Kg	☼	06/28/21 08:00	07/07/21 15:55	1
Arsenic	**1.6**	**J**	2.2	0.32	mg/Kg	☼	06/28/21 08:00	07/07/21 15:55	1
Calcium	**2000**		550	97	mg/Kg	☼	06/28/21 08:00	07/07/21 15:55	1
Cobalt	**3.1**	**J**	5.5	0.053	mg/Kg	☼	06/28/21 08:00	07/07/21 15:55	1
Iron	**3900**		22	8.7	mg/Kg	☼	06/28/21 08:00	07/07/21 15:55	1
Lithium	**0.94**	**J**	5.5	0.33	mg/Kg	☼	06/28/21 08:00	07/07/21 15:55	1
Manganese	**87**		1.7	0.69	mg/Kg	☼	06/28/21 08:00	07/07/21 15:55	1
Molybdenum	**0.29**	**J**	4.4	0.12	mg/Kg	☼	06/28/21 08:00	07/07/21 15:55	1
Potassium	**190**	**J**	550	27	mg/Kg	☼	06/28/21 08:00	07/07/21 15:55	1
Selenium	ND		1.7	0.49	mg/Kg	☼	06/28/21 08:00	07/07/21 15:55	1
Sodium	**57**	**J**	550	40	mg/Kg	☼	06/28/21 08:00	07/07/21 15:55	1

Method: 6010B - SEP Metals (ICP) - Total

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**34000**		120	19	mg/Kg	☼	07/12/21 08:00	07/28/21 17:51	10
Antimony	**0.48**	**J**	3.5	0.16	mg/Kg	☼	07/12/21 08:00	07/29/21 12:04	1
Arsenic	**3.0**	**B**	0.58	0.15	mg/Kg	☼	07/12/21 08:00	07/29/21 12:04	1
Calcium	**5100**		2900	30	mg/Kg	☼	07/12/21 08:00	07/28/21 17:51	10
Cobalt	**4.0**		2.9	0.030	mg/Kg	☼	07/12/21 08:00	07/29/21 12:04	1
Iron	**6300**		5.8	4.8	mg/Kg	☼	07/12/21 08:00	07/29/21 12:04	1
Lithium	**3.5**		2.9	0.17	mg/Kg	☼	07/12/21 08:00	07/29/21 12:04	1
Manganese	**160**		0.87	0.13	mg/Kg	☼	07/12/21 08:00	07/29/21 12:04	1
Molybdenum	**1.3**	**J**	2.3	0.096	mg/Kg	☼	07/12/21 08:00	07/29/21 12:04	1
Potassium	**22000**		1500	58	mg/Kg	☼	07/12/21 08:00	07/29/21 13:34	5
Selenium	ND		0.58	0.20	mg/Kg	☼	07/12/21 08:00	07/29/21 12:04	1
Sodium	**11000**		290	50	mg/Kg	☼	07/12/21 08:00	07/29/21 12:04	1

Client Sample Results

Client: Golder Associates Inc. Job ID: 140-23290-1
Project/Site: Labadie Energy Center - Missouri

Client Sample ID: L-BH-02S Lab Sample ID: 140-23290-4

Date Collected: 05/25/21 09:00 **Matrix: Solid**
Date Received: 05/28/21 10:00 **Percent Solids: 78.4**

Method: 6010B SEP - SEP Metals (ICP) - Step 1

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	ND		51	8.2	mg/Kg	☼	07/13/21 08:00	07/21/21 13:16	4
Antimony	ND		15	1.4	mg/Kg	☼	07/13/21 08:00	07/21/21 13:16	4
Arsenic	ND		2.6	0.66	mg/Kg	☼	07/13/21 08:00	07/21/21 13:16	4
Calcium	**450**	**J B**	1300	9.7	mg/Kg	☼	07/13/21 08:00	07/21/21 13:16	4
Cobalt	ND		13	0.23	mg/Kg	☼	07/13/21 08:00	07/21/21 13:16	4
Iron	ND		26	15	mg/Kg	☼	07/13/21 08:00	07/21/21 13:16	4
Lithium	ND		13	0.77	mg/Kg	☼	07/13/21 08:00	07/21/21 13:16	4
Manganese	**0.65**	**J**	3.8	0.16	mg/Kg	☼	07/13/21 08:00	07/21/21 13:16	4
Molybdenum	ND		10	0.42	mg/Kg	☼	07/13/21 08:00	07/21/21 13:16	4
Potassium	ND		1300	130	mg/Kg	☼	07/13/21 08:00	07/21/21 13:16	4
Selenium	ND		2.6	0.87	mg/Kg	☼	07/13/21 08:00	07/21/21 13:16	4
Sodium	ND		1300	660	mg/Kg	☼	07/13/21 08:00	07/21/21 13:16	4

Method: 6010B SEP - SEP Metals (ICP) - Step 2

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**9.1**	**J**	38	6.1	mg/Kg	☼	07/13/21 08:00	07/21/21 15:06	3
Antimony	ND		11	1.1	mg/Kg	☼	07/13/21 08:00	07/21/21 15:06	3
Arsenic	ND		1.9	0.50	mg/Kg	☼	07/13/21 08:00	07/21/21 15:06	3
Calcium	**1500**		960	8.4	mg/Kg	☼	07/13/21 08:00	07/21/21 15:06	3
Cobalt	**0.30**	**J**	9.6	0.24	mg/Kg	☼	07/13/21 08:00	07/21/21 15:06	3
Iron	**120**		19	11	mg/Kg	☼	07/13/21 08:00	07/21/21 15:06	3
Lithium	ND		9.6	0.57	mg/Kg	☼	07/13/21 08:00	07/21/21 15:06	3
Manganese	**19**		2.9	1.1	mg/Kg	☼	07/13/21 08:00	07/21/21 15:06	3
Molybdenum	ND		7.7	0.31	mg/Kg	☼	07/13/21 08:00	07/21/21 15:06	3
Potassium	**120**	**J**	960	100	mg/Kg	☼	07/13/21 08:00	07/21/21 15:06	3
Selenium	ND		1.9	0.65	mg/Kg	☼	07/13/21 08:00	07/21/21 15:06	3

Method: 6010B SEP - SEP Metals (ICP) - Step 3

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**43**		13	2.7	mg/Kg	☼	07/14/21 08:00	07/21/21 17:06	1
Antimony	ND		3.8	0.36	mg/Kg	☼	07/14/21 08:00	07/21/21 17:06	1
Arsenic	**0.93**		0.64	0.17	mg/Kg	☼	07/14/21 08:00	07/21/21 17:06	1
Calcium	**5.5**	**J**	320	1.9	mg/Kg	☼	07/14/21 08:00	07/21/21 17:06	1
Cobalt	**0.54**	**J**	3.2	0.057	mg/Kg	☼	07/14/21 08:00	07/21/21 17:06	1
Iron	**500**		6.4	3.7	mg/Kg	☼	07/14/21 08:00	07/21/21 17:06	1
Lithium	ND		3.2	0.19	mg/Kg	☼	07/14/21 08:00	07/21/21 17:06	1
Manganese	**5.1**	**B**	0.96	0.034	mg/Kg	☼	07/14/21 08:00	07/21/21 17:06	1
Molybdenum	ND		2.6	0.10	mg/Kg	☼	07/14/21 08:00	07/21/21 17:06	1
Potassium	ND		320	33	mg/Kg	☼	07/14/21 08:00	07/21/21 17:06	1
Selenium	ND		0.64	0.22	mg/Kg	☼	07/14/21 08:00	07/21/21 17:06	1
Sodium	**6700**		320	170	mg/Kg	☼	07/14/21 08:00	07/21/21 17:06	1

Method: 6010B SEP - SEP Metals (ICP) - Step 4

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**430**		13	2.0	mg/Kg	☼	07/15/21 08:00	07/22/21 14:32	1
Antimony	ND		3.8	0.57	mg/Kg	☼	07/15/21 08:00	07/22/21 14:32	1
Arsenic	**0.92**		0.64	0.28	mg/Kg	☼	07/15/21 08:00	07/22/21 14:32	1
Calcium	**1200**		320	2.8	mg/Kg	☼	07/15/21 08:00	07/22/21 14:32	1
Cobalt	**1.0**	**J**	3.2	0.068	mg/Kg	☼	07/15/21 08:00	07/22/21 14:32	1
Iron	**1500**		6.4	3.7	mg/Kg	☼	07/15/21 08:00	07/22/21 14:32	1

Client Sample Results

Client Sample ID: L-BH-02S
Date Collected: 05/25/21 09:00
Date Received: 05/28/21 10:00

Lab Sample ID: 140-23290-4
Matrix: Solid
Percent Solids: 78.4

Method: 6010B SEP - SEP Metals (ICP) - Step 4 (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Lithium	**0.81**	**J**	3.2	0.19	mg/Kg	☼	07/15/21 08:00	07/22/21 14:32	1
Manganese	**15**		0.96	0.17	mg/Kg	☼	07/15/21 08:00	07/22/21 14:32	1
Molybdenum	ND		2.6	0.10	mg/Kg	☼	07/15/21 08:00	07/22/21 14:32	1
Potassium	**50**	**J**	320	33	mg/Kg	☼	07/15/21 08:00	07/22/21 14:32	1
Selenium	ND		0.64	0.60	mg/Kg	☼	07/15/21 08:00	07/22/21 14:32	1
Sodium	**380**		320	170	mg/Kg	☼	07/15/21 08:00	07/22/21 14:32	1

Method: 6010B SEP - SEP Metals (ICP) - Step 5

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**91**	**J**	190	30	mg/Kg	☼	07/17/21 08:14	07/22/21 16:21	5
Antimony	ND		57	5.4	mg/Kg	☼	07/17/21 08:14	07/22/21 16:21	5
Arsenic	ND		9.6	2.4	mg/Kg	☼	07/17/21 08:14	07/22/21 16:21	5
Calcium	**370**	**J B**	4800	14	mg/Kg	☼	07/17/21 08:14	07/22/21 16:21	5
Cobalt	ND		48	0.77	mg/Kg	☼	07/17/21 08:14	07/22/21 16:21	5
Iron	ND		96	56	mg/Kg	☼	07/17/21 08:14	07/22/21 16:21	5
Lithium	ND		48	2.8	mg/Kg	☼	07/17/21 08:14	07/22/21 16:21	5
Manganese	ND		14	2.4	mg/Kg	☼	07/17/21 08:14	07/22/21 16:21	5
Molybdenum	ND		38	1.6	mg/Kg	☼	07/17/21 08:14	07/22/21 16:21	5
Potassium	**3200**	**J B**	4800	540	mg/Kg	☼	07/17/21 08:14	07/22/21 16:21	5
Selenium	ND		9.6	3.3	mg/Kg	☼	07/17/21 08:14	07/22/21 16:21	5

Method: 6010B SEP - SEP Metals (ICP) - Step 6

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**700**		13	2.0	mg/Kg	☼	07/16/21 12:00	07/22/21 18:09	1
Antimony	ND		3.8	0.36	mg/Kg	☼	07/16/21 12:00	07/22/21 18:09	1
Arsenic	**1.0**		0.64	0.19	mg/Kg	☼	07/16/21 12:00	07/22/21 18:09	1
Calcium	**200**	**J**	320	2.7	mg/Kg	☼	07/16/21 12:00	07/22/21 18:09	1
Cobalt	**0.72**	**J**	3.2	0.059	mg/Kg	☼	07/16/21 12:00	07/22/21 18:09	1
Iron	**2000**		6.4	3.7	mg/Kg	☼	07/16/21 12:00	07/22/21 18:09	1
Lithium	**0.80**	**J**	3.2	0.19	mg/Kg	☼	07/16/21 12:00	07/22/21 18:09	1
Manganese	**15**		0.96	0.32	mg/Kg	☼	07/16/21 12:00	07/22/21 18:09	1
Molybdenum	ND		2.6	0.13	mg/Kg	☼	07/16/21 12:00	07/22/21 18:09	1
Potassium	**240**	**J**	320	33	mg/Kg	☼	07/16/21 12:00	07/22/21 18:09	1
Selenium	ND		0.64	0.22	mg/Kg	☼	07/16/21 12:00	07/22/21 18:09	1
Sodium	**21000**		1600	830	mg/Kg	☼	07/16/21 12:00	07/22/21 19:29	5

Method: 6010B SEP - SEP Metals (ICP) - Step 7

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**41000**		130	20	mg/Kg	☼	07/20/21 08:00	07/23/21 14:11	10
Antimony	ND		3.8	0.18	mg/Kg	☼	07/20/21 08:00	07/23/21 15:30	1
Arsenic	**1.6**		0.64	0.17	mg/Kg	☼	07/20/21 08:00	07/23/21 15:30	1
Calcium	**5000**		3200	33	mg/Kg	☼	07/20/21 08:00	07/23/21 14:11	10
Cobalt	**0.28**	**J**	3.2	0.033	mg/Kg	☼	07/20/21 08:00	07/23/21 15:30	1
Iron	**2300**		6.4	5.2	mg/Kg	☼	07/20/21 08:00	07/23/21 15:30	1
Lithium	**3.5**		3.2	0.19	mg/Kg	☼	07/20/21 08:00	07/23/21 15:30	1
Manganese	**42**		0.96	0.14	mg/Kg	☼	07/20/21 08:00	07/23/21 15:30	1
Molybdenum	ND		2.6	0.10	mg/Kg	☼	07/20/21 08:00	07/23/21 15:30	1
Potassium	**26000**		1600	64	mg/Kg	☼	07/20/21 08:00	07/28/21 15:34	5
Selenium	ND		0.64	0.22	mg/Kg	☼	07/20/21 08:00	07/23/21 15:30	1
Sodium	**8800**		320	55	mg/Kg	☼	07/20/21 08:00	07/23/21 15:30	1

Client Sample Results

Client: Golder Associates Inc. Job ID: 140-23290-1
Project/Site: Labadie Energy Center - Missouri

Client Sample ID: L-BH-02S Lab Sample ID: 140-23290-4

Date Collected: 05/25/21 09:00 **Matrix: Solid**
Date Received: 05/28/21 10:00 **Percent Solids: 78.4**

Method: 6010B SEP - SEP Metals (ICP) - Sum of Steps 1-7

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**43000**		10	1.6	mg/Kg			07/29/21 21:07	1
Antimony	ND		3.0	0.14	mg/Kg			07/29/21 21:07	1
Arsenic	**4.5**		0.50	0.13	mg/Kg			07/29/21 21:07	1
Calcium	**8800**		250	0.74	mg/Kg			07/29/21 21:07	1
Cobalt	**2.9**		2.5	0.023	mg/Kg			07/29/21 21:07	1
Iron	**6400**		5.0	4.1	mg/Kg			07/29/21 21:07	1
Lithium	**5.2**		2.5	0.15	mg/Kg			07/29/21 21:07	1
Manganese	**96**		0.75	0.052	mg/Kg			07/29/21 21:07	1
Molybdenum	ND		2.0	0.082	mg/Kg			07/29/21 21:07	1
Potassium	**29000**		250	26	mg/Kg			07/29/21 21:07	1
Selenium	ND		0.50	0.17	mg/Kg			07/29/21 21:07	1
Sodium	**37000**		250	130	mg/Kg			07/29/21 21:07	1

Method: 6010B - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**2200**		48	6.0	mg/Kg	☼	06/28/21 08:00	07/07/21 16:00	1
Antimony	ND		7.2	0.41	mg/Kg	☼	06/28/21 08:00	07/07/21 16:00	1
Arsenic	**3.0**		2.4	0.35	mg/Kg	☼	06/28/21 08:00	07/07/21 16:00	1
Calcium	**3800**		600	110	mg/Kg	☼	06/28/21 08:00	07/07/21 16:00	1
Cobalt	**3.6**	**J**	6.0	0.058	mg/Kg	☼	06/28/21 08:00	07/07/21 16:00	1
Iron	**4800**		24	9.5	mg/Kg	☼	06/28/21 08:00	07/07/21 16:00	1
Lithium	**2.7**	**J**	6.0	0.36	mg/Kg	☼	06/28/21 08:00	07/07/21 16:00	1
Manganese	**64**		1.8	0.74	mg/Kg	☼	06/28/21 08:00	07/07/21 16:00	1
Molybdenum	ND		4.8	0.13	mg/Kg	☼	06/28/21 08:00	07/07/21 16:00	1
Potassium	**450**	**J**	600	29	mg/Kg	☼	06/28/21 08:00	07/07/21 16:00	1
Selenium	ND		1.8	0.53	mg/Kg	☼	06/28/21 08:00	07/07/21 16:00	1
Sodium	**71**	**J**	600	43	mg/Kg	☼	06/28/21 08:00	07/07/21 16:00	1

Method: 6010B - SEP Metals (ICP) - Total

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**54000**		130	20	mg/Kg	☼	07/12/21 08:00	07/28/21 17:56	10
Antimony	**0.63**	**J**	3.8	0.18	mg/Kg	☼	07/12/21 08:00	07/29/21 12:09	1
Arsenic	**4.8**	**B**	0.64	0.17	mg/Kg	☼	07/12/21 08:00	07/29/21 12:09	1
Calcium	**12000**		3200	33	mg/Kg	☼	07/12/21 08:00	07/28/21 17:56	10
Cobalt	**3.9**		3.2	0.033	mg/Kg	☼	07/12/21 08:00	07/29/21 12:09	1
Iron	**8000**		6.4	5.2	mg/Kg	☼	07/12/21 08:00	07/29/21 12:09	1
Lithium	**7.2**		3.2	0.19	mg/Kg	☼	07/12/21 08:00	07/29/21 12:09	1
Manganese	**140**		0.96	0.14	mg/Kg	☼	07/12/21 08:00	07/29/21 12:09	1
Molybdenum	**0.21**	**J**	2.6	0.10	mg/Kg	☼	07/12/21 08:00	07/29/21 12:09	1
Potassium	**29000**		1600	64	mg/Kg	☼	07/12/21 08:00	07/29/21 13:39	5
Selenium	ND		0.64	0.22	mg/Kg	☼	07/12/21 08:00	07/29/21 12:09	1
Sodium	**17000**		1600	270	mg/Kg	☼	07/12/21 08:00	07/29/21 13:39	5

Client Sample Results

Client: Golder Associates Inc.
Project/Site: Labadie Energy Center - Missouri

Job ID: 140-23290-1

Client Sample ID: L-BH-02M

Date Collected: 05/25/21 10:25
Date Received: 05/28/21 10:00

Lab Sample ID: 140-23290-5

Matrix: Solid
Percent Solids: 74.5

Method: 6010B SEP - SEP Metals (ICP) - Step 1

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	ND		54	8.6	mg/Kg	☼	07/13/21 08:00	07/21/21 13:21	4
Antimony	ND		16	1.5	mg/Kg	☼	07/13/21 08:00	07/21/21 13:21	4
Arsenic	ND		2.7	0.70	mg/Kg	☼	07/13/21 08:00	07/21/21 13:21	4
Calcium	**2200**	**B**	1300	10	mg/Kg	☼	07/13/21 08:00	07/21/21 13:21	4
Cobalt	ND		13	0.24	mg/Kg	☼	07/13/21 08:00	07/21/21 13:21	4
Iron	ND		27	16	mg/Kg	☼	07/13/21 08:00	07/21/21 13:21	4
Lithium	ND		13	0.80	mg/Kg	☼	07/13/21 08:00	07/21/21 13:21	4
Manganese	**7.3**		4.0	0.17	mg/Kg	☼	07/13/21 08:00	07/21/21 13:21	4
Molybdenum	ND		11	0.44	mg/Kg	☼	07/13/21 08:00	07/21/21 13:21	4
Potassium	ND		1300	140	mg/Kg	☼	07/13/21 08:00	07/21/21 13:21	4
Selenium	ND		2.7	0.91	mg/Kg	☼	07/13/21 08:00	07/21/21 13:21	4
Sodium	ND		1300	700	mg/Kg	☼	07/13/21 08:00	07/21/21 13:21	4

Method: 6010B SEP - SEP Metals (ICP) - Step 2

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**17**	**J**	40	6.4	mg/Kg	☼	07/13/21 08:00	07/21/21 15:11	3
Antimony	ND		12	1.1	mg/Kg	☼	07/13/21 08:00	07/21/21 15:11	3
Arsenic	ND		2.0	0.52	mg/Kg	☼	07/13/21 08:00	07/21/21 15:11	3
Calcium	**6800**		1000	8.9	mg/Kg	☼	07/13/21 08:00	07/21/21 15:11	3
Cobalt	**1.2**	**J**	10	0.25	mg/Kg	☼	07/13/21 08:00	07/21/21 15:11	3
Iron	**860**		20	12	mg/Kg	☼	07/13/21 08:00	07/21/21 15:11	3
Lithium	ND		10	0.60	mg/Kg	☼	07/13/21 08:00	07/21/21 15:11	3
Manganese	**160**		3.0	1.1	mg/Kg	☼	07/13/21 08:00	07/21/21 15:11	3
Molybdenum	ND		8.0	0.33	mg/Kg	☼	07/13/21 08:00	07/21/21 15:11	3
Potassium	**180**	**J**	1000	100	mg/Kg	☼	07/13/21 08:00	07/21/21 15:11	3
Selenium	ND		2.0	0.68	mg/Kg	☼	07/13/21 08:00	07/21/21 15:11	3

Method: 6010B SEP - SEP Metals (ICP) - Step 3

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**190**		13	2.8	mg/Kg	☼	07/14/21 08:00	07/21/21 17:10	1
Antimony	ND		4.0	0.38	mg/Kg	☼	07/14/21 08:00	07/21/21 17:10	1
Arsenic	**3.4**		0.67	0.17	mg/Kg	☼	07/14/21 08:00	07/21/21 17:10	1
Calcium	**7.3**	**J**	340	2.0	mg/Kg	☼	07/14/21 08:00	07/21/21 17:10	1
Cobalt	**1.0**	**J**	3.4	0.060	mg/Kg	☼	07/14/21 08:00	07/21/21 17:10	1
Iron	**3400**		6.7	3.9	mg/Kg	☼	07/14/21 08:00	07/21/21 17:10	1
Lithium	ND		3.4	0.20	mg/Kg	☼	07/14/21 08:00	07/21/21 17:10	1
Manganese	**53**	**B**	1.0	0.036	mg/Kg	☼	07/14/21 08:00	07/21/21 17:10	1
Molybdenum	**0.25**	**J**	2.7	0.11	mg/Kg	☼	07/14/21 08:00	07/21/21 17:10	1
Potassium	**75**	**J**	340	35	mg/Kg	☼	07/14/21 08:00	07/21/21 17:10	1
Selenium	ND		0.67	0.23	mg/Kg	☼	07/14/21 08:00	07/21/21 17:10	1
Sodium	**11000**		340	170	mg/Kg	☼	07/14/21 08:00	07/21/21 17:10	1

Method: 6010B SEP - SEP Metals (ICP) - Step 4

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**1100**		13	2.1	mg/Kg	☼	07/15/21 08:00	07/22/21 14:37	1
Antimony	ND		4.0	0.60	mg/Kg	☼	07/15/21 08:00	07/22/21 14:37	1
Arsenic	**1.4**		0.67	0.30	mg/Kg	☼	07/15/21 08:00	07/22/21 14:37	1
Calcium	**3800**		340	3.0	mg/Kg	☼	07/15/21 08:00	07/22/21 14:37	1
Cobalt	**1.3**	**J**	3.4	0.071	mg/Kg	☼	07/15/21 08:00	07/22/21 14:37	1
Iron	**2800**		6.7	3.9	mg/Kg	☼	07/15/21 08:00	07/22/21 14:37	1

Client Sample Results

Client: Golder Associates Inc.
Job ID: 140-23290-1
Project/Site: Labadie Energy Center - Missouri

Client Sample ID: L-BH-02M
Lab Sample ID: 140-23290-5
Date Collected: 05/25/21 10:25
Matrix: Solid
Date Received: 05/28/21 10:00
Percent Solids: 74.5

Method: 6010B SEP - SEP Metals (ICP) - Step 4 (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Lithium	**2.8**	**J**	3.4	0.20	mg/Kg	☼	07/15/21 08:00	07/22/21 14:37	1
Manganese	**35**		1.0	0.17	mg/Kg	☼	07/15/21 08:00	07/22/21 14:37	1
Molybdenum	**0.12**	**J**	2.7	0.11	mg/Kg	☼	07/15/21 08:00	07/22/21 14:37	1
Potassium	**120**	**J**	340	35	mg/Kg	☼	07/15/21 08:00	07/22/21 14:37	1
Selenium	ND		0.67	0.63	mg/Kg	☼	07/15/21 08:00	07/22/21 14:37	1
Sodium	**1200**		340	170	mg/Kg	☼	07/15/21 08:00	07/22/21 14:37	1

Method: 6010B SEP - SEP Metals (ICP) - Step 5

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**62**	**J**	200	32	mg/Kg	☼	07/17/21 08:14	07/22/21 16:26	5
Antimony	ND		60	5.6	mg/Kg	☼	07/17/21 08:14	07/22/21 16:26	5
Arsenic	ND		10	2.5	mg/Kg	☼	07/17/21 08:14	07/22/21 16:26	5
Calcium	**3600**	**J B**	5000	15	mg/Kg	☼	07/17/21 08:14	07/22/21 16:26	5
Cobalt	ND		50	0.80	mg/Kg	☼	07/17/21 08:14	07/22/21 16:26	5
Iron	ND		100	59	mg/Kg	☼	07/17/21 08:14	07/22/21 16:26	5
Lithium	ND		50	3.0	mg/Kg	☼	07/17/21 08:14	07/22/21 16:26	5
Manganese	**9.9**	**J**	15	2.5	mg/Kg	☼	07/17/21 08:14	07/22/21 16:26	5
Molybdenum	ND		40	1.7	mg/Kg	☼	07/17/21 08:14	07/22/21 16:26	5
Potassium	**3200**	**J B**	5000	570	mg/Kg	☼	07/17/21 08:14	07/22/21 16:26	5
Selenium	ND		10	3.5	mg/Kg	☼	07/17/21 08:14	07/22/21 16:26	5

Method: 6010B SEP - SEP Metals (ICP) - Step 6

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**3100**		13	2.1	mg/Kg	☼	07/16/21 12:00	07/22/21 18:13	1
Antimony	ND		4.0	0.38	mg/Kg	☼	07/16/21 12:00	07/22/21 18:13	1
Arsenic	**1.0**		0.67	0.20	mg/Kg	☼	07/16/21 12:00	07/22/21 18:13	1
Calcium	**1300**		340	2.8	mg/Kg	☼	07/16/21 12:00	07/22/21 18:13	1
Cobalt	**1.2**	**J**	3.4	0.062	mg/Kg	☼	07/16/21 12:00	07/22/21 18:13	1
Iron	**4400**		6.7	3.9	mg/Kg	☼	07/16/21 12:00	07/22/21 18:13	1
Lithium	**3.4**		3.4	0.20	mg/Kg	☼	07/16/21 12:00	07/22/21 18:13	1
Manganese	**33**		1.0	0.34	mg/Kg	☼	07/16/21 12:00	07/22/21 18:13	1
Molybdenum	ND		2.7	0.13	mg/Kg	☼	07/16/21 12:00	07/22/21 18:13	1
Potassium	**940**		340	35	mg/Kg	☼	07/16/21 12:00	07/22/21 18:13	1
Selenium	ND		0.67	0.23	mg/Kg	☼	07/16/21 12:00	07/22/21 18:13	1
Sodium	**34000**		1700	870	mg/Kg	☼	07/16/21 12:00	07/22/21 19:48	5

Method: 6010B SEP - SEP Metals (ICP) - Step 7

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**36000**		130	21	mg/Kg	☼	07/20/21 08:00	07/23/21 14:16	10
Antimony	**1.1**	**J**	4.0	0.19	mg/Kg	☼	07/20/21 08:00	07/23/21 15:49	1
Arsenic	**2.0**		0.67	0.17	mg/Kg	☼	07/20/21 08:00	07/23/21 15:49	1
Calcium	**4000**		3400	35	mg/Kg	☼	07/20/21 08:00	07/23/21 14:16	10
Cobalt	**1.2**	**J**	6.7	0.070	mg/Kg	☼	07/20/21 08:00	07/28/21 15:39	2
Iron	**6500**		6.7	5.5	mg/Kg	☼	07/20/21 08:00	07/23/21 15:49	1
Lithium	**10**		3.4	0.20	mg/Kg	☼	07/20/21 08:00	07/23/21 15:49	1
Manganese	**67**		1.0	0.15	mg/Kg	☼	07/20/21 08:00	07/23/21 15:49	1
Molybdenum	**0.22**	**J**	2.7	0.11	mg/Kg	☼	07/20/21 08:00	07/23/21 15:49	1
Potassium	**17000**		1700	67	mg/Kg	☼	07/20/21 08:00	07/28/21 15:44	5
Selenium	**0.28**	**J**	0.67	0.23	mg/Kg	☼	07/20/21 08:00	07/23/21 15:49	1
Sodium	**10000**		340	58	mg/Kg	☼	07/20/21 08:00	07/23/21 15:49	1

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Client Sample ID: L-BH-02M

Date Collected: 05/25/21 10:25
Date Received: 05/28/21 10:00

Lab Sample ID: 140-23290-5
Matrix: Solid
Percent Solids: 74.5

Method: 6010B SEP - SEP Metals (ICP) - Sum of Steps 1-7

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**40000**		10	1.6	mg/Kg			07/29/21 21:07	1
Antimony	**1.1**	**J**	3.0	0.14	mg/Kg			07/29/21 21:07	1
Arsenic	**7.7**		0.50	0.13	mg/Kg			07/29/21 21:07	1
Calcium	**22000**		250	0.74	mg/Kg			07/29/21 21:07	1
Cobalt	**5.8**		2.5	0.023	mg/Kg			07/29/21 21:07	1
Iron	**18000**		5.0	4.1	mg/Kg			07/29/21 21:07	1
Lithium	**16**		2.5	0.15	mg/Kg			07/29/21 21:07	1
Manganese	**370**		0.75	0.052	mg/Kg			07/29/21 21:07	1
Molybdenum	**0.59**	**J**	2.0	0.082	mg/Kg			07/29/21 21:07	1
Potassium	**22000**		250	26	mg/Kg			07/29/21 21:07	1
Selenium	**0.28**	**J**	0.50	0.17	mg/Kg			07/29/21 21:07	1
Sodium	**56000**		250	130	mg/Kg			07/29/21 21:07	1

Method: 6010B - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**6500**		53	6.6	mg/Kg	☼	06/28/21 08:00	07/07/21 16:05	1
Antimony	ND		7.9	0.45	mg/Kg	☼	06/28/21 08:00	07/07/21 16:05	1
Arsenic	**6.1**		2.6	0.38	mg/Kg	☼	06/28/21 08:00	07/07/21 16:05	1
Calcium	**14000**		660	120	mg/Kg	☼	06/28/21 08:00	07/07/21 16:05	1
Cobalt	**5.0**	**J**	6.6	0.063	mg/Kg	☼	06/28/21 08:00	07/07/21 16:05	1
Iron	**10000**		26	10	mg/Kg	☼	06/28/21 08:00	07/07/21 16:05	1
Lithium	**8.0**		6.6	0.39	mg/Kg	☼	06/28/21 08:00	07/07/21 16:05	1
Manganese	**230**		2.0	0.81	mg/Kg	☼	06/28/21 08:00	07/07/21 16:05	1
Molybdenum	**0.35**	**J**	5.3	0.14	mg/Kg	☼	06/28/21 08:00	07/07/21 16:05	1
Potassium	**1600**		660	32	mg/Kg	☼	06/28/21 08:00	07/07/21 16:05	1
Selenium	ND		2.0	0.58	mg/Kg	☼	06/28/21 08:00	07/07/21 16:05	1
Sodium	**160**	**J**	660	47	mg/Kg	☼	06/28/21 08:00	07/07/21 16:05	1

Method: 6010B - SEP Metals (ICP) - Total

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**64000**		130	21	mg/Kg	☼	07/12/21 08:00	07/28/21 18:01	10
Antimony	**1.1**	**J**	4.0	0.19	mg/Kg	☼	07/12/21 08:00	07/29/21 12:15	1
Arsenic	**9.6**	**B**	0.67	0.17	mg/Kg	☼	07/12/21 08:00	07/29/21 12:15	1
Calcium	**30000**		3400	35	mg/Kg	☼	07/12/21 08:00	07/28/21 18:01	10
Cobalt	**8.1**		6.7	0.070	mg/Kg	☼	07/12/21 08:00	07/29/21 13:58	2
Iron	**19000**		6.7	5.5	mg/Kg	☼	07/12/21 08:00	07/29/21 12:15	1
Lithium	**21**		3.4	0.20	mg/Kg	☼	07/12/21 08:00	07/29/21 12:15	1
Manganese	**410**		1.0	0.15	mg/Kg	☼	07/12/21 08:00	07/29/21 12:15	1
Molybdenum	**0.82**	**J**	2.7	0.11	mg/Kg	☼	07/12/21 08:00	07/29/21 12:15	1
Potassium	**25000**		1700	67	mg/Kg	☼	07/12/21 08:00	07/29/21 14:03	5
Selenium	ND		0.67	0.23	mg/Kg	☼	07/12/21 08:00	07/29/21 12:15	1
Sodium	**11000**		340	58	mg/Kg	☼	07/12/21 08:00	07/29/21 12:15	1

Client Sample ID: L-BH-02D

Lab Sample ID: 140-23290-6

Date Collected: 05/25/21 10:25
Date Received: 05/28/21 10:00

Matrix: Solid
Percent Solids: 81.6

Method: 6010B SEP - SEP Metals (ICP) - Step 1

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	ND		49	7.8	mg/Kg	☼	07/13/21 08:00	07/21/21 13:26	4
Antimony	ND		15	1.4	mg/Kg	☼	07/13/21 08:00	07/21/21 13:26	4
Arsenic	ND		2.4	0.64	mg/Kg	☼	07/13/21 08:00	07/21/21 13:26	4
Calcium	**320**	**J B**	1200	9.3	mg/Kg	☼	07/13/21 08:00	07/21/21 13:26	4
Cobalt	ND		12	0.22	mg/Kg	☼	07/13/21 08:00	07/21/21 13:26	4
Iron	ND		24	14	mg/Kg	☼	07/13/21 08:00	07/21/21 13:26	4
Lithium	ND		12	0.73	mg/Kg	☼	07/13/21 08:00	07/21/21 13:26	4
Manganese	**0.91**	**J**	3.7	0.15	mg/Kg	☼	07/13/21 08:00	07/21/21 13:26	4
Molybdenum	ND		9.8	0.40	mg/Kg	☼	07/13/21 08:00	07/21/21 13:26	4
Potassium	ND		1200	130	mg/Kg	☼	07/13/21 08:00	07/21/21 13:26	4
Selenium	ND		2.4	0.83	mg/Kg	☼	07/13/21 08:00	07/21/21 13:26	4
Sodium	ND		1200	640	mg/Kg	☼	07/13/21 08:00	07/21/21 13:26	4

Method: 6010B SEP - SEP Metals (ICP) - Step 2

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**11**	**J**	37	5.9	mg/Kg	☼	07/13/21 08:00	07/21/21 15:16	3
Antimony	ND		11	1.0	mg/Kg	☼	07/13/21 08:00	07/21/21 15:16	3
Arsenic	ND		1.8	0.48	mg/Kg	☼	07/13/21 08:00	07/21/21 15:16	3
Calcium	**1300**		920	8.1	mg/Kg	☼	07/13/21 08:00	07/21/21 15:16	3
Cobalt	ND		9.2	0.23	mg/Kg	☼	07/13/21 08:00	07/21/21 15:16	3
Iron	**190**		18	11	mg/Kg	☼	07/13/21 08:00	07/21/21 15:16	3
Lithium	ND		9.2	0.55	mg/Kg	☼	07/13/21 08:00	07/21/21 15:16	3
Manganese	**23**		2.8	1.0	mg/Kg	☼	07/13/21 08:00	07/21/21 15:16	3
Molybdenum	ND		7.3	0.30	mg/Kg	☼	07/13/21 08:00	07/21/21 15:16	3
Potassium	**100**	**J**	920	96	mg/Kg	☼	07/13/21 08:00	07/21/21 15:16	3
Selenium	ND		1.8	0.62	mg/Kg	☼	07/13/21 08:00	07/21/21 15:16	3

Method: 6010B SEP - SEP Metals (ICP) - Step 3

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**47**		12	2.6	mg/Kg	☼	07/14/21 08:00	07/21/21 17:15	1
Antimony	ND		3.7	0.34	mg/Kg	☼	07/14/21 08:00	07/21/21 17:15	1
Arsenic	**0.47**	**J**	0.61	0.16	mg/Kg	☼	07/14/21 08:00	07/21/21 17:15	1
Calcium	**5.2**	**J**	310	1.8	mg/Kg	☼	07/14/21 08:00	07/21/21 17:15	1
Cobalt	**0.39**	**J**	3.1	0.055	mg/Kg	☼	07/14/21 08:00	07/21/21 17:15	1
Iron	**600**		6.1	3.6	mg/Kg	☼	07/14/21 08:00	07/21/21 17:15	1
Lithium	ND		3.1	0.18	mg/Kg	☼	07/14/21 08:00	07/21/21 17:15	1
Manganese	**15**	**B**	0.92	0.033	mg/Kg	☼	07/14/21 08:00	07/21/21 17:15	1
Molybdenum	ND		2.4	0.10	mg/Kg	☼	07/14/21 08:00	07/21/21 17:15	1
Potassium	ND		310	32	mg/Kg	☼	07/14/21 08:00	07/21/21 17:15	1
Selenium	ND		0.61	0.21	mg/Kg	☼	07/14/21 08:00	07/21/21 17:15	1
Sodium	**6700**		310	160	mg/Kg	☼	07/14/21 08:00	07/21/21 17:15	1

Method: 6010B SEP - SEP Metals (ICP) - Step 4

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**360**		12	2.0	mg/Kg	☼	07/15/21 08:00	07/22/21 14:42	1
Antimony	ND		3.7	0.55	mg/Kg	☼	07/15/21 08:00	07/22/21 14:42	1
Arsenic	**0.50**	**J**	0.61	0.27	mg/Kg	☼	07/15/21 08:00	07/22/21 14:42	1
Calcium	**1400**		310	2.7	mg/Kg	☼	07/15/21 08:00	07/22/21 14:42	1
Cobalt	**0.63**	**J**	3.1	0.065	mg/Kg	☼	07/15/21 08:00	07/22/21 14:42	1
Iron	**1000**		6.1	3.6	mg/Kg	☼	07/15/21 08:00	07/22/21 14:42	1

Client Sample ID: L-BH-02D

Lab Sample ID: 140-23290-6

Date Collected: 05/25/21 10:25
Date Received: 05/28/21 10:00

Matrix: Solid
Percent Solids: 81.6

Method: 6010B SEP - SEP Metals (ICP) - Step 4 (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Lithium	**0.71**	**J**	3.1	0.18	mg/Kg	☼	07/15/21 08:00	07/22/21 14:42	1
Manganese	**13**		0.92	0.16	mg/Kg	☼	07/15/21 08:00	07/22/21 14:42	1
Molybdenum	ND		2.4	0.10	mg/Kg	☼	07/15/21 08:00	07/22/21 14:42	1
Potassium	**42**	**J**	310	32	mg/Kg	☼	07/15/21 08:00	07/22/21 14:42	1
Selenium	ND		0.61	0.58	mg/Kg	☼	07/15/21 08:00	07/22/21 14:42	1
Sodium	**390**		310	160	mg/Kg	☼	07/15/21 08:00	07/22/21 14:42	1

Method: 6010B SEP - SEP Metals (ICP) - Step 5

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**74**	**J**	180	29	mg/Kg	☼	07/17/21 08:14	07/22/21 16:31	5
Antimony	ND		55	5.1	mg/Kg	☼	07/17/21 08:14	07/22/21 16:31	5
Arsenic	ND		9.2	2.3	mg/Kg	☼	07/17/21 08:14	07/22/21 16:31	5
Calcium	**850**	**J B**	4600	13	mg/Kg	☼	07/17/21 08:14	07/22/21 16:31	5
Cobalt	ND		46	0.73	mg/Kg	☼	07/17/21 08:14	07/22/21 16:31	5
Iron	ND		92	54	mg/Kg	☼	07/17/21 08:14	07/22/21 16:31	5
Lithium	ND		46	2.7	mg/Kg	☼	07/17/21 08:14	07/22/21 16:31	5
Manganese	ND		14	2.3	mg/Kg	☼	07/17/21 08:14	07/22/21 16:31	5
Molybdenum	ND		37	1.5	mg/Kg	☼	07/17/21 08:14	07/22/21 16:31	5
Potassium	**3100**	**J B**	4600	520	mg/Kg	☼	07/17/21 08:14	07/22/21 16:31	5
Selenium	ND		9.2	3.2	mg/Kg	☼	07/17/21 08:14	07/22/21 16:31	5

Method: 6010B SEP - SEP Metals (ICP) - Step 6

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**720**		12	2.0	mg/Kg	☼	07/16/21 12:00	07/22/21 18:18	1
Antimony	ND		3.7	0.34	mg/Kg	☼	07/16/21 12:00	07/22/21 18:18	1
Arsenic	**0.86**		0.61	0.18	mg/Kg	☼	07/16/21 12:00	07/22/21 18:18	1
Calcium	**250**	**J**	310	2.6	mg/Kg	☼	07/16/21 12:00	07/22/21 18:18	1
Cobalt	**0.53**	**J**	3.1	0.056	mg/Kg	☼	07/16/21 12:00	07/22/21 18:18	1
Iron	**1700**		6.1	3.6	mg/Kg	☼	07/16/21 12:00	07/22/21 18:18	1
Lithium	**0.89**	**J**	3.1	0.18	mg/Kg	☼	07/16/21 12:00	07/22/21 18:18	1
Manganese	**14**		0.92	0.31	mg/Kg	☼	07/16/21 12:00	07/22/21 18:18	1
Molybdenum	ND		2.4	0.12	mg/Kg	☼	07/16/21 12:00	07/22/21 18:18	1
Potassium	**250**	**J**	310	32	mg/Kg	☼	07/16/21 12:00	07/22/21 18:18	1
Selenium	ND		0.61	0.21	mg/Kg	☼	07/16/21 12:00	07/22/21 18:18	1
Sodium	**23000**		1500	800	mg/Kg	☼	07/16/21 12:00	07/22/21 19:53	5

Method: 6010B SEP - SEP Metals (ICP) - Step 7

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**37000**		120	20	mg/Kg	☼	07/20/21 08:00	07/23/21 14:21	10
Antimony	**0.45**	**J**	3.7	0.17	mg/Kg	☼	07/20/21 08:00	07/23/21 15:54	1
Arsenic	**1.5**		1.2	0.32	mg/Kg	☼	07/20/21 08:00	07/28/21 15:48	2
Calcium	**6600**		3100	32	mg/Kg	☼	07/20/21 08:00	07/23/21 14:21	10
Cobalt	**0.30**	**J**	3.1	0.032	mg/Kg	☼	07/20/21 08:00	07/23/21 15:54	1
Iron	**2400**		6.1	5.0	mg/Kg	☼	07/20/21 08:00	07/23/21 15:54	1
Lithium	**4.4**		3.1	0.18	mg/Kg	☼	07/20/21 08:00	07/23/21 15:54	1
Manganese	**47**		0.92	0.13	mg/Kg	☼	07/20/21 08:00	07/23/21 15:54	1
Molybdenum	**0.10**	**J**	2.4	0.10	mg/Kg	☼	07/20/21 08:00	07/23/21 15:54	1
Potassium	**19000**		1500	61	mg/Kg	☼	07/20/21 08:00	07/28/21 15:54	5
Selenium	ND		1.2	0.42	mg/Kg	☼	07/20/21 08:00	07/28/21 15:48	2
Sodium	**9500**		310	53	mg/Kg	☼	07/20/21 08:00	07/23/21 15:54	1

Client Sample Results

Client: Golder Associates Inc.　　Job ID: 140-23290-1
Project/Site: Labadie Energy Center - Missouri

Client Sample ID: L-BH-02D　　Lab Sample ID: 140-23290-6

Date Collected: 05/25/21 10:25　　**Matrix: Solid**
Date Received: 05/28/21 10:00　　**Percent Solids: 81.6**

Method: 6010B SEP - SEP Metals (ICP) - Sum of Steps 1-7

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**39000**		10	1.6	mg/Kg			07/29/21 21:07	1
Antimony	**0.45**	**J**	3.0	0.14	mg/Kg			07/29/21 21:07	1
Arsenic	**3.4**		0.50	0.13	mg/Kg			07/29/21 21:07	1
Calcium	**11000**		250	0.74	mg/Kg			07/29/21 21:07	1
Cobalt	**1.8**	**J**	2.5	0.023	mg/Kg			07/29/21 21:07	1
Iron	**5900**		5.0	4.1	mg/Kg			07/29/21 21:07	1
Lithium	**6.0**		2.5	0.15	mg/Kg			07/29/21 21:07	1
Manganese	**110**		0.75	0.052	mg/Kg			07/29/21 21:07	1
Molybdenum	**0.10**	**J**	2.0	0.082	mg/Kg			07/29/21 21:07	1
Potassium	**22000**		250	26	mg/Kg			07/29/21 21:07	1
Selenium	ND		0.50	0.17	mg/Kg			07/29/21 21:07	1
Sodium	**40000**		250	130	mg/Kg			07/29/21 21:07	1

Method: 6010B - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**1700**		47	5.9	mg/Kg	☼	06/28/21 08:00	07/07/21 16:10	1
Antimony	ND		7.1	0.40	mg/Kg	☼	06/28/21 08:00	07/07/21 16:10	1
Arsenic	**2.1**	**J**	2.4	0.34	mg/Kg	☼	06/28/21 08:00	07/07/21 16:10	1
Calcium	**3800**		590	100	mg/Kg	☼	06/28/21 08:00	07/07/21 16:10	1
Cobalt	**1.8**	**J**	5.9	0.057	mg/Kg	☼	06/28/21 08:00	07/07/21 16:10	1
Iron	**3400**		24	9.4	mg/Kg	☼	06/28/21 08:00	07/07/21 16:10	1
Lithium	**2.0**	**J**	5.9	0.36	mg/Kg	☼	06/28/21 08:00	07/07/21 16:10	1
Manganese	**63**		1.8	0.74	mg/Kg	☼	06/28/21 08:00	07/07/21 16:10	1
Molybdenum	ND		4.7	0.13	mg/Kg	☼	06/28/21 08:00	07/07/21 16:10	1
Potassium	**380**	**J**	590	28	mg/Kg	☼	06/28/21 08:00	07/07/21 16:10	1
Selenium	ND		1.8	0.52	mg/Kg	☼	06/28/21 08:00	07/07/21 16:10	1
Sodium	**71**	**J**	590	43	mg/Kg	☼	06/28/21 08:00	07/07/21 16:10	1

Method: 6010B - SEP Metals (ICP) - Total

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**41000**		120	20	mg/Kg	☼	07/12/21 08:00	07/28/21 18:06	10
Antimony	**0.41**	**J**	3.7	0.17	mg/Kg	☼	07/12/21 08:00	07/29/21 12:20	1
Arsenic	**4.4**	**B**	0.61	0.16	mg/Kg	☼	07/12/21 08:00	07/29/21 12:20	1
Calcium	**13000**		3100	32	mg/Kg	☼	07/12/21 08:00	07/28/21 18:06	10
Cobalt	**2.6**	**J**	3.1	0.032	mg/Kg	☼	07/12/21 08:00	07/29/21 12:20	1
Iron	**6800**		6.1	5.0	mg/Kg	☼	07/12/21 08:00	07/29/21 12:20	1
Lithium	**6.7**		3.1	0.18	mg/Kg	☼	07/12/21 08:00	07/29/21 12:20	1
Manganese	**150**		0.92	0.13	mg/Kg	☼	07/12/21 08:00	07/29/21 12:20	1
Molybdenum	**0.29**	**J**	2.4	0.10	mg/Kg	☼	07/12/21 08:00	07/29/21 12:20	1
Potassium	**18000**		1500	61	mg/Kg	☼	07/12/21 08:00	07/29/21 14:08	5
Selenium	ND		0.61	0.21	mg/Kg	☼	07/12/21 08:00	07/29/21 12:20	1
Sodium	**11000**		310	53	mg/Kg	☼	07/12/21 08:00	07/29/21 12:20	1

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Client Sample ID: L-BH-01S

Lab Sample ID: 140-23290-7

Date Collected: 05/26/21 08:10
Matrix: Solid
Date Received: 05/28/21 10:00
Percent Solids: 76.3

Method: 6010B SEP - SEP Metals (ICP) - Step 1

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	ND		52	8.4	mg/Kg	☼	07/13/21 08:00	07/21/21 13:31	4
Antimony	ND		16	1.5	mg/Kg	☼	07/13/21 08:00	07/21/21 13:31	4
Arsenic	ND		2.6	0.68	mg/Kg	☼	07/13/21 08:00	07/21/21 13:31	4
Calcium	**740**	**J B**	1300	10	mg/Kg	☼	07/13/21 08:00	07/21/21 13:31	4
Cobalt	ND		13	0.24	mg/Kg	☼	07/13/21 08:00	07/21/21 13:31	4
Iron	ND		26	15	mg/Kg	☼	07/13/21 08:00	07/21/21 13:31	4
Lithium	ND		13	0.79	mg/Kg	☼	07/13/21 08:00	07/21/21 13:31	4
Manganese	**0.55**	**J**	3.9	0.16	mg/Kg	☼	07/13/21 08:00	07/21/21 13:31	4
Molybdenum	ND		10	0.43	mg/Kg	☼	07/13/21 08:00	07/21/21 13:31	4
Potassium	ND		1300	140	mg/Kg	☼	07/13/21 08:00	07/21/21 13:31	4
Selenium	ND		2.6	0.89	mg/Kg	☼	07/13/21 08:00	07/21/21 13:31	4
Sodium	ND		1300	680	mg/Kg	☼	07/13/21 08:00	07/21/21 13:31	4

Method: 6010B SEP - SEP Metals (ICP) - Step 2

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**6.6**	**J**	39	6.3	mg/Kg	☼	07/13/21 08:00	07/21/21 15:21	3
Antimony	ND		12	1.1	mg/Kg	☼	07/13/21 08:00	07/21/21 15:21	3
Arsenic	ND		2.0	0.51	mg/Kg	☼	07/13/21 08:00	07/21/21 15:21	3
Calcium	**1800**		980	8.6	mg/Kg	☼	07/13/21 08:00	07/21/21 15:21	3
Cobalt	**0.46**	**J**	9.8	0.25	mg/Kg	☼	07/13/21 08:00	07/21/21 15:21	3
Iron	**14**	**J**	20	11	mg/Kg	☼	07/13/21 08:00	07/21/21 15:21	3
Lithium	ND		9.8	0.59	mg/Kg	☼	07/13/21 08:00	07/21/21 15:21	3
Manganese	**16**		2.9	1.1	mg/Kg	☼	07/13/21 08:00	07/21/21 15:21	3
Molybdenum	ND		7.9	0.32	mg/Kg	☼	07/13/21 08:00	07/21/21 15:21	3
Potassium	**110**	**J**	980	100	mg/Kg	☼	07/13/21 08:00	07/21/21 15:21	3
Selenium	ND		2.0	0.67	mg/Kg	☼	07/13/21 08:00	07/21/21 15:21	3

Method: 6010B SEP - SEP Metals (ICP) - Step 3

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**36**		13	2.8	mg/Kg	☼	07/14/21 08:00	07/21/21 17:20	1
Antimony	ND		3.9	0.37	mg/Kg	☼	07/14/21 08:00	07/21/21 17:20	1
Arsenic	**1.6**		0.65	0.17	mg/Kg	☼	07/14/21 08:00	07/21/21 17:20	1
Calcium	**6.4**	**J**	330	2.0	mg/Kg	☼	07/14/21 08:00	07/21/21 17:20	1
Cobalt	**0.91**	**J**	3.3	0.059	mg/Kg	☼	07/14/21 08:00	07/21/21 17:20	1
Iron	**560**		6.5	3.8	mg/Kg	☼	07/14/21 08:00	07/21/21 17:20	1
Lithium	ND		3.3	0.20	mg/Kg	☼	07/14/21 08:00	07/21/21 17:20	1
Manganese	**4.6**	**B**	0.98	0.035	mg/Kg	☼	07/14/21 08:00	07/21/21 17:20	1
Molybdenum	ND		2.6	0.11	mg/Kg	☼	07/14/21 08:00	07/21/21 17:20	1
Potassium	ND		330	34	mg/Kg	☼	07/14/21 08:00	07/21/21 17:20	1
Selenium	ND		0.65	0.22	mg/Kg	☼	07/14/21 08:00	07/21/21 17:20	1
Sodium	**7100**		330	170	mg/Kg	☼	07/14/21 08:00	07/21/21 17:20	1

Method: 6010B SEP - SEP Metals (ICP) - Step 4

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**410**		13	2.1	mg/Kg	☼	07/15/21 08:00	07/22/21 14:47	1
Antimony	ND		3.9	0.59	mg/Kg	☼	07/15/21 08:00	07/22/21 14:47	1
Arsenic	**1.1**		0.65	0.29	mg/Kg	☼	07/15/21 08:00	07/22/21 14:47	1
Calcium	**1200**		330	2.9	mg/Kg	☼	07/15/21 08:00	07/22/21 14:47	1
Cobalt	**1.3**	**J**	3.3	0.069	mg/Kg	☼	07/15/21 08:00	07/22/21 14:47	1
Iron	**1700**		6.5	3.8	mg/Kg	☼	07/15/21 08:00	07/22/21 14:47	1

Client Sample Results

Client Sample ID: L-BH-01S

Lab Sample ID: 140-23290-7

Date Collected: 05/26/21 08:10
Date Received: 05/28/21 10:00

Matrix: Solid
Percent Solids: 76.3

Method: 6010B SEP - SEP Metals (ICP) - Step 4 (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Lithium	**0.80**	**J**	3.3	0.20	mg/Kg	☼	07/15/21 08:00	07/22/21 14:47	1
Manganese	**16**		0.98	0.17	mg/Kg	☼	07/15/21 08:00	07/22/21 14:47	1
Molybdenum	ND		2.6	0.11	mg/Kg	☼	07/15/21 08:00	07/22/21 14:47	1
Potassium	**39**	**J**	330	34	mg/Kg	☼	07/15/21 08:00	07/22/21 14:47	1
Selenium	ND		0.65	0.62	mg/Kg	☼	07/15/21 08:00	07/22/21 14:47	1
Sodium	**420**		330	170	mg/Kg	☼	07/15/21 08:00	07/22/21 14:47	1

Method: 6010B SEP - SEP Metals (ICP) - Step 5

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**130**	**J**	200	31	mg/Kg	☼	07/17/21 08:14	07/22/21 16:36	5
Antimony	ND		59	5.5	mg/Kg	☼	07/17/21 08:14	07/22/21 16:36	5
Arsenic	ND		9.8	2.5	mg/Kg	☼	07/17/21 08:14	07/22/21 16:36	5
Calcium	**480**	**J B**	4900	14	mg/Kg	☼	07/17/21 08:14	07/22/21 16:36	5
Cobalt	ND		49	0.79	mg/Kg	☼	07/17/21 08:14	07/22/21 16:36	5
Iron	ND		98	58	mg/Kg	☼	07/17/21 08:14	07/22/21 16:36	5
Lithium	ND		49	2.9	mg/Kg	☼	07/17/21 08:14	07/22/21 16:36	5
Manganese	ND		15	2.4	mg/Kg	☼	07/17/21 08:14	07/22/21 16:36	5
Molybdenum	ND		39	1.6	mg/Kg	☼	07/17/21 08:14	07/22/21 16:36	5
Potassium	**3300**	**J B**	4900	560	mg/Kg	☼	07/17/21 08:14	07/22/21 16:36	5
Selenium	ND		9.8	3.4	mg/Kg	☼	07/17/21 08:14	07/22/21 16:36	5

Method: 6010B SEP - SEP Metals (ICP) - Step 6

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**740**		13	2.1	mg/Kg	☼	07/16/21 12:00	07/22/21 18:23	1
Antimony	ND		3.9	0.37	mg/Kg	☼	07/16/21 12:00	07/22/21 18:23	1
Arsenic	**0.80**		0.65	0.20	mg/Kg	☼	07/16/21 12:00	07/22/21 18:23	1
Calcium	**150**	**J**	330	2.8	mg/Kg	☼	07/16/21 12:00	07/22/21 18:23	1
Cobalt	**0.62**	**J**	3.3	0.060	mg/Kg	☼	07/16/21 12:00	07/22/21 18:23	1
Iron	**2300**		6.5	3.8	mg/Kg	☼	07/16/21 12:00	07/22/21 18:23	1
Lithium	**0.97**	**J**	3.3	0.20	mg/Kg	☼	07/16/21 12:00	07/22/21 18:23	1
Manganese	**18**		0.98	0.33	mg/Kg	☼	07/16/21 12:00	07/22/21 18:23	1
Molybdenum	ND		2.6	0.13	mg/Kg	☼	07/16/21 12:00	07/22/21 18:23	1
Potassium	**240**	**J**	330	34	mg/Kg	☼	07/16/21 12:00	07/22/21 18:23	1
Selenium	ND		0.65	0.22	mg/Kg	☼	07/16/21 12:00	07/22/21 18:23	1
Sodium	**23000**		1600	850	mg/Kg	☼	07/16/21 12:00	07/22/21 19:58	5

Method: 6010B SEP - SEP Metals (ICP) - Step 7

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**41000**		130	21	mg/Kg	☼	07/20/21 08:00	07/23/21 14:25	10
Antimony	**0.43**	**J**	3.9	0.18	mg/Kg	☼	07/20/21 08:00	07/23/21 16:00	1
Arsenic	**1.9**		0.65	0.17	mg/Kg	☼	07/20/21 08:00	07/23/21 16:00	1
Calcium	**5400**		3300	34	mg/Kg	☼	07/20/21 08:00	07/23/21 14:25	10
Cobalt	**0.44**	**J**	3.3	0.034	mg/Kg	☼	07/20/21 08:00	07/23/21 16:00	1
Iron	**2600**		6.5	5.4	mg/Kg	☼	07/20/21 08:00	07/23/21 16:00	1
Lithium	**5.4**		3.3	0.20	mg/Kg	☼	07/20/21 08:00	07/23/21 16:00	1
Manganese	**39**		0.98	0.14	mg/Kg	☼	07/20/21 08:00	07/23/21 16:00	1
Molybdenum	**0.12**	**J**	2.6	0.11	mg/Kg	☼	07/20/21 08:00	07/23/21 16:00	1
Potassium	**26000**		1600	65	mg/Kg	☼	07/20/21 08:00	07/28/21 15:58	5
Selenium	ND		0.65	0.22	mg/Kg	☼	07/20/21 08:00	07/23/21 16:00	1
Sodium	**8900**		330	56	mg/Kg	☼	07/20/21 08:00	07/23/21 16:00	1

Client Sample Results

Client: Golder Associates Inc. Job ID: 140-23290-1
Project/Site: Labadie Energy Center - Missouri

Client Sample ID: L-BH-01S Lab Sample ID: 140-23290-7

Date Collected: 05/26/21 08:10 **Matrix: Solid**
Date Received: 05/28/21 10:00 **Percent Solids: 76.3**

Method: 6010B SEP - SEP Metals (ICP) - Sum of Steps 1-7

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**42000**		10	1.6	mg/Kg			07/29/21 21:07	1
Antimony	**0.43**	**J**	3.0	0.14	mg/Kg			07/29/21 21:07	1
Arsenic	**5.3**		0.50	0.13	mg/Kg			07/29/21 21:07	1
Calcium	**9800**		250	0.74	mg/Kg			07/29/21 21:07	1
Cobalt	**3.7**		2.5	0.023	mg/Kg			07/29/21 21:07	1
Iron	**7200**		5.0	4.1	mg/Kg			07/29/21 21:07	1
Lithium	**7.2**		2.5	0.15	mg/Kg			07/29/21 21:07	1
Manganese	**94**		0.75	0.052	mg/Kg			07/29/21 21:07	1
Molybdenum	**0.12**	**J**	2.0	0.082	mg/Kg			07/29/21 21:07	1
Potassium	**30000**		250	26	mg/Kg			07/29/21 21:07	1
Selenium	ND		0.50	0.17	mg/Kg			07/29/21 21:07	1
Sodium	**40000**		250	130	mg/Kg			07/29/21 21:07	1

Method: 6010B - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**1800**		49	6.1	mg/Kg	☼	06/28/21 08:00	07/07/21 16:24	1
Antimony	ND		7.4	0.42	mg/Kg	☼	06/28/21 08:00	07/07/21 16:24	1
Arsenic	**4.2**		2.5	0.36	mg/Kg	☼	06/28/21 08:00	07/07/21 16:24	1
Calcium	**3900**		610	110	mg/Kg	☼	06/28/21 08:00	07/07/21 16:24	1
Cobalt	**4.6**	**J**	6.1	0.059	mg/Kg	☼	06/28/21 08:00	07/07/21 16:24	1
Iron	**4500**		25	9.7	mg/Kg	☼	06/28/21 08:00	07/07/21 16:24	1
Lithium	**2.3**	**J**	6.1	0.37	mg/Kg	☼	06/28/21 08:00	07/07/21 16:24	1
Manganese	**50**		1.8	0.76	mg/Kg	☼	06/28/21 08:00	07/07/21 16:24	1
Molybdenum	ND		4.9	0.13	mg/Kg	☼	06/28/21 08:00	07/07/21 16:24	1
Potassium	**390**	**J**	610	29	mg/Kg	☼	06/28/21 08:00	07/07/21 16:24	1
Selenium	ND		1.8	0.54	mg/Kg	☼	06/28/21 08:00	07/07/21 16:24	1
Sodium	**51**	**J**	610	44	mg/Kg	☼	06/28/21 08:00	07/07/21 16:24	1

Method: 6010B - SEP Metals (ICP) - Total

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**42000**		130	21	mg/Kg	☼	07/12/21 08:00	07/28/21 18:10	10
Antimony	**0.47**	**J**	3.9	0.18	mg/Kg	☼	07/12/21 08:00	07/29/21 12:26	1
Arsenic	**7.9**	**B**	0.65	0.17	mg/Kg	☼	07/12/21 08:00	07/29/21 12:26	1
Calcium	**12000**		3300	34	mg/Kg	☼	07/12/21 08:00	07/28/21 18:10	10
Cobalt	**4.8**		3.3	0.034	mg/Kg	☼	07/12/21 08:00	07/29/21 12:26	1
Iron	**7400**		6.5	5.4	mg/Kg	☼	07/12/21 08:00	07/29/21 12:26	1
Lithium	**6.6**		3.3	0.20	mg/Kg	☼	07/12/21 08:00	07/29/21 12:26	1
Manganese	**100**		0.98	0.14	mg/Kg	☼	07/12/21 08:00	07/29/21 12:26	1
Molybdenum	**0.26**	**J**	2.6	0.11	mg/Kg	☼	07/12/21 08:00	07/29/21 12:26	1
Potassium	**19000**		1600	65	mg/Kg	☼	07/12/21 08:00	07/29/21 14:13	5
Selenium	**0.54**	**J**	0.65	0.22	mg/Kg	☼	07/12/21 08:00	07/29/21 12:26	1
Sodium	**12000**		330	56	mg/Kg	☼	07/12/21 08:00	07/29/21 12:26	1

1 2 3 4 5 6 7 8 9 10 11 12 13

Client Sample ID: L-BH-01M

Lab Sample ID: 140-23290-8

Date Collected: 05/26/21 09:25
Matrix: Solid
Date Received: 05/28/21 10:00
Percent Solids: 86.5

Method: 6010B SEP - SEP Metals (ICP) - Step 1

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	ND		46	7.4	mg/Kg	☼	07/13/21 08:00	07/21/21 13:36	4
Antimony	ND		14	1.3	mg/Kg	☼	07/13/21 08:00	07/21/21 13:36	4
Arsenic	ND		2.3	0.60	mg/Kg	☼	07/13/21 08:00	07/21/21 13:36	4
Calcium	**340**	**J B**	1200	8.8	mg/Kg	☼	07/13/21 08:00	07/21/21 13:36	4
Cobalt	ND		12	0.21	mg/Kg	☼	07/13/21 08:00	07/21/21 13:36	4
Iron	ND		23	13	mg/Kg	☼	07/13/21 08:00	07/21/21 13:36	4
Lithium	ND		12	0.69	mg/Kg	☼	07/13/21 08:00	07/21/21 13:36	4
Manganese	**1.4**	**J**	3.5	0.14	mg/Kg	☼	07/13/21 08:00	07/21/21 13:36	4
Molybdenum	ND		9.3	0.38	mg/Kg	☼	07/13/21 08:00	07/21/21 13:36	4
Potassium	ND		1200	120	mg/Kg	☼	07/13/21 08:00	07/21/21 13:36	4
Selenium	ND		2.3	0.79	mg/Kg	☼	07/13/21 08:00	07/21/21 13:36	4
Sodium	ND		1200	600	mg/Kg	☼	07/13/21 08:00	07/21/21 13:36	4

Method: 6010B SEP - SEP Metals (ICP) - Step 2

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**6.5**	**J**	35	5.6	mg/Kg	☼	07/13/21 08:00	07/21/21 15:26	3
Antimony	ND		10	0.97	mg/Kg	☼	07/13/21 08:00	07/21/21 15:26	3
Arsenic	ND		1.7	0.45	mg/Kg	☼	07/13/21 08:00	07/21/21 15:26	3
Calcium	**1400**		870	7.6	mg/Kg	☼	07/13/21 08:00	07/21/21 15:26	3
Cobalt	ND		8.7	0.22	mg/Kg	☼	07/13/21 08:00	07/21/21 15:26	3
Iron	**75**		17	10	mg/Kg	☼	07/13/21 08:00	07/21/21 15:26	3
Lithium	ND		8.7	0.52	mg/Kg	☼	07/13/21 08:00	07/21/21 15:26	3
Manganese	**33**		2.6	0.97	mg/Kg	☼	07/13/21 08:00	07/21/21 15:26	3
Molybdenum	ND		6.9	0.28	mg/Kg	☼	07/13/21 08:00	07/21/21 15:26	3
Potassium	**93**	**J**	870	90	mg/Kg	☼	07/13/21 08:00	07/21/21 15:26	3
Selenium	ND		1.7	0.59	mg/Kg	☼	07/13/21 08:00	07/21/21 15:26	3

Method: 6010B SEP - SEP Metals (ICP) - Step 3

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**32**		12	2.4	mg/Kg	☼	07/14/21 08:00	07/21/21 17:25	1
Antimony	ND		3.5	0.32	mg/Kg	☼	07/14/21 08:00	07/21/21 17:25	1
Arsenic	**0.48**	**J**	0.58	0.15	mg/Kg	☼	07/14/21 08:00	07/21/21 17:25	1
Calcium	**5.0**	**J**	290	1.7	mg/Kg	☼	07/14/21 08:00	07/21/21 17:25	1
Cobalt	**0.51**	**J**	2.9	0.052	mg/Kg	☼	07/14/21 08:00	07/21/21 17:25	1
Iron	**400**		5.8	3.4	mg/Kg	☼	07/14/21 08:00	07/21/21 17:25	1
Lithium	ND		2.9	0.17	mg/Kg	☼	07/14/21 08:00	07/21/21 17:25	1
Manganese	**15**	**B**	0.87	0.031	mg/Kg	☼	07/14/21 08:00	07/21/21 17:25	1
Molybdenum	ND		2.3	0.095	mg/Kg	☼	07/14/21 08:00	07/21/21 17:25	1
Potassium	ND		290	30	mg/Kg	☼	07/14/21 08:00	07/21/21 17:25	1
Selenium	ND		0.58	0.20	mg/Kg	☼	07/14/21 08:00	07/21/21 17:25	1
Sodium	**5800**		290	150	mg/Kg	☼	07/14/21 08:00	07/21/21 17:25	1

Method: 6010B SEP - SEP Metals (ICP) - Step 4

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**350**		12	1.9	mg/Kg	☼	07/15/21 08:00	07/22/21 14:51	1
Antimony	ND		3.5	0.52	mg/Kg	☼	07/15/21 08:00	07/22/21 14:51	1
Arsenic	**0.64**		0.58	0.25	mg/Kg	☼	07/15/21 08:00	07/22/21 14:51	1
Calcium	**1500**		290	2.5	mg/Kg	☼	07/15/21 08:00	07/22/21 14:51	1
Cobalt	**0.94**	**J**	2.9	0.061	mg/Kg	☼	07/15/21 08:00	07/22/21 14:51	1
Iron	**1300**		5.8	3.4	mg/Kg	☼	07/15/21 08:00	07/22/21 14:51	1

Client Sample Results

Client: Golder Associates Inc.
Project/Site: Labadie Energy Center - Missouri

Job ID: 140-23290-1

Client Sample ID: L-BH-01M

Date Collected: 05/26/21 09:25
Date Received: 05/28/21 10:00

Lab Sample ID: 140-23290-8

Matrix: Solid
Percent Solids: 86.5

Method: 6010B SEP - SEP Metals (ICP) - Step 4 (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Lithium	**0.68**	**J**	2.9	0.17	mg/Kg	☼	07/15/21 08:00	07/22/21 14:51	1
Manganese	**17**		0.87	0.15	mg/Kg	☼	07/15/21 08:00	07/22/21 14:51	1
Molybdenum	ND		2.3	0.095	mg/Kg	☼	07/15/21 08:00	07/22/21 14:51	1
Potassium	**36**	**J**	290	30	mg/Kg	☼	07/15/21 08:00	07/22/21 14:51	1
Selenium	ND		0.58	0.54	mg/Kg	☼	07/15/21 08:00	07/22/21 14:51	1
Sodium	**330**		290	150	mg/Kg	☼	07/15/21 08:00	07/22/21 14:51	1

Method: 6010B SEP - SEP Metals (ICP) - Step 5

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**84**	**J**	170	27	mg/Kg	☼	07/17/21 08:14	07/22/21 16:41	5
Antimony	ND		52	4.9	mg/Kg	☼	07/17/21 08:14	07/22/21 16:41	5
Arsenic	ND		8.7	2.2	mg/Kg	☼	07/17/21 08:14	07/22/21 16:41	5
Calcium	**510**	**J B**	4300	13	mg/Kg	☼	07/17/21 08:14	07/22/21 16:41	5
Cobalt	ND		43	0.69	mg/Kg	☼	07/17/21 08:14	07/22/21 16:41	5
Iron	ND		87	51	mg/Kg	☼	07/17/21 08:14	07/22/21 16:41	5
Lithium	ND		43	2.5	mg/Kg	☼	07/17/21 08:14	07/22/21 16:41	5
Manganese	**2.1**	**J**	13	2.1	mg/Kg	☼	07/17/21 08:14	07/22/21 16:41	5
Molybdenum	ND		35	1.4	mg/Kg	☼	07/17/21 08:14	07/22/21 16:41	5
Potassium	**2900**	**J B**	4300	490	mg/Kg	☼	07/17/21 08:14	07/22/21 16:41	5
Selenium	ND		8.7	3.0	mg/Kg	☼	07/17/21 08:14	07/22/21 16:41	5

Method: 6010B SEP - SEP Metals (ICP) - Step 6

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**590**		12	1.9	mg/Kg	☼	07/16/21 12:00	07/22/21 18:28	1
Antimony	ND		3.5	0.32	mg/Kg	☼	07/16/21 12:00	07/22/21 18:28	1
Arsenic	**0.88**		0.58	0.17	mg/Kg	☼	07/16/21 12:00	07/22/21 18:28	1
Calcium	**380**		290	2.4	mg/Kg	☼	07/16/21 12:00	07/22/21 18:28	1
Cobalt	**0.65**	**J**	2.9	0.053	mg/Kg	☼	07/16/21 12:00	07/22/21 18:28	1
Iron	**1900**		5.8	3.4	mg/Kg	☼	07/16/21 12:00	07/22/21 18:28	1
Lithium	**0.72**	**J**	2.9	0.17	mg/Kg	☼	07/16/21 12:00	07/22/21 18:28	1
Manganese	**14**		0.87	0.29	mg/Kg	☼	07/16/21 12:00	07/22/21 18:28	1
Molybdenum	ND		2.3	0.11	mg/Kg	☼	07/16/21 12:00	07/22/21 18:28	1
Potassium	**180**	**J**	290	30	mg/Kg	☼	07/16/21 12:00	07/22/21 18:28	1
Selenium	ND		0.58	0.20	mg/Kg	☼	07/16/21 12:00	07/22/21 18:28	1
Sodium	**18000**		1400	750	mg/Kg	☼	07/16/21 12:00	07/22/21 20:03	5

Method: 6010B SEP - SEP Metals (ICP) - Step 7

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**31000**		120	19	mg/Kg	☼	07/20/21 08:00	07/23/21 14:30	10
Antimony	**0.39**	**J**	3.5	0.16	mg/Kg	☼	07/20/21 08:00	07/23/21 16:05	1
Arsenic	**0.79**	**J**	1.2	0.30	mg/Kg	☼	07/20/21 08:00	07/28/21 16:03	2
Calcium	**4400**		2900	30	mg/Kg	☼	07/20/21 08:00	07/23/21 14:30	10
Cobalt	ND		2.9	0.030	mg/Kg	☼	07/20/21 08:00	07/23/21 16:05	1
Iron	**1400**		5.8	4.7	mg/Kg	☼	07/20/21 08:00	07/23/21 16:05	1
Lithium	**2.7**	**J**	2.9	0.17	mg/Kg	☼	07/20/21 08:00	07/23/21 16:05	1
Manganese	**25**		0.87	0.13	mg/Kg	☼	07/20/21 08:00	07/23/21 16:05	1
Molybdenum	**0.11**	**J**	2.3	0.095	mg/Kg	☼	07/20/21 08:00	07/23/21 16:05	1
Potassium	**18000**		1400	58	mg/Kg	☼	07/20/21 08:00	07/28/21 16:08	5
Selenium	ND		1.2	0.39	mg/Kg	☼	07/20/21 08:00	07/28/21 16:03	2
Sodium	**8800**		290	50	mg/Kg	☼	07/20/21 08:00	07/23/21 16:05	1

Client Sample Results

Client: Golder Associates Inc. Job ID: 140-23290-1
Project/Site: Labadie Energy Center - Missouri

Client Sample ID: L-BH-01M

Date Collected: 05/26/21 09:25
Date Received: 05/28/21 10:00

Lab Sample ID: 140-23290-8
Matrix: Solid
Percent Solids: 86.5

Method: 6010B SEP - SEP Metals (ICP) - Sum of Steps 1-7

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**32000**		10	1.6	mg/Kg			07/29/21 21:07	1
Antimony	**0.39**	**J**	3.0	0.14	mg/Kg			07/29/21 21:07	1
Arsenic	**2.8**		0.50	0.13	mg/Kg			07/29/21 21:07	1
Calcium	**8500**		250	0.74	mg/Kg			07/29/21 21:07	1
Cobalt	**2.1**	**J**	2.5	0.023	mg/Kg			07/29/21 21:07	1
Iron	**5100**		5.0	4.1	mg/Kg			07/29/21 21:07	1
Lithium	**4.1**		2.5	0.15	mg/Kg			07/29/21 21:07	1
Manganese	**110**		0.75	0.052	mg/Kg			07/29/21 21:07	1
Molybdenum	**0.11**	**J**	2.0	0.082	mg/Kg			07/29/21 21:07	1
Potassium	**22000**		250	26	mg/Kg			07/29/21 21:07	1
Selenium	ND		0.50	0.17	mg/Kg			07/29/21 21:07	1
Sodium	**33000**		250	130	mg/Kg			07/29/21 21:07	1

Method: 6010B - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**1300**		43	5.4	mg/Kg	☼	06/28/21 08:00	07/07/21 16:28	1
Antimony	ND		6.5	0.37	mg/Kg	☼	06/28/21 08:00	07/07/21 16:28	1
Arsenic	**2.9**		2.2	0.31	mg/Kg	☼	06/28/21 08:00	07/07/21 16:28	1
Calcium	**4200**		540	95	mg/Kg	☼	06/28/21 08:00	07/07/21 16:28	1
Cobalt	**2.3**	**J**	5.4	0.052	mg/Kg	☼	06/28/21 08:00	07/07/21 16:28	1
Iron	**3400**		22	8.6	mg/Kg	☼	06/28/21 08:00	07/07/21 16:28	1
Lithium	**1.7**	**J**	5.4	0.33	mg/Kg	☼	06/28/21 08:00	07/07/21 16:28	1
Manganese	**95**		1.6	0.67	mg/Kg	☼	06/28/21 08:00	07/07/21 16:28	1
Molybdenum	**0.16**	**J**	4.3	0.12	mg/Kg	☼	06/28/21 08:00	07/07/21 16:28	1
Potassium	**280**	**J**	540	26	mg/Kg	☼	06/28/21 08:00	07/07/21 16:28	1
Selenium	ND		1.6	0.48	mg/Kg	☼	06/28/21 08:00	07/07/21 16:28	1
Sodium	**46**	**J**	540	39	mg/Kg	☼	06/28/21 08:00	07/07/21 16:28	1

Method: 6010B - SEP Metals (ICP) - Total

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**38000**		120	19	mg/Kg	☼	07/12/21 08:00	07/28/21 18:15	10
Antimony	**0.41**	**J**	3.5	0.16	mg/Kg	☼	07/12/21 08:00	07/29/21 12:31	1
Arsenic	**4.1**	**B**	0.58	0.15	mg/Kg	☼	07/12/21 08:00	07/29/21 12:31	1
Calcium	**9900**		2900	30	mg/Kg	☼	07/12/21 08:00	07/28/21 18:15	10
Cobalt	**2.8**	**J**	2.9	0.030	mg/Kg	☼	07/12/21 08:00	07/29/21 12:31	1
Iron	**5700**		5.8	4.7	mg/Kg	☼	07/12/21 08:00	07/29/21 12:31	1
Lithium	**5.3**		2.9	0.17	mg/Kg	☼	07/12/21 08:00	07/29/21 12:31	1
Manganese	**140**		0.87	0.13	mg/Kg	☼	07/12/21 08:00	07/29/21 12:31	1
Molybdenum	**0.26**	**J**	2.3	0.095	mg/Kg	☼	07/12/21 08:00	07/29/21 12:31	1
Potassium	**18000**		1400	58	mg/Kg	☼	07/12/21 08:00	07/29/21 14:18	5
Selenium	ND		0.58	0.20	mg/Kg	☼	07/12/21 08:00	07/29/21 12:31	1
Sodium	**11000**		290	50	mg/Kg	☼	07/12/21 08:00	07/29/21 12:31	1

1 2 3 4 5 6 7 8 9 10 11 12 13

Client Sample ID: L-BH-01D

Lab Sample ID: 140-23290-9
Date Collected: 05/26/21 11:05
Matrix: Solid
Date Received: 05/28/21 10:00
Percent Solids: 88.2

Method: 6010B SEP - SEP Metals (ICP) - Step 1

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	ND		45	7.3	mg/Kg	☼	07/13/21 08:00	07/21/21 13:40	4
Antimony	ND		14	1.3	mg/Kg	☼	07/13/21 08:00	07/21/21 13:40	4
Arsenic	ND		2.3	0.59	mg/Kg	☼	07/13/21 08:00	07/21/21 13:40	4
Calcium	**270**	**J B**	1100	8.6	mg/Kg	☼	07/13/21 08:00	07/21/21 13:40	4
Cobalt	ND		11	0.20	mg/Kg	☼	07/13/21 08:00	07/21/21 13:40	4
Iron	ND		23	13	mg/Kg	☼	07/13/21 08:00	07/21/21 13:40	4
Lithium	ND		11	0.68	mg/Kg	☼	07/13/21 08:00	07/21/21 13:40	4
Manganese	**3.4**		3.4	0.14	mg/Kg	☼	07/13/21 08:00	07/21/21 13:40	4
Molybdenum	ND		9.1	0.37	mg/Kg	☼	07/13/21 08:00	07/21/21 13:40	4
Potassium	ND		1100	120	mg/Kg	☼	07/13/21 08:00	07/21/21 13:40	4
Selenium	ND		2.3	0.77	mg/Kg	☼	07/13/21 08:00	07/21/21 13:40	4
Sodium	ND		1100	590	mg/Kg	☼	07/13/21 08:00	07/21/21 13:40	4

Method: 6010B SEP - SEP Metals (ICP) - Step 2

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**6.0**	**J**	34	5.4	mg/Kg	☼	07/13/21 08:00	07/21/21 15:31	3
Antimony	ND		10	0.95	mg/Kg	☼	07/13/21 08:00	07/21/21 15:31	3
Arsenic	ND		1.7	0.44	mg/Kg	☼	07/13/21 08:00	07/21/21 15:31	3
Calcium	**2700**		850	7.5	mg/Kg	☼	07/13/21 08:00	07/21/21 15:31	3
Cobalt	ND		8.5	0.21	mg/Kg	☼	07/13/21 08:00	07/21/21 15:31	3
Iron	**100**		17	9.9	mg/Kg	☼	07/13/21 08:00	07/21/21 15:31	3
Lithium	ND		8.5	0.51	mg/Kg	☼	07/13/21 08:00	07/21/21 15:31	3
Manganese	**68**		2.6	0.95	mg/Kg	☼	07/13/21 08:00	07/21/21 15:31	3
Molybdenum	ND		6.8	0.28	mg/Kg	☼	07/13/21 08:00	07/21/21 15:31	3
Potassium	**90**	**J**	850	88	mg/Kg	☼	07/13/21 08:00	07/21/21 15:31	3
Selenium	ND		1.7	0.58	mg/Kg	☼	07/13/21 08:00	07/21/21 15:31	3

Method: 6010B SEP - SEP Metals (ICP) - Step 3

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**16**		11	2.4	mg/Kg	☼	07/14/21 08:00	07/21/21 17:30	1
Antimony	ND		3.4	0.32	mg/Kg	☼	07/14/21 08:00	07/21/21 17:30	1
Arsenic	ND		0.57	0.15	mg/Kg	☼	07/14/21 08:00	07/21/21 17:30	1
Calcium	**5.9**	**J**	280	1.7	mg/Kg	☼	07/14/21 08:00	07/21/21 17:30	1
Cobalt	**0.21**	**J**	2.8	0.051	mg/Kg	☼	07/14/21 08:00	07/21/21 17:30	1
Iron	**310**		5.7	3.3	mg/Kg	☼	07/14/21 08:00	07/21/21 17:30	1
Lithium	ND		2.8	0.17	mg/Kg	☼	07/14/21 08:00	07/21/21 17:30	1
Manganese	**48**	**B**	0.85	0.031	mg/Kg	☼	07/14/21 08:00	07/21/21 17:30	1
Molybdenum	**0.14**	**J**	2.3	0.093	mg/Kg	☼	07/14/21 08:00	07/21/21 17:30	1
Potassium	ND		280	29	mg/Kg	☼	07/14/21 08:00	07/21/21 17:30	1
Selenium	ND		0.57	0.19	mg/Kg	☼	07/14/21 08:00	07/21/21 17:30	1
Sodium	**6000**		280	150	mg/Kg	☼	07/14/21 08:00	07/21/21 17:30	1

Method: 6010B SEP - SEP Metals (ICP) - Step 4

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**220**		11	1.8	mg/Kg	☼	07/15/21 08:00	07/22/21 14:56	1
Antimony	ND		3.4	0.51	mg/Kg	☼	07/15/21 08:00	07/22/21 14:56	1
Arsenic	**0.31**	**J**	0.57	0.25	mg/Kg	☼	07/15/21 08:00	07/22/21 14:56	1
Calcium	**1300**		280	2.5	mg/Kg	☼	07/15/21 08:00	07/22/21 14:56	1
Cobalt	**1.3**	**J**	2.8	0.060	mg/Kg	☼	07/15/21 08:00	07/22/21 14:56	1
Iron	**1100**		5.7	3.3	mg/Kg	☼	07/15/21 08:00	07/22/21 14:56	1

Client Sample Results

Client: Golder Associates Inc. Job ID: 140-23290-1
Project/Site: Labadie Energy Center - Missouri

Client Sample ID: L-BH-01D Lab Sample ID: 140-23290-9

Date Collected: 05/26/21 11:05 **Matrix: Solid**
Date Received: 05/28/21 10:00 **Percent Solids: 88.2**

Method: 6010B SEP - SEP Metals (ICP) - Step 4 (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Lithium	**0.36**	**J**	2.8	0.17	mg/Kg	☼	07/15/21 08:00	07/22/21 14:56	1
Manganese	**100**		0.85	0.15	mg/Kg	☼	07/15/21 08:00	07/22/21 14:56	1
Molybdenum	ND		2.3	0.093	mg/Kg	☼	07/15/21 08:00	07/22/21 14:56	1
Potassium	ND		280	29	mg/Kg	☼	07/15/21 08:00	07/22/21 14:56	1
Selenium	ND		0.57	0.53	mg/Kg	☼	07/15/21 08:00	07/22/21 14:56	1
Sodium	**360**		280	150	mg/Kg	☼	07/15/21 08:00	07/22/21 14:56	1

Method: 6010B SEP - SEP Metals (ICP) - Step 5

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**31**	**J**	170	27	mg/Kg	☼	07/17/21 08:14	07/22/21 16:46	5
Antimony	ND		51	4.8	mg/Kg	☼	07/17/21 08:14	07/22/21 16:46	5
Arsenic	ND		8.5	2.2	mg/Kg	☼	07/17/21 08:14	07/22/21 16:46	5
Calcium	**990**	**J B**	4300	12	mg/Kg	☼	07/17/21 08:14	07/22/21 16:46	5
Cobalt	ND		43	0.68	mg/Kg	☼	07/17/21 08:14	07/22/21 16:46	5
Iron	ND		85	50	mg/Kg	☼	07/17/21 08:14	07/22/21 16:46	5
Lithium	ND		43	2.5	mg/Kg	☼	07/17/21 08:14	07/22/21 16:46	5
Manganese	**5.2**	**J**	13	2.1	mg/Kg	☼	07/17/21 08:14	07/22/21 16:46	5
Molybdenum	ND		34	1.4	mg/Kg	☼	07/17/21 08:14	07/22/21 16:46	5
Potassium	**2900**	**J B**	4300	480	mg/Kg	☼	07/17/21 08:14	07/22/21 16:46	5
Selenium	ND		8.5	2.9	mg/Kg	☼	07/17/21 08:14	07/22/21 16:46	5

Method: 6010B SEP - SEP Metals (ICP) - Step 6

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**450**		11	1.8	mg/Kg	☼	07/16/21 12:00	07/22/21 18:33	1
Antimony	ND		3.4	0.32	mg/Kg	☼	07/16/21 12:00	07/22/21 18:33	1
Arsenic	**0.54**	**J**	0.57	0.17	mg/Kg	☼	07/16/21 12:00	07/22/21 18:33	1
Calcium	**690**		280	2.4	mg/Kg	☼	07/16/21 12:00	07/22/21 18:33	1
Cobalt	**0.71**	**J**	2.8	0.052	mg/Kg	☼	07/16/21 12:00	07/22/21 18:33	1
Iron	**1300**		5.7	3.3	mg/Kg	☼	07/16/21 12:00	07/22/21 18:33	1
Lithium	**0.58**	**J**	2.8	0.17	mg/Kg	☼	07/16/21 12:00	07/22/21 18:33	1
Manganese	**17**		0.85	0.28	mg/Kg	☼	07/16/21 12:00	07/22/21 18:33	1
Molybdenum	ND		2.3	0.11	mg/Kg	☼	07/16/21 12:00	07/22/21 18:33	1
Potassium	**130**	**J**	280	29	mg/Kg	☼	07/16/21 12:00	07/22/21 18:33	1
Selenium	ND		0.57	0.19	mg/Kg	☼	07/16/21 12:00	07/22/21 18:33	1
Sodium	**20000**		1400	740	mg/Kg	☼	07/16/21 12:00	07/22/21 20:07	5

Method: 6010B SEP - SEP Metals (ICP) - Step 7

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**43000**		110	18	mg/Kg	☼	07/20/21 08:00	07/23/21 14:35	10
Antimony	**0.16**	**J**	3.4	0.16	mg/Kg	☼	07/20/21 08:00	07/23/21 16:10	1
Arsenic	**1.1**		0.57	0.15	mg/Kg	☼	07/20/21 08:00	07/23/21 16:10	1
Calcium	**4600**		2800	29	mg/Kg	☼	07/20/21 08:00	07/23/21 14:35	10
Cobalt	ND		2.8	0.029	mg/Kg	☼	07/20/21 08:00	07/23/21 16:10	1
Iron	**1400**		5.7	4.7	mg/Kg	☼	07/20/21 08:00	07/23/21 16:10	1
Lithium	**2.2**	**J**	2.8	0.17	mg/Kg	☼	07/20/21 08:00	07/23/21 16:10	1
Manganese	**38**		0.85	0.12	mg/Kg	☼	07/20/21 08:00	07/23/21 16:10	1
Molybdenum	ND		2.3	0.093	mg/Kg	☼	07/20/21 08:00	07/23/21 16:10	1
Potassium	**26000**		1400	57	mg/Kg	☼	07/20/21 08:00	07/28/21 16:22	5
Selenium	ND		0.57	0.19	mg/Kg	☼	07/20/21 08:00	07/23/21 16:10	1
Sodium	**18000**		1400	240	mg/Kg	☼	07/20/21 08:00	07/28/21 16:22	5

Client Sample Results

Client: Golder Associates Inc. Job ID: 140-23290-1
Project/Site: Labadie Energy Center - Missouri

Client Sample ID: L-BH-01D

Lab Sample ID: 140-23290-9

Date Collected: 05/26/21 11:05
Matrix: Solid
Date Received: 05/28/21 10:00
Percent Solids: 88.2

Method: 6010B SEP - SEP Metals (ICP) - Sum of Steps 1-7

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**44000**		10	1.6	mg/Kg			07/29/21 21:07	1
Antimony	**0.16**	**J**	3.0	0.14	mg/Kg			07/29/21 21:07	1
Arsenic	**2.0**		0.50	0.13	mg/Kg			07/29/21 21:07	1
Calcium	**11000**		250	0.74	mg/Kg			07/29/21 21:07	1
Cobalt	**2.2**	**J**	2.5	0.023	mg/Kg			07/29/21 21:07	1
Iron	**4200**		5.0	4.1	mg/Kg			07/29/21 21:07	1
Lithium	**3.1**		2.5	0.15	mg/Kg			07/29/21 21:07	1
Manganese	**280**		0.75	0.052	mg/Kg			07/29/21 21:07	1
Molybdenum	**0.14**	**J**	2.0	0.082	mg/Kg			07/29/21 21:07	1
Potassium	**30000**		250	26	mg/Kg			07/29/21 21:07	1
Selenium	ND		0.50	0.17	mg/Kg			07/29/21 21:07	1
Sodium	**45000**		250	130	mg/Kg			07/29/21 21:07	1

Method: 6010B - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**840**		42	5.2	mg/Kg	☼	06/28/21 08:00	07/07/21 16:48	1
Antimony	ND		6.3	0.36	mg/Kg	☼	06/28/21 08:00	07/07/21 16:48	1
Arsenic	**0.87**	**J**	2.1	0.30	mg/Kg	☼	06/28/21 08:00	07/07/21 16:48	1
Calcium	**4800**		520	92	mg/Kg	☼	06/28/21 08:00	07/07/21 16:48	1
Cobalt	**2.1**	**J**	5.2	0.050	mg/Kg	☼	06/28/21 08:00	07/07/21 16:48	1
Iron	**2100**		21	8.3	mg/Kg	☼	06/28/21 08:00	07/07/21 16:48	1
Lithium	**1.6**	**J**	5.2	0.31	mg/Kg	☼	06/28/21 08:00	07/07/21 16:48	1
Manganese	**99**		1.6	0.65	mg/Kg	☼	06/28/21 08:00	07/07/21 16:48	1
Molybdenum	**0.60**	**J**	4.2	0.12	mg/Kg	☼	06/28/21 08:00	07/07/21 16:48	1
Potassium	**200**	**J**	520	25	mg/Kg	☼	06/28/21 08:00	07/07/21 16:48	1
Selenium	ND		1.6	0.46	mg/Kg	☼	06/28/21 08:00	07/07/21 16:48	1
Sodium	**39**	**J**	520	38	mg/Kg	☼	06/28/21 08:00	07/07/21 16:48	1

Method: 6010B - SEP Metals (ICP) - Total

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**40000**		110	18	mg/Kg	☼	07/12/21 08:00	07/28/21 18:20	10
Antimony	**0.34**	**J**	3.4	0.16	mg/Kg	☼	07/12/21 08:00	07/29/21 12:36	1
Arsenic	**2.4**	**B**	0.57	0.15	mg/Kg	☼	07/12/21 08:00	07/29/21 12:36	1
Calcium	**8400**		2800	29	mg/Kg	☼	07/12/21 08:00	07/28/21 18:20	10
Cobalt	**2.1**	**J**	2.8	0.029	mg/Kg	☼	07/12/21 08:00	07/29/21 12:36	1
Iron	**6100**		5.7	4.7	mg/Kg	☼	07/12/21 08:00	07/29/21 12:36	1
Lithium	**3.6**		2.8	0.17	mg/Kg	☼	07/12/21 08:00	07/29/21 12:36	1
Manganese	**250**		0.85	0.12	mg/Kg	☼	07/12/21 08:00	07/29/21 12:36	1
Molybdenum	**3.2**		2.3	0.093	mg/Kg	☼	07/12/21 08:00	07/29/21 12:36	1
Potassium	**27000**		1400	57	mg/Kg	☼	07/12/21 08:00	07/29/21 14:22	5
Selenium	**0.38**	**J**	0.57	0.19	mg/Kg	☼	07/12/21 08:00	07/29/21 12:36	1
Sodium	**12000**		1400	240	mg/Kg	☼	07/12/21 08:00	07/29/21 14:22	5

Default Detection Limits

Method: 6010B SEP - SEP Metals (ICP) - Step 1

Prep: 3010A

SEP: Exchangeable

Analyte	RL	MDL	Units
Aluminum	10	1.6	mg/Kg
Antimony	3.0	0.28	mg/Kg
Arsenic	0.50	0.13	mg/Kg
Calcium	250	1.9	mg/Kg
Cobalt	2.5	0.045	mg/Kg
Iron	5.0	2.9	mg/Kg
Lithium	2.5	0.15	mg/Kg
Manganese	0.75	0.031	mg/Kg
Molybdenum	2.0	0.082	mg/Kg
Potassium	250	26	mg/Kg
Selenium	0.50	0.17	mg/Kg
Sodium	250	130	mg/Kg

Method: 6010B SEP - SEP Metals (ICP) - Step 2

Prep: 3010A

SEP: Carbonate

Analyte	RL	MDL	Units
Aluminum	10	1.6	mg/Kg
Antimony	3.0	0.28	mg/Kg
Arsenic	0.50	0.13	mg/Kg
Calcium	250	2.2	mg/Kg
Cobalt	2.5	0.063	mg/Kg
Iron	5.0	2.9	mg/Kg
Lithium	2.5	0.15	mg/Kg
Manganese	0.75	0.28	mg/Kg
Molybdenum	2.0	0.082	mg/Kg
Potassium	250	26	mg/Kg
Selenium	0.50	0.17	mg/Kg

Method: 6010B SEP - SEP Metals (ICP) - Step 3

Prep: 3010A

SEP: Non-Crystalline

Analyte	RL	MDL	Units
Aluminum	10	2.1	mg/Kg
Antimony	3.0	0.28	mg/Kg
Arsenic	0.50	0.13	mg/Kg
Calcium	250	1.5	mg/Kg
Cobalt	2.5	0.045	mg/Kg
Iron	5.0	2.9	mg/Kg
Lithium	2.5	0.15	mg/Kg
Manganese	0.75	0.027	mg/Kg
Molybdenum	2.0	0.082	mg/Kg
Potassium	250	26	mg/Kg
Selenium	0.50	0.17	mg/Kg
Sodium	250	130	mg/Kg

Method: 6010B SEP - SEP Metals (ICP) - Step 4

Prep: 3010A

SEP: Metal Hydroxide

Default Detection Limits

Method: 6010B SEP - SEP Metals (ICP) - Step 4

Prep: 3010A

SEP: Metal Hydroxide

Analyte	RL	MDL	Units
Aluminum	10	1.6	mg/Kg
Antimony	3.0	0.45	mg/Kg
Arsenic	0.50	0.22	mg/Kg
Calcium	250	2.2	mg/Kg
Cobalt	2.5	0.053	mg/Kg
Iron	5.0	2.9	mg/Kg
Lithium	2.5	0.15	mg/Kg
Manganese	0.75	0.13	mg/Kg
Molybdenum	2.0	0.082	mg/Kg
Potassium	250	26	mg/Kg
Selenium	0.50	0.47	mg/Kg
Sodium	250	130	mg/Kg

Method: 6010B SEP - SEP Metals (ICP) - Step 5

Prep: 3010A

SEP: Organic-Bound

Analyte	RL	MDL	Units
Aluminum	30	4.7	mg/Kg
Antimony	9.0	0.84	mg/Kg
Arsenic	1.5	0.38	mg/Kg
Calcium	750	2.2	mg/Kg
Cobalt	7.5	0.12	mg/Kg
Iron	15	8.8	mg/Kg
Lithium	7.5	0.44	mg/Kg
Manganese	2.3	0.37	mg/Kg
Molybdenum	6.0	0.25	mg/Kg
Potassium	750	85	mg/Kg
Selenium	1.5	0.52	mg/Kg

Method: 6010B SEP - SEP Metals (ICP) - Step 6

SEP: Acid/Sulfide

Analyte	RL	MDL	Units
Aluminum	10	1.6	mg/Kg
Antimony	3.0	0.28	mg/Kg
Arsenic	0.50	0.15	mg/Kg
Calcium	250	2.1	mg/Kg
Cobalt	2.5	0.046	mg/Kg
Iron	5.0	2.9	mg/Kg
Lithium	2.5	0.15	mg/Kg
Manganese	0.75	0.25	mg/Kg
Molybdenum	2.0	0.099	mg/Kg
Potassium	250	26	mg/Kg
Selenium	0.50	0.17	mg/Kg
Sodium	250	130	mg/Kg

Method: 6010B SEP - SEP Metals (ICP) - Step 7

Prep: Residual

Analyte	RL	MDL	Units
Aluminum	10	1.6	mg/Kg
Antimony	3.0	0.14	mg/Kg

Method: 6010B SEP - SEP Metals (ICP) - Step 7 (Continued)

Prep: Residual

Analyte	RL	MDL	Units
Arsenic	0.50	0.13	mg/Kg
Calcium	250	2.6	mg/Kg
Cobalt	2.5	0.026	mg/Kg
Iron	5.0	4.1	mg/Kg
Lithium	2.5	0.15	mg/Kg
Manganese	0.75	0.11	mg/Kg
Molybdenum	2.0	0.082	mg/Kg
Potassium	250	10	mg/Kg
Selenium	0.50	0.17	mg/Kg
Sodium	250	43	mg/Kg

Method: 6010B SEP - SEP Metals (ICP) - Sum of Steps 1-7

Analyte	RL	MDL	Units
Aluminum	10	1.6	mg/Kg
Antimony	3.0	0.14	mg/Kg
Arsenic	0.50	0.13	mg/Kg
Calcium	250	0.74	mg/Kg
Cobalt	2.5	0.023	mg/Kg
Iron	5.0	4.1	mg/Kg
Lithium	2.5	0.15	mg/Kg
Manganese	0.75	0.052	mg/Kg
Molybdenum	2.0	0.082	mg/Kg
Potassium	250	26	mg/Kg
Selenium	0.50	0.17	mg/Kg
Sodium	250	130	mg/Kg

Method: 6010B - Metals (ICP)

Prep: 3050B

Analyte	RL	MDL	Units
Aluminum	40	5.0	mg/Kg
Antimony	6.0	0.34	mg/Kg
Arsenic	2.0	0.29	mg/Kg
Calcium	500	88	mg/Kg
Cobalt	5.0	0.048	mg/Kg
Iron	20	7.9	mg/Kg
Lithium	5.0	0.30	mg/Kg
Manganese	1.5	0.62	mg/Kg
Molybdenum	4.0	0.11	mg/Kg
Potassium	500	24	mg/Kg
Selenium	1.5	0.44	mg/Kg
Sodium	500	36	mg/Kg

Method: 6010B - SEP Metals (ICP) - Total

Prep: Total

Analyte	RL	MDL	Units
Aluminum	10	1.6	mg/Kg
Antimony	3.0	0.14	mg/Kg
Arsenic	0.50	0.13	mg/Kg
Calcium	250	2.6	mg/Kg
Cobalt	2.5	0.026	mg/Kg
Iron	5.0	4.1	mg/Kg

Default Detection Limits

Client: Golder Associates Inc.
Project/Site: Labadie Energy Center - Missouri

Method: 6010B - SEP Metals (ICP) - Total (Continued)

Prep: Total

Analyte	RL	MDL	Units
Lithium	2.5	0.15	mg/Kg
Manganese	0.75	0.11	mg/Kg
Molybdenum	2.0	0.082	mg/Kg
Potassium	250	10	mg/Kg
Selenium	0.50	0.17	mg/Kg
Sodium	250	43	mg/Kg

QC Sample Results

Method: 6010B - Metals (ICP)

Lab Sample ID: MB 140-51236/21-A
Matrix: Solid
Analysis Batch: 51553

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 51236

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	ND		40	5.0	mg/Kg		06/28/21 08:00	07/07/21 11:36	1
Antimony	ND		6.0	0.34	mg/Kg		06/28/21 08:00	07/07/21 11:36	1
Arsenic	ND		2.0	0.29	mg/Kg		06/28/21 08:00	07/07/21 11:36	1
Calcium	ND		500	88	mg/Kg		06/28/21 08:00	07/07/21 11:36	1
Cobalt	ND		5.0	0.048	mg/Kg		06/28/21 08:00	07/07/21 11:36	1
Iron	ND		20	7.9	mg/Kg		06/28/21 08:00	07/07/21 11:36	1
Lithium	ND		5.0	0.30	mg/Kg		06/28/21 08:00	07/07/21 11:36	1
Manganese	ND		1.5	0.62	mg/Kg		06/28/21 08:00	07/07/21 11:36	1
Molybdenum	ND		4.0	0.11	mg/Kg		06/28/21 08:00	07/07/21 11:36	1
Potassium	ND		500	24	mg/Kg		06/28/21 08:00	07/07/21 11:36	1
Selenium	ND		1.5	0.44	mg/Kg		06/28/21 08:00	07/07/21 11:36	1
Sodium	ND		500	36	mg/Kg		06/28/21 08:00	07/07/21 11:36	1

Lab Sample ID: LCS 140-51236/22-A
Matrix: Solid
Analysis Batch: 51553

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 51236

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Aluminum	200	200		mg/Kg		100	90 - 110
Antimony	50.0	49.2		mg/Kg		98	90 - 110
Arsenic	10.0	9.56		mg/Kg		96	90 - 110
Calcium	5000	5040		mg/Kg		101	90 - 110
Cobalt	10.0	10.2		mg/Kg		102	90 - 110
Iron	100	103		mg/Kg		103	90 - 113
Lithium	10.0	9.79		mg/Kg		98	80 - 120
Manganese	10.0	10.3		mg/Kg		103	90 - 110
Molybdenum	50.0	51.8		mg/Kg		104	90 - 110
Potassium	5000	4970		mg/Kg		99	90 - 110
Selenium	15.0	14.8		mg/Kg		99	90 - 110
Sodium	5000	5050		mg/Kg		101	87 - 116

Lab Sample ID: 140-23290-6 MS
Matrix: Solid
Analysis Batch: 51553

Client Sample ID: L-BH-02D
Prep Type: Total/NA
Prep Batch: 51236

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
Aluminum	1700		225	3680	4	mg/Kg	☼	886	75 - 125
Antimony	ND		56.3	47.2		mg/Kg	☼	84	75 - 125
Arsenic	2.1	J	11.3	12.4		mg/Kg	☼	92	75 - 125
Calcium	3800		5630	9390		mg/Kg	☼	99	75 - 125
Cobalt	1.8	J	11.3	12.3		mg/Kg	☼	93	75 - 125
Iron	3400		113	3870	4	mg/Kg	☼	462	75 - 125
Lithium	2.0	J	11.3	12.5		mg/Kg	☼	93	75 - 125
Manganese	63		11.3	82.0	4	mg/Kg	☼	169	75 - 125
Molybdenum	ND		56.3	52.5		mg/Kg	☼	93	75 - 125
Potassium	380	J	5630	5820		mg/Kg	☼	97	75 - 125
Selenium	ND		16.9	15.3		mg/Kg	☼	90	75 - 121
Sodium	71	J	5630	5310		mg/Kg	☼	93	75 - 125

Method: 6010B - Metals (ICP) (Continued)

Lab Sample ID: 140-23290-6 MSD **Client Sample ID: L-BH-02D**
Matrix: Solid **Prep Type: Total/NA**
Analysis Batch: 51553 **Prep Batch: 51236**

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Aluminum	1700		240	3780	4	mg/Kg	☼	875	75 - 125	3	20
Antimony	ND		59.9	52.2		mg/Kg	☼	87	75 - 125	10	20
Arsenic	2.1	J	12.0	13.0		mg/Kg	☼	91	75 - 125	5	20
Calcium	3800		5990	9940		mg/Kg	☼	102	75 - 125	6	20
Cobalt	1.8	J	12.0	13.2		mg/Kg	☼	95	75 - 125	7	20
Iron	3400		120	4090	4	mg/Kg	☼	613	75 - 125	5	20
Lithium	2.0	J	12.0	13.4		mg/Kg	☼	95	75 - 125	7	20
Manganese	63		12.0	86.5	4	mg/Kg	☼	195	75 - 125	5	20
Molybdenum	ND		59.9	57.7		mg/Kg	☼	96	75 - 125	9	20
Potassium	380	J	5990	6350		mg/Kg	☼	100	75 - 125	9	20
Selenium	ND		18.0	16.7		mg/Kg	☼	93	75 - 121	9	20
Sodium	71	J	5990	5840		mg/Kg	☼	96	75 - 125	9	20

Method: 6010B - SEP Metals (ICP) - Total

Lab Sample ID: MB 140-51614/18-A **Client Sample ID: Method Blank**
Matrix: Solid **Prep Type: Total/NA**
Analysis Batch: 52192 **Prep Batch: 51614**

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	ND		10	1.6	mg/Kg		07/12/21 08:00	07/28/21 16:44	1
Calcium	ND		250	2.6	mg/Kg		07/12/21 08:00	07/28/21 16:44	1

Lab Sample ID: MB 140-51614/18-A **Client Sample ID: Method Blank**
Matrix: Solid **Prep Type: Total/NA**
Analysis Batch: 52210 **Prep Batch: 51614**

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	ND		10	1.6	mg/Kg		07/12/21 08:00	07/29/21 10:53	1
Antimony	ND		3.0	0.14	mg/Kg		07/12/21 08:00	07/29/21 10:53	1
Arsenic	0.134	J	0.50	0.13	mg/Kg		07/12/21 08:00	07/29/21 10:53	1
Calcium	ND		250	2.6	mg/Kg		07/12/21 08:00	07/29/21 10:53	1
Cobalt	ND		2.5	0.026	mg/Kg		07/12/21 08:00	07/29/21 10:53	1
Iron	ND		5.0	4.1	mg/Kg		07/12/21 08:00	07/29/21 10:53	1
Lithium	ND		2.5	0.15	mg/Kg		07/12/21 08:00	07/29/21 10:53	1
Manganese	ND		0.75	0.11	mg/Kg		07/12/21 08:00	07/29/21 10:53	1
Molybdenum	ND		2.0	0.082	mg/Kg		07/12/21 08:00	07/29/21 10:53	1
Potassium	ND		250	10	mg/Kg		07/12/21 08:00	07/29/21 10:53	1
Selenium	ND		0.50	0.17	mg/Kg		07/12/21 08:00	07/29/21 10:53	1
Sodium	ND		250	43	mg/Kg		07/12/21 08:00	07/29/21 10:53	1

Lab Sample ID: LCS 140-51614/19-A **Client Sample ID: Lab Control Sample**
Matrix: Solid **Prep Type: Total/NA**
Analysis Batch: 52192 **Prep Batch: 51614**

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Aluminum	100	100		mg/Kg		100	80 - 120
Calcium	2500	2550		mg/Kg		102	80 - 120

Method: 6010B - SEP Metals (ICP) - Total (Continued)

Lab Sample ID: LCS 140-51614/19-A
Client Sample ID: Lab Control Sample
Matrix: Solid
Prep Type: Total/NA
Analysis Batch: 52210
Prep Batch: 51614

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Aluminum	100	103		mg/Kg		103	80 - 120
Antimony	25.0	25.2		mg/Kg		101	80 - 125
Arsenic	5.00	5.16		mg/Kg		103	80 - 120
Calcium	2500	2610		mg/Kg		104	80 - 120
Cobalt	5.00	5.25		mg/Kg		105	80 - 125
Iron	50.0	53.6		mg/Kg		107	80 - 120
Lithium	5.00	5.15		mg/Kg		103	80 - 120
Manganese	5.00	5.42		mg/Kg		108	80 - 120
Molybdenum	25.0	26.6		mg/Kg		106	80 - 125
Potassium	2500	2630		mg/Kg		105	80 - 120
Selenium	7.50	7.51		mg/Kg		100	80 - 120
Sodium	2500	2660		mg/Kg		106	80 - 120

Lab Sample ID: LCSD 140-51614/20-A
Client Sample ID: Lab Control Sample Dup
Matrix: Solid
Prep Type: Total/NA
Analysis Batch: 52192
Prep Batch: 51614

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Aluminum	100	100		mg/Kg		100	80 - 120	0	30
Calcium	2500	2540		mg/Kg		101	80 - 120	1	30

Lab Sample ID: LCSD 140-51614/20-A
Client Sample ID: Lab Control Sample Dup
Matrix: Solid
Prep Type: Total/NA
Analysis Batch: 52210
Prep Batch: 51614

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Aluminum	100	103		mg/Kg		103	80 - 120	0	30
Antimony	25.0	25.3		mg/Kg		101	80 - 125	0	30
Arsenic	5.00	5.15		mg/Kg		103	80 - 120	0	30
Calcium	2500	2590		mg/Kg		103	80 - 120	1	30
Cobalt	5.00	5.24		mg/Kg		105	80 - 125	0	30
Iron	50.0	53.1		mg/Kg		106	80 - 120	1	30
Lithium	5.00	5.04		mg/Kg		101	80 - 120	2	30
Manganese	5.00	5.44		mg/Kg		109	80 - 120	0	30
Molybdenum	25.0	26.5		mg/Kg		106	80 - 125	0	30
Potassium	2500	2610		mg/Kg		104	80 - 120	1	30
Selenium	7.50	7.40		mg/Kg		99	80 - 120	2	30
Sodium	2500	2640		mg/Kg		105	80 - 120	1	30

Method: 6010B SEP - SEP Metals (ICP)

Lab Sample ID: MB 140-51615/18-B ^4
Client Sample ID: Method Blank
Matrix: Solid
Prep Type: Step 1
Analysis Batch: 51972
Prep Batch: 51654

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	ND		40	6.4	mg/Kg		07/13/21 08:00	07/21/21 12:08	4
Antimony	ND		12	1.1	mg/Kg		07/13/21 08:00	07/21/21 12:08	4
Arsenic	ND		2.0	0.52	mg/Kg		07/13/21 08:00	07/21/21 12:08	4

QC Sample Results

Client: Golder Associates Inc.
Project/Site: Labadie Energy Center - Missouri

Job ID: 140-23290-1

Method: 6010B SEP - SEP Metals (ICP) (Continued)

Lab Sample ID: MB 140-51615/18-B ^4
Matrix: Solid
Analysis Batch: 51972

Client Sample ID: Method Blank
Prep Type: Step 1
Prep Batch: 51654

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Calcium	23.2	J	1000	7.6	mg/Kg		07/13/21 08:00	07/21/21 12:08	4
Cobalt	ND		10	0.18	mg/Kg		07/13/21 08:00	07/21/21 12:08	4
Iron	ND		20	12	mg/Kg		07/13/21 08:00	07/21/21 12:08	4
Lithium	ND		10	0.60	mg/Kg		07/13/21 08:00	07/21/21 12:08	4
Manganese	ND		3.0	0.12	mg/Kg		07/13/21 08:00	07/21/21 12:08	4
Molybdenum	ND		8.0	0.33	mg/Kg		07/13/21 08:00	07/21/21 12:08	4
Potassium	ND		1000	100	mg/Kg		07/13/21 08:00	07/21/21 12:08	4
Selenium	ND		2.0	0.68	mg/Kg		07/13/21 08:00	07/21/21 12:08	4
Sodium	ND		1000	520	mg/Kg		07/13/21 08:00	07/21/21 12:08	4

Lab Sample ID: LCS 140-51615/19-B ^5
Matrix: Solid
Analysis Batch: 51972

Client Sample ID: Lab Control Sample
Prep Type: Step 1
Prep Batch: 51654

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Aluminum	100	94.2		mg/Kg		94	80 - 120
Antimony	25.0	23.2		mg/Kg		93	80 - 120
Arsenic	5.00	4.51		mg/Kg		90	80 - 120
Calcium	2500	2330		mg/Kg		93	80 - 120
Cobalt	5.00	4.68	J	mg/Kg		94	80 - 120
Iron	50.0	48.1		mg/Kg		96	80 - 120
Lithium	5.00	4.89	J	mg/Kg		98	80 - 120
Manganese	5.00	4.95		mg/Kg		99	80 - 120
Molybdenum	25.0	23.6		mg/Kg		94	80 - 120
Potassium	2500	2500		mg/Kg		100	80 - 120
Selenium	7.50	7.36		mg/Kg		98	80 - 120
Sodium	2500	2450		mg/Kg		98	80 - 120

Lab Sample ID: LCSD 140-51615/20-B ^5
Matrix: Solid
Analysis Batch: 51972

Client Sample ID: Lab Control Sample Dup
Prep Type: Step 1
Prep Batch: 51654

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Aluminum	100	99.7		mg/Kg		100	80 - 120	6	30
Antimony	25.0	23.7		mg/Kg		95	80 - 120	2	30
Arsenic	5.00	4.52		mg/Kg		90	80 - 120	0	30
Calcium	2500	2390		mg/Kg		95	80 - 120	2	30
Cobalt	5.00	4.80	J	mg/Kg		96	80 - 120	3	30
Iron	50.0	49.4		mg/Kg		99	80 - 120	3	30
Lithium	5.00	4.94	J	mg/Kg		99	80 - 120	1	30
Manganese	5.00	5.04		mg/Kg		101	80 - 120	2	30
Molybdenum	25.0	24.1		mg/Kg		96	80 - 120	2	30
Potassium	2500	2550		mg/Kg		102	80 - 120	2	30
Selenium	7.50	7.47		mg/Kg		100	80 - 120	1	30
Sodium	2500	2510		mg/Kg		100	80 - 120	2	30

QC Sample Results

Method: 6010B SEP - SEP Metals (ICP) (Continued)

Lab Sample ID: MB 140-51653/15-B ^3
Matrix: Solid
Analysis Batch: 51972

Client Sample ID: Method Blank
Prep Type: Step 2
Prep Batch: 51667

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	ND		30	4.8	mg/Kg		07/13/21 08:00	07/21/21 13:55	3
Antimony	ND		9.0	0.84	mg/Kg		07/13/21 08:00	07/21/21 13:55	3
Arsenic	ND		1.5	0.39	mg/Kg		07/13/21 08:00	07/21/21 13:55	3
Calcium	ND		750	6.6	mg/Kg		07/13/21 08:00	07/21/21 13:55	3
Cobalt	ND		7.5	0.19	mg/Kg		07/13/21 08:00	07/21/21 13:55	3
Iron	ND		15	8.7	mg/Kg		07/13/21 08:00	07/21/21 13:55	3
Lithium	ND		7.5	0.45	mg/Kg		07/13/21 08:00	07/21/21 13:55	3
Manganese	ND		2.3	0.84	mg/Kg		07/13/21 08:00	07/21/21 13:55	3
Molybdenum	ND		6.0	0.25	mg/Kg		07/13/21 08:00	07/21/21 13:55	3
Potassium	ND		750	78	mg/Kg		07/13/21 08:00	07/21/21 13:55	3
Selenium	ND		1.5	0.51	mg/Kg		07/13/21 08:00	07/21/21 13:55	3

Lab Sample ID: LCS 140-51653/16-B ^5
Matrix: Solid
Analysis Batch: 51972

Client Sample ID: Lab Control Sample
Prep Type: Step 2
Prep Batch: 51667

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Aluminum	100	ND		mg/Kg		0.3	
Antimony	25.0	21.2		mg/Kg		85	70 - 120
Arsenic	5.00	3.66		mg/Kg		73	60 - 120
Calcium	2500	659	J	mg/Kg		26	10 - 40
Cobalt	5.00	4.72	J	mg/Kg		94	80 - 120
Iron	50.0	ND		mg/Kg		3	
Lithium	5.00	4.68	J	mg/Kg		94	80 - 120
Manganese	5.00	4.89		mg/Kg		98	80 - 120
Molybdenum	25.0	21.2		mg/Kg		85	70 - 120
Potassium	2500	2550		mg/Kg		102	80 - 120
Selenium	7.50	6.87		mg/Kg		92	70 - 120

Lab Sample ID: LCSD 140-51653/17-B ^5
Matrix: Solid
Analysis Batch: 51972

Client Sample ID: Lab Control Sample Dup
Prep Type: Step 2
Prep Batch: 51667

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Aluminum	100	ND		mg/Kg		-2		281	
Antimony	25.0	20.9		mg/Kg		83	70 - 120	2	30
Arsenic	5.00	3.54		mg/Kg		71	60 - 120	3	30
Calcium	2500	641	J	mg/Kg		26	10 - 40	3	30
Cobalt	5.00	4.54	J	mg/Kg		91	80 - 120	4	30
Iron	50.0	ND		mg/Kg		4		35	
Lithium	5.00	4.44	J	mg/Kg		89	80 - 120	5	30
Manganese	5.00	4.69		mg/Kg		94	80 - 120	4	30
Molybdenum	25.0	20.4		mg/Kg		82	70 - 120	4	30
Potassium	2500	2450		mg/Kg		98	80 - 120	4	30
Selenium	7.50	5.97		mg/Kg		80	70 - 120	14	30

Method: 6010B SEP - SEP Metals (ICP) (Continued)

Lab Sample ID: MB 140-51666/15-B
Matrix: Solid
Analysis Batch: 51972

Client Sample ID: Method Blank
Prep Type: Step 3
Prep Batch: 51707

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	ND		10	2.1	mg/Kg		07/14/21 08:00	07/21/21 15:58	1
Antimony	ND		3.0	0.28	mg/Kg		07/14/21 08:00	07/21/21 15:58	1
Arsenic	ND		0.50	0.13	mg/Kg		07/14/21 08:00	07/21/21 15:58	1
Calcium	ND		250	1.5	mg/Kg		07/14/21 08:00	07/21/21 15:58	1
Cobalt	ND		2.5	0.045	mg/Kg		07/14/21 08:00	07/21/21 15:58	1
Iron	ND		5.0	2.9	mg/Kg		07/14/21 08:00	07/21/21 15:58	1
Lithium	ND		2.5	0.15	mg/Kg		07/14/21 08:00	07/21/21 15:58	1
Manganese	0.0895	J	0.75	0.027	mg/Kg		07/14/21 08:00	07/21/21 15:58	1
Molybdenum	ND		2.0	0.082	mg/Kg		07/14/21 08:00	07/21/21 15:58	1
Potassium	ND		250	26	mg/Kg		07/14/21 08:00	07/21/21 15:58	1
Selenium	ND		0.50	0.17	mg/Kg		07/14/21 08:00	07/21/21 15:58	1
Sodium	ND		250	130	mg/Kg		07/14/21 08:00	07/21/21 15:58	1

Lab Sample ID: LCS 140-51666/16-B
Matrix: Solid
Analysis Batch: 51972

Client Sample ID: Lab Control Sample
Prep Type: Step 3
Prep Batch: 51707

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Aluminum	100	93.0		mg/Kg		93	80 - 120
Antimony	25.0	22.7		mg/Kg		91	80 - 120
Arsenic	5.00	4.51		mg/Kg		90	80 - 120
Calcium	2500	30.3	J	mg/Kg		1	
Cobalt	5.00	4.66		mg/Kg		93	80 - 120
Iron	50.0	48.2		mg/Kg		96	80 - 120
Lithium	5.00	4.55		mg/Kg		91	80 - 120
Manganese	5.00	4.76		mg/Kg		95	80 - 120
Molybdenum	25.0	23.4		mg/Kg		93	80 - 120
Potassium	2500	2350		mg/Kg		94	80 - 120
Selenium	7.50	7.10		mg/Kg		95	80 - 120
Sodium	2500	2330		mg/Kg		93	80 - 120

Lab Sample ID: LCSD 140-51666/17-B
Matrix: Solid
Analysis Batch: 51972

Client Sample ID: Lab Control Sample Dup
Prep Type: Step 3
Prep Batch: 51707

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Aluminum	100	94.5		mg/Kg		94	80 - 120	2	30
Antimony	25.0	23.0		mg/Kg		92	80 - 120	1	30
Arsenic	5.00	4.55		mg/Kg		91	80 - 120	1	30
Calcium	2500	31.2	J	mg/Kg		1		3	
Cobalt	5.00	4.71		mg/Kg		94	80 - 120	1	30
Iron	50.0	49.2		mg/Kg		98	80 - 120	2	30
Lithium	5.00	4.57		mg/Kg		91	80 - 120	1	30
Manganese	5.00	4.81		mg/Kg		96	80 - 120	1	30
Molybdenum	25.0	23.6		mg/Kg		94	80 - 120	1	30
Potassium	2500	2370		mg/Kg		95	80 - 120	1	30
Selenium	7.50	7.31		mg/Kg		97	80 - 120	3	30
Sodium	2500	2350		mg/Kg		94	80 - 120	1	30

QC Sample Results

Method: 6010B SEP - SEP Metals (ICP) (Continued)

Lab Sample ID: MB 140-51690/15-B
Matrix: Solid
Analysis Batch: 52038

Client Sample ID: Method Blank
Prep Type: Step 4
Prep Batch: 51767

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	ND		10	1.6	mg/Kg		07/15/21 08:00	07/22/21 13:25	1
Antimony	ND		3.0	0.45	mg/Kg		07/15/21 08:00	07/22/21 13:25	1
Arsenic	ND		0.50	0.22	mg/Kg		07/15/21 08:00	07/22/21 13:25	1
Calcium	ND		250	2.2	mg/Kg		07/15/21 08:00	07/22/21 13:25	1
Cobalt	ND		2.5	0.053	mg/Kg		07/15/21 08:00	07/22/21 13:25	1
Iron	ND		5.0	2.9	mg/Kg		07/15/21 08:00	07/22/21 13:25	1
Lithium	ND		2.5	0.15	mg/Kg		07/15/21 08:00	07/22/21 13:25	1
Manganese	ND		0.75	0.13	mg/Kg		07/15/21 08:00	07/22/21 13:25	1
Molybdenum	ND		2.0	0.082	mg/Kg		07/15/21 08:00	07/22/21 13:25	1
Potassium	ND		250	26	mg/Kg		07/15/21 08:00	07/22/21 13:25	1
Selenium	ND		0.50	0.47	mg/Kg		07/15/21 08:00	07/22/21 13:25	1
Sodium	ND		250	130	mg/Kg		07/15/21 08:00	07/22/21 13:25	1

Lab Sample ID: LCS 140-51690/16-B
Matrix: Solid
Analysis Batch: 52038

Client Sample ID: Lab Control Sample
Prep Type: Step 4
Prep Batch: 51767

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Aluminum	100	94.8		mg/Kg		95	80 - 120
Antimony	25.0	23.9		mg/Kg		96	80 - 130
Arsenic	5.00	4.86		mg/Kg		97	80 - 130
Calcium	2500	2400		mg/Kg		96	80 - 120
Cobalt	5.00	4.91		mg/Kg		98	80 - 120
Iron	50.0	48.6		mg/Kg		97	80 - 120
Lithium	5.00	4.66		mg/Kg		93	80 - 120
Manganese	5.00	4.90		mg/Kg		98	80 - 120
Molybdenum	25.0	25.0		mg/Kg		100	80 - 120
Potassium	2500	2380		mg/Kg		95	80 - 120
Selenium	7.50	ND		mg/Kg		4	
Sodium	2500	2390		mg/Kg		96	80 - 120

Lab Sample ID: LCSD 140-51690/17-B
Matrix: Solid
Analysis Batch: 52038

Client Sample ID: Lab Control Sample Dup
Prep Type: Step 4
Prep Batch: 51767

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Aluminum	100	94.5		mg/Kg		95	80 - 120	0	30
Antimony	25.0	24.1		mg/Kg		96	80 - 130	1	30
Arsenic	5.00	4.83		mg/Kg		97	80 - 130	1	30
Calcium	2500	2400		mg/Kg		96	80 - 120	0	30
Cobalt	5.00	4.93		mg/Kg		99	80 - 120	0	30
Iron	50.0	49.0		mg/Kg		98	80 - 120	1	30
Lithium	5.00	4.65		mg/Kg		93	80 - 120	0	30
Manganese	5.00	4.92		mg/Kg		98	80 - 120	0	30
Molybdenum	25.0	25.1		mg/Kg		100	80 - 120	0	30
Potassium	2500	2390		mg/Kg		96	80 - 120	0	30
Selenium	7.50	ND		mg/Kg		5		27	
Sodium	2500	2400		mg/Kg		96	80 - 120	0	30

Method: 6010B SEP - SEP Metals (ICP) (Continued)

Lab Sample ID: MB 140-51761/15-B ^5
Matrix: Solid
Analysis Batch: 52038

Client Sample ID: Method Blank
Prep Type: Step 5
Prep Batch: 51837

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	ND		150	24	mg/Kg		07/17/21 08:14	07/22/21 15:11	5
Antimony	ND		45	4.2	mg/Kg		07/17/21 08:14	07/22/21 15:11	5
Arsenic	ND		7.5	1.9	mg/Kg		07/17/21 08:14	07/22/21 15:11	5
Calcium	11.0	J	3800	11	mg/Kg		07/17/21 08:14	07/22/21 15:11	5
Cobalt	ND		38	0.60	mg/Kg		07/17/21 08:14	07/22/21 15:11	5
Iron	ND		75	44	mg/Kg		07/17/21 08:14	07/22/21 15:11	5
Lithium	ND		38	2.2	mg/Kg		07/17/21 08:14	07/22/21 15:11	5
Manganese	ND		11	1.9	mg/Kg		07/17/21 08:14	07/22/21 15:11	5
Molybdenum	ND		30	1.3	mg/Kg		07/17/21 08:14	07/22/21 15:11	5
Potassium	2300	J	3800	430	mg/Kg		07/17/21 08:14	07/22/21 15:11	5
Selenium	ND		7.5	2.6	mg/Kg		07/17/21 08:14	07/22/21 15:11	5

Lab Sample ID: LCS 140-51761/16-B ^5
Matrix: Solid
Analysis Batch: 52038

Client Sample ID: Lab Control Sample
Prep Type: Step 5
Prep Batch: 51837

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Aluminum	300	ND		mg/Kg		4	
Antimony	75.0	69.4		mg/Kg		93	80 - 120
Arsenic	15.0	10.3		mg/Kg		69	60 - 100
Calcium	7500	1890	J	mg/Kg		25	20 - 50
Cobalt	15.0	0.623	J	mg/Kg		4	1 - 60
Iron	150	ND		mg/Kg		-0.8	
Lithium	15.0	15.5	J	mg/Kg		103	80 - 150
Manganese	15.0	ND		mg/Kg		12	1 - 60
Molybdenum	75.0	52.9		mg/Kg		70	60 - 100
Potassium	7500	9720		mg/Kg		130	80 - 180
Selenium	22.5	23.3		mg/Kg		103	80 - 140

Lab Sample ID: LCSD 140-51761/17-B ^5
Matrix: Solid
Analysis Batch: 52038

Client Sample ID: Lab Control Sample Dup
Prep Type: Step 5
Prep Batch: 51837

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Aluminum	300	ND		mg/Kg		2		62	
Antimony	75.0	68.0		mg/Kg		91	80 - 120	2	30
Arsenic	15.0	10.1		mg/Kg		68	60 - 100	2	30
Calcium	7500	1850	J	mg/Kg		25	20 - 50	2	30
Cobalt	15.0	ND		mg/Kg		4	1 - 60	8	30
Iron	150	ND		mg/Kg		0.5		1094	
Lithium	15.0	15.3	J	mg/Kg		102	80 - 150	2	30
Manganese	15.0	2.38	J	mg/Kg		16	1 - 60	30	30
Molybdenum	75.0	52.5		mg/Kg		70	60 - 100	1	30
Potassium	7500	9510		mg/Kg		127	80 - 180	2	30
Selenium	22.5	23.0		mg/Kg		102	80 - 140	1	30

QC Sample Results

Client: Golder Associates Inc.
Job ID: 140-23290-1
Project/Site: Labadie Energy Center - Missouri

Method: 6010B SEP - SEP Metals (ICP) (Continued)

Lab Sample ID: MB 140-51802/15-A
Matrix: Solid
Analysis Batch: 52038

Client Sample ID: Method Blank
Prep Type: Step 6
Prep Batch: 51802

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	ND		10	1.6	mg/Kg		07/16/21 12:00	07/22/21 17:00	1
Antimony	ND		3.0	0.28	mg/Kg		07/16/21 12:00	07/22/21 17:00	1
Arsenic	ND		0.50	0.15	mg/Kg		07/16/21 12:00	07/22/21 17:00	1
Calcium	ND		250	2.1	mg/Kg		07/16/21 12:00	07/22/21 17:00	1
Cobalt	ND		2.5	0.046	mg/Kg		07/16/21 12:00	07/22/21 17:00	1
Iron	ND		5.0	2.9	mg/Kg		07/16/21 12:00	07/22/21 17:00	1
Lithium	ND		2.5	0.15	mg/Kg		07/16/21 12:00	07/22/21 17:00	1
Manganese	ND		0.75	0.25	mg/Kg		07/16/21 12:00	07/22/21 17:00	1
Molybdenum	ND		2.0	0.099	mg/Kg		07/16/21 12:00	07/22/21 17:00	1
Potassium	ND		250	26	mg/Kg		07/16/21 12:00	07/22/21 17:00	1
Selenium	ND		0.50	0.17	mg/Kg		07/16/21 12:00	07/22/21 17:00	1
Sodium	ND		250	130	mg/Kg		07/16/21 12:00	07/22/21 17:00	1

Lab Sample ID: LCS 140-51802/16-A
Matrix: Solid
Analysis Batch: 52038

Client Sample ID: Lab Control Sample
Prep Type: Step 6
Prep Batch: 51802

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Aluminum	100	96.6		mg/Kg		97	80 - 120
Antimony	25.0	24.7		mg/Kg		99	80 - 120
Arsenic	5.00	4.73		mg/Kg		95	80 - 120
Calcium	2500	2410		mg/Kg		96	80 - 120
Cobalt	5.00	4.94		mg/Kg		99	80 - 120
Iron	50.0	49.4		mg/Kg		99	80 - 120
Lithium	5.00	4.52		mg/Kg		90	80 - 120
Manganese	5.00	4.94		mg/Kg		99	80 - 120
Molybdenum	25.0	25.1		mg/Kg		100	80 - 120
Potassium	2500	2420		mg/Kg		97	80 - 120
Selenium	7.50	7.56		mg/Kg		101	80 - 120
Sodium	2500	2420		mg/Kg		97	80 - 120

Lab Sample ID: LCSD 140-51802/17-A
Matrix: Solid
Analysis Batch: 52038

Client Sample ID: Lab Control Sample Dup
Prep Type: Step 6
Prep Batch: 51802

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Aluminum	100	98.0		mg/Kg		98	80 - 120	1	30
Antimony	25.0	25.0		mg/Kg		100	80 - 120	1	30
Arsenic	5.00	4.84		mg/Kg		97	80 - 120	2	30
Calcium	2500	2450		mg/Kg		98	80 - 120	2	30
Cobalt	5.00	5.02		mg/Kg		100	80 - 120	2	30
Iron	50.0	50.3		mg/Kg		101	80 - 120	2	30
Lithium	5.00	4.64		mg/Kg		93	80 - 120	2	30
Manganese	5.00	5.02		mg/Kg		100	80 - 120	2	30
Molybdenum	25.0	25.5		mg/Kg		102	80 - 120	2	30
Potassium	2500	2470		mg/Kg		99	80 - 120	2	30
Selenium	7.50	7.61		mg/Kg		102	80 - 120	1	30
Sodium	2500	2460		mg/Kg		99	80 - 120	2	30

QC Sample Results

Client: Golder Associates Inc.
Job ID: 140-23290-1
Project/Site: Labadie Energy Center - Missouri

Method: 6010B SEP - SEP Metals (ICP) (Continued)

Lab Sample ID: MB 140-51862/15-A
Client Sample ID: Method Blank
Matrix: Solid
Prep Type: Step 7
Analysis Batch: 52062
Prep Batch: 51862

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	ND		10	1.6	mg/Kg		07/20/21 08:00	07/23/21 12:35	1
Antimony	ND		3.0	0.14	mg/Kg		07/20/21 08:00	07/23/21 12:35	1
Arsenic	ND		0.50	0.13	mg/Kg		07/20/21 08:00	07/23/21 12:35	1
Calcium	ND		250	2.6	mg/Kg		07/20/21 08:00	07/23/21 12:35	1
Cobalt	ND		2.5	0.026	mg/Kg		07/20/21 08:00	07/23/21 12:35	1
Iron	ND		5.0	4.1	mg/Kg		07/20/21 08:00	07/23/21 12:35	1
Lithium	ND		2.5	0.15	mg/Kg		07/20/21 08:00	07/23/21 12:35	1
Manganese	ND		0.75	0.11	mg/Kg		07/20/21 08:00	07/23/21 12:35	1
Molybdenum	ND		2.0	0.082	mg/Kg		07/20/21 08:00	07/23/21 12:35	1
Potassium	ND		250	10	mg/Kg		07/20/21 08:00	07/23/21 12:35	1
Selenium	ND		0.50	0.17	mg/Kg		07/20/21 08:00	07/23/21 12:35	1
Sodium	ND		250	43	mg/Kg		07/20/21 08:00	07/23/21 12:35	1

Lab Sample ID: LCS 140-51862/16-A
Client Sample ID: Lab Control Sample
Matrix: Solid
Prep Type: Step 7
Analysis Batch: 52062
Prep Batch: 51862

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Aluminum	100	98.3		mg/Kg		98	80 - 120
Antimony	25.0	24.5		mg/Kg		98	80 - 125
Arsenic	5.00	4.94		mg/Kg		99	80 - 120
Calcium	2500	2480		mg/Kg		99	80 - 120
Cobalt	5.00	5.02		mg/Kg		100	80 - 125
Iron	50.0	51.6		mg/Kg		103	80 - 120
Lithium	5.00	4.90		mg/Kg		98	80 - 120
Manganese	5.00	5.18		mg/Kg		104	80 - 120
Molybdenum	25.0	25.7		mg/Kg		103	80 - 125
Potassium	2500	2500		mg/Kg		100	80 - 120
Selenium	7.50	7.19		mg/Kg		96	80 - 120
Sodium	2500	2520		mg/Kg		101	80 - 120

Lab Sample ID: LCSD 140-51862/17-A
Client Sample ID: Lab Control Sample Dup
Matrix: Solid
Prep Type: Step 7
Analysis Batch: 52062
Prep Batch: 51862

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Aluminum	100	97.4		mg/Kg		97	80 - 120	1	30
Antimony	25.0	24.6		mg/Kg		98	80 - 125	0	30
Arsenic	5.00	4.95		mg/Kg		99	80 - 120	0	30
Calcium	2500	2500		mg/Kg		100	80 - 120	1	30
Cobalt	5.00	5.05		mg/Kg		101	80 - 125	1	30
Iron	50.0	51.8		mg/Kg		104	80 - 120	1	30
Lithium	5.00	4.95		mg/Kg		99	80 - 120	1	30
Manganese	5.00	5.21		mg/Kg		104	80 - 120	1	30
Molybdenum	25.0	25.8		mg/Kg		103	80 - 125	0	30
Potassium	2500	2520		mg/Kg		101	80 - 120	1	30
Selenium	7.50	7.17		mg/Kg		96	80 - 120	0	30
Sodium	2500	2540		mg/Kg		101	80 - 120	0	30

Metals

Prep Batch: 51236

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-23290-1	L-BH-03S	Total/NA	Solid	3050B	
140-23290-2	L-BH-03M	Total/NA	Solid	3050B	
140-23290-3	L-BH-03D	Total/NA	Solid	3050B	
140-23290-4	L-BH-02S	Total/NA	Solid	3050B	
140-23290-5	L-BH-02M	Total/NA	Solid	3050B	
140-23290-6	L-BH-02D	Total/NA	Solid	3050B	
140-23290-7	L-BH-01S	Total/NA	Solid	3050B	
140-23290-8	L-BH-01M	Total/NA	Solid	3050B	
140-23290-9	L-BH-01D	Total/NA	Solid	3050B	
MB 140-51236/21-A	Method Blank	Total/NA	Solid	3050B	
LCS 140-51236/22-A	Lab Control Sample	Total/NA	Solid	3050B	
140-23290-6 MS	L-BH-02D	Total/NA	Solid	3050B	
140-23290-6 MSD	L-BH-02D	Total/NA	Solid	3050B	

Analysis Batch: 51553

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-23290-1	L-BH-03S	Total/NA	Solid	6010B	51236
140-23290-2	L-BH-03M	Total/NA	Solid	6010B	51236
140-23290-3	L-BH-03D	Total/NA	Solid	6010B	51236
140-23290-4	L-BH-02S	Total/NA	Solid	6010B	51236
140-23290-5	L-BH-02M	Total/NA	Solid	6010B	51236
140-23290-6	L-BH-02D	Total/NA	Solid	6010B	51236
140-23290-7	L-BH-01S	Total/NA	Solid	6010B	51236
140-23290-8	L-BH-01M	Total/NA	Solid	6010B	51236
140-23290-9	L-BH-01D	Total/NA	Solid	6010B	51236
MB 140-51236/21-A	Method Blank	Total/NA	Solid	6010B	51236
LCS 140-51236/22-A	Lab Control Sample	Total/NA	Solid	6010B	51236
140-23290-6 MS	L-BH-02D	Total/NA	Solid	6010B	51236
140-23290-6 MSD	L-BH-02D	Total/NA	Solid	6010B	51236

Prep Batch: 51614

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-23290-1	L-BH-03S	Total/NA	Solid	Total	
140-23290-2	L-BH-03M	Total/NA	Solid	Total	
140-23290-3	L-BH-03D	Total/NA	Solid	Total	
140-23290-4	L-BH-02S	Total/NA	Solid	Total	
140-23290-5	L-BH-02M	Total/NA	Solid	Total	
140-23290-6	L-BH-02D	Total/NA	Solid	Total	
140-23290-7	L-BH-01S	Total/NA	Solid	Total	
140-23290-8	L-BH-01M	Total/NA	Solid	Total	
140-23290-9	L-BH-01D	Total/NA	Solid	Total	
MB 140-51614/18-A	Method Blank	Total/NA	Solid	Total	
LCS 140-51614/19-A	Lab Control Sample	Total/NA	Solid	Total	
LCSD 140-51614/20-A	Lab Control Sample Dup	Total/NA	Solid	Total	

SEP Batch: 51615

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-23290-1	L-BH-03S	Step 1	Solid	Exchangeable	
140-23290-2	L-BH-03M	Step 1	Solid	Exchangeable	
140-23290-3	L-BH-03D	Step 1	Solid	Exchangeable	
140-23290-4	L-BH-02S	Step 1	Solid	Exchangeable	

Metals (Continued)

SEP Batch: 51615 (Continued)

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-23290-5	L-BH-02M	Step 1	Solid	Exchangeable	
140-23290-6	L-BH-02D	Step 1	Solid	Exchangeable	
140-23290-7	L-BH-01S	Step 1	Solid	Exchangeable	
140-23290-8	L-BH-01M	Step 1	Solid	Exchangeable	
140-23290-9	L-BH-01D	Step 1	Solid	Exchangeable	
MB 140-51615/18-B ^4	Method Blank	Step 1	Solid	Exchangeable	
LCS 140-51615/19-B ^5	Lab Control Sample	Step 1	Solid	Exchangeable	
LCSD 140-51615/20-B ^5	Lab Control Sample Dup	Step 1	Solid	Exchangeable	

SEP Batch: 51653

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-23290-1	L-BH-03S	Step 2	Solid	Carbonate	
140-23290-2	L-BH-03M	Step 2	Solid	Carbonate	
140-23290-3	L-BH-03D	Step 2	Solid	Carbonate	
140-23290-4	L-BH-02S	Step 2	Solid	Carbonate	
140-23290-5	L-BH-02M	Step 2	Solid	Carbonate	
140-23290-6	L-BH-02D	Step 2	Solid	Carbonate	
140-23290-7	L-BH-01S	Step 2	Solid	Carbonate	
140-23290-8	L-BH-01M	Step 2	Solid	Carbonate	
140-23290-9	L-BH-01D	Step 2	Solid	Carbonate	
MB 140-51653/15-B ^3	Method Blank	Step 2	Solid	Carbonate	
LCS 140-51653/16-B ^5	Lab Control Sample	Step 2	Solid	Carbonate	
LCSD 140-51653/17-B ^5	Lab Control Sample Dup	Step 2	Solid	Carbonate	

Prep Batch: 51654

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-23290-1	L-BH-03S	Step 1	Solid	3010A	51615
140-23290-2	L-BH-03M	Step 1	Solid	3010A	51615
140-23290-3	L-BH-03D	Step 1	Solid	3010A	51615
140-23290-4	L-BH-02S	Step 1	Solid	3010A	51615
140-23290-5	L-BH-02M	Step 1	Solid	3010A	51615
140-23290-6	L-BH-02D	Step 1	Solid	3010A	51615
140-23290-7	L-BH-01S	Step 1	Solid	3010A	51615
140-23290-8	L-BH-01M	Step 1	Solid	3010A	51615
140-23290-9	L-BH-01D	Step 1	Solid	3010A	51615
MB 140-51615/18-B ^4	Method Blank	Step 1	Solid	3010A	51615
LCS 140-51615/19-B ^5	Lab Control Sample	Step 1	Solid	3010A	51615
LCSD 140-51615/20-B ^5	Lab Control Sample Dup	Step 1	Solid	3010A	51615

SEP Batch: 51666

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-23290-1	L-BH-03S	Step 3	Solid	Non-Crystalline	
140-23290-2	L-BH-03M	Step 3	Solid	Non-Crystalline	
140-23290-3	L-BH-03D	Step 3	Solid	Non-Crystalline	
140-23290-4	L-BH-02S	Step 3	Solid	Non-Crystalline	
140-23290-5	L-BH-02M	Step 3	Solid	Non-Crystalline	
140-23290-6	L-BH-02D	Step 3	Solid	Non-Crystalline	
140-23290-7	L-BH-01S	Step 3	Solid	Non-Crystalline	
140-23290-8	L-BH-01M	Step 3	Solid	Non-Crystalline	
140-23290-9	L-BH-01D	Step 3	Solid	Non-Crystalline	
MB 140-51666/15-B	Method Blank	Step 3	Solid	Non-Crystalline	

Metals (Continued)

SEP Batch: 51666 (Continued)

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
LCS 140-51666/16-B	Lab Control Sample	Step 3	Solid	Non-Crystalline	
LCSD 140-51666/17-B	Lab Control Sample Dup	Step 3	Solid	Non-Crystalline	

Prep Batch: 51667

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-23290-1	L-BH-03S	Step 2	Solid	3010A	51653
140-23290-2	L-BH-03M	Step 2	Solid	3010A	51653
140-23290-3	L-BH-03D	Step 2	Solid	3010A	51653
140-23290-4	L-BH-02S	Step 2	Solid	3010A	51653
140-23290-5	L-BH-02M	Step 2	Solid	3010A	51653
140-23290-6	L-BH-02D	Step 2	Solid	3010A	51653
140-23290-7	L-BH-01S	Step 2	Solid	3010A	51653
140-23290-8	L-BH-01M	Step 2	Solid	3010A	51653
140-23290-9	L-BH-01D	Step 2	Solid	3010A	51653
MB 140-51653/15-B ^3	Method Blank	Step 2	Solid	3010A	51653
LCS 140-51653/16-B ^5	Lab Control Sample	Step 2	Solid	3010A	51653
LCSD 140-51653/17-B ^5	Lab Control Sample Dup	Step 2	Solid	3010A	51653

SEP Batch: 51690

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-23290-1	L-BH-03S	Step 4	Solid	Metal Hydroxide	
140-23290-2	L-BH-03M	Step 4	Solid	Metal Hydroxide	
140-23290-3	L-BH-03D	Step 4	Solid	Metal Hydroxide	
140-23290-4	L-BH-02S	Step 4	Solid	Metal Hydroxide	
140-23290-5	L-BH-02M	Step 4	Solid	Metal Hydroxide	
140-23290-6	L-BH-02D	Step 4	Solid	Metal Hydroxide	
140-23290-7	L-BH-01S	Step 4	Solid	Metal Hydroxide	
140-23290-8	L-BH-01M	Step 4	Solid	Metal Hydroxide	
140-23290-9	L-BH-01D	Step 4	Solid	Metal Hydroxide	
MB 140-51690/15-B	Method Blank	Step 4	Solid	Metal Hydroxide	
LCS 140-51690/16-B	Lab Control Sample	Step 4	Solid	Metal Hydroxide	
LCSD 140-51690/17-B	Lab Control Sample Dup	Step 4	Solid	Metal Hydroxide	

Prep Batch: 51707

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-23290-1	L-BH-03S	Step 3	Solid	3010A	51666
140-23290-2	L-BH-03M	Step 3	Solid	3010A	51666
140-23290-3	L-BH-03D	Step 3	Solid	3010A	51666
140-23290-4	L-BH-02S	Step 3	Solid	3010A	51666
140-23290-5	L-BH-02M	Step 3	Solid	3010A	51666
140-23290-6	L-BH-02D	Step 3	Solid	3010A	51666
140-23290-7	L-BH-01S	Step 3	Solid	3010A	51666
140-23290-8	L-BH-01M	Step 3	Solid	3010A	51666
140-23290-9	L-BH-01D	Step 3	Solid	3010A	51666
MB 140-51666/15-B	Method Blank	Step 3	Solid	3010A	51666
LCS 140-51666/16-B	Lab Control Sample	Step 3	Solid	3010A	51666
LCSD 140-51666/17-B	Lab Control Sample Dup	Step 3	Solid	3010A	51666

SEP Batch: 51761

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-23290-1	L-BH-03S	Step 5	Solid	Organic-Bound	

Metals (Continued)

SEP Batch: 51761 (Continued)

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-23290-2	L-BH-03M	Step 5	Solid	Organic-Bound	
140-23290-3	L-BH-03D	Step 5	Solid	Organic-Bound	
140-23290-4	L-BH-02S	Step 5	Solid	Organic-Bound	
140-23290-5	L-BH-02M	Step 5	Solid	Organic-Bound	
140-23290-6	L-BH-02D	Step 5	Solid	Organic-Bound	
140-23290-7	L-BH-01S	Step 5	Solid	Organic-Bound	
140-23290-8	L-BH-01M	Step 5	Solid	Organic-Bound	
140-23290-9	L-BH-01D	Step 5	Solid	Organic-Bound	
MB 140-51761/15-B ^5	Method Blank	Step 5	Solid	Organic-Bound	
LCS 140-51761/16-B ^5	Lab Control Sample	Step 5	Solid	Organic-Bound	
LCSD 140-51761/17-B ^5	Lab Control Sample Dup	Step 5	Solid	Organic-Bound	

Prep Batch: 51767

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-23290-1	L-BH-03S	Step 4	Solid	3010A	51690
140-23290-2	L-BH-03M	Step 4	Solid	3010A	51690
140-23290-3	L-BH-03D	Step 4	Solid	3010A	51690
140-23290-4	L-BH-02S	Step 4	Solid	3010A	51690
140-23290-5	L-BH-02M	Step 4	Solid	3010A	51690
140-23290-6	L-BH-02D	Step 4	Solid	3010A	51690
140-23290-7	L-BH-01S	Step 4	Solid	3010A	51690
140-23290-8	L-BH-01M	Step 4	Solid	3010A	51690
140-23290-9	L-BH-01D	Step 4	Solid	3010A	51690
MB 140-51690/15-B	Method Blank	Step 4	Solid	3010A	51690
LCS 140-51690/16-B	Lab Control Sample	Step 4	Solid	3010A	51690
LCSD 140-51690/17-B	Lab Control Sample Dup	Step 4	Solid	3010A	51690

SEP Batch: 51802

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-23290-1	L-BH-03S	Step 6	Solid	Acid/Sulfide	
140-23290-2	L-BH-03M	Step 6	Solid	Acid/Sulfide	
140-23290-3	L-BH-03D	Step 6	Solid	Acid/Sulfide	
140-23290-4	L-BH-02S	Step 6	Solid	Acid/Sulfide	
140-23290-5	L-BH-02M	Step 6	Solid	Acid/Sulfide	
140-23290-6	L-BH-02D	Step 6	Solid	Acid/Sulfide	
140-23290-7	L-BH-01S	Step 6	Solid	Acid/Sulfide	
140-23290-8	L-BH-01M	Step 6	Solid	Acid/Sulfide	
140-23290-9	L-BH-01D	Step 6	Solid	Acid/Sulfide	
MB 140-51802/15-A	Method Blank	Step 6	Solid	Acid/Sulfide	
LCS 140-51802/16-A	Lab Control Sample	Step 6	Solid	Acid/Sulfide	
LCSD 140-51802/17-A	Lab Control Sample Dup	Step 6	Solid	Acid/Sulfide	

Prep Batch: 51837

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-23290-1	L-BH-03S	Step 5	Solid	3010A	51761
140-23290-2	L-BH-03M	Step 5	Solid	3010A	51761
140-23290-3	L-BH-03D	Step 5	Solid	3010A	51761
140-23290-4	L-BH-02S	Step 5	Solid	3010A	51761
140-23290-5	L-BH-02M	Step 5	Solid	3010A	51761
140-23290-6	L-BH-02D	Step 5	Solid	3010A	51761
140-23290-7	L-BH-01S	Step 5	Solid	3010A	51761

Metals (Continued)

Prep Batch: 51837 (Continued)

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-23290-8	L-BH-01M	Step 5	Solid	3010A	51761
140-23290-9	L-BH-01D	Step 5	Solid	3010A	51761
MB 140-51761/15-B ^5	Method Blank	Step 5	Solid	3010A	51761
LCS 140-51761/16-B ^5	Lab Control Sample	Step 5	Solid	3010A	51761
LCSD 140-51761/17-B ^5	Lab Control Sample Dup	Step 5	Solid	3010A	51761

Prep Batch: 51862

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-23290-1	L-BH-03S	Step 7	Solid	Residual	
140-23290-2	L-BH-03M	Step 7	Solid	Residual	
140-23290-3	L-BH-03D	Step 7	Solid	Residual	
140-23290-4	L-BH-02S	Step 7	Solid	Residual	
140-23290-5	L-BH-02M	Step 7	Solid	Residual	
140-23290-6	L-BH-02D	Step 7	Solid	Residual	
140-23290-7	L-BH-01S	Step 7	Solid	Residual	
140-23290-8	L-BH-01M	Step 7	Solid	Residual	
140-23290-9	L-BH-01D	Step 7	Solid	Residual	
MB 140-51862/15-A	Method Blank	Step 7	Solid	Residual	
LCS 140-51862/16-A	Lab Control Sample	Step 7	Solid	Residual	
LCSD 140-51862/17-A	Lab Control Sample Dup	Step 7	Solid	Residual	

Analysis Batch: 51972

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-23290-1	L-BH-03S	Step 1	Solid	6010B SEP	51654
140-23290-1	L-BH-03S	Step 2	Solid	6010B SEP	51667
140-23290-1	L-BH-03S	Step 3	Solid	6010B SEP	51707
140-23290-2	L-BH-03M	Step 1	Solid	6010B SEP	51654
140-23290-2	L-BH-03M	Step 2	Solid	6010B SEP	51667
140-23290-2	L-BH-03M	Step 3	Solid	6010B SEP	51707
140-23290-3	L-BH-03D	Step 1	Solid	6010B SEP	51654
140-23290-3	L-BH-03D	Step 2	Solid	6010B SEP	51667
140-23290-3	L-BH-03D	Step 3	Solid	6010B SEP	51707
140-23290-4	L-BH-02S	Step 1	Solid	6010B SEP	51654
140-23290-4	L-BH-02S	Step 2	Solid	6010B SEP	51667
140-23290-4	L-BH-02S	Step 3	Solid	6010B SEP	51707
140-23290-5	L-BH-02M	Step 1	Solid	6010B SEP	51654
140-23290-5	L-BH-02M	Step 2	Solid	6010B SEP	51667
140-23290-5	L-BH-02M	Step 3	Solid	6010B SEP	51707
140-23290-6	L-BH-02D	Step 1	Solid	6010B SEP	51654
140-23290-6	L-BH-02D	Step 2	Solid	6010B SEP	51667
140-23290-6	L-BH-02D	Step 3	Solid	6010B SEP	51707
140-23290-7	L-BH-01S	Step 1	Solid	6010B SEP	51654
140-23290-7	L-BH-01S	Step 2	Solid	6010B SEP	51667
140-23290-7	L-BH-01S	Step 3	Solid	6010B SEP	51707
140-23290-8	L-BH-01M	Step 1	Solid	6010B SEP	51654
140-23290-8	L-BH-01M	Step 2	Solid	6010B SEP	51667
140-23290-8	L-BH-01M	Step 3	Solid	6010B SEP	51707
140-23290-9	L-BH-01D	Step 1	Solid	6010B SEP	51654
140-23290-9	L-BH-01D	Step 2	Solid	6010B SEP	51667
140-23290-9	L-BH-01D	Step 3	Solid	6010B SEP	51707
MB 140-51615/18-B ^4	Method Blank	Step 1	Solid	6010B SEP	51654

Metals (Continued)

Analysis Batch: 51972 (Continued)

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
MB 140-51653/15-B ^3	Method Blank	Step 2	Solid	6010B SEP	51667
MB 140-51666/15-B	Method Blank	Step 3	Solid	6010B SEP	51707
LCS 140-51615/19-B ^5	Lab Control Sample	Step 1	Solid	6010B SEP	51654
LCS 140-51653/16-B ^5	Lab Control Sample	Step 2	Solid	6010B SEP	51667
LCS 140-51666/16-B	Lab Control Sample	Step 3	Solid	6010B SEP	51707
LCSD 140-51615/20-B ^5	Lab Control Sample Dup	Step 1	Solid	6010B SEP	51654
LCSD 140-51653/17-B ^5	Lab Control Sample Dup	Step 2	Solid	6010B SEP	51667
LCSD 140-51666/17-B	Lab Control Sample Dup	Step 3	Solid	6010B SEP	51707

Analysis Batch: 52038

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-23290-1	L-BH-03S	Step 4	Solid	6010B SEP	51767
140-23290-1	L-BH-03S	Step 5	Solid	6010B SEP	51837
140-23290-1	L-BH-03S	Step 6	Solid	6010B SEP	51802
140-23290-1	L-BH-03S	Step 6	Solid	6010B SEP	51802
140-23290-2	L-BH-03M	Step 4	Solid	6010B SEP	51767
140-23290-2	L-BH-03M	Step 5	Solid	6010B SEP	51837
140-23290-2	L-BH-03M	Step 6	Solid	6010B SEP	51802
140-23290-2	L-BH-03M	Step 6	Solid	6010B SEP	51802
140-23290-3	L-BH-03D	Step 4	Solid	6010B SEP	51767
140-23290-3	L-BH-03D	Step 5	Solid	6010B SEP	51837
140-23290-3	L-BH-03D	Step 6	Solid	6010B SEP	51802
140-23290-3	L-BH-03D	Step 6	Solid	6010B SEP	51802
140-23290-4	L-BH-02S	Step 4	Solid	6010B SEP	51767
140-23290-4	L-BH-02S	Step 5	Solid	6010B SEP	51837
140-23290-4	L-BH-02S	Step 6	Solid	6010B SEP	51802
140-23290-4	L-BH-02S	Step 6	Solid	6010B SEP	51802
140-23290-5	L-BH-02M	Step 4	Solid	6010B SEP	51767
140-23290-5	L-BH-02M	Step 5	Solid	6010B SEP	51837
140-23290-5	L-BH-02M	Step 6	Solid	6010B SEP	51802
140-23290-5	L-BH-02M	Step 6	Solid	6010B SEP	51802
140-23290-6	L-BH-02D	Step 4	Solid	6010B SEP	51767
140-23290-6	L-BH-02D	Step 5	Solid	6010B SEP	51837
140-23290-6	L-BH-02D	Step 6	Solid	6010B SEP	51802
140-23290-6	L-BH-02D	Step 6	Solid	6010B SEP	51802
140-23290-7	L-BH-01S	Step 4	Solid	6010B SEP	51767
140-23290-7	L-BH-01S	Step 5	Solid	6010B SEP	51837
140-23290-7	L-BH-01S	Step 6	Solid	6010B SEP	51802
140-23290-7	L-BH-01S	Step 6	Solid	6010B SEP	51802
140-23290-8	L-BH-01M	Step 4	Solid	6010B SEP	51767
140-23290-8	L-BH-01M	Step 5	Solid	6010B SEP	51837
140-23290-8	L-BH-01M	Step 6	Solid	6010B SEP	51802
140-23290-8	L-BH-01M	Step 6	Solid	6010B SEP	51802
140-23290-9	L-BH-01D	Step 4	Solid	6010B SEP	51767
140-23290-9	L-BH-01D	Step 5	Solid	6010B SEP	51837
140-23290-9	L-BH-01D	Step 6	Solid	6010B SEP	51802
140-23290-9	L-BH-01D	Step 6	Solid	6010B SEP	51802
MB 140-51690/15-B	Method Blank	Step 4	Solid	6010B SEP	51767
MB 140-51761/15-B ^5	Method Blank	Step 5	Solid	6010B SEP	51837
MB 140-51802/15-A	Method Blank	Step 6	Solid	6010B SEP	51802
LCS 140-51690/16-B	Lab Control Sample	Step 4	Solid	6010B SEP	51767

Metals (Continued)

Analysis Batch: 52038 (Continued)

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
LCS 140-51761/16-B ^5	Lab Control Sample	Step 5	Solid	6010B SEP	51837
LCS 140-51802/16-A	Lab Control Sample	Step 6	Solid	6010B SEP	51802
LCSD 140-51690/17-B	Lab Control Sample Dup	Step 4	Solid	6010B SEP	51767
LCSD 140-51761/17-B ^5	Lab Control Sample Dup	Step 5	Solid	6010B SEP	51837
LCSD 140-51802/17-A	Lab Control Sample Dup	Step 6	Solid	6010B SEP	51802

Analysis Batch: 52062

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-23290-1	L-BH-03S	Step 7	Solid	6010B SEP	51862
140-23290-1	L-BH-03S	Step 7	Solid	6010B SEP	51862
140-23290-2	L-BH-03M	Step 7	Solid	6010B SEP	51862
140-23290-2	L-BH-03M	Step 7	Solid	6010B SEP	51862
140-23290-3	L-BH-03D	Step 7	Solid	6010B SEP	51862
140-23290-3	L-BH-03D	Step 7	Solid	6010B SEP	51862
140-23290-4	L-BH-02S	Step 7	Solid	6010B SEP	51862
140-23290-4	L-BH-02S	Step 7	Solid	6010B SEP	51862
140-23290-5	L-BH-02M	Step 7	Solid	6010B SEP	51862
140-23290-5	L-BH-02M	Step 7	Solid	6010B SEP	51862
140-23290-6	L-BH-02D	Step 7	Solid	6010B SEP	51862
140-23290-6	L-BH-02D	Step 7	Solid	6010B SEP	51862
140-23290-7	L-BH-01S	Step 7	Solid	6010B SEP	51862
140-23290-7	L-BH-01S	Step 7	Solid	6010B SEP	51862
140-23290-8	L-BH-01M	Step 7	Solid	6010B SEP	51862
140-23290-8	L-BH-01M	Step 7	Solid	6010B SEP	51862
140-23290-9	L-BH-01D	Step 7	Solid	6010B SEP	51862
140-23290-9	L-BH-01D	Step 7	Solid	6010B SEP	51862
MB 140-51862/15-A	Method Blank	Step 7	Solid	6010B SEP	51862
LCS 140-51862/16-A	Lab Control Sample	Step 7	Solid	6010B SEP	51862
LCSD 140-51862/17-A	Lab Control Sample Dup	Step 7	Solid	6010B SEP	51862

Analysis Batch: 52192

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-23290-1	L-BH-03S	Step 7	Solid	6010B SEP	51862
140-23290-1	L-BH-03S	Total/NA	Solid	6010B	51614
140-23290-2	L-BH-03M	Step 7	Solid	6010B SEP	51862
140-23290-2	L-BH-03M	Step 7	Solid	6010B SEP	51862
140-23290-2	L-BH-03M	Total/NA	Solid	6010B	51614
140-23290-3	L-BH-03D	Step 7	Solid	6010B SEP	51862
140-23290-3	L-BH-03D	Step 7	Solid	6010B SEP	51862
140-23290-3	L-BH-03D	Total/NA	Solid	6010B	51614
140-23290-4	L-BH-02S	Step 7	Solid	6010B SEP	51862
140-23290-4	L-BH-02S	Total/NA	Solid	6010B	51614
140-23290-5	L-BH-02M	Step 7	Solid	6010B SEP	51862
140-23290-5	L-BH-02M	Step 7	Solid	6010B SEP	51862
140-23290-5	L-BH-02M	Total/NA	Solid	6010B	51614
140-23290-6	L-BH-02D	Step 7	Solid	6010B SEP	51862
140-23290-6	L-BH-02D	Step 7	Solid	6010B SEP	51862
140-23290-6	L-BH-02D	Total/NA	Solid	6010B	51614
140-23290-7	L-BH-01S	Step 7	Solid	6010B SEP	51862
140-23290-7	L-BH-01S	Total/NA	Solid	6010B	51614
140-23290-8	L-BH-01M	Step 7	Solid	6010B SEP	51862

Metals (Continued)

Analysis Batch: 52192 (Continued)

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-23290-8	L-BH-01M	Step 7	Solid	6010B SEP	51862
140-23290-8	L-BH-01M	Total/NA	Solid	6010B	51614
140-23290-9	L-BH-01D	Step 7	Solid	6010B SEP	51862
140-23290-9	L-BH-01D	Total/NA	Solid	6010B	51614
MB 140-51614/18-A	Method Blank	Total/NA	Solid	6010B	51614
LCS 140-51614/19-A	Lab Control Sample	Total/NA	Solid	6010B	51614
LCSD 140-51614/20-A	Lab Control Sample Dup	Total/NA	Solid	6010B	51614

Analysis Batch: 52210

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-23290-1	L-BH-03S	Total/NA	Solid	6010B	51614
140-23290-1	L-BH-03S	Total/NA	Solid	6010B	51614
140-23290-2	L-BH-03M	Total/NA	Solid	6010B	51614
140-23290-2	L-BH-03M	Total/NA	Solid	6010B	51614
140-23290-3	L-BH-03D	Total/NA	Solid	6010B	51614
140-23290-3	L-BH-03D	Total/NA	Solid	6010B	51614
140-23290-4	L-BH-02S	Total/NA	Solid	6010B	51614
140-23290-4	L-BH-02S	Total/NA	Solid	6010B	51614
140-23290-5	L-BH-02M	Total/NA	Solid	6010B	51614
140-23290-5	L-BH-02M	Total/NA	Solid	6010B	51614
140-23290-5	L-BH-02M	Total/NA	Solid	6010B	51614
140-23290-6	L-BH-02D	Total/NA	Solid	6010B	51614
140-23290-6	L-BH-02D	Total/NA	Solid	6010B	51614
140-23290-7	L-BH-01S	Total/NA	Solid	6010B	51614
140-23290-7	L-BH-01S	Total/NA	Solid	6010B	51614
140-23290-8	L-BH-01M	Total/NA	Solid	6010B	51614
140-23290-8	L-BH-01M	Total/NA	Solid	6010B	51614
140-23290-9	L-BH-01D	Total/NA	Solid	6010B	51614
140-23290-9	L-BH-01D	Total/NA	Solid	6010B	51614
MB 140-51614/18-A	Method Blank	Total/NA	Solid	6010B	51614
LCS 140-51614/19-A	Lab Control Sample	Total/NA	Solid	6010B	51614
LCSD 140-51614/20-A	Lab Control Sample Dup	Total/NA	Solid	6010B	51614

Analysis Batch: 52216

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-23290-1	L-BH-03S	Sum of Steps 1-7	Solid	6010B SEP	
140-23290-2	L-BH-03M	Sum of Steps 1-7	Solid	6010B SEP	
140-23290-3	L-BH-03D	Sum of Steps 1-7	Solid	6010B SEP	
140-23290-4	L-BH-02S	Sum of Steps 1-7	Solid	6010B SEP	
140-23290-5	L-BH-02M	Sum of Steps 1-7	Solid	6010B SEP	
140-23290-6	L-BH-02D	Sum of Steps 1-7	Solid	6010B SEP	
140-23290-7	L-BH-01S	Sum of Steps 1-7	Solid	6010B SEP	
140-23290-8	L-BH-01M	Sum of Steps 1-7	Solid	6010B SEP	
140-23290-9	L-BH-01D	Sum of Steps 1-7	Solid	6010B SEP	

General Chemistry

Analysis Batch: 50473

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-23290-1	L-BH-03S	Total/NA	Solid	Moisture	
140-23290-2	L-BH-03M	Total/NA	Solid	Moisture	

General Chemistry (Continued)

Analysis Batch: 50473 (Continued)

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-23290-3	L-BH-03D	Total/NA	Solid	Moisture	
140-23290-4	L-BH-02S	Total/NA	Solid	Moisture	
140-23290-5	L-BH-02M	Total/NA	Solid	Moisture	
140-23290-6	L-BH-02D	Total/NA	Solid	Moisture	
140-23290-7	L-BH-01S	Total/NA	Solid	Moisture	
140-23290-8	L-BH-01M	Total/NA	Solid	Moisture	
140-23290-9	L-BH-01D	Total/NA	Solid	Moisture	

Lab Chronicle

Client Sample ID: L-BH-03S

Lab Sample ID: 140-23290-1

Date Collected: 05/24/21 08:45

Matrix: Solid

Date Received: 05/28/21 10:00

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Sum of Steps 1-7	Analysis	6010B SEP		1			52216	07/29/21 21:07	DKW	TAL KNX
	Instrument ID:	NOEQUIP								
Total/NA	Analysis	Moisture		1			50473	06/04/21 08:31	BKD	TAL KNX
	Instrument ID:	NOEQUIP								

Client Sample ID: L-BH-03S

Lab Sample ID: 140-23290-1

Date Collected: 05/24/21 08:45

Matrix: Solid

Date Received: 05/28/21 10:00

Percent Solids: 80.7

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3050B			0.532 g	50 mL	51236	06/28/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		1			51553	07/07/21 15:29	KNC	TAL KNX
	Instrument ID:	DUO								
Total/NA	Prep	Total			1 g	50 mL	51614	07/12/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		10			52192	07/28/21 17:42	KNC	TAL KNX
	Instrument ID:	DUO								
Total/NA	Prep	Total			1 g	50 mL	51614	07/12/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		1			52210	07/29/21 11:53	KNC	TAL KNX
	Instrument ID:	DUO								
Total/NA	Prep	Total			1 g	50 mL	51614	07/12/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		5			52210	07/29/21 13:25	KNC	TAL KNX
	Instrument ID:	DUO								
Step 1	SEP	Exchangeable			5 g	25 mL	51615	07/12/21 08:00	JTB	TAL KNX
Step 1	Prep	3010A			5 mL	50 mL	51654	07/13/21 08:00	JTB	TAL KNX
Step 1	Analysis	6010B SEP		4			51972	07/21/21 12:47	KNC	TAL KNX
	Instrument ID:	DUO								
Step 2	SEP	Carbonate			5 g	25 mL	51653	07/12/21 12:12	JTB	TAL KNX
Step 2	Prep	3010A			5 mL	50 mL	51667	07/13/21 08:00	JTB	TAL KNX
Step 2	Analysis	6010B SEP		3			51972	07/21/21 14:36	KNC	TAL KNX
	Instrument ID:	DUO								
Step 3	SEP	Non-Crystalline			5 g	25 mL	51666	07/13/21 08:00	JTB	TAL KNX
Step 3	Prep	3010A			5 mL	50 mL	51707	07/14/21 08:00	JTB	TAL KNX
Step 3	Analysis	6010B SEP		1			51972	07/21/21 16:37	KNC	TAL KNX
	Instrument ID:	DUO								
Step 4	SEP	Metal Hydroxide			5 g	25 mL	51690	07/14/21 08:00	JTB	TAL KNX
Step 4	Prep	3010A			5 mL	50 mL	51767	07/15/21 08:00	JTB	TAL KNX
Step 4	Analysis	6010B SEP		1			52038	07/22/21 14:03	KNC	TAL KNX
	Instrument ID:	DUO								
Step 5	SEP	Organic-Bound			5 g	75 mL	51761	07/15/21 08:00	JTB	TAL KNX
Step 5	Prep	3010A			5 mL	50 mL	51837	07/17/21 08:14	KNC	TAL KNX
Step 5	Analysis	6010B SEP		5			52038	07/22/21 15:51	KNC	TAL KNX
	Instrument ID:	DUO								
Step 6	SEP	Acid/Sulfide			5.00 g	250 mL	51802	07/16/21 12:00	JTB	TAL KNX
Step 6	Analysis	6010B SEP		1			52038	07/22/21 17:39	KNC	TAL KNX
	Instrument ID:	DUO								

Client Sample ID: L-BH-03S

Lab Sample ID: 140-23290-1

Date Collected: 05/24/21 08:45

Matrix: Solid

Date Received: 05/28/21 10:00

Percent Solids: 80.7

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 6	SEP	Acid/Sulfide			5.00 g	250 mL	51802	07/16/21 12:00	JTB	TAL KNX
Step 6	Analysis	6010B SEP		5			52038	07/22/21 19:14	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1.00 g	50 mL	51862	07/20/21 08:00	JTB	TAL KNX
Step 7	Analysis	6010B SEP		10			52062	07/23/21 13:57	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1.00 g	50 mL	51862	07/20/21 08:00	JTB	TAL KNX
Step 7	Analysis	6010B SEP		1			52062	07/23/21 15:15	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1.00 g	50 mL	51862	07/20/21 08:00	JTB	TAL KNX
Step 7	Analysis	6010B SEP		5			52192	07/28/21 14:55	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: L-BH-03M

Lab Sample ID: 140-23290-2

Date Collected: 05/24/21 10:00

Matrix: Solid

Date Received: 05/28/21 10:00

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Sum of Steps 1-7	Analysis	6010B SEP		1			52216	07/29/21 21:07	DKW	TAL KNX
	Instrument ID: NOEQUIP									
Total/NA	Analysis	Moisture		1			50473	06/04/21 08:31	BKD	TAL KNX
	Instrument ID: NOEQUIP									

Client Sample ID: L-BH-03M

Lab Sample ID: 140-23290-2

Date Collected: 05/24/21 10:00

Matrix: Solid

Date Received: 05/28/21 10:00

Percent Solids: 91.1

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3050B			0.531 g	50 mL	51236	06/28/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		1			51553	07/07/21 15:50	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1 g	50 mL	51614	07/12/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		10			52192	07/28/21 17:47	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1 g	50 mL	51614	07/12/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		1			52210	07/29/21 11:59	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1 g	50 mL	51614	07/12/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		5			52210	07/29/21 13:30	KNC	TAL KNX
	Instrument ID: DUO									
Step 1	SEP	Exchangeable			5 g	25 mL	51615	07/12/21 08:00	JTB	TAL KNX
Step 1	Prep	3010A			5 mL	50 mL	51654	07/13/21 08:00	JTB	TAL KNX
Step 1	Analysis	6010B SEP		4			51972	07/21/21 13:06	KNC	TAL KNX
	Instrument ID: DUO									

Lab Chronicle

Client: Golder Associates Inc.
Project/Site: Labadie Energy Center - Missouri

Job ID: 140-23290-1

Client Sample ID: L-BH-03M

Date Collected: 05/24/21 10:00
Date Received: 05/28/21 10:00

Lab Sample ID: 140-23290-2
Matrix: Solid
Percent Solids: 91.1

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 2	SEP	Carbonate			5 g	25 mL	51653	07/12/21 12:10	JTB	TAL KNX
Step 2	Prep	3010A			5 mL	50 mL	51667	07/13/21 08:00	JTB	TAL KNX
Step 2	Analysis	6010B SEP		3			51972	07/21/21 14:56	KNC	TAL KNX
	Instrument ID: DUO									
Step 3	SEP	Non-Crystalline			5 g	25 mL	51666	07/13/21 08:00	JTB	TAL KNX
Step 3	Prep	3010A			5 mL	50 mL	51707	07/14/21 08:00	JTB	TAL KNX
Step 3	Analysis	6010B SEP		1			51972	07/21/21 16:56	KNC	TAL KNX
	Instrument ID: DUO									
Step 4	SEP	Metal Hydroxide			5 g	25 mL	51690	07/14/21 08:00	JTB	TAL KNX
Step 4	Prep	3010A			5 mL	50 mL	51767	07/15/21 08:00	JTB	TAL KNX
Step 4	Analysis	6010B SEP		1			52038	07/22/21 14:23	KNC	TAL KNX
	Instrument ID: DUO									
Step 5	SEP	Organic-Bound			5 g	75 mL	51761	07/15/21 08:00	JTB	TAL KNX
Step 5	Prep	3010A			5 mL	50 mL	51837	07/17/21 08:14	KNC	TAL KNX
Step 5	Analysis	6010B SEP		5			52038	07/22/21 16:11	KNC	TAL KNX
	Instrument ID: DUO									
Step 6	SEP	Acid/Sulfide			5.00 g	250 mL	51802	07/16/21 12:00	JTB	TAL KNX
Step 6	Analysis	6010B SEP		1			52038	07/22/21 17:59	KNC	TAL KNX
	Instrument ID: DUO									
Step 6	SEP	Acid/Sulfide			5.00 g	250 mL	51802	07/16/21 12:00	JTB	TAL KNX
Step 6	Analysis	6010B SEP		5			52038	07/22/21 19:19	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1.00 g	50 mL	51862	07/20/21 08:00	JTB	TAL KNX
Step 7	Analysis	6010B SEP		10			52062	07/23/21 14:01	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1.00 g	50 mL	51862	07/20/21 08:00	JTB	TAL KNX
Step 7	Analysis	6010B SEP		1			52062	07/23/21 15:20	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1.00 g	50 mL	51862	07/20/21 08:00	JTB	TAL KNX
Step 7	Analysis	6010B SEP		2			52192	07/28/21 15:00	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1.00 g	50 mL	51862	07/20/21 08:00	JTB	TAL KNX
Step 7	Analysis	6010B SEP		5			52192	07/28/21 15:05	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: L-BH-03D

Date Collected: 05/24/21 11:45
Date Received: 05/28/21 10:00

Lab Sample ID: 140-23290-3
Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Sum of Steps 1-7	Analysis	6010B SEP		1			52216	07/29/21 21:07	DKW	TAL KNX
	Instrument ID: NOEQUIP									
Total/NA	Analysis	Moisture		1			50473	06/04/21 08:31	BKD	TAL KNX
	Instrument ID: NOEQUIP									

Lab Chronicle

Client: Golder Associates Inc.
Project/Site: Labadie Energy Center - Missouri

Job ID: 140-23290-1

Client Sample ID: L-BH-03D
Date Collected: 05/24/21 11:45
Date Received: 05/28/21 10:00

Lab Sample ID: 140-23290-3
Matrix: Solid
Percent Solids: 85.7

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3050B			0.527 g	50 mL	51236	06/28/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		1			51553	07/07/21 15:55	KNC	TAL KNX
	Instrument ID:	DUO								
Total/NA	Prep	Total			1 g	50 mL	51614	07/12/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		10			52192	07/28/21 17:51	KNC	TAL KNX
	Instrument ID:	DUO								
Total/NA	Prep	Total			1 g	50 mL	51614	07/12/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		1			52210	07/29/21 12:04	KNC	TAL KNX
	Instrument ID:	DUO								
Total/NA	Prep	Total			1 g	50 mL	51614	07/12/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		5			52210	07/29/21 13:34	KNC	TAL KNX
	Instrument ID:	DUO								
Step 1	SEP	Exchangeable			5 g	25 mL	51615	07/12/21 08:00	JTB	TAL KNX
Step 1	Prep	3010A			5 mL	50 mL	51654	07/13/21 08:00	JTB	TAL KNX
Step 1	Analysis	6010B SEP		4			51972	07/21/21 13:11	KNC	TAL KNX
	Instrument ID:	DUO								
Step 2	SEP	Carbonate			5 g	25 mL	51653	07/12/21 12:10	JTB	TAL KNX
Step 2	Prep	3010A			5 mL	50 mL	51667	07/13/21 08:00	JTB	TAL KNX
Step 2	Analysis	6010B SEP		3			51972	07/21/21 15:01	KNC	TAL KNX
	Instrument ID:	DUO								
Step 3	SEP	Non-Crystalline			5 g	25 mL	51666	07/13/21 08:00	JTB	TAL KNX
Step 3	Prep	3010A			5 mL	50 mL	51707	07/14/21 08:00	JTB	TAL KNX
Step 3	Analysis	6010B SEP		1			51972	07/21/21 17:01	KNC	TAL KNX
	Instrument ID:	DUO								
Step 4	SEP	Metal Hydroxide			5 g	25 mL	51690	07/14/21 08:00	JTB	TAL KNX
Step 4	Prep	3010A			5 mL	50 mL	51767	07/15/21 08:00	JTB	TAL KNX
Step 4	Analysis	6010B SEP		1			52038	07/22/21 14:28	KNC	TAL KNX
	Instrument ID:	DUO								
Step 5	SEP	Organic-Bound			5 g	75 mL	51761	07/15/21 08:00	JTB	TAL KNX
Step 5	Prep	3010A			5 mL	50 mL	51837	07/17/21 08:14	KNC	TAL KNX
Step 5	Analysis	6010B SEP		5			52038	07/22/21 16:16	KNC	TAL KNX
	Instrument ID:	DUO								
Step 6	SEP	Acid/Sulfide			5.00 g	250 mL	51802	07/16/21 12:00	JTB	TAL KNX
Step 6	Analysis	6010B SEP		1			52038	07/22/21 18:04	KNC	TAL KNX
	Instrument ID:	DUO								
Step 6	SEP	Acid/Sulfide			5.00 g	250 mL	51802	07/16/21 12:00	JTB	TAL KNX
Step 6	Analysis	6010B SEP		5			52038	07/22/21 19:24	KNC	TAL KNX
	Instrument ID:	DUO								
Step 7	Prep	Residual			1.00 g	50 mL	51862	07/20/21 08:00	JTB	TAL KNX
Step 7	Analysis	6010B SEP		10			52062	07/23/21 14:06	KNC	TAL KNX
	Instrument ID:	DUO								
Step 7	Prep	Residual			1.00 g	50 mL	51862	07/20/21 08:00	JTB	TAL KNX
Step 7	Analysis	6010B SEP		1			52062	07/23/21 15:25	KNC	TAL KNX
	Instrument ID:	DUO								

Lab Chronicle

Client: Golder Associates Inc. Job ID: 140-23290-1

Project/Site: Labadie Energy Center - Missouri

Client Sample ID: L-BH-03D Lab Sample ID: 140-23290-3

Date Collected: 05/24/21 11:45 **Matrix: Solid**

Date Received: 05/28/21 10:00 **Percent Solids: 85.7**

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 7	Prep	Residual			1.00 g	50 mL	51862	07/20/21 08:00	JTB	TAL KNX
Step 7	Analysis	6010B SEP		2			52192	07/28/21 15:24	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1.00 g	50 mL	51862	07/20/21 08:00	JTB	TAL KNX
Step 7	Analysis	6010B SEP		5			52192	07/28/21 15:29	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: L-BH-02S Lab Sample ID: 140-23290-4

Date Collected: 05/25/21 09:00 **Matrix: Solid**

Date Received: 05/28/21 10:00

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Sum of Steps 1-7	Analysis	6010B SEP		1			52216	07/29/21 21:07	DKW	TAL KNX
	Instrument ID: NOEQUIP									
Total/NA	Analysis	Moisture		1			50473	06/04/21 08:31	BKD	TAL KNX
	Instrument ID: NOEQUIP									

Client Sample ID: L-BH-02S Lab Sample ID: 140-23290-4

Date Collected: 05/25/21 09:00 **Matrix: Solid**

Date Received: 05/28/21 10:00 **Percent Solids: 78.4**

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3050B			0.532 g	50 mL	51236	06/28/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		1			51553	07/07/21 16:00	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1 g	50 mL	51614	07/12/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		10			52192	07/28/21 17:56	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1 g	50 mL	51614	07/12/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		1			52210	07/29/21 12:09	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1 g	50 mL	51614	07/12/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		5			52210	07/29/21 13:39	KNC	TAL KNX
	Instrument ID: DUO									
Step 1	SEP	Exchangeable			5 g	25 mL	51615	07/12/21 08:00	JTB	TAL KNX
Step 1	Prep	3010A			5 mL	50 mL	51654	07/13/21 08:00	JTB	TAL KNX
Step 1	Analysis	6010B SEP		4			51972	07/21/21 13:16	KNC	TAL KNX
	Instrument ID: DUO									
Step 2	SEP	Carbonate			5 g	25 mL	51653	07/12/21 12:10	JTB	TAL KNX
Step 2	Prep	3010A			5 mL	50 mL	51667	07/13/21 08:00	JTB	TAL KNX
Step 2	Analysis	6010B SEP		3			51972	07/21/21 15:06	KNC	TAL KNX
	Instrument ID: DUO									
Step 3	SEP	Non-Crystalline			5 g	25 mL	51666	07/13/21 08:00	JTB	TAL KNX
Step 3	Prep	3010A			5 mL	50 mL	51707	07/14/21 08:00	JTB	TAL KNX
Step 3	Analysis	6010B SEP		1			51972	07/21/21 17:06	KNC	TAL KNX
	Instrument ID: DUO									

Lab Chronicle

Client: Golder Associates Inc. Job ID: 140-23290-1
Project/Site: Labadie Energy Center - Missouri

Client Sample ID: L-BH-02S **Lab Sample ID: 140-23290-4**
Date Collected: 05/25/21 09:00 **Matrix: Solid**
Date Received: 05/28/21 10:00 **Percent Solids: 78.4**

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 4	SEP	Metal Hydroxide			5 g	25 mL	51690	07/14/21 08:00	JTB	TAL KNX
Step 4	Prep	3010A			5 mL	50 mL	51767	07/15/21 08:00	JTB	TAL KNX
Step 4	Analysis	6010B SEP		1			52038	07/22/21 14:32	KNC	TAL KNX
	Instrument ID: DUO									
Step 5	SEP	Organic-Bound			5 g	75 mL	51761	07/15/21 08:00	JTB	TAL KNX
Step 5	Prep	3010A			5 mL	50 mL	51837	07/17/21 08:14	KNC	TAL KNX
Step 5	Analysis	6010B SEP		5			52038	07/22/21 16:21	KNC	TAL KNX
	Instrument ID: DUO									
Step 6	SEP	Acid/Sulfide			5.00 g	250 mL	51802	07/16/21 12:00	JTB	TAL KNX
Step 6	Analysis	6010B SEP		1			52038	07/22/21 18:09	KNC	TAL KNX
	Instrument ID: DUO									
Step 6	SEP	Acid/Sulfide			5.00 g	250 mL	51802	07/16/21 12:00	JTB	TAL KNX
Step 6	Analysis	6010B SEP		5			52038	07/22/21 19:29	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1.00 g	50 mL	51862	07/20/21 08:00	JTB	TAL KNX
Step 7	Analysis	6010B SEP		10			52062	07/23/21 14:11	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1.00 g	50 mL	51862	07/20/21 08:00	JTB	TAL KNX
Step 7	Analysis	6010B SEP		1			52062	07/23/21 15:30	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1.00 g	50 mL	51862	07/20/21 08:00	JTB	TAL KNX
Step 7	Analysis	6010B SEP		5			52192	07/28/21 15:34	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: L-BH-02M **Lab Sample ID: 140-23290-5**
Date Collected: 05/25/21 10:25 **Matrix: Solid**
Date Received: 05/28/21 10:00

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Sum of Steps 1-7	Analysis	6010B SEP		1			52216	07/29/21 21:07	DKW	TAL KNX
	Instrument ID: NOEQUIP									
Total/NA	Analysis	Moisture		1			50473	06/04/21 08:31	BKD	TAL KNX
	Instrument ID: NOEQUIP									

Client Sample ID: L-BH-02M **Lab Sample ID: 140-23290-5**
Date Collected: 05/25/21 10:25 **Matrix: Solid**
Date Received: 05/28/21 10:00 **Percent Solids: 74.5**

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3050B			0.511 g	50 mL	51236	06/28/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		1			51553	07/07/21 16:05	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1 g	50 mL	51614	07/12/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		10			52192	07/28/21 18:01	KNC	TAL KNX
	Instrument ID: DUO									

Lab Chronicle

Client: Golder Associates Inc. Job ID: 140-23290-1
Project/Site: Labadie Energy Center - Missouri

Client Sample ID: L-BH-02M **Lab Sample ID: 140-23290-5**
Date Collected: 05/25/21 10:25 **Matrix: Solid**
Date Received: 05/28/21 10:00 **Percent Solids: 74.5**

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	Total			1 g	50 mL	51614	07/12/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		1			52210	07/29/21 12:15	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1 g	50 mL	51614	07/12/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		2			52210	07/29/21 13:58	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1 g	50 mL	51614	07/12/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		5			52210	07/29/21 14:03	KNC	TAL KNX
	Instrument ID: DUO									
Step 1	SEP	Exchangeable			5 g	25 mL	51615	07/12/21 08:00	JTB	TAL KNX
Step 1	Prep	3010A			5 mL	50 mL	51654	07/13/21 08:00	JTB	TAL KNX
Step 1	Analysis	6010B SEP		4			51972	07/21/21 13:21	KNC	TAL KNX
	Instrument ID: DUO									
Step 2	SEP	Carbonate			5 g	25 mL	51653	07/12/21 12:10	JTB	TAL KNX
Step 2	Prep	3010A			5 mL	50 mL	51667	07/13/21 08:00	JTB	TAL KNX
Step 2	Analysis	6010B SEP		3			51972	07/21/21 15:11	KNC	TAL KNX
	Instrument ID: DUO									
Step 3	SEP	Non-Crystalline			5 g	25 mL	51666	07/13/21 08:00	JTB	TAL KNX
Step 3	Prep	3010A			5 mL	50 mL	51707	07/14/21 08:00	JTB	TAL KNX
Step 3	Analysis	6010B SEP		1			51972	07/21/21 17:10	KNC	TAL KNX
	Instrument ID: DUO									
Step 4	SEP	Metal Hydroxide			5 g	25 mL	51690	07/14/21 08:00	JTB	TAL KNX
Step 4	Prep	3010A			5 mL	50 mL	51767	07/15/21 08:00	JTB	TAL KNX
Step 4	Analysis	6010B SEP		1			52038	07/22/21 14:37	KNC	TAL KNX
	Instrument ID: DUO									
Step 5	SEP	Organic-Bound			5 g	75 mL	51761	07/15/21 08:00	JTB	TAL KNX
Step 5	Prep	3010A			5 mL	50 mL	51837	07/17/21 08:14	KNC	TAL KNX
Step 5	Analysis	6010B SEP		5			52038	07/22/21 16:26	KNC	TAL KNX
	Instrument ID: DUO									
Step 6	SEP	Acid/Sulfide			5.00 g	250 mL	51802	07/16/21 12:00	JTB	TAL KNX
Step 6	Analysis	6010B SEP		1			52038	07/22/21 18:13	KNC	TAL KNX
	Instrument ID: DUO									
Step 6	SEP	Acid/Sulfide			5.00 g	250 mL	51802	07/16/21 12:00	JTB	TAL KNX
Step 6	Analysis	6010B SEP		5			52038	07/22/21 19:48	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1.00 g	50 mL	51862	07/20/21 08:00	JTB	TAL KNX
Step 7	Analysis	6010B SEP		10			52062	07/23/21 14:16	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1.00 g	50 mL	51862	07/20/21 08:00	JTB	TAL KNX
Step 7	Analysis	6010B SEP		1			52062	07/23/21 15:49	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1.00 g	50 mL	51862	07/20/21 08:00	JTB	TAL KNX
Step 7	Analysis	6010B SEP		2			52192	07/28/21 15:39	KNC	TAL KNX
	Instrument ID: DUO									

Lab Chronicle

Client: Golder Associates Inc. Job ID: 140-23290-1
Project/Site: Labadie Energy Center - Missouri

Client Sample ID: L-BH-02M Lab Sample ID: 140-23290-5

Date Collected: 05/25/21 10:25 **Matrix: Solid**
Date Received: 05/28/21 10:00 **Percent Solids: 74.5**

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 7	Prep	Residual			1.00 g	50 mL	51862	07/20/21 08:00	JTB	TAL KNX
Step 7	Analysis	6010B SEP		5			52192	07/28/21 15:44	KNC	TAL KNX
	Instrument ID:	DUO								

Client Sample ID: L-BH-02D Lab Sample ID: 140-23290-6

Date Collected: 05/25/21 10:25 **Matrix: Solid**
Date Received: 05/28/21 10:00

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Sum of Steps 1-7	Analysis	6010B SEP		1			52216	07/29/21 21:07	DKW	TAL KNX
	Instrument ID:	NOEQUIP								
Total/NA	Analysis	Moisture		1			50473	06/04/21 08:31	BKD	TAL KNX
	Instrument ID:	NOEQUIP								

Client Sample ID: L-BH-02D Lab Sample ID: 140-23290-6

Date Collected: 05/25/21 10:25 **Matrix: Solid**
Date Received: 05/28/21 10:00 **Percent Solids: 81.6**

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3050B			0.516 g	50 mL	51236	06/28/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		1			51553	07/07/21 16:10	KNC	TAL KNX
	Instrument ID:	DUO								
Total/NA	Prep	Total			1 g	50 mL	51614	07/12/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		10			52192	07/28/21 18:06	KNC	TAL KNX
	Instrument ID:	DUO								
Total/NA	Prep	Total			1 g	50 mL	51614	07/12/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		1			52210	07/29/21 12:20	KNC	TAL KNX
	Instrument ID:	DUO								
Total/NA	Prep	Total			1 g	50 mL	51614	07/12/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		5			52210	07/29/21 14:08	KNC	TAL KNX
	Instrument ID:	DUO								
Step 1	SEP	Exchangeable			5 g	25 mL	51615	07/12/21 08:00	JTB	TAL KNX
Step 1	Prep	3010A			5 mL	50 mL	51654	07/13/21 08:00	JTB	TAL KNX
Step 1	Analysis	6010B SEP		4			51972	07/21/21 13:26	KNC	TAL KNX
	Instrument ID:	DUO								
Step 2	SEP	Carbonate			5 g	25 mL	51653	07/12/21 12:10	JTB	TAL KNX
Step 2	Prep	3010A			5 mL	50 mL	51667	07/13/21 08:00	JTB	TAL KNX
Step 2	Analysis	6010B SEP		3			51972	07/21/21 15:16	KNC	TAL KNX
	Instrument ID:	DUO								
Step 3	SEP	Non-Crystalline			5 g	25 mL	51666	07/13/21 08:00	JTB	TAL KNX
Step 3	Prep	3010A			5 mL	50 mL	51707	07/14/21 08:00	JTB	TAL KNX
Step 3	Analysis	6010B SEP		1			51972	07/21/21 17:15	KNC	TAL KNX
	Instrument ID:	DUO								

Lab Chronicle

Client: Golder Associates Inc.
Project/Site: Labadie Energy Center - Missouri

Job ID: 140-23290-1

Client Sample ID: L-BH-02D

Date Collected: 05/25/21 10:25
Date Received: 05/28/21 10:00

Lab Sample ID: 140-23290-6
Matrix: Solid
Percent Solids: 81.6

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 4	SEP	Metal Hydroxide			5 g	25 mL	51690	07/14/21 08:00	JTB	TAL KNX
Step 4	Prep	3010A			5 mL	50 mL	51767	07/15/21 08:00	JTB	TAL KNX
Step 4	Analysis	6010B SEP		1			52038	07/22/21 14:42	KNC	TAL KNX
	Instrument ID: DUO									
Step 5	SEP	Organic-Bound			5 g	75 mL	51761	07/15/21 08:00	JTB	TAL KNX
Step 5	Prep	3010A			5 mL	50 mL	51837	07/17/21 08:14	KNC	TAL KNX
Step 5	Analysis	6010B SEP		5			52038	07/22/21 16:31	KNC	TAL KNX
	Instrument ID: DUO									
Step 6	SEP	Acid/Sulfide			5.00 g	250 mL	51802	07/16/21 12:00	JTB	TAL KNX
Step 6	Analysis	6010B SEP		1			52038	07/22/21 18:18	KNC	TAL KNX
	Instrument ID: DUO									
Step 6	SEP	Acid/Sulfide			5.00 g	250 mL	51802	07/16/21 12:00	JTB	TAL KNX
Step 6	Analysis	6010B SEP		5			52038	07/22/21 19:53	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1.00 g	50 mL	51862	07/20/21 08:00	JTB	TAL KNX
Step 7	Analysis	6010B SEP		10			52062	07/23/21 14:21	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1.00 g	50 mL	51862	07/20/21 08:00	JTB	TAL KNX
Step 7	Analysis	6010B SEP		1			52062	07/23/21 15:54	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1.00 g	50 mL	51862	07/20/21 08:00	JTB	TAL KNX
Step 7	Analysis	6010B SEP		2			52192	07/28/21 15:48	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1.00 g	50 mL	51862	07/20/21 08:00	JTB	TAL KNX
Step 7	Analysis	6010B SEP		5			52192	07/28/21 15:54	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: L-BH-01S

Date Collected: 05/26/21 08:10
Date Received: 05/28/21 10:00

Lab Sample ID: 140-23290-7
Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Sum of Steps 1-7	Analysis	6010B SEP		1			52216	07/29/21 21:07	DKW	TAL KNX
	Instrument ID: NOEQUIP									
Total/NA	Analysis	Moisture		1			50473	06/04/21 08:31	BKD	TAL KNX
	Instrument ID: NOEQUIP									

Client Sample ID: L-BH-01S

Date Collected: 05/26/21 08:10
Date Received: 05/28/21 10:00

Lab Sample ID: 140-23290-7
Matrix: Solid
Percent Solids: 76.3

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3050B			0.534 g	50 mL	51236	06/28/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		1			51553	07/07/21 16:24	KNC	TAL KNX
	Instrument ID: DUO									

Lab Chronicle

Client: Golder Associates Inc.
Project/Site: Labadie Energy Center - Missouri

Job ID: 140-23290-1

Client Sample ID: L-BH-01S
Date Collected: 05/26/21 08:10
Date Received: 05/28/21 10:00

Lab Sample ID: 140-23290-7
Matrix: Solid
Percent Solids: 76.3

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	Total			1 g	50 mL	51614	07/12/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		10			52192	07/28/21 18:10	KNC	TAL KNX
	Instrument ID:	DUO								
Total/NA	Prep	Total			1 g	50 mL	51614	07/12/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		1			52210	07/29/21 12:26	KNC	TAL KNX
	Instrument ID:	DUO								
Total/NA	Prep	Total			1 g	50 mL	51614	07/12/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		5			52210	07/29/21 14:13	KNC	TAL KNX
	Instrument ID:	DUO								
Step 1	SEP	Exchangeable			5 g	25 mL	51615	07/12/21 08:00	JTB	TAL KNX
Step 1	Prep	3010A			5 mL	50 mL	51654	07/13/21 08:00	JTB	TAL KNX
Step 1	Analysis	6010B SEP		4			51972	07/21/21 13:31	KNC	TAL KNX
	Instrument ID:	DUO								
Step 2	SEP	Carbonate			5 g	25 mL	51653	07/12/21 12:10	JTB	TAL KNX
Step 2	Prep	3010A			5 mL	50 mL	51667	07/13/21 08:00	JTB	TAL KNX
Step 2	Analysis	6010B SEP		3			51972	07/21/21 15:21	KNC	TAL KNX
	Instrument ID:	DUO								
Step 3	SEP	Non-Crystalline			5 g	25 mL	51666	07/13/21 08:00	JTB	TAL KNX
Step 3	Prep	3010A			5 mL	50 mL	51707	07/14/21 08:00	JTB	TAL KNX
Step 3	Analysis	6010B SEP		1			51972	07/21/21 17:20	KNC	TAL KNX
	Instrument ID:	DUO								
Step 4	SEP	Metal Hydroxide			5 g	25 mL	51690	07/14/21 08:00	JTB	TAL KNX
Step 4	Prep	3010A			5 mL	50 mL	51767	07/15/21 08:00	JTB	TAL KNX
Step 4	Analysis	6010B SEP		1			52038	07/22/21 14:47	KNC	TAL KNX
	Instrument ID:	DUO								
Step 5	SEP	Organic-Bound			5 g	75 mL	51761	07/15/21 08:00	JTB	TAL KNX
Step 5	Prep	3010A			5 mL	50 mL	51837	07/17/21 08:14	KNC	TAL KNX
Step 5	Analysis	6010B SEP		5			52038	07/22/21 16:36	KNC	TAL KNX
	Instrument ID:	DUO								
Step 6	SEP	Acid/Sulfide			5.00 g	250 mL	51802	07/16/21 12:00	JTB	TAL KNX
Step 6	Analysis	6010B SEP		1			52038	07/22/21 18:23	KNC	TAL KNX
	Instrument ID:	DUO								
Step 6	SEP	Acid/Sulfide			5.00 g	250 mL	51802	07/16/21 12:00	JTB	TAL KNX
Step 6	Analysis	6010B SEP		5			52038	07/22/21 19:58	KNC	TAL KNX
	Instrument ID:	DUO								
Step 7	Prep	Residual			1.00 g	50 mL	51862	07/20/21 08:00	JTB	TAL KNX
Step 7	Analysis	6010B SEP		10			52062	07/23/21 14:25	KNC	TAL KNX
	Instrument ID:	DUO								
Step 7	Prep	Residual			1.00 g	50 mL	51862	07/20/21 08:00	JTB	TAL KNX
Step 7	Analysis	6010B SEP		1			52062	07/23/21 16:00	KNC	TAL KNX
	Instrument ID:	DUO								
Step 7	Prep	Residual			1.00 g	50 mL	51862	07/20/21 08:00	JTB	TAL KNX
Step 7	Analysis	6010B SEP		5			52192	07/28/21 15:58	KNC	TAL KNX
	Instrument ID:	DUO								

Lab Chronicle

Client: Golder Associates Inc.
Project/Site: Labadie Energy Center - Missouri

Job ID: 140-23290-1

Client Sample ID: L-BH-01M

Date Collected: 05/26/21 09:25
Date Received: 05/28/21 10:00

Lab Sample ID: 140-23290-8
Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Sum of Steps 1-7	Analysis	6010B SEP		1			52216	07/29/21 21:07	DKW	TAL KNX
	Instrument ID:	NOEQUIP								
Total/NA	Analysis	Moisture		1			50473	06/04/21 08:31	BKD	TAL KNX
	Instrument ID:	NOEQUIP								

Client Sample ID: L-BH-01M

Date Collected: 05/26/21 09:25
Date Received: 05/28/21 10:00

Lab Sample ID: 140-23290-8
Matrix: Solid
Percent Solids: 86.5

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3050B			0.533 g	50 mL	51236	06/28/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		1			51553	07/07/21 16:28	KNC	TAL KNX
	Instrument ID:	DUO								
Total/NA	Prep	Total			1 g	50 mL	51614	07/12/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		10			52192	07/28/21 18:15	KNC	TAL KNX
	Instrument ID:	DUO								
Total/NA	Prep	Total			1 g	50 mL	51614	07/12/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		1			52210	07/29/21 12:31	KNC	TAL KNX
	Instrument ID:	DUO								
Total/NA	Prep	Total			1 g	50 mL	51614	07/12/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		5			52210	07/29/21 14:18	KNC	TAL KNX
	Instrument ID:	DUO								
Step 1	SEP	Exchangeable			5 g	25 mL	51615	07/12/21 08:00	JTB	TAL KNX
Step 1	Prep	3010A			5 mL	50 mL	51654	07/13/21 08:00	JTB	TAL KNX
Step 1	Analysis	6010B SEP		4			51972	07/21/21 13:36	KNC	TAL KNX
	Instrument ID:	DUO								
Step 2	SEP	Carbonate			5 g	25 mL	51653	07/12/21 12:10	JTB	TAL KNX
Step 2	Prep	3010A			5 mL	50 mL	51667	07/13/21 08:00	JTB	TAL KNX
Step 2	Analysis	6010B SEP		3			51972	07/21/21 15:26	KNC	TAL KNX
	Instrument ID:	DUO								
Step 3	SEP	Non-Crystalline			5 g	25 mL	51666	07/13/21 08:00	JTB	TAL KNX
Step 3	Prep	3010A			5 mL	50 mL	51707	07/14/21 08:00	JTB	TAL KNX
Step 3	Analysis	6010B SEP		1			51972	07/21/21 17:25	KNC	TAL KNX
	Instrument ID:	DUO								
Step 4	SEP	Metal Hydroxide			5 g	25 mL	51690	07/14/21 08:00	JTB	TAL KNX
Step 4	Prep	3010A			5 mL	50 mL	51767	07/15/21 08:00	JTB	TAL KNX
Step 4	Analysis	6010B SEP		1			52038	07/22/21 14:51	KNC	TAL KNX
	Instrument ID:	DUO								
Step 5	SEP	Organic-Bound			5 g	75 mL	51761	07/15/21 08:00	JTB	TAL KNX
Step 5	Prep	3010A			5 mL	50 mL	51837	07/17/21 08:14	KNC	TAL KNX
Step 5	Analysis	6010B SEP		5			52038	07/22/21 16:41	KNC	TAL KNX
	Instrument ID:	DUO								
Step 6	SEP	Acid/Sulfide			5.00 g	250 mL	51802	07/16/21 12:00	JTB	TAL KNX
Step 6	Analysis	6010B SEP		1			52038	07/22/21 18:28	KNC	TAL KNX
	Instrument ID:	DUO								

Lab Chronicle

Client: Golder Associates Inc.
Project/Site: Labadie Energy Center - Missouri

Job ID: 140-23290-1

Client Sample ID: L-BH-01M

Date Collected: 05/26/21 09:25
Date Received: 05/28/21 10:00

Lab Sample ID: 140-23290-8
Matrix: Solid
Percent Solids: 86.5

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 6	SEP	Acid/Sulfide			5.00 g	250 mL	51802	07/16/21 12:00	JTB	TAL KNX
Step 6	Analysis	6010B SEP		5			52038	07/22/21 20:03	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1.00 g	50 mL	51862	07/20/21 08:00	JTB	TAL KNX
Step 7	Analysis	6010B SEP		10			52062	07/23/21 14:30	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1.00 g	50 mL	51862	07/20/21 08:00	JTB	TAL KNX
Step 7	Analysis	6010B SEP		1			52062	07/23/21 16:05	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1.00 g	50 mL	51862	07/20/21 08:00	JTB	TAL KNX
Step 7	Analysis	6010B SEP		2			52192	07/28/21 16:03	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1.00 g	50 mL	51862	07/20/21 08:00	JTB	TAL KNX
Step 7	Analysis	6010B SEP		5			52192	07/28/21 16:08	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: L-BH-01D

Date Collected: 05/26/21 11:05
Date Received: 05/28/21 10:00

Lab Sample ID: 140-23290-9
Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Sum of Steps 1-7	Analysis	6010B SEP		1			52216	07/29/21 21:07	DKW	TAL KNX
	Instrument ID: NOEQUIP									
Total/NA	Analysis	Moisture		1			50473	06/04/21 08:31	BKD	TAL KNX
	Instrument ID: NOEQUIP									

Client Sample ID: L-BH-01D

Date Collected: 05/26/21 11:05
Date Received: 05/28/21 10:00

Lab Sample ID: 140-23290-9
Matrix: Solid
Percent Solids: 88.2

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3050B			0.542 g	50 mL	51236	06/28/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		1			51553	07/07/21 16:48	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1 g	50 mL	51614	07/12/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		10			52192	07/28/21 18:20	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1 g	50 mL	51614	07/12/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		1			52210	07/29/21 12:36	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1 g	50 mL	51614	07/12/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		5			52210	07/29/21 14:22	KNC	TAL KNX
	Instrument ID: DUO									

Lab Chronicle

Client: Golder Associates Inc. Job ID: 140-23290-1
Project/Site: Labadie Energy Center - Missouri

Client Sample ID: L-BH-01D

Lab Sample ID: 140-23290-9

Date Collected: 05/26/21 11:05

Matrix: Solid

Date Received: 05/28/21 10:00

Percent Solids: 88.2

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 1	SEP	Exchangeable			5 g	25 mL	51615	07/12/21 08:00	JTB	TAL KNX
Step 1	Prep	3010A			5 mL	50 mL	51654	07/13/21 08:00	JTB	TAL KNX
Step 1	Analysis	6010B SEP		4			51972	07/21/21 13:40	KNC	TAL KNX
	Instrument ID: DUO									
Step 2	SEP	Carbonate			5 g	25 mL	51653	07/12/21 12:10	JTB	TAL KNX
Step 2	Prep	3010A			5 mL	50 mL	51667	07/13/21 08:00	JTB	TAL KNX
Step 2	Analysis	6010B SEP		3			51972	07/21/21 15:31	KNC	TAL KNX
	Instrument ID: DUO									
Step 3	SEP	Non-Crystalline			5 g	25 mL	51666	07/13/21 08:00	JTB	TAL KNX
Step 3	Prep	3010A			5 mL	50 mL	51707	07/14/21 08:00	JTB	TAL KNX
Step 3	Analysis	6010B SEP		1			51972	07/21/21 17:30	KNC	TAL KNX
	Instrument ID: DUO									
Step 4	SEP	Metal Hydroxide			5 g	25 mL	51690	07/14/21 08:00	JTB	TAL KNX
Step 4	Prep	3010A			5 mL	50 mL	51767	07/15/21 08:00	JTB	TAL KNX
Step 4	Analysis	6010B SEP		1			52038	07/22/21 14:56	KNC	TAL KNX
	Instrument ID: DUO									
Step 5	SEP	Organic-Bound			5 g	75 mL	51761	07/15/21 08:00	JTB	TAL KNX
Step 5	Prep	3010A			5 mL	50 mL	51837	07/17/21 08:14	KNC	TAL KNX
Step 5	Analysis	6010B SEP		5			52038	07/22/21 16:46	KNC	TAL KNX
	Instrument ID: DUO									
Step 6	SEP	Acid/Sulfide			5.00 g	250 mL	51802	07/16/21 12:00	JTB	TAL KNX
Step 6	Analysis	6010B SEP		1			52038	07/22/21 18:33	KNC	TAL KNX
	Instrument ID: DUO									
Step 6	SEP	Acid/Sulfide			5.00 g	250 mL	51802	07/16/21 12:00	JTB	TAL KNX
Step 6	Analysis	6010B SEP		5			52038	07/22/21 20:07	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1.00 g	50 mL	51862	07/20/21 08:00	JTB	TAL KNX
Step 7	Analysis	6010B SEP		10			52062	07/23/21 14:35	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1.00 g	50 mL	51862	07/20/21 08:00	JTB	TAL KNX
Step 7	Analysis	6010B SEP		1			52062	07/23/21 16:10	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1.00 g	50 mL	51862	07/20/21 08:00	JTB	TAL KNX
Step 7	Analysis	6010B SEP		5			52192	07/28/21 16:22	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Method Blank

Lab Sample ID: MB 140-51236/21-A

Date Collected: N/A

Matrix: Solid

Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3050B			0.500 g	50 mL	51236	06/28/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		1			51553	07/07/21 11:36	KNC	TAL KNX
	Instrument ID: DUO									

Lab Chronicle

1 2 3 4 5 6 7 8 9 10 11 12 13

Client Sample ID: Method Blank

Lab Sample ID: MB 140-51614/18-A

Date Collected: N/A

Matrix: Solid

Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	Total			1 g	50 mL	51614	07/12/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		1			52192	07/28/21 16:44	KNC	TAL KNX
	Instrument ID:	DUO								
Total/NA	Prep	Total			1 g	50 mL	51614	07/12/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		1			52210	07/29/21 10:53	KNC	TAL KNX
	Instrument ID:	DUO								

Client Sample ID: Method Blank

Lab Sample ID: MB 140-51615/18-B ^4

Date Collected: N/A

Matrix: Solid

Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 1	SEP	Exchangeable			5 g	25 mL	51615	07/12/21 08:00	JTB	TAL KNX
Step 1	Prep	3010A			5 mL	50 mL	51654	07/13/21 08:00	JTB	TAL KNX
Step 1	Analysis	6010B SEP		4			51972	07/21/21 12:08	KNC	TAL KNX
	Instrument ID:	DUO								

Client Sample ID: Method Blank

Lab Sample ID: MB 140-51653/15-B ^3

Date Collected: N/A

Matrix: Solid

Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 2	SEP	Carbonate			5 g	25 mL	51653	07/12/21 12:10	JTB	TAL KNX
Step 2	Prep	3010A			5 mL	50 mL	51667	07/13/21 08:00	JTB	TAL KNX
Step 2	Analysis	6010B SEP		3			51972	07/21/21 13:55	KNC	TAL KNX
	Instrument ID:	DUO								

Client Sample ID: Method Blank

Lab Sample ID: MB 140-51666/15-B

Date Collected: N/A

Matrix: Solid

Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 3	SEP	Non-Crystalline			5 g	25 mL	51666	07/13/21 08:00	JTB	TAL KNX
Step 3	Prep	3010A			5 mL	50 mL	51707	07/14/21 08:00	JTB	TAL KNX
Step 3	Analysis	6010B SEP		1			51972	07/21/21 15:58	KNC	TAL KNX
	Instrument ID:	DUO								

Client Sample ID: Method Blank

Lab Sample ID: MB 140-51690/15-B

Date Collected: N/A

Matrix: Solid

Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 4	SEP	Metal Hydroxide			5 g	25 mL	51690	07/14/21 08:00	JTB	TAL KNX
Step 4	Prep	3010A			5 mL	50 mL	51767	07/15/21 08:00	JTB	TAL KNX
Step 4	Analysis	6010B SEP		1			52038	07/22/21 13:25	KNC	TAL KNX
	Instrument ID:	DUO								

Lab Chronicle

Client Sample ID: Method Blank

Lab Sample ID: MB 140-51761/15-B ^5

Date Collected: N/A

Matrix: Solid

Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 5	SEP	Organic-Bound			5 g	75 mL	51761	07/15/21 08:00	JTB	TAL KNX
Step 5	Prep	3010A			5 mL	50 mL	51837	07/17/21 08:14	KNC	TAL KNX
Step 5	Analysis	6010B SEP		5			52038	07/22/21 15:11	KNC	TAL KNX
	Instrument ID:	DUO								

Client Sample ID: Method Blank

Lab Sample ID: MB 140-51802/15-A

Date Collected: N/A

Matrix: Solid

Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 6	SEP	Acid/Sulfide			5.00 g	250 mL	51802	07/16/21 12:00	JTB	TAL KNX
Step 6	Analysis	6010B SEP		1			52038	07/22/21 17:00	KNC	TAL KNX
	Instrument ID:	DUO								

Client Sample ID: Method Blank

Lab Sample ID: MB 140-51862/15-A

Date Collected: N/A

Matrix: Solid

Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 7	Prep	Residual			1.00 g	50 mL	51862	07/20/21 08:00	JTB	TAL KNX
Step 7	Analysis	6010B SEP		1			52062	07/23/21 12:35	KNC	TAL KNX
	Instrument ID:	DUO								

Client Sample ID: Lab Control Sample

Lab Sample ID: LCS 140-51236/22-A

Date Collected: N/A

Matrix: Solid

Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3050B			0.500 g	50 mL	51236	06/25/21 10:16	JTB	TAL KNX
Total/NA	Analysis	6010B		1			51553	07/07/21 11:40	KNC	TAL KNX
	Instrument ID:	DUO								

Client Sample ID: Lab Control Sample

Lab Sample ID: LCS 140-51614/19-A

Date Collected: N/A

Matrix: Solid

Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	Total			1 g	50 mL	51614	07/12/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		1			52192	07/28/21 16:49	KNC	TAL KNX
	Instrument ID:	DUO								
Total/NA	Prep	Total			1 g	50 mL	51614	07/12/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		1			52210	07/29/21 10:58	KNC	TAL KNX
	Instrument ID:	DUO								

Lab Chronicle

Client: Golder Associates Inc.
Project/Site: Labadie Energy Center - Missouri

Job ID: 140-23290-1

Client Sample ID: Lab Control Sample

Lab Sample ID: LCS 140-51615/19-B ^5

Date Collected: N/A
Date Received: N/A

Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 1	SEP	Exchangeable			5 g	25 mL	51615	07/12/21 08:00	JTB	TAL KNX
Step 1	Prep	3010A			5 mL	50 mL	51654	07/13/21 08:00	JTB	TAL KNX
Step 1	Analysis	6010B SEP		5			51972	07/21/21 12:13	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Lab Control Sample

Lab Sample ID: LCS 140-51653/16-B ^5

Date Collected: N/A
Date Received: N/A

Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 2	SEP	Carbonate			5 g	25 mL	51653	07/12/21 12:10	JTB	TAL KNX
Step 2	Prep	3010A			5 mL	50 mL	51667	07/13/21 08:00	JTB	TAL KNX
Step 2	Analysis	6010B SEP		5			51972	07/21/21 14:00	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Lab Control Sample

Lab Sample ID: LCS 140-51666/16-B

Date Collected: N/A
Date Received: N/A

Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 3	SEP	Non-Crystalline			5 g	25 mL	51666	07/13/21 08:00	JTB	TAL KNX
Step 3	Prep	3010A			5 mL	50 mL	51707	07/14/21 08:00	JTB	TAL KNX
Step 3	Analysis	6010B SEP		1			51972	07/21/21 16:03	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Lab Control Sample

Lab Sample ID: LCS 140-51690/16-B

Date Collected: N/A
Date Received: N/A

Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 4	SEP	Metal Hydroxide			5 g	25 mL	51690	07/14/21 08:00	JTB	TAL KNX
Step 4	Prep	3010A			5 mL	50 mL	51767	07/15/21 08:00	JTB	TAL KNX
Step 4	Analysis	6010B SEP		1			52038	07/22/21 13:30	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Lab Control Sample

Lab Sample ID: LCS 140-51761/16-B ^5

Date Collected: N/A
Date Received: N/A

Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 5	SEP	Organic-Bound			5 g	75 mL	51761	07/15/21 08:00	JTB	TAL KNX
Step 5	Prep	3010A			5 mL	50 mL	51837	07/17/21 08:14	KNC	TAL KNX
Step 5	Analysis	6010B SEP		5			52038	07/22/21 15:16	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Lab Control Sample — Lab Sample ID: LCS 140-51802/16-A

Date Collected: N/A **Matrix: Solid**
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 6	SEP	Acid/Sulfide			5.00 g	250 mL	51802	07/16/21 12:00	JTB	TAL KNX
Step 6	Analysis	6010B SEP		1			52038	07/22/21 17:05	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Lab Control Sample — Lab Sample ID: LCS 140-51862/16-A

Date Collected: N/A **Matrix: Solid**
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 7	Prep	Residual			1.00 g	50 mL	51862	07/20/21 08:00	JTB	TAL KNX
Step 7	Analysis	6010B SEP		1			52062	07/23/21 12:40	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Lab Control Sample Dup — Lab Sample ID: LCSD 140-51614/20-A

Date Collected: N/A **Matrix: Solid**
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	Total			1 g	50 mL	51614	07/12/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		1			52192	07/28/21 16:54	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1 g	50 mL	51614	07/12/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		1			52210	07/29/21 11:03	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Lab Control Sample Dup — Lab Sample ID: LCSD 140-51615/20-B ^5

Date Collected: N/A **Matrix: Solid**
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 1	SEP	Exchangeable			5 g	25 mL	51615	07/12/21 08:00	JTB	TAL KNX
Step 1	Prep	3010A			5 mL	50 mL	51654	07/13/21 08:00	JTB	TAL KNX
Step 1	Analysis	6010B SEP		5			51972	07/21/21 12:18	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Lab Control Sample Dup — Lab Sample ID: LCSD 140-51653/17-B ^5

Date Collected: N/A **Matrix: Solid**
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 2	SEP	Carbonate			5 g	25 mL	51653	07/12/21 12:10	JTB	TAL KNX
Step 2	Prep	3010A			5 mL	50 mL	51667	07/13/21 08:00	JTB	TAL KNX
Step 2	Analysis	6010B SEP		5			51972	07/21/21 14:05	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Lab Control Sample Dup — Lab Sample ID: LCSD 140-51666/17-B

Date Collected: N/A **Matrix: Solid**

Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 3	SEP	Non-Crystalline			5 g	25 mL	51666	07/13/21 08:00	JTB	TAL KNX
Step 3	Prep	3010A			5 mL	50 mL	51707	07/14/21 08:00	JTB	TAL KNX
Step 3	Analysis	6010B SEP		1			51972	07/21/21 16:08	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Lab Control Sample Dup — Lab Sample ID: LCSD 140-51690/17-B

Date Collected: N/A **Matrix: Solid**

Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 4	SEP	Metal Hydroxide			5 g	25 mL	51690	07/14/21 08:00	JTB	TAL KNX
Step 4	Prep	3010A			5 mL	50 mL	51767	07/15/21 08:00	JTB	TAL KNX
Step 4	Analysis	6010B SEP		1			52038	07/22/21 13:35	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Lab Control Sample Dup — Lab Sample ID: LCSD 140-51761/17-B ^5

Date Collected: N/A **Matrix: Solid**

Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 5	SEP	Organic-Bound			5 g	75 mL	51761	07/15/21 08:00	JTB	TAL KNX
Step 5	Prep	3010A			5 mL	50 mL	51837	07/17/21 08:14	KNC	TAL KNX
Step 5	Analysis	6010B SEP		5			52038	07/22/21 15:21	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Lab Control Sample Dup — Lab Sample ID: LCSD 140-51802/17-A

Date Collected: N/A **Matrix: Solid**

Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 6	SEP	Acid/Sulfide			5.00 g	250 mL	51802	07/16/21 12:00	JTB	TAL KNX
Step 6	Analysis	6010B SEP		1			52038	07/22/21 17:10	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Lab Control Sample Dup — Lab Sample ID: LCSD 140-51862/17-A

Date Collected: N/A **Matrix: Solid**

Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 7	Prep	Residual			1.00 g	50 mL	51862	07/20/21 08:00	JTB	TAL KNX
Step 7	Analysis	6010B SEP		1			52062	07/23/21 12:45	KNC	TAL KNX
	Instrument ID: DUO									

Lab Chronicle

Client: Golder Associates Inc.
Job ID: 140-23290-1
Project/Site: Labadie Energy Center - Missouri

Client Sample ID: L-BH-02D

Lab Sample ID: 140-23290-6 MS

Date Collected: 05/25/21 10:25
Date Received: 05/28/21 10:00
Matrix: Solid
Percent Solids: 81.6

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3050B			0.544 g	50 mL	51236	06/28/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		1			51553	07/07/21 16:14	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: L-BH-02D

Lab Sample ID: 140-23290-6 MSD

Date Collected: 05/25/21 10:25
Date Received: 05/28/21 10:00
Matrix: Solid
Percent Solids: 81.6

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3050B			0.511 g	50 mL	51236	06/28/21 08:00	JTB	TAL KNX
Total/NA	Analysis	6010B		1			51553	07/07/21 16:19	KNC	TAL KNX
	Instrument ID: DUO									

Laboratory References:

TAL KNX = Eurofins TestAmerica, Knoxville, 5815 Middlebrook Pike, Knoxville, TN 37921, TEL (865)291-3000

Accreditation/Certification Summary

Client: Golder Associates Inc.
Project/Site: Labadie Energy Center - Missouri

Job ID: 140-23290-1

Laboratory: Eurofins TestAmerica, Knoxville

All accreditations/certifications held by this laboratory are listed. Not all accreditations/certifications are applicable to this report.

Authority	Program	Identification Number	Expiration Date
	AFCEE	N/A	
ANAB	Dept. of Defense ELAP	L2311	02-13-22
ANAB	Dept. of Energy	L2311.01	02-13-22
ANAB	ISO/IEC 17025	L2311	02-13-22
Arkansas DEQ	State	88-0688	06-17-21 *
California	State	2423	06-30-22
Colorado	State	TN00009	02-28-22
Connecticut	State	PH-0223	09-30-21
Florida	NELAP	E87177	06-30-22
Georgia (DW)	State	906	12-11-22
Hawaii	State	NA	12-11-21
Kansas	NELAP	E-10349	10-31-21
Kentucky (DW)	State	90101	12-31-21
Louisiana	NELAP	83979	06-30-22
Louisiana (DW)	State	LA019	12-31-21
Maryland	State	277	03-31-22
Michigan	State	9933	12-11-22
Nevada	State	TN00009	08-01-21
New Hampshire	NELAP	299919	01-17-22
New Jersey	NELAP	TN001	06-30-22
New York	NELAP	10781	03-31-22
North Carolina (DW)	State	21705	07-31-21
North Carolina (WW/SW)	State	64	12-31-21
Ohio VAP	State	CL0059	06-02-23
Oklahoma	State	9415	08-31-21
Oregon	NELAP	TNI0189	01-01-22
Pennsylvania	NELAP	68-00576	12-31-21
Tennessee	State	02014	12-11-22
Texas	NELAP	T104704380-18-12	08-31-21
US Fish & Wildlife	US Federal Programs	058448	07-31-21
USDA	US Federal Programs	P330-19-00236	08-20-22
Utah	NELAP	TN00009	07-31-21
Virginia	NELAP	460176	09-14-21
Washington	State	C593	01-19-22
West Virginia (DW)	State	9955C	01-02-22
West Virginia DEP	State	345	04-30-22
Wisconsin	State	998044300	08-31-21

* Accreditation/Certification renewal pending - accreditation/certification considered valid.

Method Summary

Method	Method Description	Protocol	Laboratory
6010B	Metals (ICP)	SW846	TAL KNX
6010B	SEP Metals (ICP) - Total	SW846	TAL KNX
6010B SEP	SEP Metals (ICP)	SW846	TAL KNX
Moisture	Percent Moisture	EPA	TAL KNX
3010A	Preparation, Total Metals	SW846	TAL KNX
3050B	Preparation, Metals	SW846	TAL KNX
Acid/Sulfide	Sequential Extraction Procedure, Acid/Sulfide Fraction	TAL-KNOX	TAL KNX
Carbonate	Sequential Extraction Procedure, Carbonate Fraction	TAL-KNOX	TAL KNX
Exchangeable	Sequential Extraction Procedure, Exchangeable Fraction	TAL-KNOX	TAL KNX
Metal Hydroxide	Sequential Extraction Procedure, Metal Hydroxide Fraction	TAL-KNOX	TAL KNX
Non-Crystalline	Sequential Extraction Procedure, Non-crystalline Materials	TAL-KNOX	TAL KNX
Organic-Bound	Sequential Extraction Procedure, Organic Bound Fraction	TAL-KNOX	TAL KNX
Residual	Sequential Extraction Procedure, Residual Fraction	TAL-KNOX	TAL KNX
Total	Preparation, Total Material	TAL-KNOX	TAL KNX

Protocol References:

EPA = US Environmental Protection Agency
SW846 = "Test Methods For Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 And Its Updates.
TAL-KNOX = TestAmerica Laboratories, Knoxville, Facility Standard Operating Procedure.

Laboratory References:

TAL KNX = Eurofins TestAmerica, Knoxville, 5815 Middlebrook Pike, Knoxville, TN 37921, TEL (865)291-3000

Eurofins TestAmerica, Knoxville
5815 Middlebrook Pike
Knoxville, TN 37921
Phone: 865-291-3000 Fax: 865-584-4315

Chain of Custody Record

eurofins | Environment Testing America

Client Information	Sampler: Brendan Talbert	Lab PM: Henry, Ryan	Carrier Tracking No(s):	COC No: 140-9342-2809.2
Client Contact: Jeffrey Ingram	Phone:	E-Mail: williamr.henry@eurofinset.com	State of Origin:	Page: Page ~~2~~ of ~~2~~ 1 of 1
Company: Golder Associates Inc.	PWSID:			Job #:
Address: 13515 Barrett Parkway Drive Suite 260	**Due Date Requested:**			
City: Ballwin	**TAT Requested (days):**			
State, Zip: MO, 63021	**Compliance Project:** ∆ Yes ∆ No			
Phone: 314-984-8800(Tel) 636-724-9323(Fax)	PO #: Purchase Order not required			
Email: Jeffrey_Ingram@golder.com	WO #:			
Project Name: ~~Duck Creek Power Station - Illinois~~ Labadie MNA	Project #: ~~14000015~~ 14006342			
Site: Labadie Energy Center	SSOW#:			

Analysis Requested

Preservation Codes:

A - HCL
B - NaOH
C - Zn Acetate
D - Nitric Acid
E - NaHSO4
F - MeOH
G - Amchlor
H - Ascorbic Acid
I - Ice
J - DI Water
K - EDTA
L - EDA
M - Hexane
N - None
O - AsNaO2
P - Na2O4S
Q - Na2SO3
R - Na2S2O3
S - H2SO4
T - TSP Dodecahydrate
U - Acetone
V - MCAA
W - pH 4-5
Z - other (specify)

Other:

Sample Identification	Sample Date	Sample Time	Sample Type (C=comp, G=grab)	Matrix (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	6010B_SEP - SEP Metals	6010B - Total Metals	Total Number of containers	Special Instructions/Note:
			Preservation Code:				N	N		
L-BH-03S	5-24-21	0845	G	S	N	N	/	/		
L-BH-03M	|	1000	|	|	|	|	/	/		
L-BH-03D	|	1145	|	|	|	|	/	/		
L-BH-02S	5-25-21	0900	G	S	N	N	/	/		
L-BH-02M	|	1025	|	|	|	|	/	/		
L-BH-02D	|	1025	|	|	|	|	/	/		
L-BH-01S	5-26-21	0810	G	S	N	N	/	/		
L-BH-01M	|	0925	|	|	|	|	/	/		
L-BH-01D	|	1105	|	|	|	|	/	/		

140-23290 Chain of Custody

Possible Hazard Identification
☑ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown ☐ Radiological

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ Return To Client ☑ Disposal By Lab ☐ Archive For ______ Months

Deliverable Requested: I, II, III, IV, Other (specify)

Special Instructions/QC Requirements:

Empty Kit Relinquished by:	Date:	Time:	Method of Shipment:

Relinquished by: Brendan Talbert	Date/Time: 5-27-21 1700	Company: Golder	Received by:	Date/Time: 5-28-21 10:00	Company: ETA KNX
Relinquished by:	Date/Time:	Company:	Received by:	Date/Time:	Company:
Relinquished by:	Date/Time:	Company:	Received by:	Date/Time:	Company:

Custody Seals Intact: ∆ Yes ∆ No	Custody Seal No.:	Cooler Temperature(s) °C and Other Remarks:

Ver: 11/01/2020

EUROFINS/TESTAMERICA KNOXVILLE SAMPLE RECEIPT/CONDITION UPON RECEIPT ANOMALY CHECKLIST **Log In Number:**

Review Items	Yes	No	NA	If No, what was the problem?	Comments/Actions Taken
1. Are the shipping containers intact?	✓			☐ Containers, Broken	CUSTODY SEALS INTACT RECEIVED AT RT 0.4/CT 0.5°C BMD 5.28.21 1 COOLER FDX# 7876 7506 7039 PD
2. Were ambient air containers received intact?			✓	☐ Checked in lab	
3. The coolers/containers custody seal if present, is it intact?	✓			☐ Yes ☐ NA	
4. Is the cooler temperature within limits? (> freezing temp. of water to 6 °C, VOST: 10°C) Thermometer ID : SC71 Correction factor: +0.1°C	✓			☐ Cooler Out of Temp, Client Contacted, Proceed/Cancel ☐ Cooler Out of Temp, Same Day Receipt	
5. Were all of the sample containers received intact?	✓			☐ Containers, Broken	
6. Were samples received in appropriate containers?	✓			☐ Containers, Improper; Client Contacted; Proceed/Cancel	
7. Do sample container labels match COC? (IDs, Dates, Times)	✓			☐ COC & Samples Do Not Match ☐ COC Incorrect/Incomplete ☐ COC Not Received	
8. Were all of the samples listed on the COC received?	✓			☐ Sample Received, Not on COC ☐ Sample on COC, Not Received	
9. Is the date/time of sample collection noted?	✓			☐ COC; No Date/Time; Client Contacted	**Labeling Verified by:** **Date:**
10. Was the sampler identified on the COC?	✓			☐ Sampler Not Listed on COC	
11. Is the client and project name/# identified?	✓			☐ COC Incorrect/Incomplete	**pH test strip lot number:**
12. Are tests/parameters listed for each sample?	✓			☐ COC No tests on COC	
13. Is the matrix of the samples noted?	✓			☐ COC Incorrect/Incomplete	
14. Was COC relinquished? (Signed/Dated/Timed)	✓			☐ COC Incorrect/Incomplete	
15. Were samples received within holding time?	✓			☐ Holding Time - Receipt	
16. Were samples received with correct chemical preservative (excluding Encore)?			✓	☐ pH Adjusted, pH Included (See box 16A) ☐ Incorrect Preservative	
17. Were VOA samples received without headspace?			✓	☐ Headspace (VOA only)	
18. Did you check for residual chlorine, if necessary? (e.g. 1613B, 1668) Chlorine test strip lot number:			✓	☐ Residual Chlorine	
19. For 1613B water samples is pH<9?			✓	☐ If no, notify lab to adjust	
20. For rad samples was sample activity info. Provided?			✓	☐ Project missing info	

	Box 16A: pH Preservation	Box 18A: Residual Chlorine
Preservative:		
Lot Number:		
Exp Date:		
Analyst:		
Date:		
Time:		

Project #: PM Instructions:

Sample Receiving Associate: Date: 5.28.21

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APPENDIX C

Groundwater Modeling Report

GOLDER
MEMBER OF WSP

TECHNICAL MEMORANDUM

DATE September 29, 2021 **Project No.** 153140603

TO Ameren Missouri
1901 Chouteau Avenue, St. Louis, Missouri 63103

CC

FROM Jeffrey Ingram, Joanna Moreno, Mark Haddock
RG, PE **EMAIL JIngram@Golder.com**

GROUNDWATER MODELING SUMMARY FOR LCPA MONITORED NATURAL ATTENUATION EVALUATION

1.0 INTRODUCTION

Golder Associates Inc. (Golder) is pleased to provide this Technical Memorandum summarizing modeling results for closure scenarios at the Ameren Missouri (Ameren) Labadie Energy Center (LEC) in Franklin County, Missouri. As part of the Monitored Natural Attenuation (MNA) Evaluation, the fate and transport of metals after closure of the bottom ash basin (LCPA) was investigated through modeling and this memo summarizes these tasks conducted in support of the MNA Evaluation.

1.1 Groundwater Modeling Objectives

The objectives of the modeling analysis are as follows:

- Use and update the previously generated groundwater model for the LEC and synthesize the most recent hydrogeologic data into an integrated conceptual and numerical framework for evaluation of remedial strategies at the Site.
- Use the groundwater model to predict future metal concentrations (molybdenum) after capping and closing the LCPA surface impoundment along with the addition of the groundwater pump, treat and re-injection system.

2.0 GROUNDWATER MODEL DEVELOPMENT

In 2019, a groundwater model and draft report was prepared by Gredell Engineering, Inc (Gredell, 2019), to provide a preliminary predictive analysis for groundwater flow at the LEC for the CMA evaluation. In 2021, this groundwater model was updated by XDD Environmental, LLC (XDD), to provide predictive analysis for groundwater flow at the LEC for the design of a pump, treat, and re-injection system for LCPA Corrective Action. For this evaluation, the XDD model was updated to model the fate and transport of molybdenum under different corrective action scenarios.

Updates to the model include the addition of bedrock to the south and below the alluvial aquifer to incorporate regional groundwater flow, inclusion of a constant head boundary within the bedrock aquifer, changes to hydraulic conductivity and recharge properties for groundwater flow and transport calibration purposes, and approximate geometry of the LCPA. Discussions and figures displaying the updates are provided in the following sections.

There have been many groundwater samples, CCR pore-water samples, and groundwater elevation measurements collected at the Site and these sampling locations which were used to generate the model input data are shown in Figure 1. The area covered by the groundwater flow model is shown in Figure 2. The purpose of this groundwater model summary is to document model setup, calibration and prediction results, and related data. The focus of the Technical Memorandum is on the groundwater flow as well as the fate and transport of metals after closure of the LCPA with a treatment system installed.

2.1 Conceptual Model and General Setting

The geology immediately surrounding the Facility is comprised of two distinctly different geological terrains; (1) floodplain deposits of the Missouri River Valley and (2) older sedimentary bedrock formations. Most of the Facility, including all the plant infrastructure and the LCPA, lies within the Missouri River Valley on floodplain and alluvial soil deposits. The Mississippi River Valley in this region is an approximately 2- to 3-mile-wide area of floodplain with alluvial deposits that are the result of the water flow and deposition from the Missouri River. Based on boring logs, the alluvial deposits are typically comprised of sands and gravels with lesser amounts of silts and clays, with an overall fining upward sequence. With depth, silt and clay deposits are less abundant and the sands and gravels typically coarsen. The depth of the alluvial deposits near the Surface Impoundment ranges from approximately 90 to 130 feet below ground surface (350 to 385 feet above mean sea level (MSL).

Bluffs to the south, as well as bedrock underlying the floodplain alluvial deposits, are comprised of relatively horizontal Ordovician-aged limestones, sandstones and dolomites. In progression from youngest to oldest, these deposits consist of the Plattin Group, Joachim Dolomite, St. Peter Sandstone, Powell Dolomite, and the Cotter/Jefferson City Dolomites (Starbuck, 2010; Gredell and Reitz & Jens, 2011).

Groundwater flow is generally from the south topographic high in the bluffs toward the Missouri River in the North/North-east. Some groundwater flow beneath and parallel with the Missouri River likely also occurs. In addition, some upward flow into the alluvium occurs from bedrock, which is recharged regionally outside the model area to the south.

The water level in the Missouri River varies daily, particularly during floods, which typically occur annually in the spring and during major storm events in the watershed basin. Floods can range from minor flooding that may only last days to major flooding which can last months.

2.2 Selection of Computer Code

The numerical computer code MODFLOW – developed by the United States Geological Survey (USGS) – was selected for much of this analysis because it is well suited to represent a wide range of hydrologic and hydrogeologic conditions, has been widely tested and accepted in the professional hydrology community and by regulatory agencies, and has been scrutinized closely in a number of legal proceedings over the past 20 years. In total, five software packages were used for the groundwater investigation:

- Groundwater flow: USGS software package MODFLOW (McDonald and Harbaugh 1988, Harbaugh and McDonald 1996, Harbaugh et al. 2000, Harbaugh 2005). MODFLOW-2005 was used in the analyses presented here.
- Groundwater transport: USGS software package MT3DMS (Zheng and Wang, 1999).
- Particle tracking: USGS software package MODPATH (Pollock 2012)

- Parameter estimation: PEST (Doherty 2010 and 2016)
- Graphical user interface: Groundwater Vistas (Environmental Simulations 2017, Rumbaugh and Rumbaugh 2011).

2.3 Model Domain, Grid, and Layering

The finite-difference model grid size and location are shown in Figure 3. The model grid was oriented 36 degrees from north as the primary groundwater flow direction is north-northeasterly from the bluffs towards the Missouri River. The grid contains 360 rows and 170 columns. The grid sizes are uniform horizontally (100 ft by 100 ft). The model is divided into seven layers with the top of the model reflecting ground surface topography (USGS, 2018). The lower 6 layers are horizontal, based on the elevations from the initial model (Gredell, 2019). Overall, the model is divided into 7 different layers, and hydraulic conductivity values in each layer vary, due to the geologic conditions onsite. Figures 4 and 5 displays the distribution of the different geological units within the different model layers in vertical cross-sectional view across the model.

The model area (excluding inactive cells) is approximately 36,000 feet east-west along the x-axis by 17,000 feet north-south along the y-axis at the widest points. The southwest corner of the model grid (model coordinates 0,0) corresponds with NAD 83 Missouri East coordinates 981161 north and 721788 West. Vertically, the model base is at elevation 350 feet above mean sea level (feet MSL) and ranges up to approximately 800 feet MSL in the highest bluff area to the south.

2.4 Model Input Data

The model input data consisted of geologic layering, hydraulic properties of these layers, surface recharge, river/stream properties, landfill geometry data, and calibration data (hydraulic heads, concentration data). Many of the parameters are used from the initial GW model (Gredell, 2019) as well as those updated by XDD in 2021. These inputs are described in more detail in the following sections.

2.4.1 Hydraulic Properties

Hydraulic conductivity testing has been completed within the ash materials as well as in the native materials present below the CCR units. These tests were used to generate ranges of appropriate hydraulic conductivities for the model and calibration tests were used to refine these values as completed by Gredell (2019), and XDD. The hydraulic properties used for this modeling effort as well as the reported ranges from site conductivity testing are provided below in **Table 1**.

Table 1 – Hydraulic Properties of Geological Units Applied in the Model

Geologic Unit	Hydraulic Conductivity		Vertical Anisotropy Ratio	Reported Range		Data Sources
	feet per day	cm/sec		feet per day	cm/sec	
Ash (CCR)	0.085	3.0x10^{-05}	1	0.024 to 1417.3	8.3x10^{-06} to 0.5	Gredell 2019, Reitz & Jens et al 2017

Berm Materials	0.0028	$1.0\text{x}10^{-06}$	1	0.0028	$1.0\text{x}10^{-06}$	Gredell 2019
Shallow Alluvium	28.34*	$1.0\text{x}10^{-02}$	0.1	28.3 to 85.0	$3.0\text{x}10^{-02}$ to $1.0\text{x}10^{-02}$	Gredell 2019, Gredell et al. 2011, Golder 2017a.
Intermediate Alluvium	42.5*	$2.4\text{x}10^{-02}$	0.1	31.2 to 141.7	$1.1\text{x}10^{-02}$ to $5.0\text{x}10^{-02}$	Gredell 2019, Gredell et al. 2011, Golder 2017a.
Deep Alluvium	600**	$1.5\text{x}10^{-01}$	0.1	36.9 to 1,701	$1.3\text{x}10^{-02}$ to $6\text{x}10^{-01}$	Gredell 2019, Fetter C.W. 2000, Calibrated Values
Bedrock	0.005**	$1.5\text{x}10^{-07}$	0.1	$2.8\text{x}10^{-05}$ to 28.35	$1.0\text{x}10^{-02}$ to $1.0\text{x}10^{-08}$	Fetter, C.W. 2011, Calibrated Values

Notes:

1) ft – feet.
2) cm/sec – centimeters per second.
3) Vertical Anisotropy Ratio is the ratio of vertical to horizontal hydraulic conductivity
4) CCR – Coal Combustion Residuals.
5) Specific storage (1/ft) is $2.3\text{x}10^{-4}$ for each unit based on Gredell, 2019.
6) Specific yield is 0.25 for each unit.
7) * - indicates that a different value is used than in the Gredell, 2019 report, provided by XDD.
8) ** - indicates a value different than the previous models, based on model calibrations.
9) No hydraulic conductivity testing has been completed within the deep alluvium units onsite. Value based on calibration results.

2.4.2 Model Recharge

Recharge rates were applied to the highest active layer of the model. Recharge in the model represents (a) natural infiltration, i.e.,the amount of precipitation that recharges the aquifer, which is generally the precipitation rate minus losses due to runoff, evapotranspiration, and changes in soil moisture, and (b) recharge generated by site activities.

During flow and transport calibration, these values were refined, and the model is subdivided into a total of 10 different recharge zones as displayed in Figure 6. Of these 10 zones, five (5) are associated with the LCPA and represent the different recharge rates and historical active CCR impoundment conditions applied to the transient fate and transport modeling. The remaining 6 (six) recharge zone are associated with recharge rates outside of the CCR unit including the bedrock bluffs area, the bottoms area, the embankment berm areas, and surface water areas.

2.5 Model Boundary Conditions

The following sections describe the boundary conditions used in the model, including constant head boundaries, drains, no flow boundaries, and river boundaries. Figure 7 displays the model boundary conditions used in the model.

2.5.1 No Flow Boundaries

By default, no flow boundaries are assumed at the bottom of the lowest layer and along the edge of each layer, unless another boundary condition is specified. Additionally, for this groundwater model, no flow boundaries were placed to the north of the Missouri River and south of the approximate elevation 495 ft MSL groundwater contour in the bedrock aquifer (Golder 2015) as displayed in Figure 7.

2.5.1.1 Constant Head Boundaries

Constant head boundaries were assigned within the bedrock aquifer at the approximately 495 feet MSL groundwater contour. This is based on the potentiometric surface mapping within the bedrock aquifer completed in 2014 – 2015 (Golder, 2015) and is displayed in Figure 7.

2.5.1.2 River Boundary Conditions

River boundary conditions are a head-dependent boundary condition, where the model computes the difference in head between the river cell where the boundary is defined and underlying or adjacent model cells. River boundary cells were used for the Missouri River, Labadie and Fiddle Creeks, the Ponded areas on the western side of the LCPA, the LCPB, and the LCL1. All river boundary conditions are modeled in Layers 1 & 2, and information on each of the river boundary areas is provided below:

- **Missouri River** – The Missouri River is the northernmost feature in the groundwater model as displayed in Figure 7. For the steady state calibration model, the river stage was set to elevation 457.61 feet MSL at the water intake area of the river, and then decreased/increased from there up and down river based on the average gradient of the Missouri River of 0.000183 ft/ft. This gradient was calculated using daily elevations and river miles between the Washington, Labadie, and St. Charles staging gauges. For the transient model, the average river elevation of 456.97 feet MSL was used (Gredell, 2019). The riverbed has a simulated thickness of 1 foot and a hydraulic conductivity of 4.25 feet per day ($1.5x10^{-3}$ cm/sec, from Gredell, 2019).

- **LCPA Surface Impoundment** –The LCPA has a “riverbed” thickness of 5 feet, with a vertical hydraulic conductivity equal to that of the CCR materials (0.085 ft/day, $3.0x10^{-05}$ cm/sec). The “river” section of the LCPA is only along the western edge, where historically water has been ponded within the surface impoundment during operation.

- **LCPB Surface Impoundment** - The LCPB is a lined CCR unit, has a “riverbed” thickness of 1 foot, with a vertical hydraulic conductivity equal approximately to the liner system of $1.0x10^{-08}$ ft/day or $3.5x10^{-12}$ cm/sec.

- **Labadie and Fiddle Creeks** – Labadie Creek is located on the western edge of Ameren’s property and Fiddle Creek is located along the eastern edge of the Labadie Bottoms. The model simulates these creeks as a river boundary condition in the areas that the creeks are present in the Labadie Bottoms area. The creeks have a modeled “riverbed” thickness of 2 feet, with a vertical hydraulic conductivity of 0.28 ft/day ($9.9x10^{-05}$ cm/sec). The width of the different features was based on aerial imagery and is 25 feet. The stage the creeks is based on the corresponding Missouri River levels, and digital elevation maps.

2.5.1.3 Drain Boundary Conditions

Drain boundaries were used in the bluff areas to represent localized creeks and drainage ditches in low lying areas. The drain elevation was set equal to the approximate ground surface and the conductivity of the drains were equal to the vertical hydraulic conductivity used for bedrock.

2.5.2 Groundwater Treatment Wells

As a part of ongoing Corrective Action activities at the site, Ameren commissioned the design of a groundwater pump, treat, and re-inject system. The modeled design consists of 24 injection and 24 extraction wells, modeled in layers 2-6 as applicable. These wells are proposed to be located on the northwestern side of the LCPA and LCPB as well as between the LCPA and LCPB Units. These wells were incorporated to simulate the pump and treat system in the model. These features are only used in the transient modeling scenario.

2.6 Flow Calibration

Model calibration consists of successive refinement of estimated model properties and input data within expected ranges to improve the fit between observed and model-simulated flows and elevations. A steady state flow model calibration was carried out for September 27, 2018, for which 93 groundwater elevations within the alluvial aquifer were available as targets. In addition, 6 pore-water elevations within the LCPA were used from February-March 2018. This combination was used because there were more targets available in September 2018 in the alluvial aquifer and the river levels were more representative of average conditions. Additionally, pore-water elevations were only collected in February-March 2018 before the temporary piezometers were abandoned, however, pond elevations in the LCPA were within 0.5 feet in both March and September 2018. Therefore, these levels were deemed representative of pond conditions in September 2018.

Manual and automated parameter estimation approaches were used to derive reasonable estimates of hydraulic conductivities and natural recharge rates that produce groundwater elevations close to the observed data. The resulting estimated parameter values fall within expected ranges (Table 1). The results are summarized in Figure 8. The average head residual is less than 0.25 feet and the normalized root mean square error in the model is 8.9%. The calibrated model was found to be acceptable for current purposes.

2.7 Transport Model Analysis

This section describes the transport modeling analyses conducted for the LCPA contaminant source area. The LCPB, LCL1 were not modeled as a source area because they are all lined with geomembrane liners, while the LCPA is unlined. Based on drilling data and historical images, the LCPA has historically been managed with the ash materials contained in the southern and eastern portions of the CCR unit while the ponded area has been historically managed in the western portion of the unit. In 1993, the LCPB was built to the east of the LCPA and fly ash was then managed in the LCPB and not the LCPA, although the outfall for the LCPB discharged into the southeastern portion of the LCPA during its operation. Table 2 provides the dates and a brief description of the stress periods used in the Transient Model.

Table 2: Description of Stress Periods

Stress Period	Start Date	End Date	Length (Days)	Description
1	1/1/1970	12/31/1992	8765	Beginning of LEC with LCPA as only active CCR Unit.
2	1/1/1993	9/28/2019	9402	LCPB now active along with the LCPA. LCPA no longer receives fly ash management water, therefore, molybdenum concentrations and recharge values go down.
3	9/28/2019	12/29/2020	459	Closure construction on the LPCA. No more active addition of CCR materials to LCPA. Recharge equal to that of surrounding alluvial aquifer.
4	12/30/2020	12/31/2022	732	LCPA closed with geomembrane liner system. No groundwater treatment system in place
5	1/1/2023	8/1/2120	35652	LCPA closed along with active treatment system.

Molybdenum was selected as the primary constituent for transport analysis because it is the only Appendix IV parameter that is present at a Statistically Significant Level in accordance with the CCR Rule. The primary Molybdenum transport mechanisms are advection and mixing due to natural and pond recharge, advection and mixing under varying natural hydraulic gradients controlled by river water elevations and buffering and/or precipitation due to interaction between Molybdenum in porewater and aquifer solids.

Transport model setup details include:

Aquifer bulk densities based on results from Golder 2017a:

- CCR Materials:1.2 g/mL
- Sandy Alluvial Materials: 1.4 g/mL
- Bedrock: 2.6 g/mL

- Uniform effective porosity of 0.20 based on Gredell, 2019.
- Longitudinal, transverse and vertical dispersivity were assumed to have values of 15, 1.5, and 0.15 ft, respectively. Values were calculated using the EPA on-line tool for estimating longitudinal dispersity (available at: https://www3.epa.gov/ceampubl/learn2model/part-two/onsite/longdisp.html)
- Linear sorption represented by a partition coefficient (Kd) in the aquifer of 0.15 mL/g. This value was determined via calibration and is based on a range calculated from onsite data that consisted of 7 non-detect values, 1 value at 1.88 mL/g, and a final value of 31.1 mL/g. This is consistent with the range provided in Allison and Allison (2005).
- Molybdenum concentrations as shown below in Table 3.

Table 3: Molybdenum Concentration Data Ranges

Parameter	Reported Range	Model Values	Data Source
Molybdenum Concentrations (µg/L)			
Missouri River	Minimum: 1.9	3.123	Haley and Aldrich 2018
	Maximum: 6.2		
	Mean: 3.123		
Bedrock Aquifer	Minimum: Non-Detect (<0.85)	3.945	AECOM, 2014
	Maximum: 14.5		
	Mean: 3.945		
Background (BMW-1S, BMW-2S, BMW-1D, and BMW-2D)	Minimum: Non-Detect (<0.26)	1.588	Golder 2017-2021 (a-c)
	Maximum: 7.0 J		
	Mean: 1.588 J		
Ponded portion of LCPA	52.0	52.0	2018 NPDES Report
Fly Ash / Mixed Ash	Site Minimum: 83.7	LCPA only / LCPA + LCPB	Golder 2018b, EPRI, 2011
	Site Maximum: 2,370	North central: 1,250 / 230	
	Site Mean: 827.1	South central: 2,100 / 230	
	EPRI minimum: non-detect	Northeastern: 2,100 / 150	
	EPRI Maximum: 60,800	Southeastern: 5,100 / 500	

Molybdenum data from 2013 to June 2021 were included as calibration targets in the model using 115 locations within the alluvial aquifer. The transport model calibration results are summarized in Figure 9. The average molybdenum concentration residual is less than 21 µg/L and the normalized root mean square error is 8.1%. It should be noted that observed molybdenum concentrations varied from non-detect (1/2 method detection limit at 0.25) – 1,410 µg/L in the alluvial aquifer. The calibrated model was found to be acceptable for current purposes.

Predictive simulations were used to assess future plume movement under existing and capped-pond conditions with the installation of a groundwater treatment system along the northwestern side of the LCPA and LCPB as well as between the two units. The predicted future molybdenum concentrations in groundwater were found to be sensitive to the assumed partition coefficient, the dispersivity, and the hydraulic conductivity parameters. Predicted groundwater concentrations are provided in Figures 10-11.

As displayed in Figure 10, monitoring wells within the detection and assessment (compliance) monitoring well network that are present at a SSL, including UMW-3D, UMW-4D, UMW-5D, UMW-6D, and UMW-7D are predicted to be below the GWPS within 2 – 13 years of the treatment system start of operation. The model calculated attenuation rate from these wells is approximately 10 to 162 micrograms (µg/L) per year, with an average decrease in concentration of approximately 80 µg/L per year.

Figure 11 displays the model predicted decrease in molybdenum concentrations in the corrective action well network that are currently at concentrations above the GWPS (LMW-8S, AM-1D, TP-2D, TP-2M, TP-3D, TP-3M, AMW-8, MW-33D, MW-34D, MW-35D). These monitoring wells are located outside of the treatment capture zone and are predicted to reach concentrations below the GWPS within 2 - 39 years. The model calculated attenuation rate from these wells is approximately 4.5 to 24.2 µg/L per year, with an average decrease in concentration of approximately 14 µg/L per year.

3.0 GROUNDWATER MODELING SUMMARY

Using standard numerical groundwater modeling procedures, Golder has updated both a steady state model and developed a transient groundwater flow model for the site that are calibrated to site data. The modeling results were used to inform the groundwater monitoring natural attenuation evaluation by providing predicted molybdenum concentrations at monitoring wells downgradient of the LCPA, where molybdenum is present at a Statistically Significant Level (SSL). The predicted molybdenum concentrations will be used for further geochemical evaluation in the Labadie MNA Evaluation Report.

4.0 LIMITATIONS

The modeling analyses presented in this report are a simplification of reality and the model-predicted results should be used with this understanding. The limitations associated with analyses such as these are detailed below.

Hydrogeologic investigations and groundwater modeling are dynamic and inexact sciences. They are dynamic in the sense that the state of any hydrological system is changing with time, and in the sense that the science is continually developing new techniques to evaluate these systems. They are inexact in the sense that groundwater systems are complicated beyond human capability to evaluate them comprehensively in detail, and we invariably do not have sufficient data to do so. A groundwater model uses the laws of science and mathematics to draw together the available data into a mathematical or computer-based representation of the essential features of an existing hydrogeologic system. While the model itself obviously lacks the detailed reality of the existing hydrogeologic system, the behavior of a valid groundwater model reasonably approximates that of the real system. The validity and accuracy of the model depends on the amount of data available relative to the degree of complexity of the geologic formations, the site geochemistry, the fate and transport of the dissolved compounds, and on the quality and degree of accuracy of the data entered. Therefore, every groundwater model is a simplification of a reality and the model described in this report is not an exception.

The professional groundwater and geochemical modeling services performed as described in this report were conducted in a manner consistent with that level of care and skill normally exercised by other members of the engineering and science professions currently practicing under similar conditions, subject to the quality and quality of available data, the time limits and financial and physical constraints applicable to the services. Unless otherwise specified, the results of previous or simultaneous work provided by sources other than Golder and quoted and/or used herein are considered as having been obtained according to recognized and accepted professional rules and practices, and therefore deemed valid. This model provides a predictive scientific tool to evaluate the impacts on a real groundwater system of specified hydrological stresses and/or to compare various scenarios in a decision-making process. However, and despite the professional care taken during the construction of the model and in conducting the simulations, its accuracy is bound to the normal uncertainty associated to groundwater modeling and no warranty, express or implied, is made.

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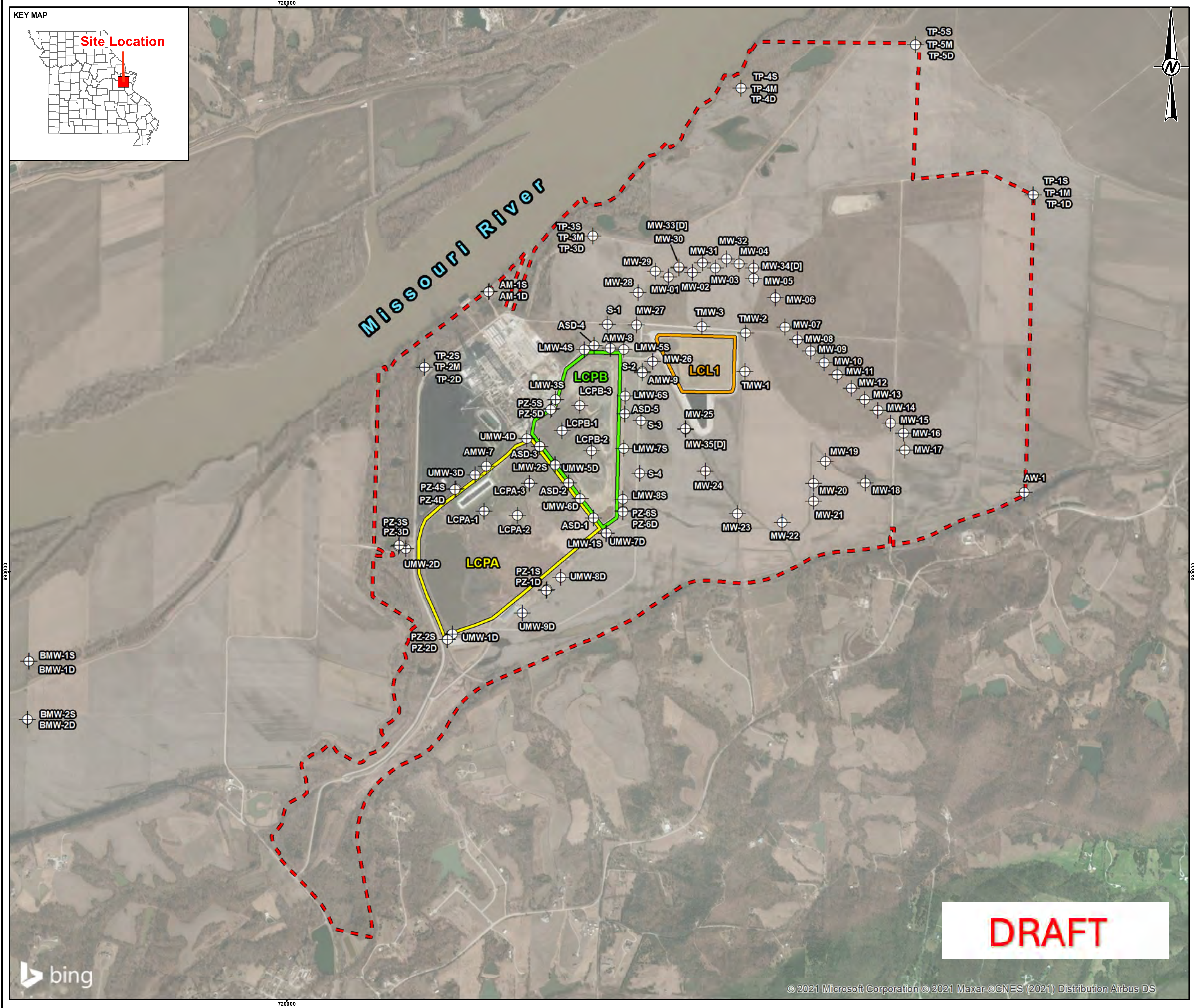
Tables:

Figures:



LEGEND

- 🟥 Approximate Property Boundary

Labadie Energy Center CCR Units

- 🟨 LCPA - Bottom Ash Surface Impoundment
- 🟩 LCPB - Fly Ash Surface Impoundment
- 🟧 LCL1 - Utility Waste Landfill Cell 1
- ⊕ Calibration Target Point

0 1,000 2,000 3,000 4,000
Feet

NOTE(S)

1.) ALL LOCATIONS AND BOUNDARIES ARE APPROXIMATE.
2.) MNA - MONITORED NATURAL ATTENUATION.
3.) ASD - ALTERNATIVE SOURCE DEMONSTRATION.
4.) EACH LCPA POREWATER SAMPLING LOCATION HAS A SHALLOW AND DEEP INTERVAL.
5.) EACH ASD SAMPLING LOCATION HAS A SHALLOW, MIDDLE, AND DEEP INTERVAL.

REFERENCE(S)

1.) ZAHNER AND ASSOCIATES, INC. 2016. LOT CONSOLIDATION PLAT OF "LABADIE ENERGY CENTER" - PREPARED FOR AMEREN MISSOURI. REVISED JUNE 15, 2016.
2.) COORDINATE SYSTEM: NAD 1983 STATEPLANE MISSOURI EAST FIPS 2,401 FEET.

CLIENT
AMEREN MISSOURI
LCPA SURFACE IMPOUNDMENT LABADIE ENERGY CENTER

PROJECT
GROUNDWATER MONITORING PROGRAM
MONITORED NATURAL ATTENUATION

TITLE
GROUNDWATER SAMPLING AND WATER LEVEL ELEVATION COLLECTION POINTS

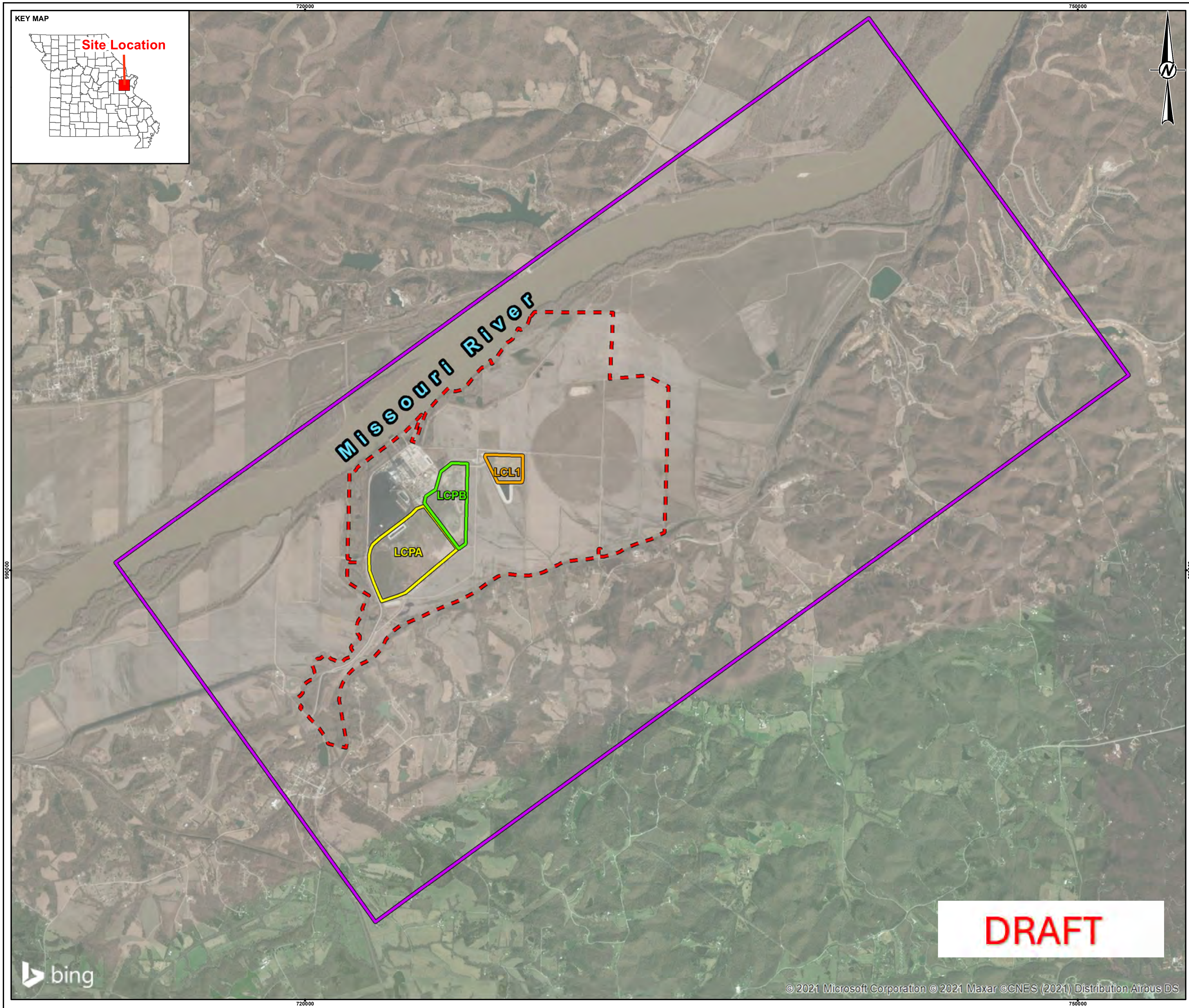
CONSULTANT

YYYY-MM-DD	2021-09-27
DESIGNED	JSI
PREPARED	BTT
REVIEWED	EMS
APPROVED	JM

PROJECT NO.	CONTROL	REV.	FIGURE
153140603	1240	1.0	1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B
0 1 in

PATH: C:\Users\BTalbert\Golder Associates\153140601,02 - Ameren CCR GW Monitoring Program 2020 - 15314106 - All Project Files\5 Technical Work\0001-LEC\5.5-Figures-Drawings\PRODUCTION\20210210-LECMNA-MAP\20210927-FigureX-All Wells.mxd PRINTED ON: 2021-09-29 AT: 8:54:32 AM



LEGEND

🟥	Approximate Property Boundary
🟪	Groundwater Model Domain

Labadie Energy Center CCR Units

🟨	LCPA - Bottom Ash Surface Impoundment
🟩	LCPB - Fly Ash Surface Impoundment
🟧	LCL1 - Utility Waste Landfill Cell 1

0 2,000 4,000 6,000 8,000
Feet

NOTE(S)
1.) ALL LOCATIONS AND BOUNDARIES ARE APPROXIMATE.
2.) MNA - MONITORED NATURAL ATTENUATION.

REFERENCE(S)
1.) ZAHNER AND ASSOCIATES, INC. 2016. LOT CONSOLIDATION PLAT OF "LABADIE ENERGY CENTER" - PREPARED FOR AMEREN MISSOURI. REVISED JUNE 15, 2016.
2.) COORDINATE SYSTEM: NAD 1983 STATEPLANE MISSOURI EAST FIPS 2,401 FEET.

CLIENT
AMEREN MISSOURI
LCPA SURFACE IMPOUNDMENT LABADIE ENERGY CENTER

PROJECT
GROUNDWATER MONITORING PROGRAM
MONITORED NATURAL ATTENUATION

Ameren

TITLE
GROUNDWATER MODEL DOMAIN

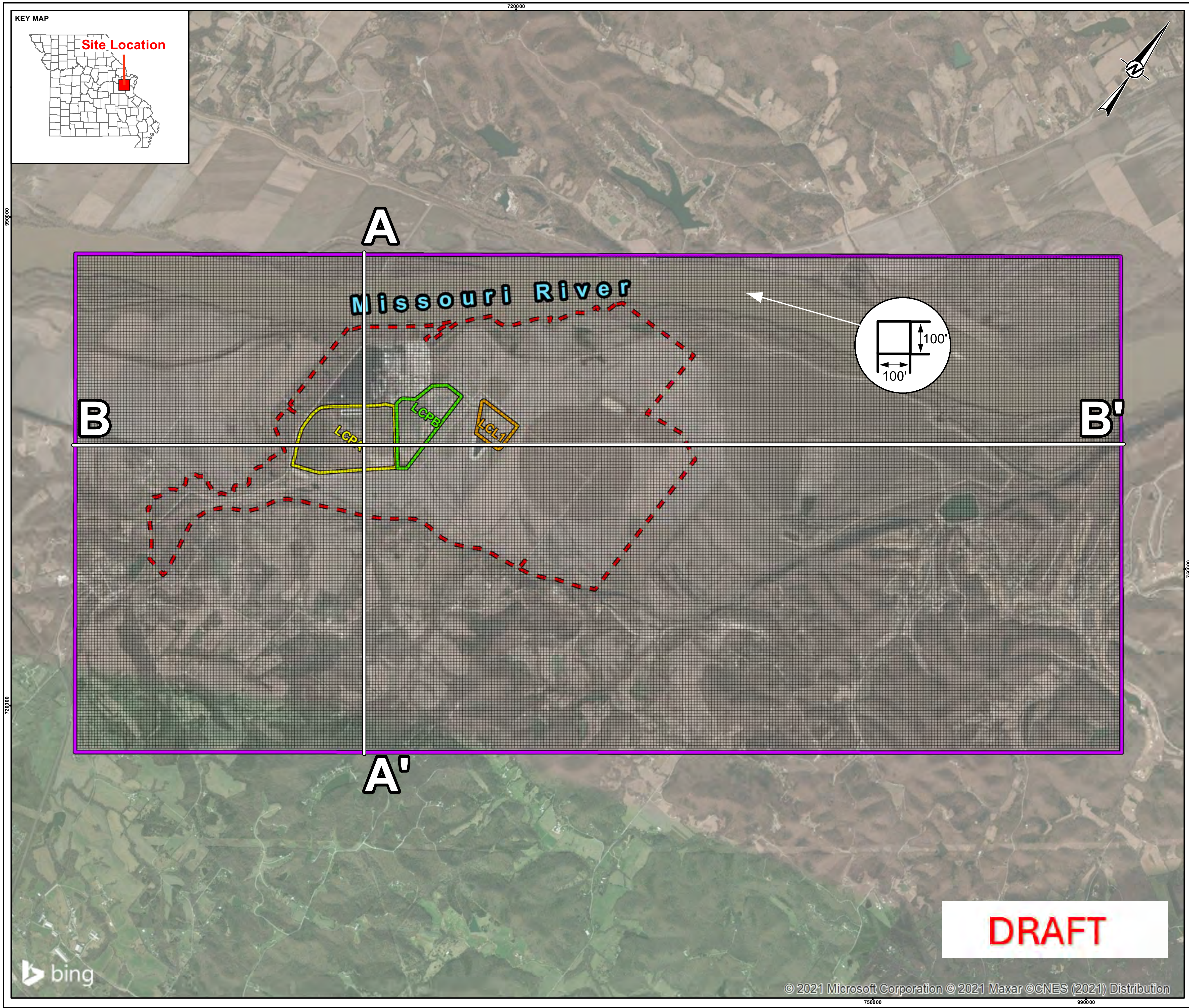
CONSULTANT
GOLDER

YYYY-MM-DD	2021-09-27
DESIGNED	JSI
PREPARED	JSI
REVIEWED	BTT
APPROVED	JM

PROJECT NO.	CONTROL	REV.	FIGURE
153140603	1240	1.0	2

0 1 in
IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

PATH: C:\Users\jingram\Golder Associates\153140601,02 - Ameren CCR GW Monitoring Program 2020 - APF\5 Technical Work\0001-LEC\5.8_GWVModel\8 - Reporting\Figures\MXD\F2- Domain.mxd PRINTED ON: 2021-09-29 AT: 8:49:42 AM



LEGEND

🟥 Approximate Property Boundary
▭ Groundwater Model Domain

Labadie Energy Center CCR Units

🟨 LCPA - Bottom Ash Surface Impoundment
🟩 LCPB - Fly Ash Surface Impoundment
🟧 LCL1 - Utility Waste Landfill Cell 1

0 2,000 4,000 6,000 8,000
Feet

NOTE(S)

1.) ALL LOCATIONS AND BOUNDARIES ARE APPROXIMATE.
2.) MNA - MONITORED NATURAL ATTENUATION.

REFERENCE(S)

1.) ZAHNER AND ASSOCIATES, INC. 2016. LOT CONSOLIDATION PLAT OF "LABADIE ENERGY CENTER" - PREPARED FOR AMEREN MISSOURI. REVISED JUNE 15, 2016.
2.) COORDINATE SYSTEM: NAD 1983 STATEPLANE MISSOURI EAST FIPS 2,401 FEET.

CLIENT
AMEREN MISSOURI
LCPA SURFACE IMPOUNDMENT LABADIE ENERGY CENTER

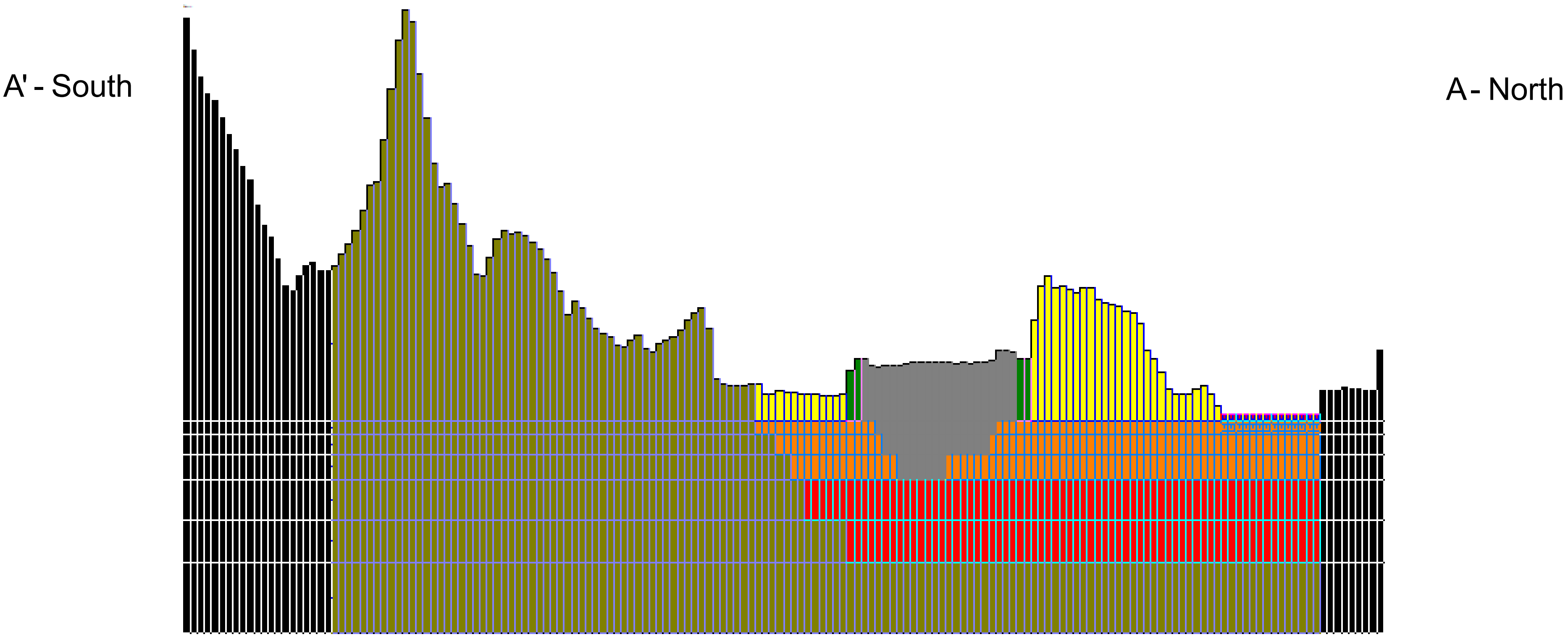
PROJECT
GROUNDWATER MONITORING PROGRAM
MONITORED NATURAL ATTENUATION

TITLE
GROUNDWATER MODEL GRID AND CROSS SECTION LOCATION MAP

CONSULTANT

YYYY-MM-DD	2021-09-27
DESIGNED	JSI
PREPARED	JSI
REVIEWED	BTT
APPROVED	JM

PROJECT NO.	CONTROL	REV.	FIGURE
153140603	1240	1.0	3



Color	Layer	Kx, Ky		Kz		Vertical Anisotropy
		cm/sec	ft/day	cm/sec	ft/day	
🟩	Compacted Berm Materials	1.0E-06	0.0028	1.0E-06	0.0028	1
⬜	CCR Materials	3.0E-05	0.085	3.0E-05	0.085	1
🟨	Shallow Zone of the Alluvial Aquifer	1.0E-02	28.346	1.0E-03	2.8346	0.1
🟧	Intermediate Zone of the Alluvial Aquifer	1.5E-02	42.5	1.5E-03	4.25	0.1
🟥	Deep Zone of the Alluvial Aquifer	1.5E-01	425.2	1.5E-02	42.52	0.1
🟫	Bedrock	1.8E-06	0.005	1.8E-07	0.0005	0.1
⬛	No Flow Areas	Not Applicable				
🟦	Surface Water					

NOTE(S)

1) Cross-section has a 20X vertical exaggeration.
2) Cm/sec = centimeters per second.
3) Ft/day = feet per day.
4) See Figure 3 for cross section locations.
5) Cross-section along column 99.

CLIENT
AMEREN MISSOURI
LCPA SURFACE IMPOUNDMENT, LABADIE ENERGY CENTER

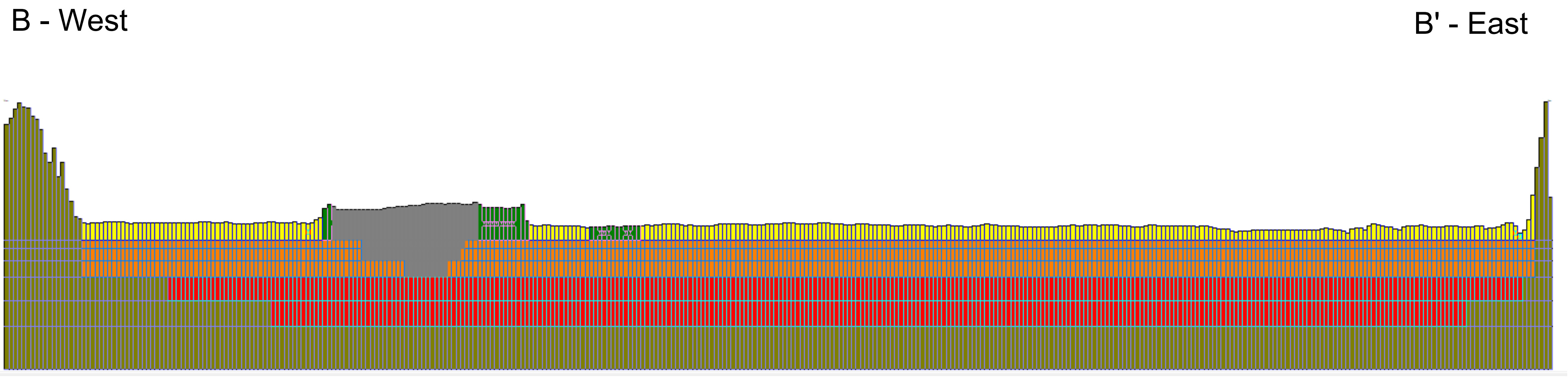
CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	2021-09-26
PREPARED	JSI
DESIGN	JSI
REVIEW	BTT
APPROVED	JM

PROJECT
GROUNDWATER MONITORING PROGRAM
MONITORED NATURAL ATTENUATION

TITLE
A-A' CROSS-SECTION AND HYDRAULIC CONDUCTIVITIES

PROJECT No.	REV.	FIGURE
153140603	**0.0**	**04**



Color	Layer	Kx, Ky		Kz		Vertical Anisotropy
		cm/sec	ft/day	cm/sec	ft/day	
🟩	Compacted Berm Materials	1.0E-06	0.0028	1.0E-06	0.0028	1
⬜	CCR Materials	3.0E-05	0.085	3.0E-05	0.085	1
🟨	Shallow Zone of the Alluvial Aquifer	1.0E-02	28.346	1.0E-03	2.8346	0.1
🟧	Intermediate Zone of the Alluvial Aquifer	1.5E-02	42.5	1.5E-03	4.25	0.1
🟥	Deep Zone of the Alluvial Aquifer	1.5E-01	425.2	1.5E-02	42.52	0.1
🟫	Bedrock	1.8E-06	0.005	1.8E-07	0.0005	0.1
⬛	No Flow Areas	Not Applicable				
🟦	Surface Water					

NOTE(S)

1) Cross-section has a 20X vertical exaggeration.
2) Cm/sec = centimeters per second.
3) Ft/day = feet per day.
4) See Figure 3 for cross section locations.
5) Cross-section along Row 65.

CLIENT
AMEREN MISSOURI
LCPA SURFACE IMPOUNDMENT, LABADIE ENERGY CENTER

CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	2021-09-26
PREPARED	JSI
DESIGN	JSI
REVIEW	BTT
APPROVED	JM

PROJECT
GROUNDWATER MONITORING PROGRAM
MONITORED NATURAL ATTENUATION

TITLE
B-B' CROSS-SECTION AND HYDRAULIC CONDUCTIVITIES

PROJECT No.	REV.	FIGURE
153140603	0.0	05

LEGEND

🟥 Approximate Property Boundary
🟪 Groundwater Model Domain

Color	Layer	Stress Period 1		Stress Period 2		Stress Period 3		Stress Period 4		Stress Period 5	
		LCPA Only -Active		LCPA and LCPB -Active		Closure Construction		Capped and Closed		Capped & Treatment	
		In/yr	ft/day	In/yr	ft/day	in/yr	ft/day	in/yr	ft/day	in/yr	ft/day
🟨	Alluvial Area	5.7	0.0013	5.7	0.0013	5.7	0.0013	5.7	0.0013	5.7	0.0013
🟩	Compacted Berms	2.6	0.0006	2.6	0.0006	2.6	0.0006	2.6	0.0006	2.6	0.0006
⬜	LCPA - North Central	175.2	0.04	109.5	0.025	5.7	0.0013	0.5	0.000112	0.5	0.000112
🟧	LCPA - Southeastern	175.2	0.04	131.4	0.03	5.7	0.0013	0.5	0.000112	0.5	0.000112
🟫	LCPA - Northeastern	175.2	0.04	131.4	0.03	5.7	0.0013	0.5	0.000112	0.5	0.000112
🟥	LCPA - South Central	175.2	0.04	131.4	0.03	5.7	0.0013	0.5	0.000112	0.5	0.000112
🟪	Infiltration Basin	5.7	0.0013	5.7	0.0013	5.7	0.0013	5.7	0.0013	131.4	0.0300
🟫	Bedrock	1.1	0.00026	1.1	0.00026	1.1	0.00026	1.1	0.00026	1.1	0.00026
⬛	No Flow Areas	Not Applicable									
🟦	Surface Water										

DRAFT

0 2,000 4,000 6,000 8,000
Feet

NOTE(S)
1.) ALL LOCATIONS AND BOUNDARIES ARE APPROXIMATE.
2.) MNA - MONITORED NATURAL ATTENUATION.

REFERENCE(S)
1.) ZAHNER AND ASSOCIATES, INC. 2016. LOT CONSOLIDATION PLAT OF "LABADIE ENERGY CENTER" - PREPARED FOR AMEREN MISSOURI. REVISED JUNE 15, 2016.
2.) COORDINATE SYSTEM: NAD 1983 STATEPLANE MISSOURI EAST FIPS 2,401 FEET.

CLIENT
AMEREN MISSOURI
LABADIE ENERGY CENTER

PROJECT
LABADIE MNA EVALUATION

TITLE
RECHARGE DISTRIBUTION

CONSULTANT

YYYY-MM-DD	2021-09-27
DESIGNED	JSI
PREPARED	JSI
REVIEWED	BTT
APPROVED	JM

PROJECT NO.	CONTROL	REV.	FIGURE
153140603	1240	1.0	6

PATH: C:\Users\jingram\Golder Associates\153140601,02 - Ameren CCR GW Monitoring Program 2020 - APF\5 Technical Work\0001-LEC\5.8_GWVModel\8 - Reporting\Figures\MXD\F5 - Recharges.mxd PRINTED ON: 2021-09-29 AT: 5:21:49 PM

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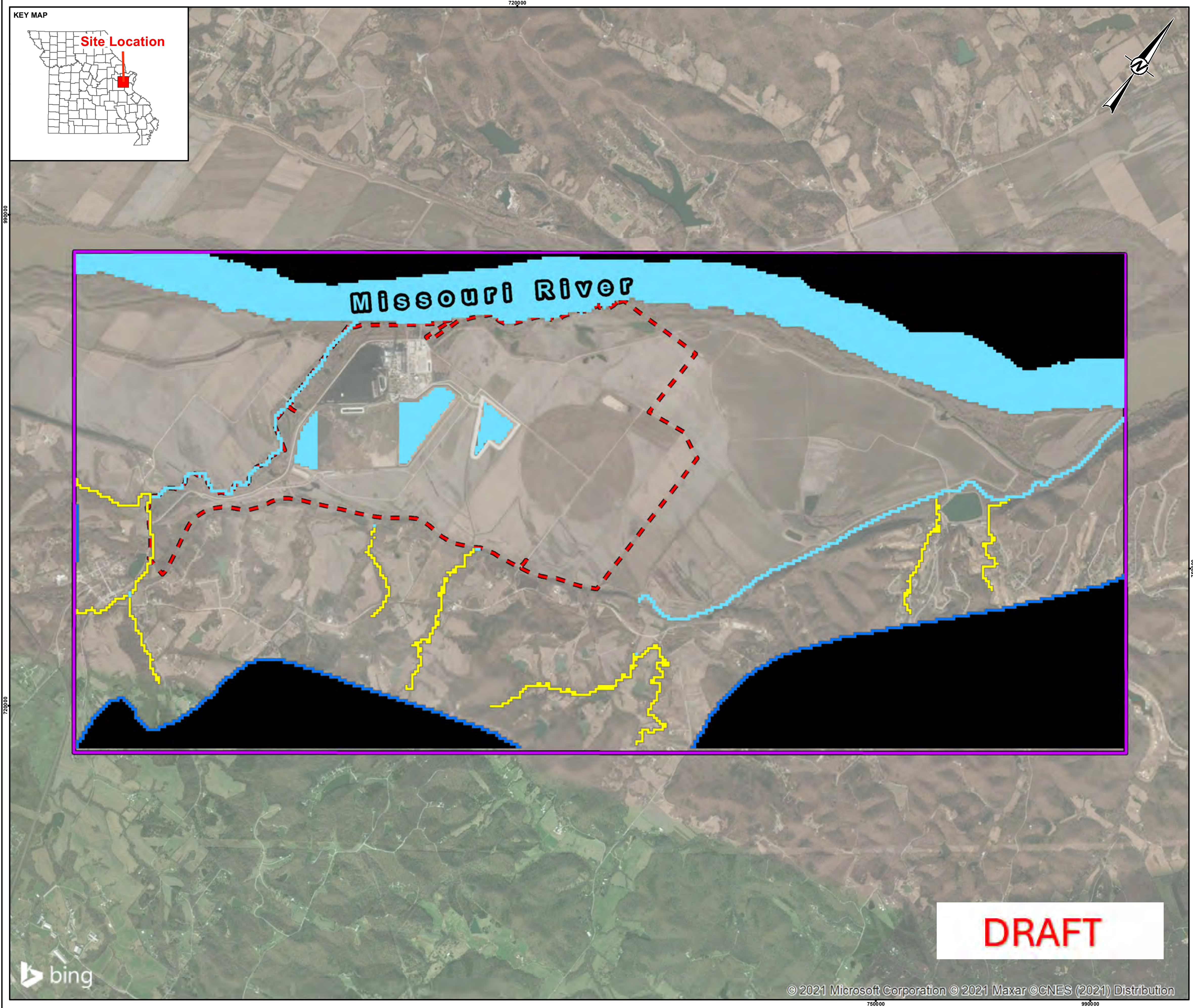

LEGEND

- 🟥 Approximate Property Boundary
- ▭ Groundwater Model Domain
- 🟦 Constant Head Boundary (CHB) - Layers 1-7
- 🟨 Drain Cell - Layer 1
- ■ No Flow Areas - Layers 1
- 🟦 River - Surface Water Features - Layer 1 (Layers 1 and 2 for Missouri River)

0 2,000 4,000 6,000 8,000
Feet

NOTE(S)
1.) ALL LOCATIONS AND BOUNDARIES ARE APPROXIMATE.
2.) MNA - MONITORED NATURAL ATTENUATION.

REFERENCE(S)
1.) ZAHNER AND ASSOCIATES, INC. 2016. LOT CONSOLIDATION PLAT OF "LABADIE ENERGY CENTER" - PREPARED FOR AMEREN MISSOURI. REVISED JUNE 15, 2016.
2.) COORDINATE SYSTEM: NAD 1983 STATEPLANE MISSOURI EAST FIPS 2,401 FEET.

CLIENT
AMEREN MISSOURI
LCPA SURFACE IMPOUNDMENT LABADIE ENERGY CENTER

PROJECT
GROUNDWATER MONITORING PROGRAM
MONITORED NATURAL ATTENUATION

Ameren

TITLE
BOUNDARY CONDITIONS

CONSULTANT
GOLDER

YYYY-MM-DD	2021-09-27
DESIGNED	JSI
PREPARED	JSI
REVIEWED	BTT
APPROVED	JM

PROJECT NO.	CONTROL	REV.	FIGURE
153140603	1240	1.0	7

PATH: C:\Users\jingram\Golder Associates\153140601,02 - Ameren CCR GW Monitoring Program 2020 - APF\5 Technical Work\0001-LEC\5.8_GWVModel\8 - Reporting\Figures\MXD\F6 - Boundary Condition.mxd PRINTED ON: 2021-09-28 AT: 10:59:42 PM

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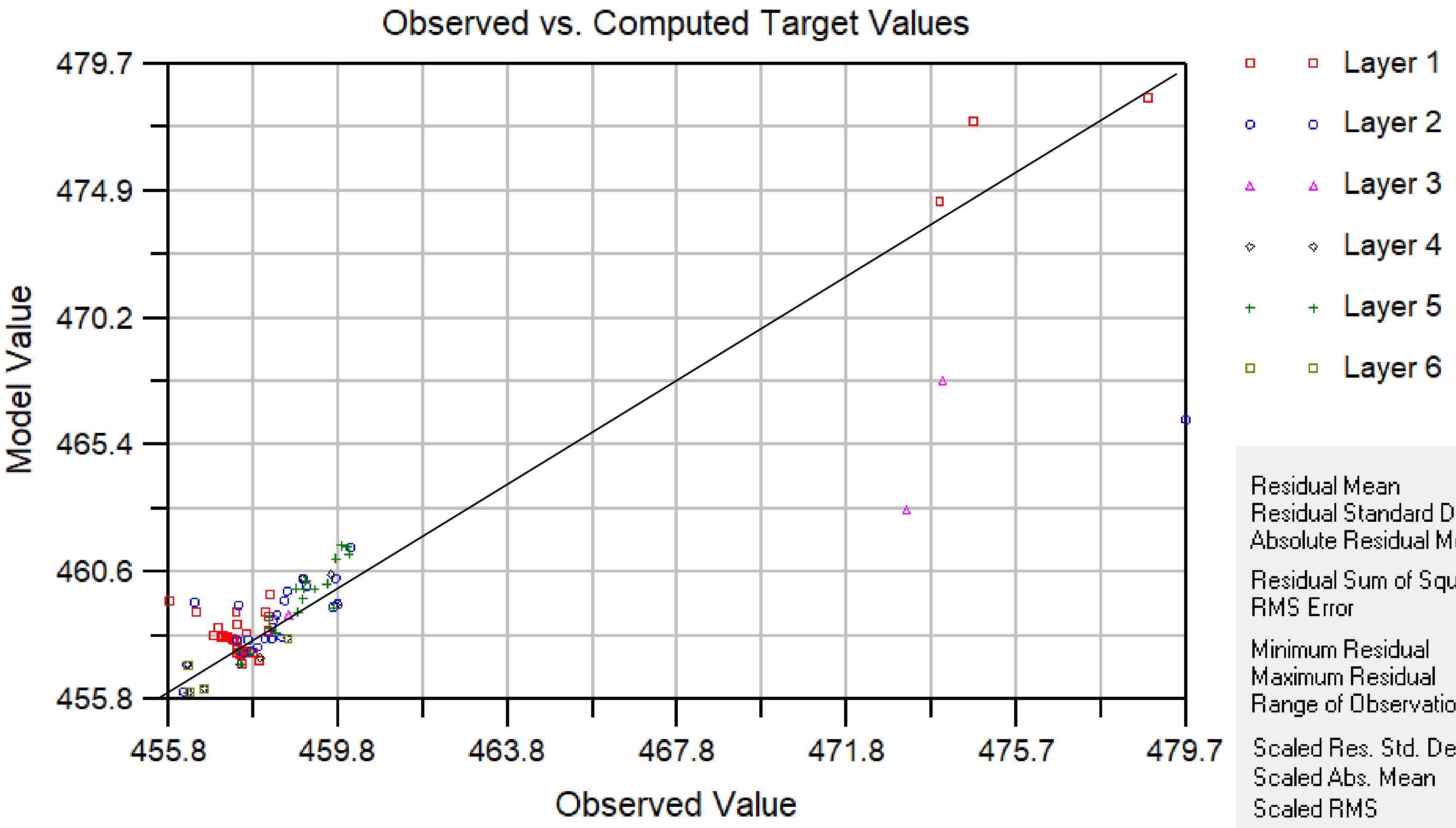


Residual Mean = -0.24
Residual Standard Dev. = 2.11
Absolute Residual Mean = 1.07

Residual Sum of Squares =4.19e+002
RMS Error =2.12

Minimum Residual = -3.72
Maximum Residual = 13.43
Range of Observations = 23.97

Scaled Res. Std. Dev. = 0.088
Scaled Abs. Mean = 0.044
Scaled RMS = 0.089

Number of Observations = 93

NOTE(S)

1) Values from water levels collected September 27, 2018, when the LCPA was in active conditions.

CLIENT
AMEREN MISSOURI
LCPA SURFACE IMPOUNDMENT, LABADIE ENERGY CENTER

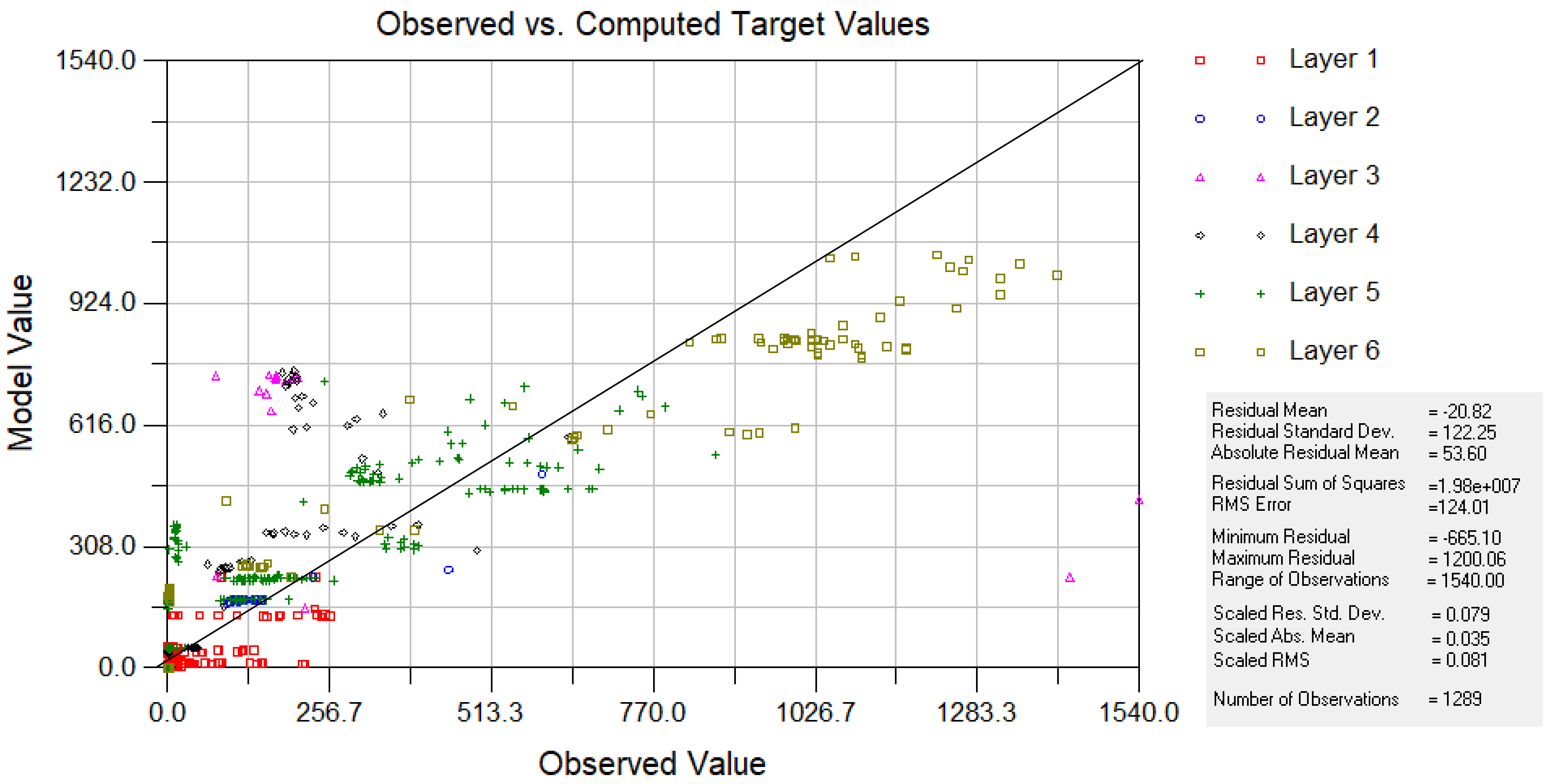
PROJECT
GROUNDWATER MONITORING PROGRAM
MONITORED NATURAL ATTENUATION

CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	2021-09-26
PREPARED	JSI
DESIGN	JSI
REVIEW	BTT
APPROVED	JM

TITLE
SCATTER DIAGRAM FOR PREDICTED AND OBSERVED HYDRAULIC HEADS – STEADY STATE CONDITIONS

PROJECT No.	REV.	FIGURE
153140603	**0.0**	**8**



NOTE(S)

1) Values from groundwater samples collected between 2015 and 2021.

CLIENT
AMEREN MISSOURI
LCPA SURFACE IMPOUNDMENT, LABADIE ENERGY CENTER

PROJECT
GROUNDWATER MONITORING PROGRAM
MONITORED NATURAL ATTENUATION

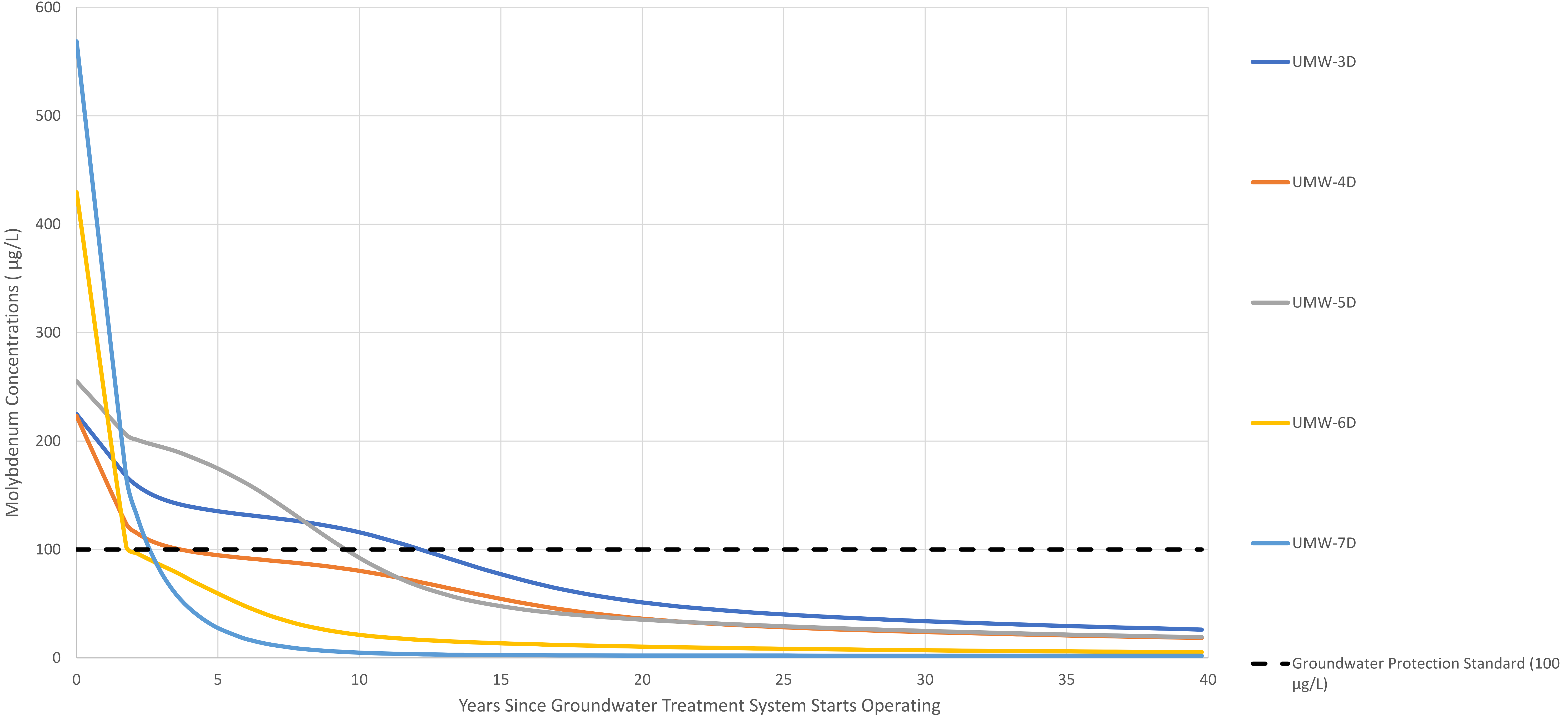
CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	2021-09-26
PREPARED	JSI
DESIGN	JSI
REVIEW	BTT
APPROVED	JM

TITLE
SCATTER DIAGRAM FOR PREDICTED AND OBSERVED MOLYBDENUM CONCENTRATIONS – TRANSIENT CONDITIONS

PROJECT No.	REV.	FIGURE
153140603	**0.0**	**9**

Model Predicted Molybdenum Concentrations Over Time



Notes:
1) µg/L - Micrograms per liter.

CLIENT
AMEREN MISSOURI
LCPA SURFACE IMPOUNDMENT, LABADIE ENERGY CENTER

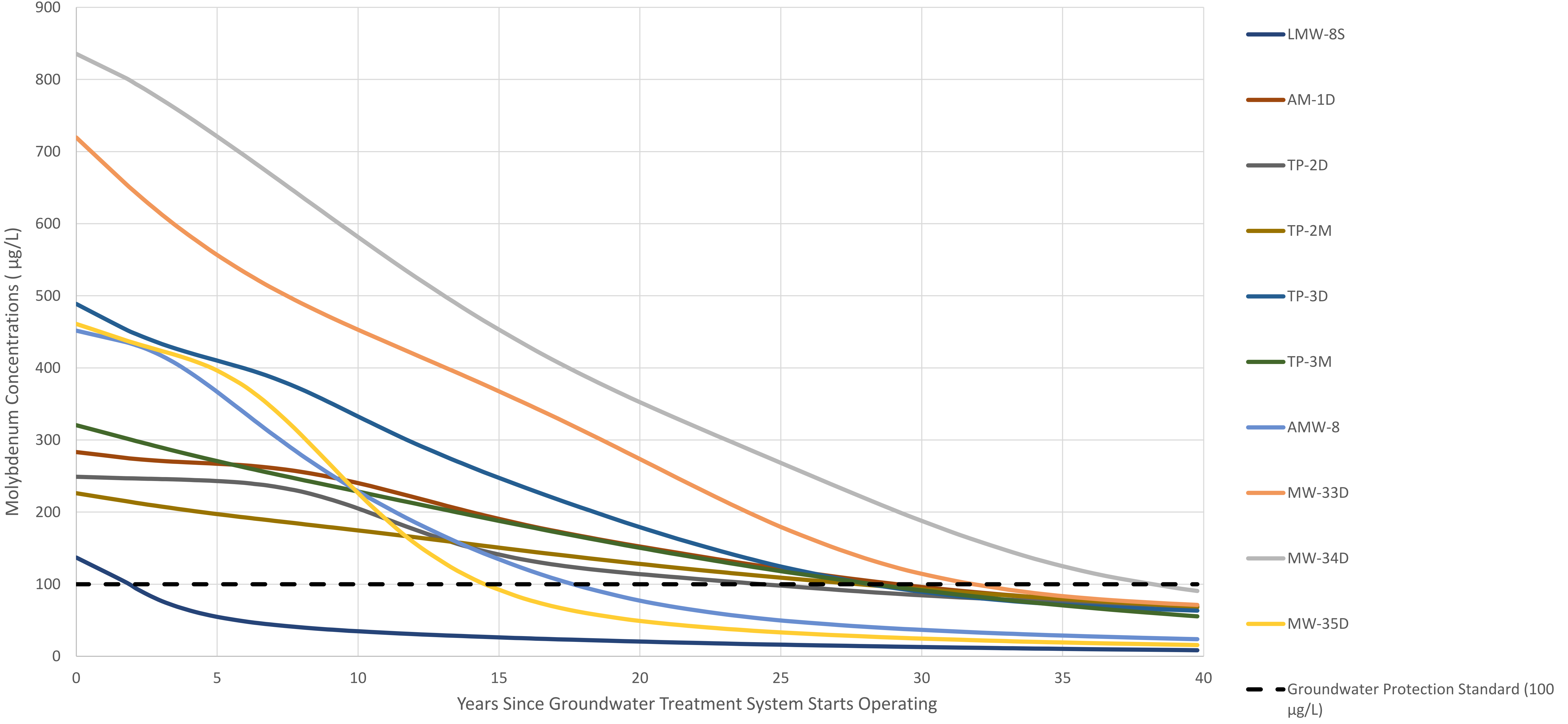
CONSULTANT
GOLDER
MEMBER OF WSP

PROJECT
GROUNDWATER MONITORING PROGRAM
MONITORED NATURAL ATTENUATION

TITLE
Model Predicted Molybdenum Concentrations Over Time
Detection and Assessment Monitoring Well Network

PROJECT NO.	PHASE	REV.	FIGURE
153140603	0001D	A	10

Model Predicted Molybdenum Concentrations Over Time



Notes:
1) µg/L - Micrograms per liter.

CLIENT
AMEREN MISSOURI
LCPA SURFACE IMPOUNDMENT, LABADIE ENERGY CENTER

CONSULTANT
GOLDER
MEMBER OF WSP

PROJECT
GROUNDWATER MONITORING PROGRAM
MONITORED NATURAL ATTENUATION

TITLE
Model Predicted Molybdenum Concentrations Over Time
Corrective Action Monitoring Well Network

PROJECT NO.	PHASE	REV.	FIGURE
153140603	0001D	A	11

APPENDIX G

2018 Risk Assessment Report

REPORT ON

HUMAN HEALTH AND ECOLOGICAL ASSESSMENT OF THE LABADIE ENERGY CENTER

AMEREN MISSOURI
LABADIE, MISSOURI

by Haley & Aldrich, Inc.
Boston, Massachusetts

for Ameren Missouri
St. Louis, Missouri

File No. 130182-002
February 2018

LABADIE ENERGY CENTER

1. Introduction

The Ameren Missouri Labadie Energy Center (LEC) is a 2,407 MW coal-fueled steam electrical power generating facility located along the southern side of the Missouri River below the Missouri River bluffs, near the Town of Labadie in Franklin County, Missouri. The facility has been in operation since 1970. Coal ash is produced by the use of coal in the facility, and since 2010, approximately 50% of fly ash and bottom ash produced at the facility has been put into various beneficial uses.

Coal ash is presently stored on-site in two ponds and a Utility Waste Landfill (LC1) that are operated in accordance with permits issued by the State of Missouri. Figure 1 shows the location of the facility, and the location of the ash management areas LCPA, LCPB, and LCL1. LCPB contains fly ash and is lined with high density polyethylene (HDPE); LCPA currently receives bottom ash and is unlined. These ponds have been in operation for over 40 years. Labadie is in the process of converting to a dry ash management system. Following dry ash conversion, the ash ponds will be removed from service and closed. Thereafter, LCL1, which began operation in December 2016, will be used to manage coal ash not used for beneficial purposes.

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 ("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 LEC ash management areas. The Labadie Energy Center has been a focus of interest of environmental groups. On multiple occasions, Ameren Missouri has retained outside experts (Golder, AECOM, Kleinfelder, Haley & Aldrich) to evaluate whether either the construction of a dry ash landfill at Labadie or historical ash pond operations pose a risk to the public. Those reports[1] are posted on Ameren's publicly available website: *https://www.ameren.com/Environment/managing-ccrs/ash-pond-closure*. In this report, Haley & Aldrich expands upon those earlier efforts and examines both surface and groundwater data reported under the CCR Rule, and the results of previous surface water investigations of the Missouri River and Labadie Creek, which border the Labadie Energy Center.

Ameren Missouri's comprehensive evaluation demonstrates that there are no adverse impacts resulting from coal ash management practices at the Labadie Energy Center on human health or the environment

---

[1] The Kleinfelder report documents the following: groundwater sampling around perimeter and outside Ameren property; sampling of Labadie Creek and Missouri River; location of private wells; groundwater flow rate; groundwater modeling, and hydraulic gradients in alluvial and bedrock aquifers. To address whether groundwater from the Labadie Bottoms area could ever pose a risk to drinking water supplies, modelling was conducted to confirm that groundwater from the shallow aquifer within the Labadie Bottoms would not "reverse flow" into the bluffs area and impact private wells. It cannot. (The modelling evaluation assumed an extreme river condition (i.e., the 1993 flood lasting 55 straight days).

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 Labadie 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 conceptual model approach also identified where ecological populations could come into contact with surface water. This information 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[2]. 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 then evaluated using human health risk-based and ecological risk-based screening levels drawn from Federal and State sources. The evaluation looks first at whether constituents are present in groundwater and surface water that could be present due to the ash management operations. Then, if present, screening levels are used to determine if the concentration level of such constituent could pose a risk to human health or the environment.

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

Conceptual Site Model

A conceptual site model 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 Labadie Energy Center, the coal ash stored in the LCPA, LCPB, and LCL1 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 in a downgradient/downhill direction. These constituents derived from the coal ash could then be introduced to adjacent surface water bodies; here, that could be the Missouri River and/or Labadie Creek. 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;
- Missouri River surface water; and
- Labadie Creek surface water.

The direction of groundwater flow has been cataloged for many years at the Labadie Energy Center. The direction and rate of flow can vary with Missouri River stage but as Figure 1 shows, the direction of groundwater flow is mainly from the bluffs on the southern side of the facility towards the Missouri River.

There are no users of shallow groundwater in the vicinity of the ash management areas. While there are approximately 76 private wells recorded within a one-mile radius of the facility, all are located in the bluff area south and upgradient of the facility (see Figure 2; a detailed discussion of the wells in Figure 2 is presented in the AECOM 2014 report). Thus, there are no users of groundwater that may contain constituents derived from coal ash in the vicinity of the Labadie Energy Center ash management areas.

The Missouri River is a source of drinking water for the City of St. Louis, Missouri. The drinking water intake is located approximately 19.5 miles downstream from the facility at Howard Bend. Labadie Creek does not serve as a source of drinking water.

The Missouri River can be used for human recreation – wading, swimming, boating, fishing. Labadie Creek can also be used recreationally, though its small size would limit it mostly to wading.

Both the creek and the river 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, samples have been collected from each of these environmental media – groundwater, Missouri River and Labadie Creek. 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 can also be 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 is 19.5 miles downstream in the Missouri River. All of the surface water data is compared to risk-based human recreational screening levels, and to ecological screening levels. The 2014 AECOM report demonstrated that the drinking water wells in the bluffs above the facility are screened in the bedrock aquifer and are not impacted by any release from the coal ash management areas.

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

Groundwater samples were collected from monitoring wells placed around each ash management area consistent with the CCR Rule. In addition, four (4) background groundwater monitoring were installed at locations selected intentionally so as to avoid potential CCR impacts. The presence of constituents in a background well is indicative of naturally occurring conditions.

Eleven (11) groundwater monitoring wells were installed to evaluate deep alluvial groundwater at the LCPA under the CCR Rule, as shown on Figure 1. Nine (9) monitoring wells were installed around the perimeter of the LCPA to assess groundwater conditions at the ash management area (UMW-1D through UMW-9D), and two (2) monitoring wells were installed west of the facility to assess background groundwater conditions (BMW-1D and BMW-2D). LCPA has a deep alluvial aquifer monitoring system due to the depth of the ash in this unlined impoundment.

Ten (10) groundwater monitoring wells were installed to evaluate shallow alluvial groundwater at the LCPB under the CCR Rule, as shown on Figure 1. Eight (8) monitoring wells were installed around the perimeter of the LCPB to assess groundwater conditions at the ash management area (LMW-1S through LMW-8S), and the two (2) monitoring wells installed west of the facility are used to assess background groundwater conditions at the LCPB (BMW-1S and BMW-2S). LCPB has a shallow alluvial aquifer monitoring system due to the shallow depth of the lined impoundment.

Six (6) groundwater monitoring wells were installed to evaluate shallow alluvial groundwater at the LCL1 under the CCR Rule, as shown on Figure 1. Four (4) monitoring wells were installed around the perimeter of the LCL1 to assess groundwater conditions at the ash management area (MW-26, TMW-1, TMW-2, and TMW-3), and the two (2) shallow monitoring wells installed west of the facility are used to assess background groundwater conditions at the LCL1 also (BMW-1S and BMW-2S).

Each groundwater monitoring well was sampled nine (9) times[3] in 2016 and 2017.

Missouri River

Surface water samples were collected from 12 locations in the Missouri River in October 2013 and November 2014. 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.

Three (3) locations are approximately 0.25 miles upstream of the Facility (LBD-R-4 through -6) to assess water conditions unaffected by facility operations. Samples were collected in October 2013 and November 2014 to represent the following environments:

- Nearshore on the side closest to the Labadie Energy Center (LBD-R-4S and LBD-R-4AS), shallow depth;
- Midstream (LBD-R-6S/M and LBD-R-6AS/M), shallow depth, and mid-depth; and
- Near midstream (LBD-R-5S/M and LBD-R-5AS/M), shallow depth, and mid-depth.

Thus, a total of ten (10) upstream samples were collected.

Three (3) locations are approximately 0.25 miles downstream of the facility (LBD-R-1 through -3). 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, samples were collected in October 2013 and November 2014 to represent the following environments:

- Nearshore on the side closest to the Labadie Energy Center (LBD-R-1S and LBD-R-1AS), shallow depth;
- Midstream (LBD-R-3S/M and LBD-R-3AS/M), shallow depth, and mid-depth; and
- Near midstream (LBD-R-2S/M and LBD-R-2AS/M), shallow depth, and mid-depth.

Thus, a total of ten (10) downstream samples were collected.

In addition, an extra water sample was collected randomly from one of the locations, in this case an extra shallow sample was collected from the midstream downstream location.

Because of the variability in the groundwater flow directions over time, in November 2014, two additional downstream areas were sampled.

Three (3) locations are approximately 0.50 miles further downstream of the facility (LBD-R-10 through -12). 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, samples were collected in November 2014 to represent the following environments:

- Nearshore on the side closest to the Labadie Energy Center (LBD-R-10S), shallow depth;
- Midstream (LBD-R-12S/M), shallow depth, and mid-depth; and
- Near midstream (LBD-R-11S/M), shallow depth, and mid-depth.

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[3] 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.

Thus, a total of five (5) further downstream samples were collected.

In addition, an extra water sample was collected randomly from one of the locations, in this case an extra shallow sample was collected from the nearshore further downstream location.

Three (3) locations are approximately 0.75 miles furthest downstream of the facility (LBD-R-7 through -9). 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, samples were collected in November 2014 to represent the following environments:

- Nearshore on the side closest to the Labadie Energy Center (LBD-R-7S), shallow depth;
- Midstream (LBD-R-9S/M), shallow depth, and mid-depth; and
- Near midstream (LBD-R-8S/M), shallow depth, and mid-depth.

Thus, a total of five (5) furthest downstream samples were collected.

In addition, an extra water sample was collected randomly from one of the locations, in this case an extra shallow sample was collected from the nearshore furthest downstream location.

Thus, a total of 30 samples and three duplicates were collected from the 12 locations in the Missouri River.

Labadie Creek

The western border of the Labadie Energy Center is adjacent to Labadie Creek. Shallow surface water samples were collected from six (6) locations in the creek in October 2013. These locations are shown on Figure 4. Three locations are upstream of the facility, three locations are near the confluence of the creek with the Missouri River. Samples were collected:

- Upstream (LBD-C-4 through LBD-C-6); and
- Downstream (LBD-C-1 through LBD-C-3).

Thus, a total of six (6) surface water samples were collected. In addition, an extra water sample was collected randomly from one of the locations, in this case an extra shallow sample was collected from a downstream location.

4. Sample Analysis

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

Boron
Calcium
Chloride
pH
Sulfate
TDS
Fluoride
Antimony
Arsenic
Barium
Beryllium
Cadmium
Chromium
Cobalt
Lead
Lithium
Mercury
Molybdenum
Selenium
Thallium
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. Detection monitoring 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, these same parameters were used for the surface water sample analysis except for chloride, TDS (TDS was included in the November 2014 sampling), lithium, and radium 226/228[4]. 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 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.

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.

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[4] The analyte list was selected to be the same as the NPDES permit application analyte list, as the list is comprehensive and approved by the State. Because the radiological parameters included on the NPDES list were not above the screening levels during outfall monitoring, these parameters were not included in the surface water sampling program. As discussed in Section 6, chloride was not detected at concentrations above risk-based screening levels in the CCR Rule monitoring wells.

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 Table 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 the Missouri River based on its hardness data. 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: *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.

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 from the LCPA and the LCPB; there were no SSIs identified for the LCL1.

The statistical analysis of the LCPA data has indicated an SSI for samples collected from monitoring wells UMW-1 through UMW-9 (see Figure 1) that monitor the deeper alluvial aquifer. Analytes exhibiting an SSI are pH, boron, calcium, chloride, fluoride, sulfate, and TDS.

The statistical analysis of the LCPB data has indicated an SSI for samples collected from monitoring wells LMW-1S, LMW-2S, LMW-3S, LMW-4S, LMW-6S, LMW-7S, and LMW-8S. Analytes exhibiting an SSI are pH, boron, chloride, fluoride, and sulfate.

There were no SSIs identified for the LCL1.

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 LCPA, LCPB, and LCL1 pose 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.

Groundwater – Risk-Based Evaluation

Groundwater data from all nine rounds of groundwater monitoring were compared to the human health risk-based drinking water screening levels. Figure 1 shows that the monitoring wells are all located at the edges of the LCPA, LCBP, and LCL1 and should, therefore, provide worst-case groundwater results.

Tables 3 through 5 provide a summary of the results. Analytical results greater than the screening level are provided; analytical results below the risk-based drinking water screening levels are indicated by "<". Note also that the first two wells listed in each table are the two background wells. The vast majority of the results are below the human health risk-based drinking water screening levels.

There are four (4) background wells. L-BMW-1D and L-BMW-2D serve as the background wells in the deeper alluvial aquifer for the LCPA. Both wells exhibit TDS concentrations above the human health drinking water screening level. L-BMW-2D also exhibits sulfate and lithium concentrations above the human health drinking water screening levels. L-BMW-1S and L-BMW-2S serve as the shallow alluvial aquifer background wells for the LCPB and LCL1. L-BMW-1S exhibits TDS concentrations above the human health drinking water screening level. Thus, these results represent naturally occurring conditions in the alluvial aquifer.

L-UMW-5D and L-UMW-7D, along the perimeter of the LCPA, have the most results above the screening levels: these are for boron, pH, sulfate, TDS, and molybdenum. As noted earlier, the alluvial aquifer in the vicinity of the LEC ash management areas is not used as a source of drinking water.

L-LMW-2S and L-LMW-4S, along the perimeter of the LCPB, have the most results above the screening levels: these are for boron, pH, sulfate, TDS, and molybdenum; and, boron, sulfate, TDS, lithium, and molybdenum, respectively. As noted earlier, the alluvial aquifer in the vicinity of the LEC ash management areas is not used as a source of drinking water.

L-TMW-3, associated with the LCL1, has the most results above the screening levels: these are for pH, TDS, and lithium. As noted earlier, the alluvial aquifer in the vicinity of the LEC ash management areas is not used as a source of drinking water.

The striking aspect of the analysis shown in Tables 3 through 5 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 48 years[5]. 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.

Missouri River

The comparison to risk-based screening levels of the analytical results for the Missouri River are presented in Tables 6 through 8.

- Table 6 – Comparison to drinking water screening levels – All results are below risk-based screening levels for drinking water with the exception of TDS; the TDS results upstream and downstream are similar, thus, indicative of normal river conditions.
- Table 7 – 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.
- Table 8 – Comparison to ecological screening levels – No results are above risk-based screening levels.

All analytical results for the Missouri River are below the ecological screening levels. All analytical results for the Missouri River are below drinking water screening levels with the exception of TDS, and the concentrations are similar upstream and downstream. While arsenic concentrations in the river are slightly above the human health recreational screening levels, the concentrations are similar upstream and downstream.

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 Missouri River sampling results do not show evidence of impact of constituents derived from LEC's ash management areas. This is important in that the absence of concentrations above risk-based screening levels means that there is not a significant pathway of exposure.

Labadie Creek

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

- Table 9 – Comparison to drinking water screening levels – All results are below risk-based screening levels.

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[5] Out of the 4386 groundwater analyses conducted at all three ash management areas, only 404 results are above a drinking water screening level (see Table 4). Put another way, approximately 90% of the groundwater results for the CCR Rule monitoring wells located at the edge of the LEC ash management areas are below drinking water screening levels.

- Table 10 – 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 normal creek conditions.
- Table 11 – Comparison to ecological screening levels – All results are below risk-based screening levels.

There are no analytical results for Labadie Creek that above drinking water or ecological screening levels. While arsenic concentrations in the creek are slightly above the human health recreational screening levels, the concentrations are similar upstream and downstream. As noted above, this is a common occurrence in surface water in Missouri.

Thus, even this small water body immediately adjacent to the Labadie Energy Center does not show evidence of risk to human health or the environment from ash management operations.

NPDES Outfall WET Testing Results

The outfall for the Labadie Energy Center is Outfall 002 and shown on Figure 4. This is a permitted outfall under the National Pollutant Discharge Elimination System (NPDES) program and discharges into a channel that runs parallel to Labadie Creek before reaching the Missouri River. The outfall effluent water is tested for toxicity on a periodic basis as required by the permit.

WET testing involves mixing the effluent water from Outfall 002 with synthetic laboratory water at various dilutions. 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 12 shows the results of the direct aquatic organism toxicity testing that was conducted using the outfall effluent. The results indicate no evidence of aquatic toxicity of the outfall effluent, even at a 100% effluent exposure concentration. This is a direct biological measure demonstrating the lack of toxicity of the Outfall 002 effluent.

7. Derivation of Risk-Based Screening Levels for Groundwater

The results presented here demonstrate that the 48-year history of ash management activities at the LEC have not had an adverse effect on human health or the environment. These results confirm that while some of the concentrations in the monitoring wells at the ash management areas are above the screening levels, and may be above the levels used to evaluate data under the CCR Rule, there is no pathway of exposure to the on-site groundwater. Where there is no exposure, there is no risk.

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 Missouri River is the longest river in North America and as depicted on Table 13 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 13 is summarized below and shows the application of the dilution factor to calculate alternative risk-based screening levels for the following parameters: boron, sulfate, cobalt, lithium, molybdenum, and TDS. These Tables 3-5 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. The dilution factor is then applied to this lowest screening level for surface water to result in the groundwater alternative risk-based screening level, which is what is shown in the table below.

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].

CALCULATING RISK-BASED SCREENING LEVELS FOR GROUNDWATER BASED ON THE MISSOURI RIVER (see Table 13)

	Estimated Dilution Factor for Missouri River (d) =	100,000

Constituents*	**Lowest of the Human Health and Eco Screening Levels (mg/L)**	**Groundwater Target Level** (mg/L)**	**Maximum LEC Groundwater Concentration (mg/L)**		**Ratio Between Groundwater Target Level and the Maximum LEC Groundwater Concentration**
Boron***	2	200000	18.2	L-UMW-6D	>10,000
Sulfate***	250	25000000	774	L-UMW-3D	>32,000
Cobalt	0.006	600	0.0095	L-LMW-6S	>63,000
Lithium	0.04	4000	0.0575	L-TMW-2	>69,000
Molybdenum	0.1	10000	0.674	L-UMW-6D	>14,000
TDS***	500	50000000	1240	L-UMW-3D	>40,000

*** A dilution factor is not directly applicable to pH, thus it is not included in this analysis.**

**** Where the Groundwater Target Level = Screening Level x Dilution Factor.**

***** Constituents for which an SSI has been identified. Note that although an SSI was identified for boron and sulfate, these constituents are not present in surface water at concentrations above the risk-based screening levels. Note that although an SSI was identified for chloride and fluoride for LCPA and LCPB, none of the groundwater results are above risk-based drinking water screening levels for these constituents.**

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

The groundwater target 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[7,8].

The table identifies the maximum groundwater concentration of each constituent detected in the monitoring wells for the ash management areas. The comparison between the target levels and the maximum concentrations indicates that there is a wide margin of safety between the two values. This margin is shown in the last column of the table. To illustrate, concentration levels of boron and lithium would need to be more than 10,000 and 69,000 times higher, respectively, than currently measured levels before an adverse impact in the river could occur.

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

8. Closure of the LCPA and LCPB

Current plans for the facility are to close the surface impoundments[9]. Closure of the surface impoundments is expected to be completed in 2020. Closure is estimated to reduce the movement of CCR constituents from the surface impoundments discharge (or flux) of water into the alluvial aquifer to 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 in this area 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 Labadie Energy Center.

10. Attachments

TABLES

1 HUMAN HEALTH SCREENING LEVELS

2 ECOLOGICAL SCREENING LEVELS

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[7] Note that because the target level calculation is a mathematical exercise, certain results may not be applicable in the real world. For example, the result for sulfate is 25 million parts per million, which is not physically possible. However, what this means is that there is no level of sulfate that could be present in the groundwater at the LEC that could result in a risk of harm to human health or the environment.

[8] 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.

[9] 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
LABADIE ENERGY CENTER, FRANKLIN 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
LABADIE ENERGY CENTER, FRANKLIN COUNTY, MISSOURI
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	0.015	0.013	0.00059	0.0005	NA	NA	0.0053 (f)	0.0048 (g)	0.0018 (f)	0.0016 (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	4.2	1.3	0.20	0.17	0.1 (e)	NA	4.2 (e,f)	1.3 (e,g)	0.20 (e,f)	0.17 (e,g)
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	0.31	0.20	0.0120	0.0077	NA	NA	0.31 (f)	0.20 (g)	0.0120 (f)	0.0077 (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	1830 (g,h)	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.	mg/L - milligram per liter.
CASRN - Chemical Abstracts Service Registry Number.	NA - Not Available.
CMC - Criterion Maximum Concentration	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) - 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 the Missouri River of 284.5 mg/L as $CaCO_3$ used

(g) - Hardness dependent value for total metals adjusted for dissolved fraction. Site-specific total recoverable mean hardness value for the Missouri River of 284.5 mg/L as $CaCO_3$ used

(h) - Chloride dependent value (Site-specific mean chloride value of 19.5 mg/L is assumed) for the Missouri 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 LCPA SURFACE IMPOUNDMENT GROUNDWATER MONITORING RESULTS COMPARISON TO HUMAN HEALTH DRINKING WATER SCREENING LEVELS
LABADIE ENERGY CENTER, FRANKLIN 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
	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
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
L-BMW-1D (b)	Mar-16	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	May-16	<	<	<	<	<	570	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Jul-16	<	<	<	<	<	504	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Sep-16	<	<	<	<	<	514	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Nov-16	<	<	<	<	<	521	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Jan-17	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Mar-17	<	<	<	<	<	505	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Jun-17	<	<	<	<	<	518	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Nov-17	<	<	<	NA	<	<	<	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
L-BMW-2D (b)	Mar-16	<	<	<	<	<	555	<	<	<	<	<	<	<	<	<	0.0474	<	<	<	<
	May-16	<	<	<	<	272	613	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Jul-16	<	<	<	<	<	538	<	<	<	<	<	<	<	<	<	0.0441	<	<	<	<
	Sep-16	<	<	<	<	<	524	<	<	<	<	<	<	<	<	<	0.0432	<	<	<	<
	Nov-16	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	0.0461	<	<	<	<
	Jan-17	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Mar-17	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	0.0415	<	<	<	<
	Jun-17	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Nov-17	<	<	<	NA	<	<	<	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
L-UMW-1D	Mar-16	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	May-16	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Jul-16	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Sep-16	<	<	<	<	<	512	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Nov-16	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Jan-17	<	<	<	<	<	531	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Mar-17	<	<	<	<	<	517	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Jun-17	<	<	<	<	<	568	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Nov-17	<	<	<	NA	<	<	<	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
L-UMW-2D	Mar-16	<	<	<	<	270	669	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	May-16	<	<	<	<	<	535	<	<	<	<	<	<	<	<	<	0.0451	<	<	<	<
	Jul-16	<	<	<	<	<	659	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Sep-16	<	<	<	<	<	625	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Nov-16	<	<	<	<	<	669	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Jan-17	<	<	<	<	<	547	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Mar-17	<	<	<	<	<	540	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Jun-17	<	<	<	<	<	543	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Nov-17	<	<	<	NA	<	583	<	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
L-UMW-3D	Mar-16	8.98	<	<	<	364	601	<	<	<	<	<	<	<	<	<	<	<	0.195	<	<
	May-16	9.43	<	<	<	473	735	<	<	<	<	<	<	<	<	<	<	<	0.171	<	<
	Jul-16	9.8	<	<	<	382	670	<	<	<	<	<	<	<	<	<	<	<	0.192	<	<
	Sep-16	9.23	<	<	<	454	781	<	<	<	<	<	<	<	<	<	<	<	0.175	<	<
	Nov-16	8.55	<	<	<	774	1240	<	<	<	<	<	<	<	<	<	<	<	0.113	<	<
	Jan-17	7.85	<	<	<	597	1030	<	<	<	<	<	<	<	<	<	<	<	0.127	<	<
	Mar-17	7.87	<	<	<	634	1150	<	<	<	<	<	<	<	<	<	<	<	0.116	<	<
	Jun-17	12.4	<	<	<	386	777	<	<	<	<	<	<	<	<	<	<	<	0.171	<	<
	Nov-17	9.85	<	<	NA	422	596	<	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
L-UMW-4D	Mar-16	4.01	<	<	<	343	590	<	<	<	<	<	<	<	<	<	<	<	0.148	<	<
	May-16	<	<	<	<	330	550	<	<	<	<	<	<	<	<	<	<	<	0.145	<	<
	Jul-16	4.34	<	<	<	372	629	<	<	<	<	<	<	<	<	<	<	<	0.192	<	<
	Sep-16	<	<	<	<	360	618	<	<	<	<	<	<	<	<	<	<	<	0.156	<	<
	Nov-16	<	<	<	<	274	<	<	<	<	<	<	<	<	<	<	<	<	0.122	<	<
	Jan-17	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Mar-17	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	0.116	<	<
	Jun-17	5.24	<	<	<	342	610	<	<	<	<	<	<	<	<	<	<	<	0.192	<	<
	Nov-17	4.02	<	<	NA	312	536	<	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
L-UMW-5D	Mar-16	5.15	<	<	<	261	<	<	<	<	<	<	<	<	<	<	<	<	0.109	<	<
	May-16	5.22	<	<	9.3	312	548	<	<	<	<	<	<	<	<	<	<	<	0.13	<	<
	Jul-16	5.3	<	<	<	267	515	<	<	<	<	<	<	<	<	<	<	<	0.117	<	<
	Sep-16	5.08	<	<	9.2	275	513	<	<	<	<	<	<	<	<	<	<	<	0.12	<	<
	Nov-16	5.4	<	<	9.2	263	<	<	<	<	<	<	<	<	<	<	<	<	0.122	<	<
	Jan-17	5.48	<	<	9.1	<	<	<	<	<	<	<	<	<	<	<	<	<	0.106	<	<
	Mar-17	6.15	<	<	9.1	252	<	<	<	<	<	<	<	<	<	<	<	<	0.111	<	<
	Jun-17	5.69	<	<	9.3	<	<	<	<	<	<	<	<	<	<	<	<	<	0.136	<	<
	Nov-17	5.92	<	<	NA	<	<	<	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
L-UMW-6D	Mar-16	18.2	<	<	<	278	547	<	<	<	<	<	<	<	<	<	<	<	0.668	<	<
	May-16	16.7	<	<	<	400	571	<	<	<	<	<	<	<	<	<	<	<	0.634	<	<
	Jul-16	17.7	<	<	<	350	548	<	<	<	<	<	<	<	<	<	<	<	0.674	<	<
	Sep-16	16.8	<	<	<	316	589	<	<	<	<	<	<	<	<	<	<	<	0.596	<	<
	Nov-16	15.9	<	<	<	384	630	<	<	<	<	<	<	<	<	<	<	<	0.554	<	<
	Jan-17	14	<	<	<	504	680	<	<	<	<	<	<	<	<	<	<	<	0.504	<	<
	Mar-17	14.2	<	<	<	446	749	<	<	<	<	<	<	<	<	<	<	<	0.496	<	<
	Jun-17	17.4	<	<	<	366	672	<	<	<	<	<	<	<	<	<	<	<	0.548	<	<
	Nov-17	15.7	<	<	NA	467	645	<	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

TABLE 3
SUMMARY OF LCPA SURFACE IMPOUNDMENT GROUNDWATER MONITORING RESULTS COMPARISON TO HUMAN HEALTH DRINKING WATER SCREENING LEVELS
LABADIE ENERGY CENTER, FRANKLIN 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
	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
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
L-UMW-7D	Mar-16	5.81	<	<	<	<	725	<	<	<	<	<	<	<	<	<	<	<	0.201	<	<
	May-16	5.74	<	<	<	<	726	<	<	<	<	<	<	<	<	<	<	<	0.182	<	<
	Jul-16	5.82	<	<	<	<	760	<	<	<	<	<	<	<	<	<	<	<	0.198	<	<
	Sep-16	4.82	<	<	6	<	766	<	<	<	<	<	<	<	<	<	<	<	0.205	<	<
	Nov-16	5.26	<	<	<	252	740	<	<	<	<	<	<	<	<	<	<	<	0.191	<	<
	Jan-17	5.57	<	<	<	318	800	<	<	<	<	<	<	<	<	<	<	<	0.205	<	<
	Mar-17	5.84	<	<	<	295	801	<	<	<	<	<	<	<	<	<	<	<	0.191	<	<
	Jun-17	5.98	<	<	<	305	809	<	<	<	<	<	<	<	<	<	<	<	0.188	<	<
	Nov-17	6.36	<	<	NA	313	825	<	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
L-UMW-8D	Mar-16	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	May-16	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Jul-16	<	<	<	<	<	507	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Sep-16	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Nov-16	<	<	<	<	<	521	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Jan-17	<	<	<	<	<	511	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Mar-17	<	<	<	<	<	536	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Jun-17	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Nov-17	<	<	<	NA	<	<	<	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
L-UMW-9D	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
Summary Ratio of # Results above the SL : Total # Results		40:99	0:99	0:99	7:88	38:99	63:99	0:99	0:88	0:88	0:88	0:88	0:88	0:88	0:88	0:88	6:88	0:88	39:88	0:88	0:88

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.
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.
(b) - Background monitoring wells.

TABLE 4
SUMMARY OF LCPB SURFACE IMPOUNDMENT GROUNDWATER MONITORING RESULTS COMPARISON TO HUMAN HEALTH DRINKING WATER SCREENING LEVELS
LABADIE ENERGY CENTER, FRANKLIN 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
	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
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
L-BMW-1S (b)	Mar-16	<	<	<	<	<	712	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	May-16	<	<	<	<	<	772	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Jul-16	<	<	<	<	<	780	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Sep-16	<	<	<	<	<	752	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Nov-16	<	<	<	<	<	692	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Jan-17	<	<	<	<	<	704	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Mar-17	<	<	<	<	<	748	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Jun-17	<	<	<	<	<	749	<	<	<	<	<	<	<	<	<	<	<	<	<	<
L-BMW-2S (b)	Mar-16	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	May-16	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Jul-16	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Sep-16	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Nov-16	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Jan-17	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Mar-17	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Jun-17	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
L-LMW-1S	Mar-16	<	<	<	<	<	529	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	May-16	<	<	<	<	<	525	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Jul-16	<	<	<	<	<	552	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Sep-16	4.34	<	<	<	<	615	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Nov-16	6.23	<	<	<	<	688	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Jan-17	<	<	<	<	<	519	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Mar-17	<	<	<	<	<	521	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Jun-17	<	<	<	<	<	685	<	<	<	<	<	<	<	<	<	<	<	<	<	<
L-LMW-2S	Mar-16	6.97	<	<	<	295	<	<	<	<	<	<	<	<	<	<	<	<	0.141	<	<
	May-16	6.92	<	<	9.3	312	505	<	<	<	<	<	<	<	<	<	<	<	0.137	<	<
	Jul-16	6.72	<	<	9.3	365	519	<	<	<	<	<	<	<	<	<	<	<	0.123	<	<
	Sep-16	6.9	<	<	9.4	311	526	<	<	<	<	<	<	<	<	<	<	<	0.119	<	<
	Nov-16	7.19	<	<	9.3	275	<	<	<	<	<	<	<	<	<	<	<	<	0.111	<	<
	Jan-17	6.86	<	<	9.2	285	<	<	<	<	<	<	<	<	<	<	<	<	0.115	<	<
	Mar-17	6.68	<	<	9	293	519	<	<	<	<	<	<	<	<	<	<	<	0.151	<	<
	Jun-17	7.3	<	<	9.3	317	523	<	<	<	<	<	<	<	<	<	<	<	0.148	<	<
L-LMW-3S	Mar-16	4.76	<	<	<	254	595	<	<	<	<	<	<	<	<	<	<	<	0.202	<	<
	May-16	4.04	<	<	<	286	508	<	<	<	<	<	<	<	<	<	<	<	0.172	<	<
	Jul-16	4.3	<	<	<	256	576	<	<	<	<	<	<	<	<	<	<	<	0.173	<	<
	Sep-16	<	<	<	<	256	501	<	<	<	<	<	<	<	<	<	<	<	0.171	<	<
	Nov-16	5.31	<	<	<	260	641	<	<	<	<	<	<	<	<	<	<	<	0.207	<	<
	Jan-17	5.55	<	<	<	257	666	<	<	<	<	<	<	<	<	<	<	<	0.197	<	<
	Mar-17	4.53	<	<	<	<	516	<	<	<	<	<	<	<	<	<	<	<	0.172	<	<
	Jun-17	5.39	<	<	<	271	627	<	<	<	<	<	<	<	<	<	<	<	0.187	<	<
L-LMW-4S	Mar-16	7.32	<	<	<	<	793	<	<	<	<	<	<	<	<	<	0.042	<	<	<	<
	May-16	9.46	<	<	<	266	648	<	<	<	<	<	<	<	<	<	<	<	0.218	<	<
	Jul-16	9.48	<	<	<	<	712	<	<	<	<	<	<	<	<	<	<	<	0.142	<	<
	Sep-16	9.56	<	<	<	<	677	<	<	<	<	<	<	<	<	<	<	<	0.214	<	<
	Nov-16	7.6	<	<	<	<	748	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Jan-17	8.12	<	<	<	<	724	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Mar-17	9.5	<	<	<	<	740	<	<	<	<	<	<	<	<	<	0.0446	<	<	<	<
	Jun-17	10.6	<	<	<	264	695	<	<	<	<	<	<	<	<	<	<	<	0.13	<	<
L-LMW-5S	Mar-16	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	May-16	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Jul-16	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Sep-16	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Nov-16	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Jan-17	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Mar-17	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Jun-17	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
L-LMW-6S	Mar-16	<	<	<	<	<	642	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	May-16	4.78	<	<	<	<	633	<	<	<	<	<	<	<	<	<	0.0444	<	<	<	<
	Jul-16	5.15	<	<	<	<	656	<	<	<	<	<	<	<	0.0095	<	<	<	<	<	<
	Sep-16	<	<	<	<	<	659	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Nov-16	<	<	<	<	<	608	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Jan-17	<	<	<	<	<	602	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Mar-17	<	<	<	<	<	599	<	<	<	<	<	<	<	<	<	0.0413	<	<	<	<
	Jun-17	5.77	<	<	<	<	627	<	<	<	<	<	<	<	0.0061	<	0.0408	<	<	<	<
L-LMW-7S	Mar-16	4.06	<	<	<	<	551	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	May-16	4.15	<	<	<	<	732	<	<	<	<	<	<	<	<	<	0.0486	<	<	<	<
	Jul-16	6.4	<	<	<	<	687	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Sep-16	4.28	<	<	<	<	722	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Nov-16	<	<	<	<	<	578	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Jan-17	<	<	<	<	<	607	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Mar-17	<	<	<	<	<	636	<	<	<	<	<	<	<	<	<	0.0402	<	<	<	<
	Jun-17	5.66	<	<	<	<	752	<	<	<	<	<	<	<	<	<	0.0442	<	<	<	<

TABLE 4
SUMMARY OF LCPB SURFACE IMPOUNDMENT GROUNDWATER MONITORING RESULTS COMPARISON TO HUMAN HEALTH DRINKING WATER SCREENING LEVELS
LABADIE ENERGY CENTER, FRANKLIN 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
	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
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
L-LMW-8S	Mar-16	5.53	<	<	<	287	791	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	May-16	7.16	<	<	<	522	899	<	<	<	<	<	<	<	<	<	<	<	0.206	<	<
	Jul-16	6.22	<	<	<	338	865	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Sep-16	5.22	<	<	<	309	845	<	<	<	<	<	<	<	<	<	<	<	0.11	<	<
	Nov-16	<	<	<	<	<	649	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Jan-17	<	<	<	<	<	596	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Mar-17	<	<	<	<	<	585	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Jun-17	8.73	<	<	<	448	913	<	<	<	<	<	<	<	<	<	<	<	0.258	<	<
Summary Ratio of # Results above the SL : Total # Results		38:80	0:80	0:80	7:80	22:80	61:80	0:80	0:80	0:80	0:80	0:80	0:80	0:80	2:80	0:80	8:80	0:80	23:80	0:80	0:80

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.
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.
(b) - Background monitoring well also associated with LCL1.

TABLE 5
SUMMARY OF LCL1 UTILITY WASTE LANDFILL CELL 1 GROUNDWATER MONITORING RESULTS COMPARISON TO HUMAN HEALTH DRINKING WATER SCREENING LEVELS
LABADIE ENERGY CENTER, FRANKLIN 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
	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
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
L-BMW-1S (b)	Mar-16	<	<	<	<	<	712	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	May-16	<	<	<	<	<	772	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Jul-16	<	<	<	<	<	780	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Sep-16	<	<	<	<	<	752	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Nov-16	<	<	<	<	<	692	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Jan-17	<	<	<	<	<	704	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Mar-17	<	<	<	<	<	748	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Jun-17	<	<	<	<	<	749	<	<	<	<	<	<	<	<	<	<	<	<	<	<
L-BMW-2S (b)	Mar-16	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	May-16	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Jul-16	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Sep-16	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Nov-16	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Jan-17	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Mar-17	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Jun-17	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
L-MW-26	May-16	<	<	<	<	<	510	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Jun-16	<	<	<	<	<	506	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Jul-16	<	<	<	<	<	611	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Sep-16	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Nov-16	<	<	<	<	<	505	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Jan-17	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Mar-17	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Jun-17	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
L-TMW-1	May-16	<	<	<	<	<	559	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Jun-16	<	<	<	<	<	622	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Jul-16	<	<	<	<	<	668	<	<	<	<	<	<	<	<	<	0.043	<	<	<	<
	Sep-16	<	<	<	<	<	647	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Nov-16	<	<	<	<	<	578	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Jan-17	<	<	<	<	<	576	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Mar-17	<	<	<	<	<	642	<	<	<	<	<	<	<	<	<	0.0401	<	<	<	<
	Jun-17	<	<	<	<	<	628	<	<	<	<	<	<	<	<	<	<	<	<	<	<
L-TMW-2	May-16	<	<	<	<	<	664	<	<	<	<	<	<	<	<	<	0.049	<	<	<	<
	Jun-16	<	<	<	<	<	681	<	<	<	<	<	<	<	<	<	0.0401	<	<	<	<
	Jul-16	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Sep-16	<	<	<	<	<	743	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Nov-16	<	<	<	<	<	698	<	<	<	<	<	<	<	<	<	0.0526	<	<	<	<
	Jan-17	<	<	<	<	<	683	<	<	<	<	<	<	<	<	<	0.0506	<	<	<	<
	Mar-17	<	<	<	<	<	737	<	<	<	<	<	<	<	<	<	0.0575	<	<	<	<
	Jun-17	<	<	<	<	<	684	<	<	<	<	<	<	<	<	<	<	<	<	<	<
L-TMW-3	May-16	<	<	<	9.6	<	718	<	<	<	<	<	<	<	<	<	0.0546	<	<	<	<
	Jun-16	<	<	<	<	<	683	<	<	<	<	<	<	<	<	<	0.0419	<	<	<	<
	Jul-16	<	<	<	<	<	695	<	<	<	<	<	<	<	<	<	0.0463	<	<	<	<
	Sep-16	<	<	<	<	<	604	<	<	<	<	<	<	<	<	<	<	<	<	<	<
	Nov-16	<	<	<	<	<	717	<	<	<	<	<	<	<	<	<	0.0552	<	<	<	<
	Jan-17	<	<	<	<	<	668	<	<	<	<	<	<	<	<	<	0.045	<	<	<	<
	Mar-17	<	<	<	<	<	684	<	<	<	<	<	<	<	<	<	0.0543	<	<	<	<
	Jun-17	<	<	<	<	<	711	<	<	<	<	<	<	<	<	<	0.0475	<	<	<	<
Summary Ratio of # Results above the SL : Total # Results		0:48	0:48	0:48	1:48	0:48	35:48	0:48	0:48	0:48	0:48	0:48	0:48	0:48	0:48	0:48	14:48	0:48	0:48	0:48	0:48

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.

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.
(b) - Background monitoring well also associated with LCPB.

TABLE 6
SUMMARY OF MISSOURI RIVER SURFACE WATER TOTAL (UNFILTERED) AND DISSOLVED (FILTERED) RESULTS COMPARISON TO HUMAN HEALTH DRINKING WATER SCREENING LEVELS
LABADIE ENERGY CENTER, FRANKLIN COUNTY, MO
AMEREN MISSOURI

		Human Health Drinking Water Screening (a)																		
	Constituent	Boron		Calcium		Chloride	pH	Sulfate	TDS	Fluoride	Antimony		Arsenic		Barium		Beryllium		Cadmium	
	Fraction	Total	Dissolved	Total	Dissolved	Total	Total	Total	Total	Total	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
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
UPSTREAM																				
LBD-R-4S	Oct-13	<	<	<	<	NA	NA	<	NA	<	<	<	<	<	<	<	<	<	<	<
LBD-R-4AS	Nov-14	<	<	<	<	NA	NA	<	539	<	<	<	<	<	<	<	<	<	<	<
LBD-R-5S	Oct-13	<	<	<	<	NA	NA	<	NA	<	<	<	<	<	<	<	<	<	<	<
LBD-R-5AS	Nov-14	<	<	<	<	NA	NA	<	548	<	<	<	<	<	<	<	<	<	<	<
LBD-R-5M	Oct-13	<	<	<	<	NA	NA	<	NA	<	<	<	<	<	<	<	<	<	<	<
LBD-R-5AM	Nov-14	<	<	<	<	NA	NA	<	553	<	<	<	<	<	<	<	<	<	<	<
LBD-R-6S	Oct-13	<	<	<	<	NA	NA	<	NA	<	<	<	<	<	<	<	<	<	<	<
LBD-R-6AS	Nov-14	<	<	<	<	NA	NA	<	550	<	<	<	<	<	<	<	<	<	<	<
LBD-R-6M	Oct-13	<	<	<	<	NA	NA	<	NA	<	<	<	<	<	<	<	<	<	<	<
LBD-R-6AM	Nov-14	<	<	<	<	NA	NA	<	544	<	<	<	<	<	<	<	<	<	<	<
DOWNSTREAM																				
LBD-R-1S	Oct-13	<	<	<	<	NA	NA	<	NA	<	<	<	<	<	<	<	<	<	<	<
LBD-R-1AS	Nov-14	<	<	<	<	NA	NA	<	532	<	<	<	<	<	<	<	<	<	<	<
LBD-R-2S	Oct-13	<	<	<	<	NA	NA	<	NA	<	<	<	<	<	<	<	<	<	<	<
LBD-R-2AS	Nov-14	<	<	<	<	NA	NA	<	541	<	<	<	<	<	<	<	<	<	<	<
LBD-R-2M	Oct-13	<	<	<	<	NA	NA	<	NA	<	<	<	<	<	<	<	<	<	<	<
LBD-R-2M-DUP	Oct-13	<	<	<	<	NA	NA	<	NA	<	<	<	<	<	<	<	<	<	<	<
LBD-R-2AM	Nov-14	<	<	<	<	NA	NA	<	531	<	<	<	<	<	<	<	<	<	<	<
LBD-R-3S	Oct-13	<	<	<	<	NA	NA	<	NA	<	<	<	<	<	<	<	<	<	<	<
LBD-R-3AS	Nov-14	<	<	<	<	NA	NA	<	540	<	<	<	<	<	<	<	<	<	<	<
LBD-R-3M	Oct-13	<	<	<	<	NA	NA	<	NA	<	<	<	<	<	<	<	<	<	<	<
LBD-R-3AM	Nov-14	<	<	<	<	NA	NA	<	541	<	<	<	<	<	<	<	<	<	<	<
FURTHER DOWNSTREAM																				
LBD-R-10S	Nov-14	<	<	<	<	NA	NA	<	550	<	<	<	<	<	<	<	<	<	<	<
LBD-R-10S-DUP	Nov-14	<	<	<	<	NA	NA	<	NA	<	<	<	<	<	<	<	<	<	<	<
LBD-R-11S	Nov-14	<	<	<	<	NA	NA	<	543	<	<	<	<	<	<	<	<	<	<	<
LBD-R-11M	Nov-14	<	<	<	<	NA	NA	<	546	<	<	<	<	<	<	<	<	<	<	<
LBD-R-12S	Nov-14	<	<	<	<	NA	NA	<	516	<	<	<	<	<	<	<	<	<	<	<
LBD-R-12M	Nov-14	<	<	<	<	NA	NA	<	555	<	<	<	<	<	<	<	<	<	<	<
FURTHEST DOWNSTREAM																				
LBD-R-7S	Nov-14	<	<	<	<	NA	NA	<	524	<	<	<	<	<	<	<	<	<	<	<
LBD-R-7S-DUP	Nov-14	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	<	<	<	<	<
LBD-R-8S	Nov-14	<	<	<	<	NA	NA	<	538	<	<	<	<	<	<	<	<	<	<	<
LBD-R-8M	Nov-14	<	<	<	<	NA	NA	<	551	<	<	<	<	<	<	<	<	<	<	<
LBD-R-9S	Nov-14	<	<	<	<	NA	NA	<	547	<	<	<	<	<	<	<	<	<	<	<
LBD-R-9M	Nov-14	<	<	<	<	NA	NA	<	551	<	<	<	<	<	<	<	<	<	<	<

Notes:

< - Less than the Human Health Drinking Water Screening Level.
DUP - Duplicate sample.
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 6
SUMMARY OF MISSOURI RIVER SURFACE WATER TOTAL (UNFILTERED) AND DISSOLVED (FILTERED) RESULTS COMPARISON TO HUMAN HEALTH DRINKING WATER SCREENING LEVELS
LABADIE ENERGY CENTER, FRANKLIN COUNTY, MO
AMEREN MISSOURI

		Human Health Drinking Water Screening (a)																			
	Constituent	Chromium		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	Dissolved	Total	Total
Sample	**HH DW SL**	0.1	0.1	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	mg/L	mg/L	pCi/L	mg/L
UPSTREAM																			
LBD-R-4S	Oct-13	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
LBD-R-4AS	Nov-14	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
LBD-R-5S	Oct-13	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
LBD-R-5AS	Nov-14	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
LBD-R-5M	Oct-13	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
LBD-R-5AM	Nov-14	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
LBD-R-6S	Oct-13	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
LBD-R-6AS	Nov-14	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
LBD-R-6M	Oct-13	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
LBD-R-6AM	Nov-14	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
DOWNSTREAM																			
LBD-R-1S	Oct-13	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
LBD-R-1AS	Nov-14	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
LBD-R-2S	Oct-13	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
LBD-R-2AS	Nov-14	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
LBD-R-2M	Oct-13	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
LBD-R-2M	Oct-13	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
LBD-R-2AM	Nov-14	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
LBD-R-3S	Oct-13	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
LBD-R-3AS	Nov-14	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
LBD-R-3M	Oct-13	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
LBD-R-3AM	Nov-14	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
FURTHER DOWNSTREAM																			
LBD-R-10S	Nov-14	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
LBD-R-10S-DUP	Nov-14	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
LBD-R-11S	Nov-14	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
LBD-R-11M	Nov-14	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
LBD-R-12S	Nov-14	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
LBD-R-12M	Nov-14	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
FURTHEST DOWNSTREAM																			
LBD-R-7S	Nov-14	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
LBD-R-7S-DUP	Nov-14	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
LBD-R-8S	Nov-14	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
LBD-R-8M	Nov-14	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
LBD-R-9S	Nov-14	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
LBD-R-9M	Nov-14	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<

Notes:

< - Less than the Human Health Drinking Water Screening Level.
DUP - Duplicate sample.
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 MISSOURI RIVER SURFACE WATER TOTAL (UNFILTERED) AND DISSOLVED (FILTERED) RESULTS COMPARISON TO HUMAN HEALTH RECREATIONAL USE SCREENING LEVELS
LABADIE ENERGY CENTER, FRANKLIN COUNTY, MO
AMEREN MISSOURI

		Human Health Recreational Use Screening (a)																		
	Constituent	Boron		Calcium		Chloride	pH	Sulfate	TDS	Fluoride	Antimony		Arsenic		Barium		Beryllium		Cadmium	
	Fraction	Total	Dissolved	Total	Dissolved	Total	Total	Total	Total	Total	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved
Sample	**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
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
UPSTREAM																				
LBD-R-4S	Oct-13	<	<	<	<	NA	NA	<	NA	<	<	<	0.0050	0.0035	<	<	<	<	<	<
LBD-R-4AS	Nov-14	<	<	<	<	NA	NA	<	<	<	<	<	0.0033	0.0024	<	<	<	<	<	<
LBD-R-5S	Oct-13	<	<	<	<	NA	NA	<	NA	<	<	<	0.0050	0.0035	<	<	<	<	<	<
LBD-R-5AS	Nov-14	<	<	<	<	NA	NA	<	<	<	<	<	0.0035	0.0023	<	<	<	<	<	<
LBD-R-5M	Oct-13	<	<	<	<	NA	NA	<	NA	<	<	<	0.0048	0.0038	<	<	<	<	<	<
LBD-R-5AM	Nov-14	<	<	<	<	NA	NA	<	<	<	<	<	0.0032	0.0027	<	<	<	<	<	<
LBD-R-6S	Oct-13	<	<	<	<	NA	NA	<	NA	<	<	<	0.0047	0.0037	<	<	<	<	<	<
LBD-R-6AS	Nov-14	<	<	<	<	NA	NA	<	<	<	<	<	0.0030	0.0026	<	<	<	<	<	<
LBD-R-6M	Oct-13	<	<	<	<	NA	NA	<	NA	<	<	<	0.0047	0.0034	<	<	<	<	<	<
LBD-R-6AM	Nov-14	<	<	<	<	NA	NA	<	<	<	<	<	0.0031	0.0026	<	<	<	<	<	<
DOWNSTREAM																				
LBD-R-1S	Oct-13	<	<	<	<	NA	NA	<	NA	<	<	<	0.0044	0.0040	<	<	<	<	<	<
LBD-R-1AS	Nov-14	<	<	<	<	NA	NA	<	<	<	<	<	0.0038	0.0028	<	<	<	<	<	<
LBD-R-2S	Oct-13	<	<	<	<	NA	NA	<	NA	<	<	<	0.0045	0.0037	<	<	<	<	<	<
LBD-R-2AS	Nov-14	<	<	<	<	NA	NA	<	<	<	<	<	0.0032	0.0024	<	<	<	<	<	<
LBD-R-2M	Oct-13	<	<	<	<	NA	NA	<	NA	<	<	<	0.0047	0.0036	<	<	<	<	<	<
LBD-R-2M-DUP	Oct-13	<	<	<	<	NA	NA	<	NA	<	<	<	0.0047	0.0041	<	<	<	<	<	<
LBD-R-2AM	Nov-14	<	<	<	<	NA	NA	<	<	<	<	<	0.0034	0.0022	<	<	<	<	<	<
LBD-R-3S	Oct-13	<	<	<	<	NA	NA	<	NA	<	<	<	0.0048	0.0033	<	<	<	<	<	<
LBD-R-3AS	Nov-14	<	<	<	<	NA	NA	<	<	<	<	<	0.0034	0.0026	<	<	<	<	<	<
LBD-R-3M	Oct-13	<	<	<	<	NA	NA	<	NA	<	<	<	0.0049	0.0035	<	<	<	<	<	<
LBD-R-3AM	Nov-14	<	<	<	<	NA	NA	<	<	<	<	<	0.0028	0.0026	<	<	<	<	<	<
FURTHER DOWNSTREAM																				
LBD-R-10S	Nov-14	<	<	<	<	NA	NA	<	<	<	<	<	0.0037	0.0026	<	<	<	<	<	<
LBD-R-10S-DUP	Nov-14	<	<	<	<	NA	NA	<	<	<	<	<	0.0033	0.0027	<	<	<	<	<	<
LBD-R-11S	Nov-14	<	<	<	<	NA	NA	<	<	<	<	<	0.0033	0.0027	<	<	<	<	<	<
LBD-R-11M	Nov-14	<	<	<	<	NA	NA	<	<	<	<	<	0.0032	0.0025	<	<	<	<	<	<
LBD-R-12S	Nov-14	<	<	<	<	NA	NA	<	<	<	<	<	0.0035	0.0026	<	<	<	<	<	<
LBD-R-12M	Nov-14	<	<	<	<	NA	NA	<	<	<	<	<	0.0035	0.0023	<	<	<	<	<	<
FURTHEST DOWNSTREAM																				
LBD-R-7S	Nov-14	<	<	<	<	NA	NA	<	<	<	<	<	0.0046	0.0027	<	<	<	<	<	<
LBD-R-7S-DUP	Nov-14	<	<	<	<	NA	NA	<	<	<	<	<	0.0049	0.0027	<	<	<	<	<	<
LBD-R-8S	Nov-14	<	<	<	<	NA	NA	<	<	<	<	<	0.0034	0.0028	<	<	<	<	<	<
LBD-R-8M	Nov-14	<	<	<	<	NA	NA	<	<	<	<	<	0.0034	0.0026	<	<	<	<	<	<
LBD-R-9S	Nov-14	<	<	<	<	NA	NA	<	<	<	<	<	0.0035	0.0025	<	<	<	<	<	<
LBD-R-9M	Nov-14	<	<	<	<	NA	NA	<	<	<	<	<	0.0037	0.0027	<	<	<	<	<	<

Notes:

< - Less than the Human Health Recreational Use Screening Level.
DUP - Duplicate sample.
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 7
SUMMARY OF MISSOURI RIVER SURFACE WATER TOTAL (UNFILTERED) AND DISSOLVED (FILTERED) RESULTS COMPARISON TO HUMAN HEALTH RECREATIONAL USE SCREENING LEVELS
LABADIE ENERGY CENTER, FRANKLIN COUNTY, MO
AMEREN MISSOURI

Sample Location ID		Human Health Recreational Use Screening (a)															
	Constituent	Chromium		Cobalt		Lead		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
	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																	
LBD-R-4S	Oct-13	<	<	<	<	<	<	<	<	<	<	<	<	<	<	NA	<
LBD-R-4AS	Nov-14	<	<	<	<	<	<	<	<	<	<	<	<	<	<	NA	<
LBD-R-5S	Oct-13	<	<	<	<	<	<	<	<	<	<	<	<	<	<	NA	<
LBD-R-5AS	Nov-14	<	<	<	<	<	<	<	<	<	<	<	<	<	<	NA	<
LBD-R-5M	Oct-13	<	<	<	<	<	<	<	<	<	<	<	<	<	<	NA	<
LBD-R-5AM	Nov-14	<	<	<	<	<	<	<	<	<	<	<	<	<	<	NA	<
LBD-R-6S	Oct-13	<	<	<	<	<	<	<	<	<	<	<	<	<	<	NA	<
LBD-R-6AS	Nov-14	<	<	<	<	<	<	<	<	<	<	<	<	<	<	NA	<
LBD-R-6M	Oct-13	<	<	<	<	<	<	<	<	<	<	<	<	<	<	NA	<
LBD-R-6AM	Nov-14	<	<	<	<	<	<	<	<	<	<	<	<	<	<	NA	<
DOWNSTREAM																	
LBD-R-1S	Oct-13	<	<	<	<	<	<	<	<	<	<	<	<	<	<	NA	<
LBD-R-1AS	Nov-14	<	<	<	<	<	<	<	<	<	<	<	<	<	<	NA	<
LBD-R-2S	Oct-13	<	<	<	<	<	<	<	<	<	<	<	<	<	<	NA	<
LBD-R-2AS	Nov-14	<	<	<	<	<	<	<	<	<	<	<	<	<	<	NA	<
LBD-R-2M	Oct-13	<	<	<	<	<	<	<	<	<	<	<	<	<	<	NA	<
LBD-R-2M	Oct-13	<	<	<	<	<	<	<	<	<	<	<	<	<	<	NA	<
LBD-R-2AM	Nov-14	<	<	<	<	<	<	<	<	<	<	<	<	<	<	NA	<
LBD-R-3S	Oct-13	<	<	<	<	<	<	<	<	<	<	<	<	<	<	NA	<
LBD-R-3AS	Nov-14	<	<	<	<	<	<	<	<	<	<	<	<	<	<	NA	<
LBD-R-3M	Oct-13	<	<	<	<	<	<	<	<	<	<	<	<	<	<	NA	<
LBD-R-3AM	Nov-14	<	<	<	<	<	<	<	<	<	<	<	<	<	<	NA	<
FURTHER DOWNSTREAM																	
LBD-R-10S	Nov-14	<	<	<	<	<	<	<	<	<	<	<	<	<	<	NA	<
LBD-R-10S	Nov-14	<	<	<	<	<	<	<	<	<	<	<	<	<	<	NA	<
LBD-R-11S	Nov-14	<	<	<	<	<	<	<	<	<	<	<	<	<	<	NA	<
LBD-R-11M	Nov-14	<	<	<	<	<	<	<	<	<	<	<	<	<	<	NA	<
LBD-R-12S	Nov-14	<	<	<	<	<	<	<	<	<	<	<	<	<	<	NA	<
LBD-R-12M	Nov-14	<	<	<	<	<	<	<	<	<	<	<	<	<	<	NA	<
FURTHEST DOWNSTREAM																	
LBD-R-7S	Nov-14	<	<	<	<	<	<	<	<	<	<	<	<	<	<	NA	<
LBD-R-7S	Nov-14	<	<	<	<	<	<	<	<	<	<	<	<	<	<	NA	<
LBD-R-8S	Nov-14	<	<	<	<	<	<	<	<	<	<	<	<	<	<	NA	<
LBD-R-8M	Nov-14	<	<	<	<	<	<	<	<	<	<	<	<	<	<	NA	<
LBD-R-9S	Nov-14	<	<	<	<	<	<	<	<	<	<	<	<	<	<	NA	<
LBD-R-9M	Nov-14	<	<	<	<	<	<	<	<	<	<	<	<	<	<	NA	<

Notes:

< - Less than the Human Health Recreational Use Screening Level.
DUP - Duplicate sample.
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 MISSOURI RIVER SURFACE WATER TOTAL (UNFILTERED) AND DISSOLVED (FILTERED) RESULTS COMPARISON TO ECOLOGICAL SCREENING LEVELS
LABADIE ENERGY CENTER, FRANKLIN COUNTY, MO
AMEREN MISSOURI

		Ecological Screening (a)																		
	Constituent	Boron		Calcium		Chloride	pH	Sulfate	TDS	Fluoride	Antimony		Arsenic		Barium		Beryllium		Cadmium	
	Fraction	Total	Dissolved	Total	Dissolved	Total	Total	Total	Total	Total	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved
Sample	**ECO SL**	2	2	NA	NA	230	6.5-8.5	1825	NA	4	NA	NA	0.15	0.15	NA	NA	0.1	0.1	0.00059	0.00059
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
UPSTREAM																				
LBD-R-4S	Oct-13	<	<	<	<	NA	NA	<	NA	<	<	<	<	<	<	<	<	<	<	<
LBD-R-4AS	Nov-14	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	<	<	<	<	<
LBD-R-5S	Oct-13	<	<	<	<	NA	NA	<	NA	<	<	<	<	<	<	<	<	<	<	<
LBD-R-5AS	Nov-14	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	<	<	<	<	<
LBD-R-5M	Oct-13	<	<	<	<	NA	NA	<	NA	<	<	<	<	<	<	<	<	<	<	<
LBD-R-5AM	Nov-14	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	<	<	<	<	<
LBD-R-6S	Oct-13	<	<	<	<	NA	NA	<	NA	<	<	<	<	<	<	<	<	<	<	<
LBD-R-6AS	Nov-14	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	<	<	<	<	<
LBD-R-6M	Oct-13	<	<	<	<	NA	NA	<	NA	<	<	<	<	<	<	<	<	<	<	<
LBD-R-6AM	Nov-14	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	<	<	<	<	<
DOWNSTREAM																				
LBD-R-1S	Oct-13	<	<	<	<	NA	NA	<	NA	<	<	<	<	<	<	<	<	<	<	<
LBD-R-1AS	Nov-14	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	<	<	<	<	<
LBD-R-2S	Oct-13	<	<	<	<	NA	NA	<	NA	<	<	<	<	<	<	<	<	<	<	<
LBD-R-2AS	Nov-14	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	<	<	<	<	<
LBD-R-2M	Oct-13	<	<	<	<	NA	NA	<	NA	<	<	<	<	<	<	<	<	<	<	<
LBD-R-2M-DUP	Oct-13	<	<	<	<	NA	NA	<	NA	<	<	<	<	<	<	<	<	<	<	<
LBD-R-2AM	Nov-14	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	<	<	<	<	<
LBD-R-3S	Oct-13	<	<	<	<	NA	NA	<	NA	<	<	<	<	<	<	<	<	<	<	<
LBD-R-3AS	Nov-14	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	<	<	<	<	<
LBD-R-3M	Oct-13	<	<	<	<	NA	NA	<	NA	<	<	<	<	<	<	<	<	<	<	<
LBD-R-3AM	Nov-14	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	<	<	<	<	<
FURTHER DOWNSTREAM																				
LBD-R-10S	Nov-14	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	<	<	<	<	<
LBD-R-10S-DUP	Nov-14	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	<	<	<	<	<
LBD-R-11S	Nov-14	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	<	<	<	<	<
LBD-R-11M	Nov-14	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	<	<	<	<	<
LBD-R-12S	Nov-14	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	<	<	<	<	<
LBD-R-12M	Nov-14	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	<	<	<	<	<
FURTHEST DOWNSTREAM																				
LBD-R-7S	Nov-14	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	<	<	<	<	<
LBD-R-7S-DUP	Nov-14	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	<	<	<	<	<
LBD-R-8S	Nov-14	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	<	<	<	<	<
LBD-R-8M	Nov-14	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	<	<	<	<	<
LBD-R-9S	Nov-14	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	<	<	<	<	<
LBD-R-9M	Nov-14	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	<	<	<	<	<

Notes:
< - Less than the Ecological Screening Level.
DUP - Duplicate sample.
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 8
SUMMARY OF MISSOURI RIVER SURFACE WATER TOTAL (UNFILTERED) AND DISSOLVED (FILTERED) RESULTS COMPARISON TO ECOLOGICAL SCREENING LEVELS
LABADIE ENERGY CENTER, FRANKLIN COUNTY, MO
AMEREN MISSOURI

		Ecological Screening (a)																	
	Constituent	Chromium		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	Dissolved	Total	Total
	ECO SL	0.203	0.203	1	1	0.012	0.012	NA	NA	0.0005	0.0005	NA	NA	0.005	0.005	NA	NA	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	mg/L	mg/L	pCi/L	mg/L
UPSTREAM																			
LBD-R-4S	Oct-13	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
LBD-R-4AS	Nov-14	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
LBD-R-5S	Oct-13	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
LBD-R-5AS	Nov-14	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
LBD-R-5M	Oct-13	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
LBD-R-5AM	Nov-14	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
LBD-R-6S	Oct-13	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
LBD-R-6AS	Nov-14	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
LBD-R-6M	Oct-13	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
LBD-R-6AM	Nov-14	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
DOWNSTREAM																			
LBD-R-1S	Oct-13	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
LBD-R-1AS	Nov-14	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
LBD-R-2S	Oct-13	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
LBD-R-2AS	Nov-14	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
LBD-R-2M	Oct-13	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
LBD-R-2M-DUP	Oct-13	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
LBD-R-2AM	Nov-14	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
LBD-R-3S	Oct-13	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
LBD-R-3AS	Nov-14	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
LBD-R-3M	Oct-13	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
LBD-R-3AM	Nov-14	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
FURTHER DOWNSTREAM																			
LBD-R-10S	Nov-14	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
LBD-R-10S-DUP	Nov-14	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
LBD-R-11S	Nov-14	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
LBD-R-11M	Nov-14	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
LBD-R-12S	Nov-14	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
LBD-R-12M	Nov-14	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
FURTHEST DOWNSTREAM																			
LBD-R-7S	Nov-14	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
LBD-R-7S-DUP	Nov-14	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
LBD-R-8S	Nov-14	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
LBD-R-8M	Nov-14	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
LBD-R-9S	Nov-14	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
LBD-R-9M	Nov-14	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<

Notes:

< - Less than the Ecological Screening Level.
DUP - Duplicate sample.
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 LABADIE CREEK SURFACE WATER TOTAL (UNFILTERED) AND DISSOLVED (FILTERED) RESULTS COMPARISON TO HUMAN HEALTH DRINKING WATER SCREENING LEVELS
LABADIE ENERGY CENTER, FRANKLIN COUNTY, MO
AMEREN MISSOURI

		Human Health Drinking Water Screening (a)																		
	Constituent	Boron		Calcium		Chloride	pH	Sulfate	TDS	Fluoride	Antimony		Arsenic		Barium		Beryllium		Cadmium	
	Fraction	Total	Dissolved	Total	Dissolved	Total	Total	Total	Total	Total	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved
	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
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
UPSTREAM																				
LBD-C-4	Oct-13	<	<	<	<	NA	NA	<	NA	<	<	<	<	<	<	<	<	<	<	<
LBD-C-5	Oct-13	<	<	<	<	NA	NA	<	NA	<	<	<	<	<	<	<	<	<	<	<
LBD-C-6	Oct-13	<	<	<	<	NA	NA	<	NA	<	<	<	<	<	<	<	<	<	<	<
DOWNSTREAM																				
LBD-C-1	Oct-13	<	<	<	<	NA	NA	<	NA	<	<	<	<	<	<	<	<	<	<	<
LBD-C-1-DUP	Oct-13	<	NA	<	NA	NA	NA	<	NA	<	<	NA	<	NA	<	NA	<	NA	<	NA
LBD-C-2	Oct-13	<	<	<	<	NA	NA	<	NA	<	<	<	<	<	<	<	<	<	<	<
LBD-C-3	Oct-13	<	<	<	<	NA	NA	<	NA	<	<	<	<	<	<	<	<	<	<	<

Notes:

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

(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 9
SUMMARY OF LABADIE CREEK SURFACE WATER TOTAL (UNFILTERED) AND DISSOLVED (FILTERED) RESULTS COMPARISON TO HUMAN HEALTH DRINKING WATER SCREENING LEVELS
LABADIE ENERGY CENTER, FRANKLIN COUNTY, MO
AMEREN MISSOURI

		Human Health Drinking Water Screening (a)																	
	Constituent	Chromium		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	Dissolved	Total	Total
Sample	**HH DW SL**	0.1	0.1	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	mg/L	mg/L	pCi/L	mg/L
UPSTREAM																			
LBD-C-4	Oct-13	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
LBD-C-5	Oct-13	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
LBD-C-6	Oct-13	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
DOWNSTREAM																			
LBD-C-1	Oct-13	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
LBD-C-1-DUP	Oct-13	<	NA	<	NA	<	NA	NA	NA	<	NA	<	NA	<	NA	<	NA	NA	<
LBD-C-2	Oct-13	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
LBD-C-3	Oct-13	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<

Notes:
< - Less than the Human Health Drinking Water Screening Level.
DUP - Duplicate sample.
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 LABADIE CREEK SURFACE WATER TOTAL (UNFILTERED) AND DISSOLVED (FILTERED) RESULTS COMPARISON TO HUMAN HEALTH RECREATIONAL USE SCREENING LEVELS
LABADIE ENERGY CENTER, FRANKLIN COUNTY, MO
AMEREN MISSOURI

Sample Location ID		**Human Health Recreational Use Screening (a)**																		
	Constituent	Boron		Calcium		Chloride	pH	Sulfate	TDS	Fluoride	Antimony		Arsenic		Barium		Beryllium		Cadmium	
	Fraction	Total	Dissolved	Total	Dissolved	Total	Total	Total	Total	Total	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
	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
UPSTREAM																				
LBD-C-4	Oct-13	<	<	<	<	NA	NA	<	NA	<	<	<	0.0056	0.0056	<	<	<	<	<	<
LBD-C-5	Oct-13	<	<	<	<	NA	NA	<	NA	<	<	<	0.0055	0.0051	<	<	<	<	<	<
LBD-C-6	Oct-13	<	<	<	<	NA	NA	<	NA	<	<	<	0.0061	0.0051	<	<	<	<	<	<
DOWNSTREAM																				
LBD-C-1	Oct-13	<	<	<	<	NA	NA	<	NA	<	<	<	0.0065	0.0039	<	<	<	<	<	<
LBD-C-1-DUP	Oct-13	<	NA	<	NA	NA	NA	<	NA	<	<	NA	0.0067	NA	<	NA	<	NA	<	NA
LBD-C-2	Oct-13	<	<	<	<	NA	NA	<	NA	<	<	<	0.0061	0.0039	<	<	<	<	<	<
LBD-C-3	Oct-13	<	<	<	<	NA	NA	<	NA	<	<	<	0.0066	0.0043	<	<	<	<	<	<

Notes:

< - Less than the Human Health Recreational Use Screening Level.
DUP - Duplicate sample.
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.

(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 10
SUMMARY OF LABADIE CREEK SURFACE WATER TOTAL (UNFILTERED) AND DISSOLVED (FILTERED) RESULTS COMPARISON TO HUMAN HEALTH RECREATIONAL USE SCREENING LEVELS
LABADIE ENERGY CENTER, FRANKLIN COUNTY, MO
AMEREN MISSOURI

		Human Health Recreational Use Screening (a)																	
	Constituent	Chromium		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	Dissolved	Total	Total
Sample	**HH REC SL**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	4.2	4.2	0.0063	0.0063	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	mg/L	mg/L	pCi/L	mg/L
UPSTREAM																			
LBD-C-4	Oct-13	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
LBD-C-5	Oct-13	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
LBD-C-6	Oct-13	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
DOWNSTREAM																			
LBD-C-1	Oct-13	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
LBD-C-1-DUP	Oct-13	<	NA	<	NA	<	NA	NA	NA	<	NA	<	NA	<	NA	<	NA	NA	<
LBD-C-2	Oct-13	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
LBD-C-3	Oct-13	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<

Notes:

< - Less than the Human Health Recreational Use Screening Level.
DUP - Duplicate sample.
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.

(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 LABADIE CREEK SURFACE WATER TOTAL (UNFILTERED) AND DISSOLVED (FILTERED) RESULTS COMPARISON TO ECOLOGICAL SCREENING LEVELS
LABADIE ENERGY CENTER, FRANKLIN COUNTY, MO
AMEREN MISSOURI

		Ecological Screening (a)																		
	Constituent	Boron		Calcium		Chloride	pH	Sulfate	TDS	Fluoride	Antimony		Arsenic		Barium		Beryllium		Cadmium	
	Fraction	Total	Dissolved	Total	Dissolved	Total	Total	Total	Total	Total	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved
	ECO SL	2	2	NA	NA	230	6.5-8.5	1825	NA	4	NA	NA	0.15	0.15	NA	NA	0.1	0.1	0.00059	0.00059
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
UPSTREAM																				
LBD-C-4	Oct-13	<	<	<	<	NA	NA	<	NA	<	<	<	<	<	<	<	<	<	<	<
LBD-C-5	Oct-13	<	<	<	<	NA	NA	<	NA	<	<	<	<	<	<	<	<	<	<	<
LBD-C-6	Oct-13	<	<	<	<	NA	NA	<	NA	<	<	<	<	<	<	<	<	<	<	<
DOWNSTREAM																				
LBD-C-1	Oct-13	<	<	<	<	NA	NA	<	NA	<	<	<	<	<	<	<	<	<	<	<
LBD-C-1-DUP	Oct-13	<	NA	<	NA	NA	NA	<	NA	<	<	NA	<	NA	<	NA	<	NA	<	NA
LBD-C-2	Oct-13	<	<	<	<	NA	NA	<	NA	<	<	<	<	<	<	<	<	<	<	<
LBD-C-3	Oct-13	<	<	<	<	NA	NA	<	NA	<	<	<	<	<	<	<	<	<	<	<

Notes:

< - Less than the Ecological Screening Level.
DUP - Duplicate sample.
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 11
SUMMARY OF LABADIE CREEK SURFACE WATER TOTAL (UNFILTERED) AND DISSOLVED (FILTERED) RESULTS COMPARISON TO ECOLOGICAL SCREENING LEVELS
LABADIE ENERGY CENTER, FRANKLIN COUNTY, MO
AMEREN MISSOURI

		Ecological Screening (a)																			
	Constituent	Chromium		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	Dissolved	Total	Total
Sample Location ID	**ECO SL**	0.203	0.203	1	1	0.012	0.012	NA	NA	0.0005	0.0005	NA	NA	0.005	0.005	NA	NA	NA	NA
	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	mg/L	mg/L	pCi/L	mg/L
UPSTREAM																			
LBD-C-4	Oct-13	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
LBD-C-5	Oct-13	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
LBD-C-6	Oct-13	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
DOWNSTREAM																			
LBD-C-1	Oct-13	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
LBD-C-1-DUP	Oct-13	<	NA	<	NA	<	NA	NA	NA	<	NA	<	NA	<	NA	<	NA	NA	<
LBD-C-2	Oct-13	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<
LBD-C-3	Oct-13	<	<	<	<	<	<	NA	NA	<	<	<	<	<	<	<	<	NA	<

Notes:
< - Less than the Ecological Screening Level.
DUP - Duplicate sample.
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 WHOLE EFFLUENT TOXICITY TESTING RESULTS FOR NPDES OUTFALL 002
LABADIE ENERGY CENTER, FRANKLIN COUNTY, MO
AMEREN MISSOURI

Sampling Event	Treatment	Percent Survival at 48 hours	
		Pimephales promelas	*Ceriodaphnia dubia*
Outfall 002 (Ash Pond)			
August 2015	100% Effluent	100%	100%
	50% Effluent	100%	100%
	100% Laboratory Control Water	100%	100%
August 2016	100% Effluent	100%	100%
	50% Effluent	100%	100%
	100% Laboratory Control Water	100%	100%
August 2017	100% Effluent	100%	100%
	50% Effluent	100%	100%
	100% Laboratory Control Water	100%	100%

Notes:
NPDES - Natural Pollutant Discharge Elimination System.

Effluent passes in all tests conducted from 2015 through 2017.
50% Effluent - Outfall 002 effluent mixed with laboratory control water.
Effluent dilutions were analzyed at 0%, 3.5%, 7%, 25%, 50%, and 100%. Only 50% and 100% are presented in the above table

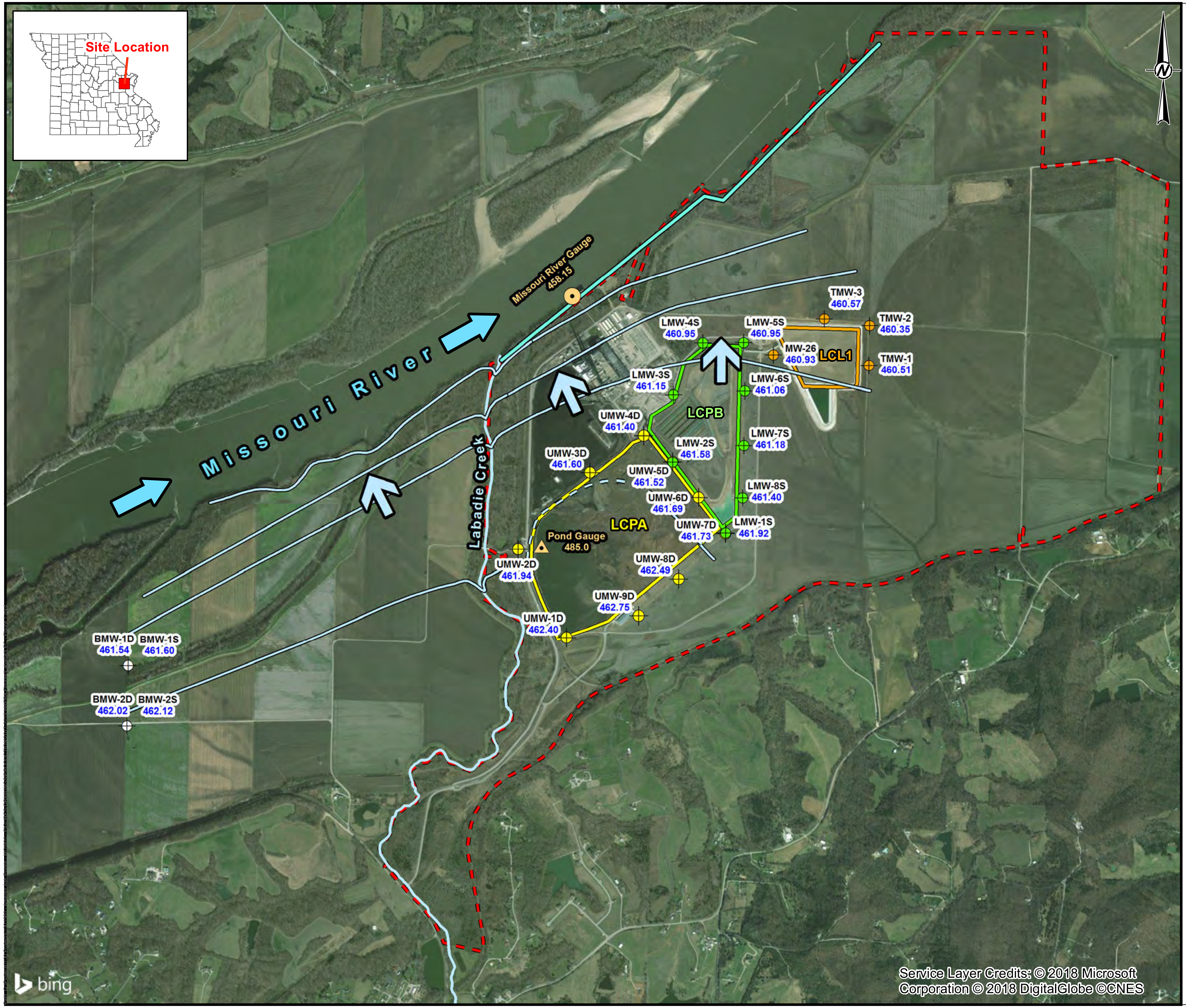
TABLE 13
DERIVATION OF RISK-BASED SCREENING LEVELS FOR GROUNDWATER BASED ON MISSOURI RIVER
LABADIE ENERGY CENTER, FRANKLIN COUNTY, MC
AMEREN MISSOURI

				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 LEC Groundwater Concentration (mg/L)		Ratio Between Groundwater Risk-Based Screening Level and the Maximum LEC Groundwater Concentration
Boron	4	NA	2	2	200000	18.2	L-UMW-6D	>10,000
Sulfate	250	NA	1773	250	25000000	774	L-UMW-3D	>32,000
Cobalt	0.006	NA	1	0.006	600	0.0095	L-LMW-6S	>63,000
Lithium	0.04	NA	NA	0.04	4000	0.0575	L-TMW-2	>69,000
Molybdenum	0.1	NA	NA	0.1	10000	0.674	L-UMW-6D	>14,000
TDS	500	NA	NA	500	50000000	1240	L-UMW-3D	>40,000

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.

FIGURES



LEGEND

- Length of Groundwater Discharge Used in the Dilution Factor Calculations
- Labadie Energy Center Property Boundary
- LCPA - Bottom Ash Surface
- LCPB - Fly Ash Surface
- LCL1 - Utility Waste Landfill Cell 1

Groundwater Elevation Contours

- Groundwater Elevation Contour (FT MSL)
- Inferred Groundwater Elevation Contour (FT MSL)

Ground/Surface Water Measurement Locations

- ⊕ LCPA Monitoring Well
- ⊙ Missouri River Gauge
- ▲ LCPA - Bottom Ash Surface Impoundment
- ⊕ LCPB Monitoring Well
- ⊕ Background Monitoring Well
- ⊕ UWL Monitoring Well
- ⇧ Groundwater Flow Direction
- ⇗ Surface Water Flow Direction

NOTES

1. ALL LOCATIONS AND BOUNDARIES ARE APPROXIMATE.
2. GROUNDWATER ELEVATION MEASUREMENTS OBTAINED ONSITE BY GOLDER ON JULY 11, 2016.
3. GROUNDWATER MONITORING WELLS (EXCEPT TMW-1 AND MW-26) SURVEYED BY ZAHNER AND ASSOCIATES, INC. ON JANUARY 13 AND FEBRUARY 11, 2016.
4. GROUNDWATER MONITORING WELLS TMW-1 AND MW-26 INSTALLED BY RIETZ AND JENS, INC. AND SURVEYED BY KDG INC.
5. GROUNDWATER ELEVATIONS DISPLAYED IN FT MSL (FEET ABOVE MEAN SEA LEVEL).
6. MISSOURI RIVER LEVEL OBTAINED FROM USGS LABADIE GAUGE 06935550.
7. POND GAUGE LEVEL OBTAINED ONSITE BY GOLDER.
8. THE UWL BOUNDARIES AND DESIGNATIONS ARE BASED ON AMEREN LABADIE CONSTRUCTION PERMIT APPLICATION DRAWINGS.

REFERENCES

1. ZAHNER AND ASSOCIATES, INC. 2016. LOT CONSOLIDATION PLAT OF "LABADIE ENERGY CENTER" - PREPARED FOR AMEREN MISSOURI. REVISED JUNE 15, 2016.
2. COORDINATE SYSTEM: NAD 1983 STATEPLANE MISSOURI EAST FIPS 2,401 FEET.
3. USGS (UNITED STATES GEOLOGICAL SURVEY), NATIONAL WATER INFORMATION SYSTEM, USGS GAUGE 06935550 MISSOURI RIVER NEAR LABADIE, MO.

0 1,000 2,000 3,000 4,000 5,000
Feet

CLIENT
AMEREN MISSOURI
LABADIE ENERGY CENTER

Ameren

PROJECT
AMEREN HYDROGEOLOGICAL CONSULTING

TITLE

ESTIMATED LENGTH OF DISCHARGE AND EXAMPLE GROUNDWATER FLOW MAP

CONSULTANT

Golder Associates

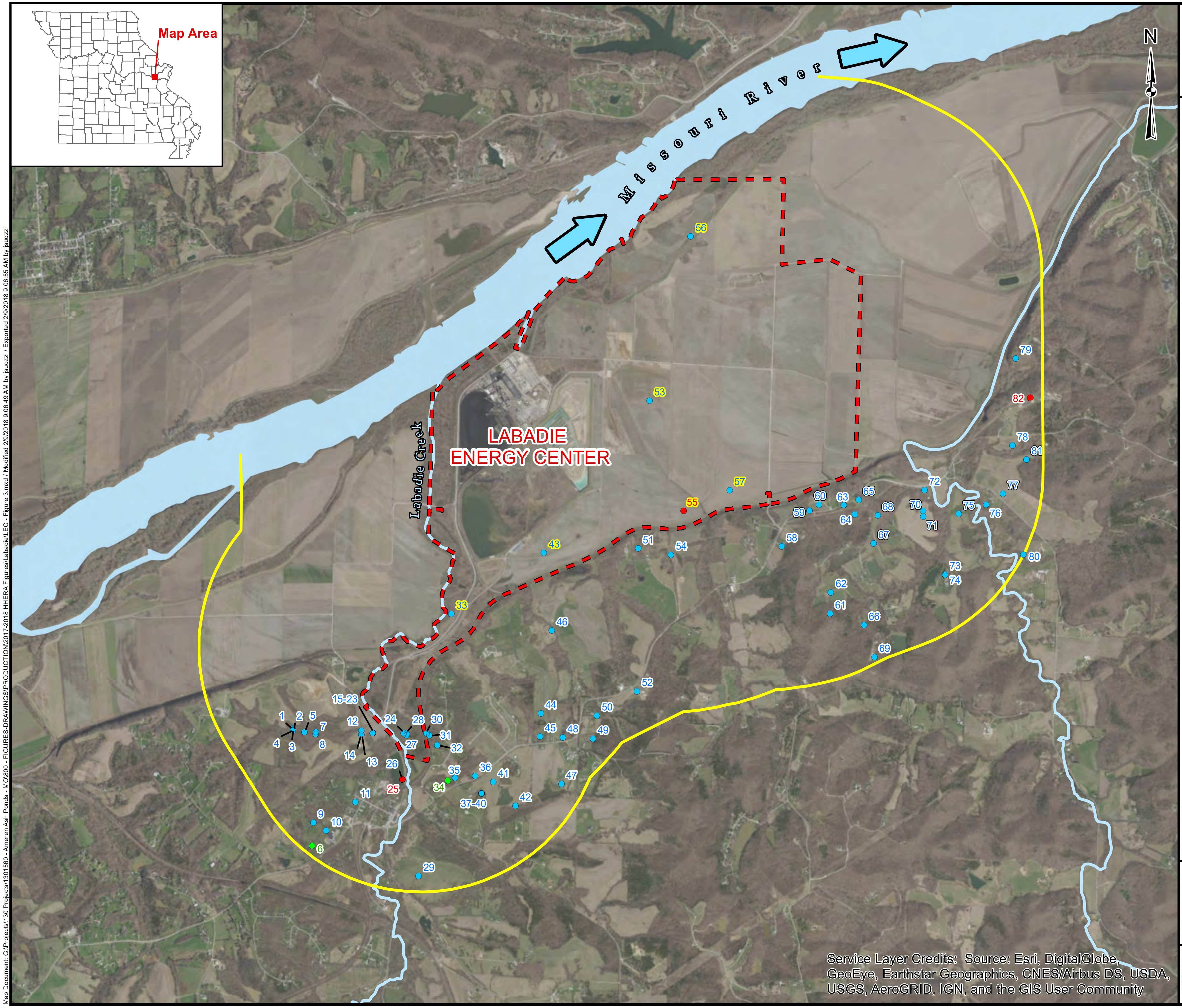
YYYY-MM-DD	2017-12-17
PREPARED	JSI
DESIGN	JSI
REVIEW	RJF
APPROVED	MNH

PROJECT No.
130-1560

FIGURE
1

TITLE

PRIVATE WELL LOCATIONS WITHIN 1-MILE RADIUS OF FACILITY BOUNDARY



LEGEND

- ▬ Labadie Energy Center Property Boundary
- ▭ Approximate 1-Mile Radius
- ● Private Well
- ● Industrial Well
- ● Non-Community Public Well

*Yellow highlighted wells appear to be located incorrectly in the MDNR Wellhead Protection Database.

- ➡ Surface Water Flow Direction

NOTES

1.) Search radius is approximately 1-mile beyond the Ameren Missouri Labadie Energy Center property boundary within Franklin County, Missouri.
2.) See Table 2 for details on wells within the 1-mile radius.
3.) Wells outside of the approximate 1-mile radius and those outside of Franklin County, Missouri are not shown.
4.) Yellow highlighted wells (33, 43, 53, 55, 56, 57) appear to be located incorrectly in MDNR Wellhead Protection Database. Further information for these wells is provided in Appendix B.
5.) This figure displays non-community public, private and industrial wells within approximately one mile of the Ameren Missouri Labadie Energy Center property boundary in Franklin County, Missouri; monitoring wells, soil borings, heat pump borings, stratigraphic test holes and abandonments are not displayed on this figure.
6.) All boundaries and locations are approximate. Wells are plotted according to database coordinates.
7.) MDNR - Missouri Department of Natural Resources.
8.) MSDIS - Missouri Spatial Data Information Service.

REFERENCES

1.) University of Missouri - Columbia - Department of Geography - MSDIS Database (MSDIS, 2013).
2.) Missouri Department of Natural Resources - Water Resources Center - Geologic Well Logs (MDNR, 2013c).
3.) Missouri Environmental Geology Atlas 2007 (MEGA) (MDNR, 2007).
4.) MDNR Wellhead Protection Program (MDNR, 2013b).
5.) Ameren Missouri Labadie Energy Center, Labadie Property. Control Map, November 2011.
6.) COORDINATE SYSTEM: NAD 1983 StatePlane Missouri East FIPS 2401 Feet.

0 3,000 6,000
Feet

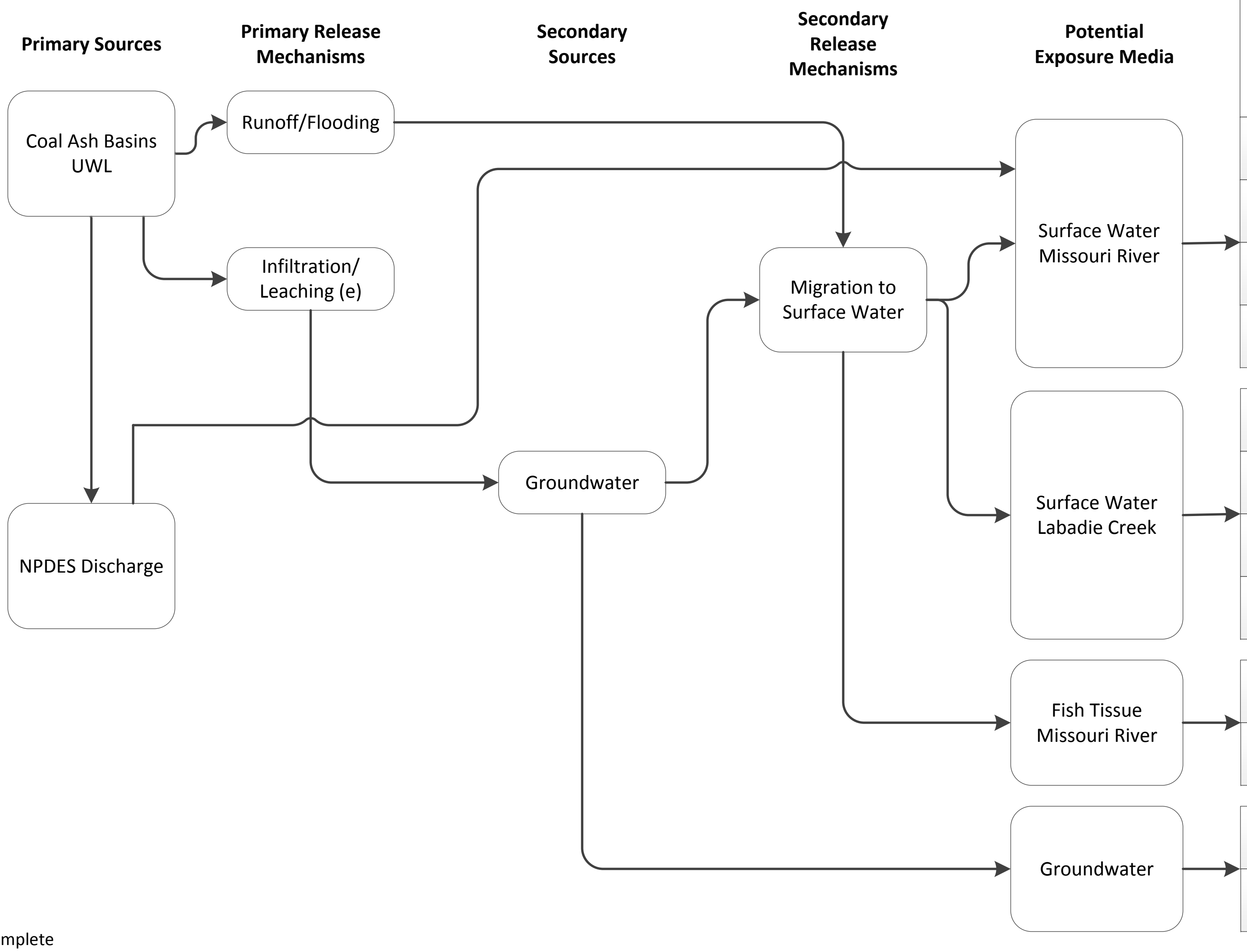
PROJECT

AMEREN MISSOURI LABADIE ENERGY CENTER
FRANKLIN COUNTY, MISSOURI

PROJECT No. 130-1560			FILE No. LEC - Figure 3.mxd	
DESIGN	-	-	SCALE: AS SHOWN	REV. 0
GIS	JSI	2/9/2018	**FIGURE 2**	
CHECK	MWD	2/9/2018		
REVIEW	MNH	2/9/2018		

Map Document: G:\Projects\130 Projects\1301560 - Ameren Ash Ponds - MO\800 - FIGURES-DRAWINGS\PRODUCTION\2017-2018 HHERA Figures\Labadie\LEC - Figure 3.mxd / Modified 2/9/2018 9:06:49 AM by jsuozzi / Exported 2/9/2018 9:06:55 AM by jsuozzi

FIGURE 3
CONCEPTUAL SITE MODEL
LABADIE ENERGY CENTER, FRANKLIN COUNTY, MO
AMEREN MISSOURI



Potential Exposure Media	Potential Exposure Route	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	Aquatic Receptors
		Potential Human Health Receptors					Potential Ecological Receptors
Surface Water Missouri River	Drinking Water Use	⊙ (a)	○	○	○	○	NA
	Incidental Ingestion	○	⊙	⊙	⊙	⊙	NA
	Dermal Contact	○	⊙	⊙	⊙	⊙	NA
	Aquatic Exposure	NA	NA	NA	NA	NA	⊙
Surface Water Labadie Creek	Drinking Water Use	○ (b)	○	○	○	○	NA
	Incidental Ingestion	○	○ (c)	⊙	○ (c)	○ (c)	NA
	Dermal Contact	○	○ (c)	⊙	○ (c)	○ (c)	NA
	Aquatic Exposure	NA	NA	NA	NA	NA	⊙
Fish Tissue Missouri River	Ingestion	○	○	○	○	●	NA
	Aquatic Exposure	NA	NA	NA	NA	NA	⊙
Groundwater	Drinking Water Use	○ (d)	○	○	○	○	NA
	Aquatic Exposure	NA	NA	NA	NA	NA	○

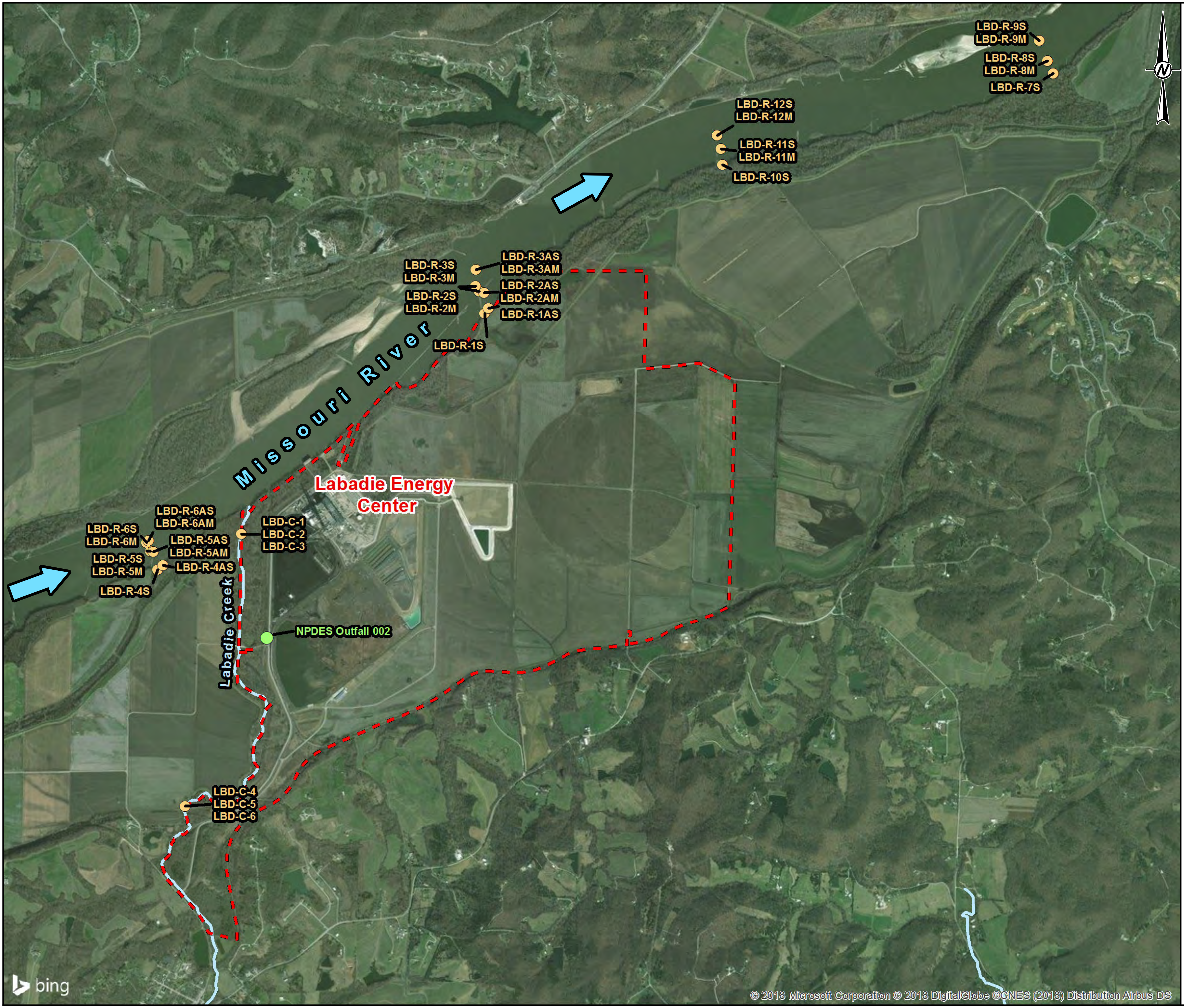
Notes:

- ● Pathway potentially complete
- ⊙ Pathway potentially complete, but insignificant.
- ○ Pathway evaluated and found incomplete.
- (a) The Missouri River is used as a source of drinking water; the nearest downstream drinking water intake is 19.5 miles downstream at Howard Bend in Missouri. All detected constituent concentrations are below drinking water screening levels.
- (b) Labadie Creek is not used as a source of drinking water.
- (c) The size of Labadie Creek precludes swimming, fishing and boating activities.
- (d) The shallow alluvial aquifer in the vicinity of the coal ash management areas is not used for drinking water purposes.
- (e) LCPB and LCL1 are lined, thus, infiltration/leaching to groundwater are incomplete pathways.

NA – Not Applicable.

NPDES - National Pollutant Discharge Elimination System.

UWL – Utility Whole Landfill.



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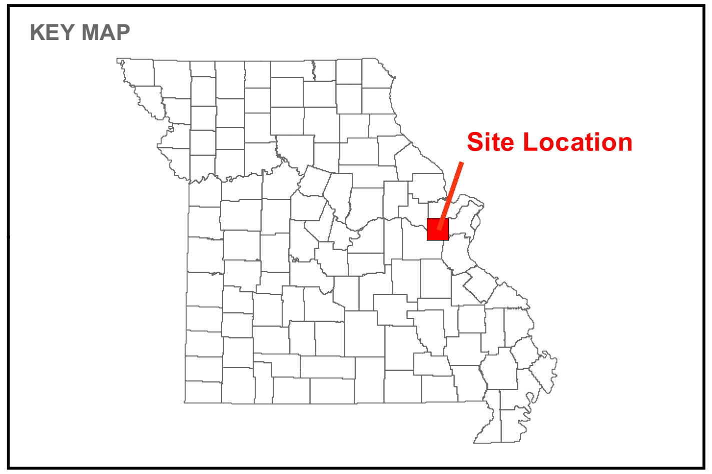
LEGEND

●	NPDES Sample Location
●	Surface Water Sample Location
▭	Approximate Property Boundary
⬈	Surface Water Flow Direction



NOTES

1. ALL LOCATIONS AND BOUNDARIES ARE APPROXIMATE.
2. SAMPLE LOCATIONS FOR SURFACE WATER SAMPLES WERE OBTAINED DURING SAMPLING USING A TRIMBLE GEOXH GPS UNIT.
3. NPDES - NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM.

REFERENCES

1. ZAHNER AND ASSOCIATES, INC. 2016. LOT CONSOLIDATION PLAT OF "LABADIE ENERGY CENTER" - PREPARED FOR AMEREN MISSOURI. REVISED JUNE 15, 2016.
2.) COORDINATE SYSTEM: NAD 1983 STATEPLANE MISSOURI EAST FIPS 2,401 FEET.

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Feet

CLIENT
AMEREN MISSOURI
LABADIE ENERGY CENTER

PROJECT
AMEREN HYDROGEOLOGICAL CONSULTING

TITLE
NPDES OUTFALL AND SURFACE WATER SAMPLE LOCATIONS

CONSULTANT
Golder Associates

YYYY-MM-DD	2018-01-29
PREPARED	JSI
DESIGN	JSI
REVIEW	JS
APPROVED	MNH

PROJECT No.	Rev.	FIGURE
130-1560	0	**4**

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ATTACHMENT A

Dilution Factor Calculation

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

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[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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USEPA. 2014c. USEPA Regional Screening Levels. May 2014. U.S. Environmental Protection Agency. Available at http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm

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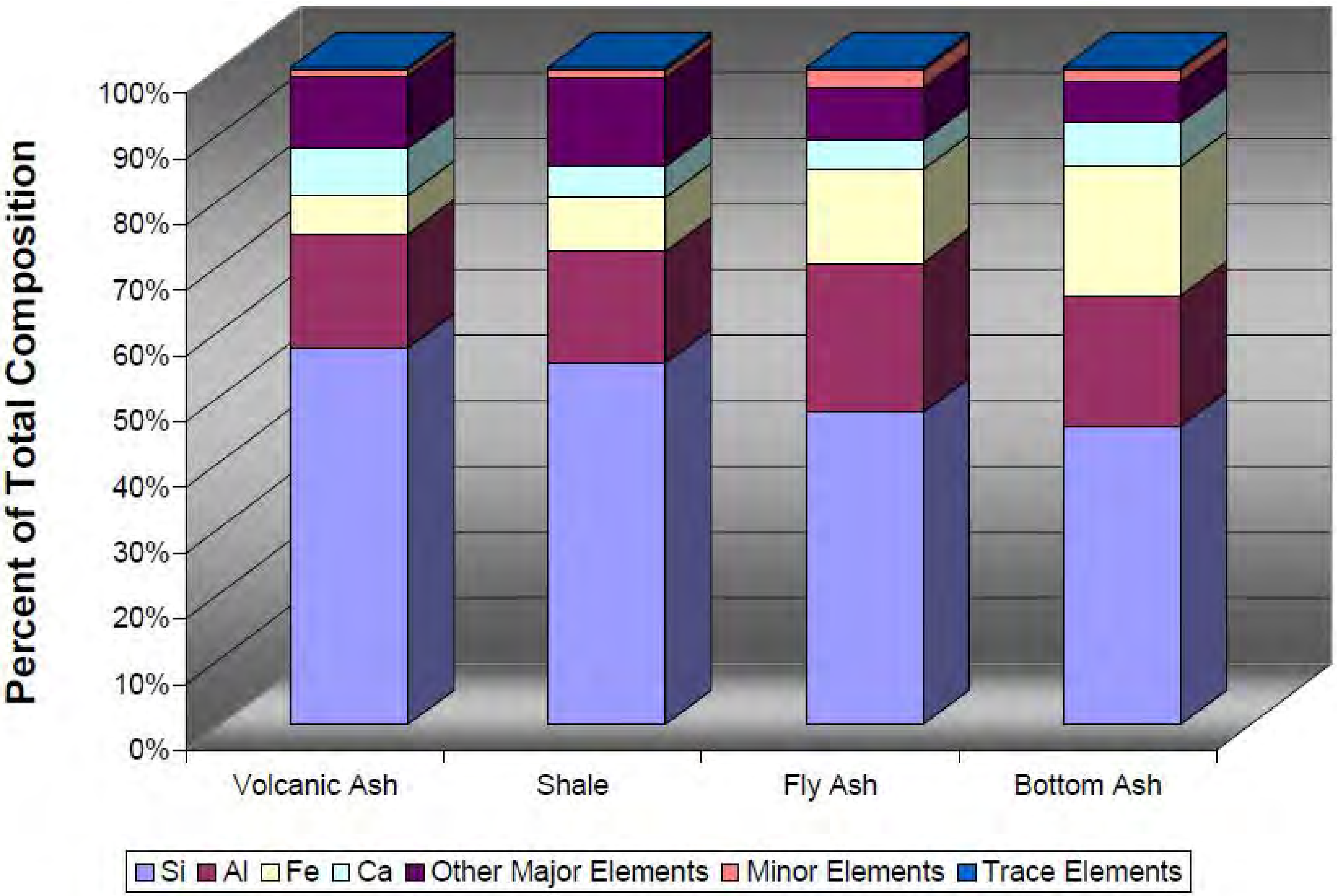
WHO. 2006. Cobalt and Inorganic Cobalt Compounds. Concise International Chemical Assessment Document 69. World Health Organization.

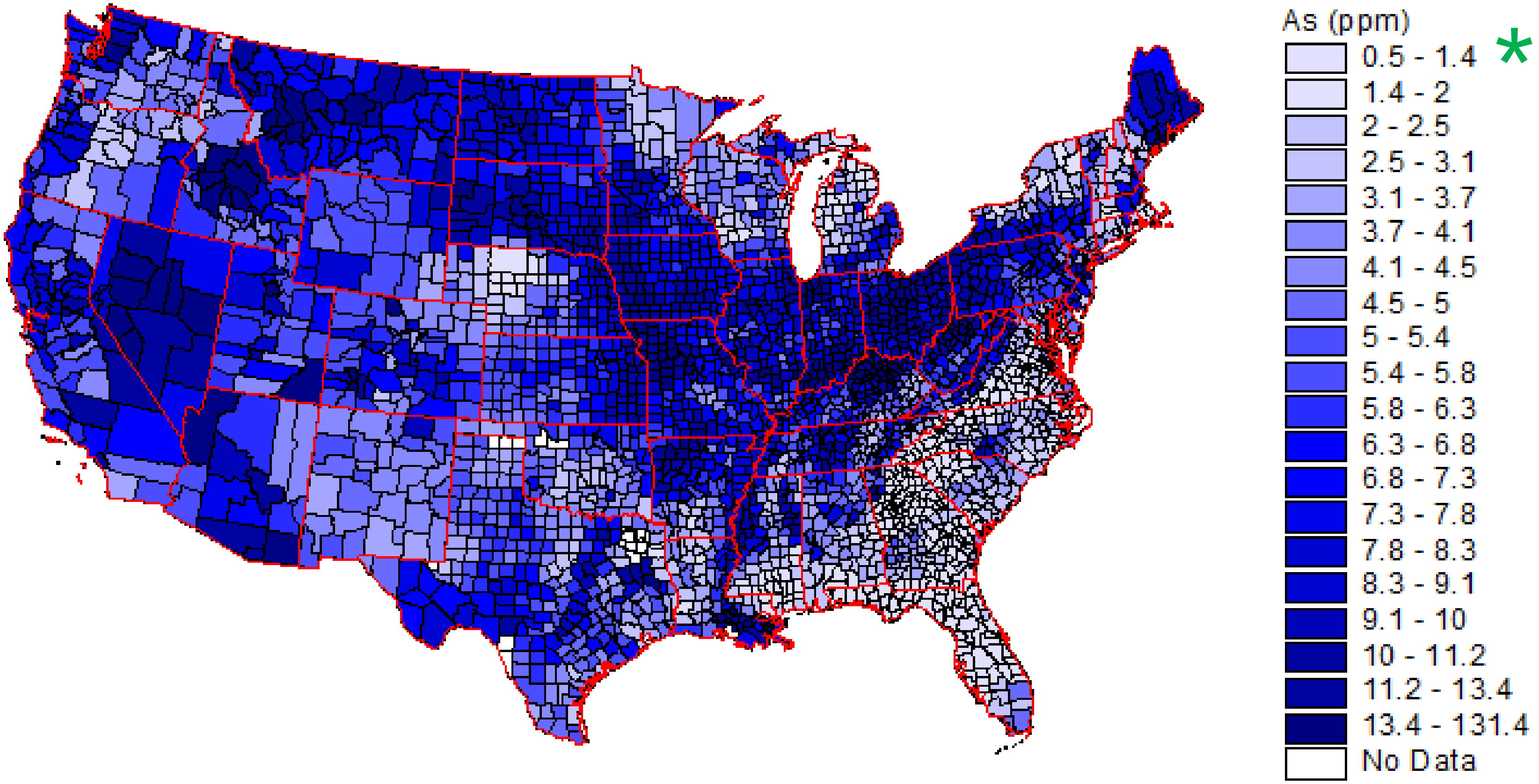
Attachment A – Figures

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.

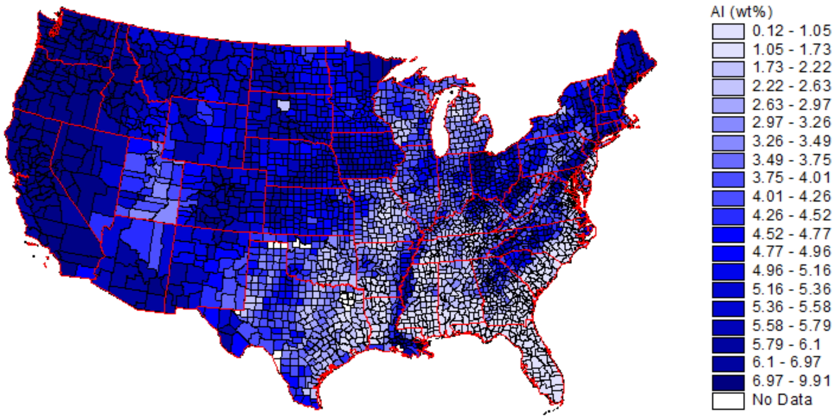


***The USEPA regional screening level for arsenic in residential soil at a one in one million risk level is 0.67 mg/kg. USEPA. 2014c.**
http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm
Thus the arsenic concentration in the majority of the soils in the U.S. are above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

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

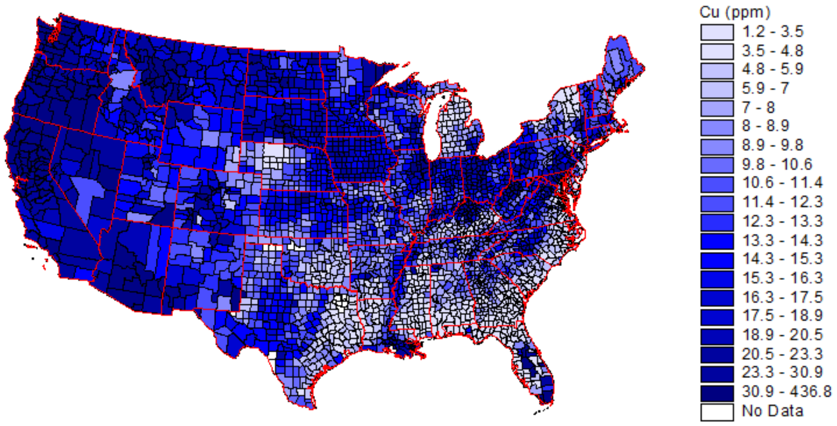
Figure A-3

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

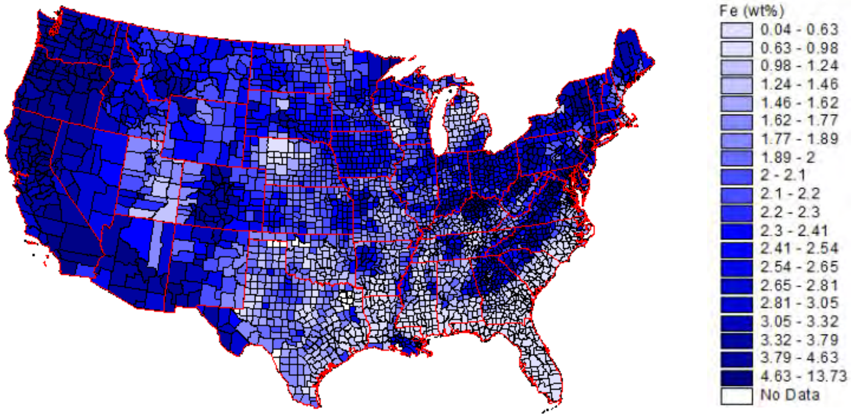
Copper is Present in our Natural Environment –
Background Levels in Soils in the U.S.



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

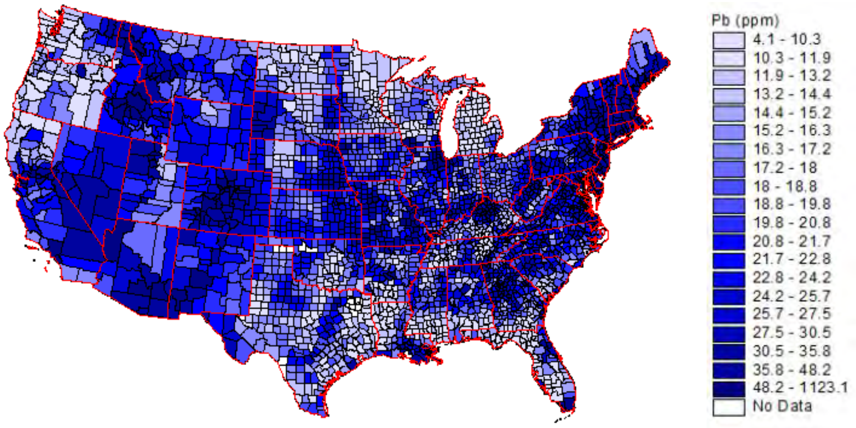
Figure A-4

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

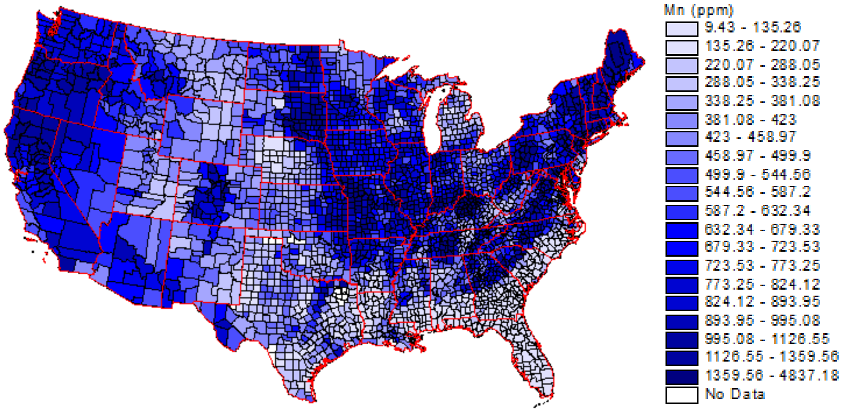
Lead is present in our natural environment –
Background levels in soils in the U.S.



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

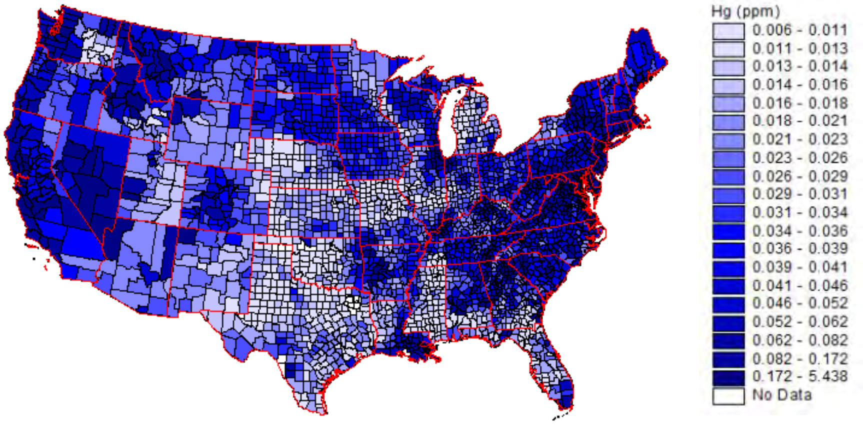
Figure A-5

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

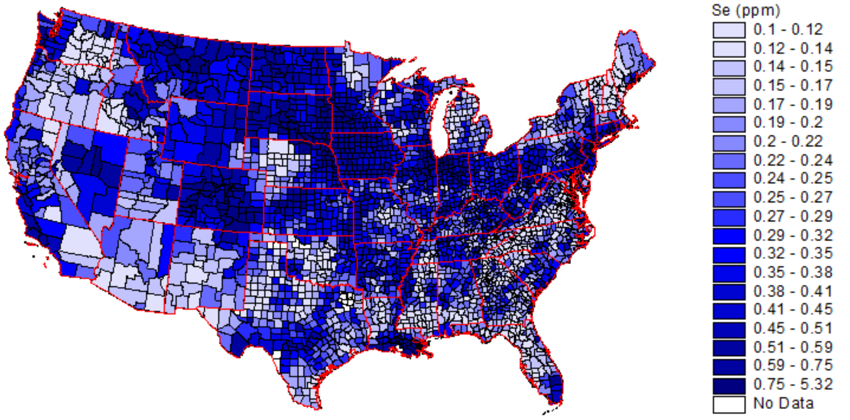
Mercury is present in our natural environment –
Background levels in soils in the U.S.



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

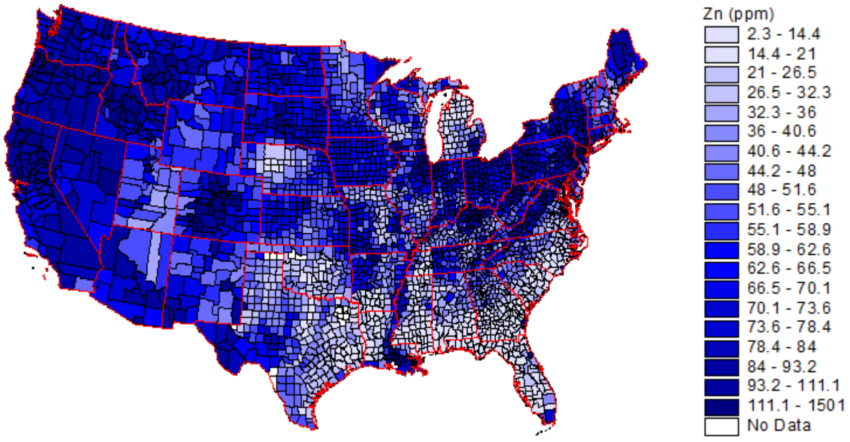
Figure A-6

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

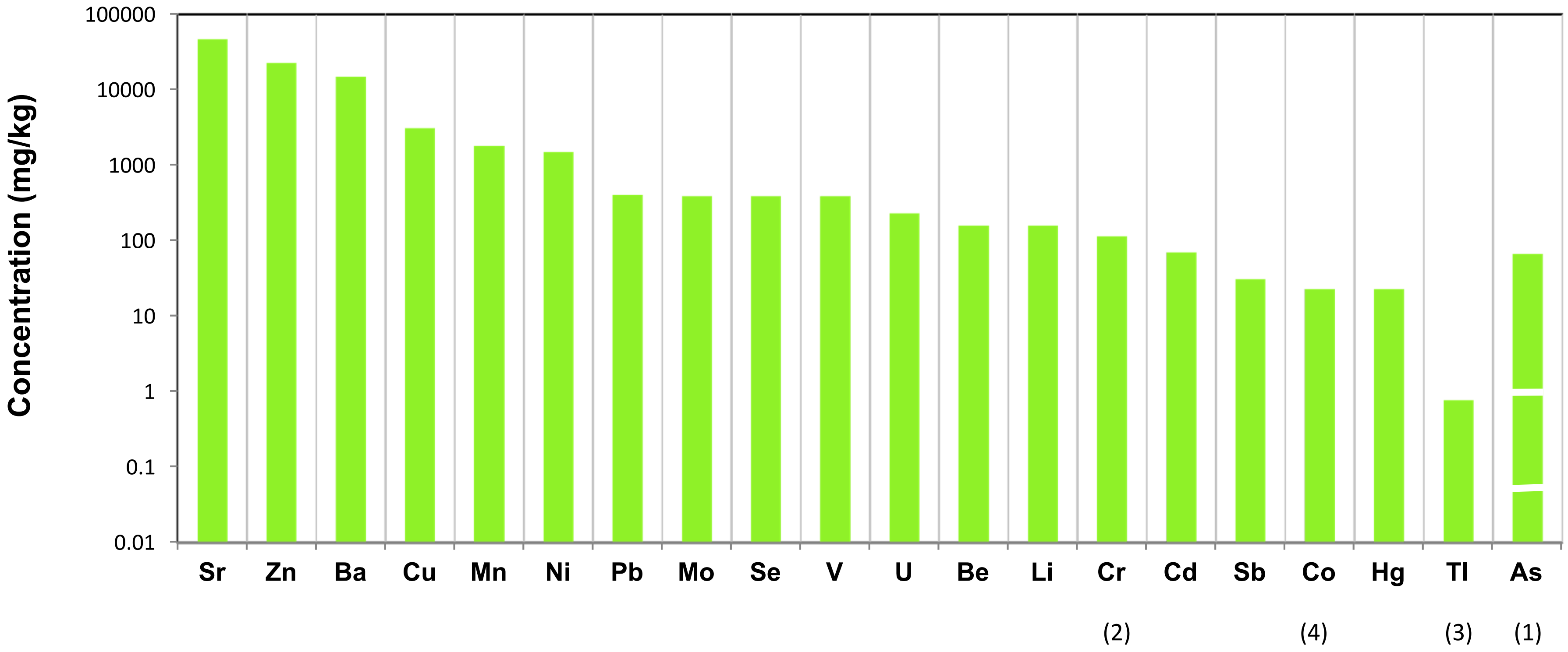
Zinc is present in our natural environment –
Background levels in soils in the U.S.



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.

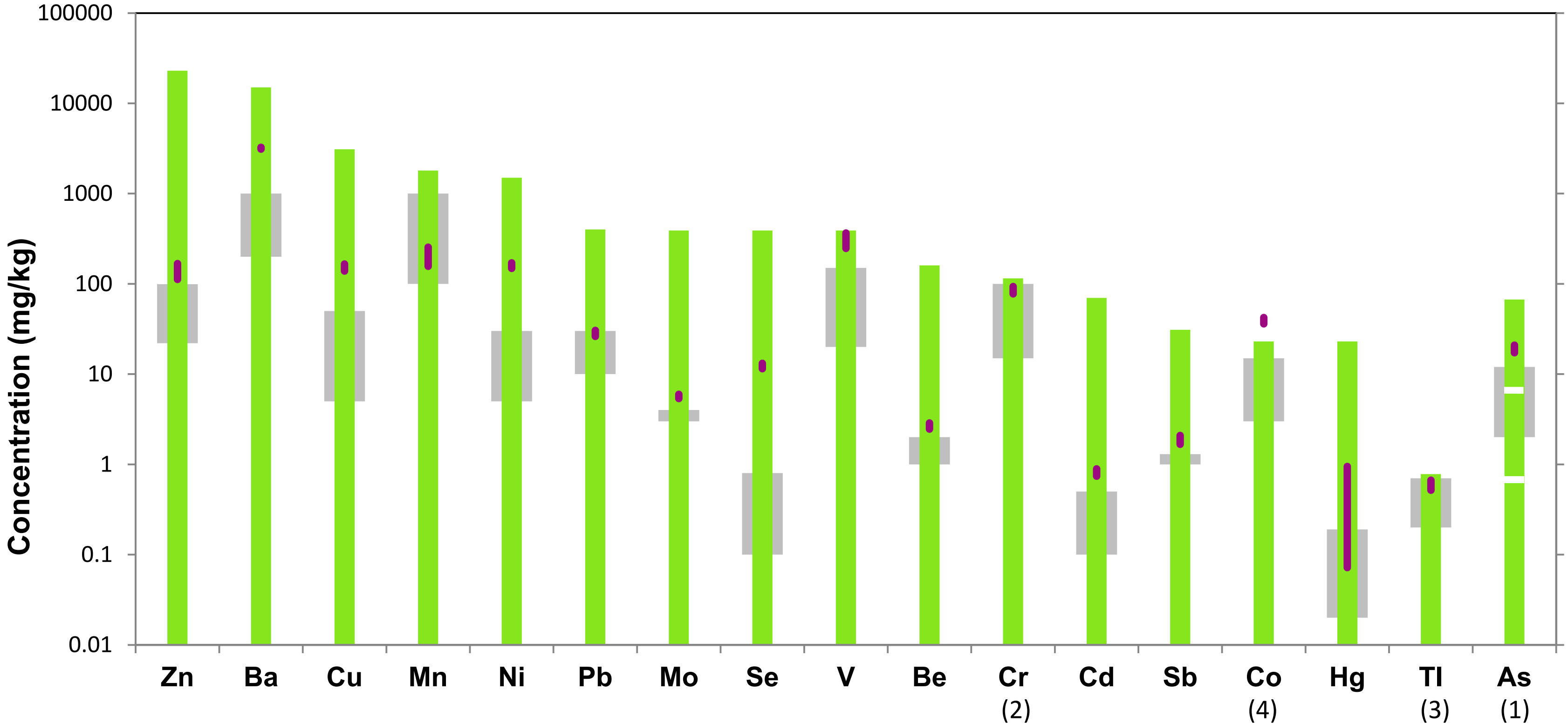
(2) The screening level shown for chromium is the value calculated using toxicity information for hexavalent chromium currently available on USEPA's IRIS database [http://www.epa.gov/iris/subst/0144.htm]. The screening level for trivalent chromium is 120,000 mg/kg.

(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.

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(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

Labadie Energy Center Dilution Factor Calculations

CALCULATIONS

Date: February 8, 2018 **Made by:** J. Ingram
Project No.: 130-1560 **Checked by:** E. Kinder
Subject: Labadie Energy Center Dilution Factor Calculations **Reviewed by:** M.Haddock

1.0 Introduction

The Missouri River is a large, flowing water body and daily flow at the Labadie Energy Center (LEC) is estimated to range between 25 and 332 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 163,000 gallons or 0.0006%) 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	Washington Gauge Height (Feet Above Gauge)	Washington Gauge Elevation (Feet Above Mean Sea Level)	Missouri River Elevation at the Washington Gauge (feet MSL)	St. Charles Gauge Height (Feet Above Gauge)	St. Charles Gauge Elevation (Feet Above Mean Sea Level)	Missouri River Elevation at the St. Charles Gauge (feet MSL)
1/13/2015 17:00	1.21	457.27	458.48	7.92	413.47	421.39

Notes:
1) feet MSL - feet above mean sea level.
2) Information on the Washington Gauge available at https://waterdata.usgs.gov/usa/nwis/uv?06935450.
3) Information on the St. Charles Gauge available at https://waterdata.usgs.gov/mo/nwis/uv?site_no=06935965.
4) 1.21 is the lowest gauge height for the Missouri River since October, 2014. This date is used because prior to this date no publicly available flow data was collected at the Washington Gauge.

Missouri River Elevation at the Washington Gauge (feet MSL)	St. Charles Gauge Elevation (Feet Above Mean Sea Level)	Distance Between Washington and St. Charles Gauges (River Miles)	Missouri River Gradient (feet/feet)	Distance from Washington Gauge to LEC (River Miles)	Estimated Missouri River Elevation at LEC (feet MSL)
458.48	421.39	39.1	0.00018	10.0	449

Notes
1) Estimated Missouri River level calculated by subtracting the gradient of the Missouri River multiplied by the distance from the Washington Gauge (in river feet) from the Washington Gauge elevation.

1.2 Aquifer Discharge Length and Area

Description	Value	Units
Estimated length of discharge zone	9,200	feet
Estimated top of discharge zone (low river level)	449	feet above mean sea level
Estimated bottom of discharge zone (Bedrock)	365	feet above mean sea level
Estimated thickness of discharge zone (Top - Bottom)	84	feet
Estimated area of discharge zone (length x thickness)	772,800	feet^2

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1.3 Groundwater Properties

Description	Symbol	Value	Units
Average Hydraulic Conductivity (CCR Rule Monitoring Wells)	K	63	feet/day
Average Groundwater Gradient (from GMP)	I	0.0004	feet/feet
Effective Porosity (from GMP)	n	35	%
Average linear groundwater velocity (V=KI/n)	*V*	0.08	feet/day

1.4 Groundwater Discharge

Description	*Symbol*	Value	Units
Average linear groundwater velocity	*V*	0.08	feet/day
Estimated Discharge zone area	*A*	772,800	feet^2
Effective Porosity (from GMP)	*n*	35	%
Estimated total GW Discharge (Q=V*A*n)	*Q*	21,851	feet^3/day

1.5 Missouri River Flow

Description	*Value*	Units
Estimated low Missouri River Conditions (1/13/2015)	449	feet above mean sea level
Corresponding Discharge from Washington Gauge (1/13/2015)	39,700	feet^3/sec
Seconds per Day	86,400	seconds/day
Estimated low Flow Daily Discharge (Average Discharge * seconds per day)	3,430,080,000	feet^3/day

Washington Discharge data from https://waterdata.usgs.gov/usa/nwis/uv?06935450.

1.5 Dilution Factor

Description	Values	Units
Estimated Total Daily Groundwater Discha	21,851	feet^3/day
Estimated Daily Groundwater Discharge	163,457	gallons/day
Estimated Daily River Flow	3,430,080,000	feet^3/day
Estimated Daily River Flow	25,658,782,042	gallons/day
Estimated Dilution Factor (River / GW)	**156,975 or >100,000**	Unitless

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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 Labadie Energy Center are from January 13, 2015 which is the lowest value since October 2014. Using river flow averages would greatly increase the dilution by an order of magnitude. Missouri River data is available at https://waterdata.usgs.gov/nwis/uv?site_no=06935450.
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.