Assessment of Corrective Measures Fly Ash Impoundment

Sibley Generating Station

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EXECUTIVE SUMMARY

Evergy Missouri West, Inc. retained SCS Engineers (SCS) to prepare this Assessment of Corrective Measures (ACM) for the former Fly Ash Impoundment (FAI) at the former Sibley Generating Station. It is important to note that the Sibley Generating Station has been decommissioned and raised, and the FAI is no longer operational. Removal of the fly ash from the FAI was certified complete on January 14, 2022. Before and after Google Earth images showing the Sibley Generating Station and the FAI are provided below.

Google Earth Image April 2018

Google Earth Image July 2022

This ACM was completed in accordance with Title 40 Code of Federal Regulations (40 CFR 257.95(g)(3)(i) and 40 CFR 257.96 of the U.S. Environmental Protection Agency Federal Coal Combustion Residuals (CCR) Rule (40 CFR 257 and 261), effective October 19, 2015 and subsequent revisions.

SCS Engineers collected groundwater samples for closure confirmation from the FAI groundwater monitoring network on November 15, 2021 and analyzed the samples for Appendix IV constituents in accordance with 40 CFR 257.102(c). Groundwater protection standards (GWPS) were determined for each Appendix IV constituent detected in the FAI's monitoring wells pursuant to 40 CFR 257.95(h). In accordance with 40 CFR 257.102(c) groundwater closure monitoring concentrations cannot exceed the groundwater protection standard (GWPS). Statistical evaluation of the results identified one Appendix IV constituent (molybdenum) in groundwater monitoring well MW-806R at a statistically significant level (SSL) above its GWPS. This SSL for molybdenum in groundwater monitoring well MW-806R resulted in the initiation of this ACM.

In addition to preparing the ACM, SCS prepared an "Exposure Evaluation and Assessment of Risk" report, provided as **Appendix A**, to identify whether current groundwater conditions pose an unacceptable risk to human health and the environment, and whether corrective measures mitigate such risk, if present. The report concluded that present molybdenum concentrations in groundwater at the FAI do not pose adverse impacts on human health or the environment from either groundwater or surface water. Further, molybdenum concentrations up to at least 77 times greater than current concentrations would not pose adverse impacts to human health or the environment. Therefore, because no adverse risk currently exists, any of the remedies considered in this ACM are protective of human health and the environment.

1.0 INTRODUCTION AND BACKGROUND

This Assessment of Corrective Measures (ACM) for the Fly Ash Impoundment (FAI) at the Evergy Missouri West, Inc. (Evergy) Sibley Generating Station has been prepared to comply with U.S. Environmental Protection Agency (USEPA) regulations regarding the Disposal of Coal Combustion Residuals (CCR) from Electric Utilities [40 CFR 257.50-107], or the “CCR Rule”. Specifically, the ACM was initiated and this report has been timely completed to fulfill the requirements of 40 CFR 257.96.

Evergy Missouri West, Inc. (Evergy), in accordance with Title 40 Code of Federal Regulations (40 CFR 257.95(g)(3)(i) and 40 CFR 257.96 of the U.S. Environmental Protection Agency Federal Coal Combustion Residuals (CCR) Rule (40 CFR 257 and 261), effective October 19, 2015 and subsequent revisions, Evergy Missouri West, Inc. (Evergy), engaged SCS Engineers to provided notification for the Initiation of Assessment of Corrective Measures for the Fly Ash Impoundment (FAI) at the Sibley Generating Station. Evergy provided SCS Engineers with groundwater monitoring data collected from the FAI groundwater monitoring system that meets the requirements of 40 CFR 257.91 and 40 CFR 257.93 and completed detection monitoring (40 CFR 257.94) for the FAI. Additionally, SCS Engineers collected groundwater samples for closure confirmation from the FAI groundwater monitoring network on November 15, 2021 and analyzed the samples for Appendix IV constituents in accordance with 40 CFR 257.102(c). Groundwater protection standards (GWPS) were determined for each Appendix IV constituent detected in the FAI’s monitoring wells pursuant to 40 CFR 257.95(h).

Statistical analysis of Appendix IV monitoring data from the groundwater monitoring system for the FAI at the Sibley Generating Station was completed in substantial compliance with the “*Statistical Method Certification by A Qualified Professional Engineer*” dated October 12, 2017. Appendix IV groundwater samples for closure confirmation monitoring were collected on November 15, 2021 following removal of coal combustion residuals (CCR) from the FAI. Review and validation of the results from the November 2021 closure confirmation sampling event was completed on January 7, 2022, which constituted completion and finalization of the closure confirmation monitoring laboratory analyses. In accordance with 40 CFR 257.102(c) groundwater closure monitoring concentrations cannot exceed the GWPS.

The GWPSs for Appendix IV constituents were set equal to the highest value of the MCL, concentrations specified by 40 CFR 257.95(h)(2), or background concentrations. The background concentrations for each of the Appendix IV constituents were determined following the prediction limit statistical procedures as specified in the *“Statistical Method Certification by A Qualified Professional Engineer”* dated October 12, 2017. The resulting GWPS for Appendix IV constituents are provided in **Table 1** along with the Appendix IV constituent background sample results for eight sampling events between December 2015 and October 2017. The completed statistical evaluation identified one Appendix IV constituent (molybdenum) in groundwater monitoring well MW-806R at a statistically significant level (SSL) above its GWPS. This SSL for molybdenum in groundwater monitoring well MW-806R resulted in the initiation of this ACM.

1.1 ASSESSMENT OF CORRECTIVE MEASURES PROCESS

The ACM process involves assessment of groundwater remediation technologies preliminarily identified to meet the following threshold criteria as stated in the CCR Rule:

40 CFR 257.97 Selection of remedy **[Threshold Criteria]**

(b) Remedies must:

(1) Be protective of human health and the environment;

(2) Attain the groundwater protection standard as specified 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 to this part 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;

(5) Comply with standards for management of wastes as specified in 40 CFR 257.98(d).

Once these remediation technologies have been identified, they are compared one to another with respect to the following balancing criteria as stated in the CCR Rule:

40 CFR 257.97 Selection of remedy **[Balancing Criteria]**

(c) In selecting a remedy that meets the standards of paragraph (b) of this section, the owner or operator of the CCR unit shall consider the following evaluation factors:

(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 fourth balancing criterion involves evaluating the degree to which community concerns regarding the proposed remedial alternatives are addressed. This criterion will be assessed by presenting the remedial alternatives at a public meeting and soliciting comments. That meeting will be held by Evergy at least 30 days prior to remedy selection.

1.2 REMEDY SCHEDULE CONSIDERATIONS RELATIVE TO RISK REDUCTION

Per 40 CFR 257.97(d), a schedule(s) for implementing and completing remedial activities must be specified as part of the selected remedy. Remedial activities must be completed within a reasonable period of time, taking into consideration six factors set forth in paragraphs (d)(1) through (6). As several of the Balancing Criteria considerations are related to risk reduction [(c)(1)(i), (c)(1)(ii), (c)(1)(iv), and (c)(1)(vi)], several of the remedy schedule considerations are also relative to risk reduction. The following are remedy schedule considerations related to risk that are factored into the schedule for implementing and completing remedial activities once a remedy is selected:

40 CFR 257.97 Remedy Schedule (Additional Risk Reduction Considerations)

(d) In scheduling the remedy the following factors must be considered [only risk reduction considerations listed].

   (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 of the aquifer;

      (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 characteristics of the facility and surrounding land; and

      (vi) The availability of alternative water supplies.

1.3 ACM AMENDMENTS

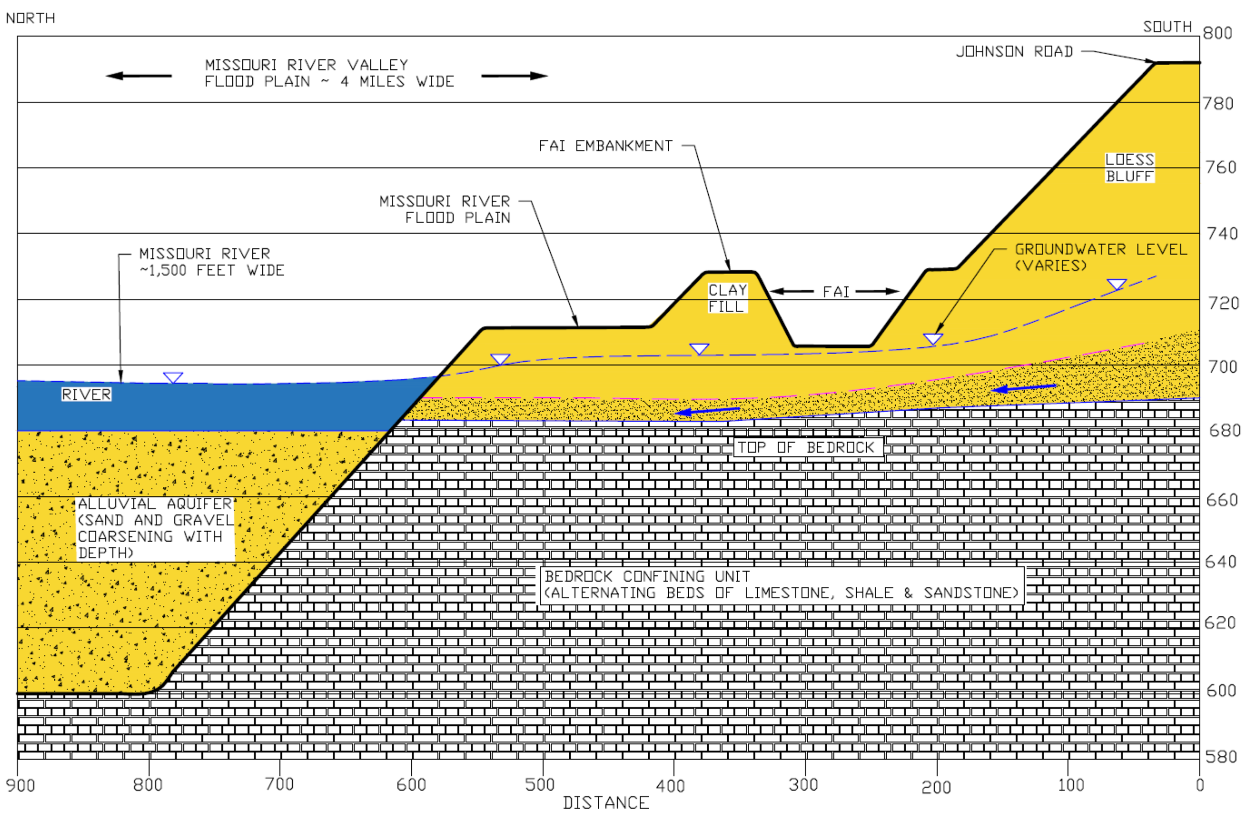
As additional information becomes available, including future groundwater monitoring results or other site-specific or general information, or technological developments, this ACM is subject to change. Nature and extent evaluations of Appendix IV constituents above the GWPS are still underway for the site and may influence the information presented in this report, including the potential corrective measures and the analysis of the potential corrective measures.

2.0 GROUNDWATER CONCEPTUAL SITE MODEL

To aid in the evaluation of remedial options, a Groundwater Conceptual Site Model (GwCSM) was developed for the FAI based on data from a number of site-specific documents and information from various sources, including previous field investigations at and near the facility, published literature, recent groundwater monitoring data, and field investigations performed as part of this ACM. Documents used for development of the GwCSM included but were not limited to the following:

- AECOM, (2017). *"Detailed Hydrogeologic Site Characterization Report, Fly Ash Impoundment, Sibley Generating Station"*
- AECOM, (2017). *"Groundwater Monitoring Well Installation Documentation Report, Fly Ash Impoundment, Sibley Generating Station"*
- Burns & McDonnell (1977. Subsurface Information. Memorandum. *"Subsurface Recommendation for Fly Ash Pond Missouri Public Service – Sibley"*

The GwCSM characterizes the subsurface conditions including site geology, hydrogeology, and the uppermost groundwater flow regime for the FAI site. The GwCSM is then used to evaluate and understand how groundwater and potential contaminants travel beneath the FAI, and provides the basis for assessing the efficacy of potential corrective measures to address the contaminant source, release mechanisms, and exposure routes. A visual representation of the GwCSM for the FAI is provided in the schematic below.



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The following sections describe the FAI site setting, history, geology, hydrogeology, and groundwater flow regime, and provide the overall site characterization for the GwCSM.

2.1 SITE LOCATION AND HISTORY

The Fly Ash Impoundment (FAI) at the Sibley Generating Station is located in the northwest ¼ of Section 1 and the northeast ¼ of Section 2, Township 50 North, Range 30 West, in Jackson County, Missouri. A Site location map is provided as **Figure 1**. The FAI was a surface impoundment designed by Burns and McDonnell in 1977 with a 2-foot thick compacted clay liner (Burns and McDonnell, 1977), and was used primarily for fly ash management. According to engineering drawings and specifications, the bottom of the FAI was to be excavated to an elevation of 705 feet and a compacted clay liner constructed to 707 feet (Burns and McDonnell, 1977). Since its construction, the FAI was modified several times. Between 1993 and 1994, the western end of the FAI was filled in and a new silo was placed on driven steel piles. In 1996, shot rock work pads and interior dikes were constructed within the FAI to provide a stable and durable location for heavy equipment when dredging and performing other maintenance operations. Use of the FAI was discontinued in 2019 and closure by CCR removal began in 2020 in accordance with the October 14, 2016, *"CCR Closure Plan, Sibley Fly Ash Impoundment, Sibley Generating Station"* (Closure Plan). Certification of removal of the CCR from the FAI in accordance with the Closure Plan was completed January 14, 2022 (Burns and McDonnell, 2022).

2.2 PHYSIOGRAPHY AND GEOMORPHOLOGY

The FAI is located near the southern bank of the Missouri River and lies within the Central Lowlands Physiographic Province along the boundary between the Osage Plains and the Dissected Till Plains Subprovinces. Glaciation in the Pleistocene covered the northern part of Missouri southward to just past the current Missouri River depositing glacial till and drift along the Missouri River valley and in the Sibley area. The Missouri River valley walls in the Sibley area are composed of glacial till and drift overlain by thick deposits of loess; wind-blown deposits of primarily silt and very fine sand associated with the Pleistocene glaciation. The Missouri River floodplain in the vicinity of Sibley is approximately four miles wide and underlain by unconsolidated alluvial deposits estimated to be approximately 100 feet thick.

The FAI is located on the southern edge of the Missouri River floodplain between the southern river valley wall at the foot of the loess bluffs. The current river channel is located as close as 50 feet from the FAI embankment, but not further than approximately 200 feet from the FAI embankment. The elevation of the crest of the FAI embankment is approximately 725 feet above mean sea level (ft amsl). The area south of the FAI consists of undulating hills that form a series of ridges overlooking the south side of the Missouri River floodplain. The topography to the south of the FAI rises sharply to the top of the loess bluff at an elevation of approximately 780 ft amsl within a horizontal distance of approximately 150 feet. The toe of the northern embankment drops down to the floodplain at an elevation of approximately 712 ft amsl.

Generally, the alluvial deposits on the south side of the Missouri River are thin, between 25 and 50 feet thick, and mostly fine grained with a coarsening sequence of primarily clay, with silt, sand, and some gravel. Alluvial deposits on the north side of the Missouri River are estimated to be approximately 100 feet deep, and have a more pronounced transition from the overlying clay to sand to boulders with depth (Gentile, 2014).

2.3 SITE SPECIFIC GEOLOGY AND HYDROGEOLOGY

Figure 2 is an aerial view site map showing the FAI, the bluff to the south, the river to the north and the locations of the groundwater monitoring wells.

2.3.1 Overlying Geologic Units

The material overlying the aquifer at the FAI is mostly low plasticity clay fill overlying silt, which transitions to sand with depth. The boring logs show medium stiff to very stiff low plasticity clay extending to elevations between approximately 701 and 713 feet, where the material type changes to native loess or native alluvium. The fill was, at some locations, noted as being silty, and, at some locations, as high plasticity clay. The transition from fill to native alluvium was typically marked by an increase in silt content. The silt beneath the fill was often mixed with fine sand and sometimes transitioned into poorly graded, very fine to fine sand and then back to silt. This sequence is believed to be overbank deposits and at most locations lies over a coarser basal sand unit. The silt and clay overlying the coarser basal sand (where present) is partially saturated. In several of the borings, water was encountered within the clay or silt at depths ranging between 10 and 33 feet below ground surface (bgs). At some locations water was perched on the silt unit, but the water level in the boring for MW-802 quickly rose about 6 feet after drilling into the lower basal sand unit. This indicates that the primary water-bearing unit at that location, the lower basal sand unit, appears to be at least locally confined to semi-confined by either the fill material or silt. Although moisture was encountered within the clay or silt, for the purposes of the CCR Rule, the water-bearing unit that has been defined as the uppermost aquifer is primarily the basal sand unit below the clay and silt. In some of the borings, the basal sand unit was overlying till which was hard and dry, consisting of silt, sand, and gravel in a clay matrix. The basal sand unit, at least in part, may be from the reworking of the till. Bedrock was found below the basal sand or till.

The vertical hydraulic conductivity of the embankment fill (clay) and native alluvium (silt) was measured by conducting falling head permeability laboratory tests from representative samples collected within the clay and silt from several borings. The results of these tests indicated a hydraulic conductivity range of 2.9×10^{-09} to 2.6×10^{-06} centimeters per second (cm/sec) for the clay and 2.7×10^{-06} to 5.7×10^{-06} cm/sec for the silt. The porosity of clay is estimated to be approximately 34 to 60%, and the effective porosity is estimated to be approximately 1 to 20%, based on literature values after Walton, 1988 and Domenico and Schwartz, 1990. The porosity of silt is similar to clay, estimated to be approximately 34 to 61%, and the effective porosity of silt is estimated to be approximately 1 to 30%, based on literature values after Walton, 1988 and Domenico and Schwartz, 1990.

2.3.2 Aquifer Characterization

Section §257.53 of the CCR Rule defines an aquifer as the geologic formation, group of formations, or portion of a formation capable of yielding usable quantities of groundwater to wells or springs. The uppermost aquifer is defined in §257.53 of the CCR Rule as the geologic formation nearest the natural ground surface that is an aquifer, as well as lower aquifers that are hydraulically interconnected with this aquifer within the facility boundary.

Based on the field investigation activities, conducted by SCS, the basal sand unit, where present, acts as the uppermost aquifer at the FAI. This unit was typically composed of fine to medium grained silty sand or sand with silt, but ranged in composition to include clayey gravel or silty clay with coarse sand and gravel.

Water level data collected during drilling and after well construction, along with the groundwater elevations in the temporary piezometer clusters, indicate the overlying silt and clay act as a confining or semi-confining unit to the basal sand unit. The aquifer appears to be locally semi-confined by the overlying lower permeability clay/silt acting as an upper confining unit. The aquifer is confined on the bottom by Pennsylvanian age limestone and shale bedrock of the Appanoose Subgroup of the Marmaton Group. The thickness of the aquifer beneath the FAI ranges from approximately 2 to 18 feet, with an average thickness of approximately 8 to 10 feet. Based on the water level measurements in the monitoring wells, the groundwater flow direction is primarily from south to north across the FAI, toward the Missouri River.

The horizontal hydraulic conductivity of the aquifer was characterized using published correlations from a Mansur-Kaufman field study to relate grain-size and hydraulic conductivity (USACE, 2000). Grain size data from the FAI borings were used along with grain size data from the nearby Slag Settling Impoundment (AECOM, 2017). Materials classified as fine grained or with considerable fines were not considered for the grain size-hydraulic conductivity correlation. These correlations indicated a hydraulic conductivity range of 6.0×10^{-03} to 7.2×10^{-02} cm/sec. A comparison of grain size and hydraulic conductivity to elevation showed a layer of high hydraulic conductivity from approximately 690 to 700 feet in several of the borings, and then a slight increase in grain size/hydraulic conductivity with decreasing elevation. The porosity of the aquifer is estimated to be approximately 26 to 53% and the effective porosity is estimated to be approximately 10 to 35%, based on literature values for the types of materials after Walton, 1988 and Domenico and Schwartz, 1990.

The groundwater flow direction is generally north towards the Missouri River, at a gradient ranging from less than 0.01 to approximately 0.06 feet per foot, from south to north. The calculated seepage velocity of the aquifer ranges from about 2.0×10^{-04} to 1.4×10^{-02} cm/sec.

2.3.3 Lower Boundary Confining Geologic Unit

The lower boundary confining geologic unit is a thick sequence of Pennsylvanian age sedimentary rocks consisting of alternating beds of shale, sandstone, and limestone of the Pleasanton Group as well as the Holdenville, Appanoose, and Fort Scott Subgroups of the Marmaton Group (Gentile, 2014). The erosional channel of the Missouri River cuts deep into the stratigraphic column, extending into the Appanoose and Fort Scott Subgroups. Bedrock encountered directly beneath the basal sand unit included limestone and shale. Bedrock surface dips generally north towards the Missouri River.

The hydraulic conductivity, porosity, and effective porosity ranges of the limestone are 1 x 10^{-07} to 6 x 10^{-04} cm/sec, 0 to 40%, and 0.1 to 5%, respectively, based on literature values for limestone after Walton, 1988 and Domenico and Schwartz, 1990. The hydraulic conductivity, porosity, and effective porosity ranges of the shale are 1 x 10^{-11} to 2 x 10^{-07} cm/sec, 1 to 10%, and 0.5 to 5%, respectively, based on literature values for the shale after Walton, 1988 and Domenico and Schwartz, 1990

2.3.4 Characteristics of Geologic Units

A summary table including the hydraulic conductivities, porosities, and effective porosities of each geologic unit encountered during the field investigation activities at the FAI is provided below.

Unit	Classification/ Lithology	Hydraulic Conductivity(1)	Porosity(2)	Effective Porosity(2)
Overlying Unconsolidated Geologic Units	Embankment Fill and Compacted Liner/Clay Alluvium/Silt	2.9 x 10^{-09} to 2.6 x 10^{-06} cm/sec 2.7 x 10^{-06} to 5.7 x 10^{-06} cm/sec	34 – 60% 34 – 61%	1 – 20% 1 – 30%
Aquifer (locally confined to semi-confined)	Alluvium Basal Sand/ Fine, Medium and Gravely Sand	6.0 x 10^{-03} to 7.2 x 10^{-02} cm/sec	26 - 53%	10 – 35%
Lower Confining Unit	Bedrock Interbedded Shale Limestone	1 x 10^{-11} to 2 x 10^{-07} cm/sec 1 x 10^{-07} to 6 x 10^{-04} cm/sec	1 – 10% 0 – 40%	0.5 – 5% 0.1 – 5%

Notes:

1. Hydraulic Conductivities of the clay and silt are from laboratory permeability tests; hydraulic conductivities of the sand were chosen from published correlations between grain-size and hydraulic conductivity (USACE, 2000); hydraulic conductivities of the bedrock were chosen based on literature values after Domenico and Schwartz, 1990.
2. Porosities and effective porosities were chosen based on literature values after Walton, 1988 and Domenico and Schwartz, 1990.

In summary, the aquifer beneath the FAI is primarily the basal sand unit present directly above bedrock or till. This unit is overlain by embankment fill, compacted soil liner, and alluvial clay and silt overbank deposits. The aquifer appears to be locally semi-confined to confined by the lower permeability clay/silt above and bedrock below, which act as confining units to the basal sand aquifer. Laboratory falling head permeability tests were conducted to measure the vertical hydraulic conductivity of the clay/silt unit. Laboratory grain size analyses were conducted on the basal sand unit to obtain hydraulic conductivity values through published grain size correlations (USACE, 2000).

2.3.5 Groundwater Depths, Elevations, and Flow Directions

Based on groundwater monitoring events since December 2015, the depth to groundwater ranges from approximately 10 to 34 feet bgs and can fluctuate by over 20 feet depending on precipitation in the drainage basin and the Missouri River stage. During the observed period, groundwater elevations have ranged from approximately 692 to 720 ft amsl. The groundwater flow direction is generally to the northeast, toward the Missouri River. As part of the nature and extent (N&E) portion of this ACM, several new wells were installed downgradient from the FAI groundwater monitoring network wells in the flood plain near the river bank, with an approximate ground elevation of 713 ft amsl. **Figure 3** is the most recent, August 19, 2022, potentiometric surface contour map for the FAI.

2.4 SUMMARY OF GROUNDWATER CONCEPTUAL SITE MODEL;

Figure 4 presents the GwCSM for FAI. Based on the data summarized above, the FAI is positioned on a narrow strip of the Missouri River flood plain, consisting of relatively thin sequence of overbank deposits sitting on bedrock and/or a thin till layer above the bedrock. The overbank deposits are typically approximately 20 to 30 feet thick and composed of primarily silt and fine sand with a coarser basal sand along the bottom. The FAI embankments were constructed of clay material brought onto the site. The Missouri River alluvial channel deposits to the north are reported to be approximately 100 feet thick and consist of much coarser sand, gravel, and boulders with depth. Groundwater beneath the FAI is primarily recharged from offsite groundwater entering the site from the south. Groundwater flows from the south valley wall beneath the FAI, north to the Missouri River. Flow is primarily within the coarser basal sand near the bottom of the overbank deposits. **Figure 4** presents the GwCSM for the FAI.

3.0 NATURE AND EXTENT OF MOLYBDENUM IN GROUNDWATER

As stated in Section 1.0, molybdenum was identified at a statistically significant level (SSL) at monitoring well MW-806R within the Sibley FAI Monitoring Well Network. As a result, Evergy directed SCS to initiate an N&E investigation for molybdenum as required by the CCR Rule. Additional groundwater monitoring wells (MW-807 through MW-822) were installed upgradient, cross-gradient, and downgradient of MW-806R and the FAI to determine the nature and extent (N&E) of the molybdenum impact. Four of the new N&E wells (MW-809, MW-810, MW-811, and MW-812) were installed within approximately 180 feet downgradient of MW-806R in the flood plain, and approximately 50 feet from the river bank. Of these four downgradient monitoring wells, only one well (MW-809) repeatedly demonstrated molybdenum above the USEPA Regional Screening Level (RSL). For the June 15, 2022 groundwater sampling event, the reported molybdenum concentration for upgradient monitoring well MW-808 exceeded the RSL with a concentration of 0.319 mg/L; however, prior and subsequent sampling has shown well MW-808 to be below the RSL.

Table 2 presents the laboratory results for molybdenum beginning with the closure sample collected from MW-806R on November 15, 2021, and subsequent sampling events for MW-806R and the newly installed N&E monitoring wells. The below image and **Figure 5** identifies the estimated boundaries of the groundwater plume at the FAI. This estimated boundary is based on molybdenum concentrations at wells consistently present at levels above a GWPS or RSL. MW-808 is not currently

included in the boundary as the one RSL exceedance at that location is considered an anomaly. This boundary may be modified based on future sampling.

A summary of the samples collected, the number of molybdenum detections above the laboratory reporting limits, and the number of detections exceeding either a GWPS or RSL is provided below.

Well ID	MW-801	MW-802	MW-803	MW-804	MW-805	MW-806R	MW-807	MW-808	MW-809	MW-810	MW-811
Samples	13	15	13	13	13	18	5	5	4	4	4
Detections	0	0	0	0	0	18	4	1	4	4	3
GWPS or RSL Exceedances	0	0	0	0	0	**18**	0	**1**	**2**	0	0

Well ID	MW-812	MW-813	MW-814	MW-815	MW-816	MW-817	MW-818	MW-819	MW-820	MW-821	MW-822
Samples	4	4	4	2	2	2	0	2	2	2	2
Detections	1	1	4	2	0	2	0	1	0	0	0
GWPS or RSL Exceedances	0	0	0	0	0	0	0	0	0	0	0

4.0 EXPOSURE EVALUATION AND ASSESSMENT OF RISK

Several of the Balancing Criteria considerations in 40 CFR 257.97(c) Selection of Remedy pertain to risk reduction. These risk reduction considerations are listed below:

40 CFR 257.97(c) Selection of Remedy

(c) In selecting a remedy that meets the standards of paragraph (b) of this section, the owner or operator of the CCR unit shall consider the following evaluation factors:

(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;

(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;

(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.

In addition to several Balancing Criteria considerations being relative to risk reduction, several of the remedy schedule considerations per 40 CFR 257.97(d) are also related to risk reduction. The following are remedy schedule considerations related to risk that are factored into the schedule for implementing and completing remedial activities once a remedy is selected:

40 CFR 257.97 Remedy Schedule (Additional Risk Reduction Considerations)

(d) In scheduling the remedy, the following factors must be considered [only risk reduction considerations listed].

(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 of the aquifer;

(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 characteristics of the facility and surrounding land; and

(vi) The availability of alternative water supplies.

To address these risk related considerations, an "Exposure Evaluation and Assessment of Risk" report has been prepared by SCS, as a companion to this ACM document, and is presented in **Appendix A.** This evaluation is supplemental to the specific monitoring and ACM requirements of the CCR Rule. The purpose of this evaluation is to provide the information needed to interpret and meaningfully understand the groundwater monitoring data collected and the ACM performed for the FAI under the CCR Rule. Because the FAI's close proximity to the Missouri River, this evaluation also considers the potential groundwater-to-surface water transport and exposure pathways, and makes comparison to state and federal screening levels of constituent concentrations that are considered to be protective of specific human exposures. Additionally, this evaluation will help determine whether current and anticipated future groundwater and surface water conditions pose a risk to human health and the environment and, if so, whether the corrective measures identified in this ACM report are expected to mitigate such risk.

An Exposure Conceptual Site Model (ExCSM) was developed based on the GwCSM discussed in Section 2.0 and the N&E investigation discussed in Section 3.0 above. The ExCSM is used to identify whether human populations or other organisms could come into contact with impacted groundwater and/or surface water in the area of the FAI. It provides a framework for identifying potential sources, potential exposure pathways, and potential receptors. Potential exposure pathways are the media and transport mechanisms the CCR impacts might utilize to reach potential receptors. Potential receptors are people or other organisms potentially affected by the CCR impacts through various exposure routes. The exposure pathway is the key mechanism by which an environmental contaminant can come into contact with a potential receptor. Therefore, if the exposure pathway is incomplete, the contaminant cannot reach a potential receptor and there is no risk to the receptor.

For an exposure pathway to be complete, the following conditions must exist (as defined by USEPA (1989)):

1. A source and mechanism of chemical release to the environment;
2. An environmental transport medium (e.g., air, water, soil);
3. A point of potential contact with the receiving medium by a receptor; and
4. A receptor exposure route at the contact point (e.g., inhalation, ingestion, dermal contact).

The "Exposure Evaluation and Assessment of Risk" report concluded, that while there are molybdenum concentrations in groundwater samples collected from two monitoring wells (MW-806R and MW-809) at the FAI above the tapwater regional screening levels (RSLs) used to evaluate data under the CCR Rule (0.100 mg/L), there are no potential human receptor exposure pathways for groundwater ingestion or dermal contact. Where there is no exposure, there is no risk.

The surface water exposure pathway was found to be potentially complete for the drinking water, incidental ingestion and dermal contact exposure routes for various scenarios. However, further evaluation indicates the risk is considered insignificant.

The molybdenum sampling results for the Missouri River are important. Although groundwater from one network monitoring well at the downgradient edge of the FAI (MW-806R) and one N&E monitoring well approximately 100 feet downgradient of the FAI (MW-809) exhibit molybdenum concentrations above the RSL, the adjacent Missouri River does not show evidence of molybdenum impact. The absence of molybdenum concentrations above the generic RSL or an RBSL indicates there is not a significant pathway of exposure. Furthermore, although elevated molybdenum concentrations in groundwater adjacent to the FAI have been documented, impacts to the Missouri River water have not been documented.

The interaction between groundwater and the river is dependent upon a number of variables including hydraulic conductivity, gradient, flow rate, and constituent concentrations of both the groundwater and the river. Groundwater and river water flow at significantly different rates and volumes. The Missouri River in the vicinity of the FAI has an average flow of approximately 38 billion gallons per day and an approximately 11 billion gallons per day flow during low flow conditions. The groundwater flowing into the river at the FAI is significantly less than the river flow. At the river's average flow, the groundwater is diluted by a conservatively estimated factor of approximately 4,900 times. Even at low flow conditions, the groundwater is diluted by a conservatively estimated factor of approximately 1,600 times.

When the calculated dilution and attenuation factor (DAF) for the FAI of 1,600 to 4,900 (unitless) is applied to the generic RSL for molybdenum of 0.100 mg/L, the calculated site-specific risk-based screening level for groundwater that is protective of the Missouri River water is at least 77 times higher than the maximum observed concentration at MW-806R.

The "Exposure Evaluation and Assessment of Risk" report demonstrates that present molybdenum concentrations in groundwater at the FAI do not pose adverse impacts on human health or the environment from either groundwater or surface water. Further, molybdenum concentrations up to at least 77 times greater than current concentrations would not pose adverse impacts to human health or the environment. Therefore, because no adverse risk currently exists, all of the corrective measures considered in this ACM are protective of human health and the environment.

5.0 CORRECTIVE MEASURES ALTERNATIVES

The overall goal of this ACM is to identify and evaluate the appropriateness of potential corrective measures to prevent further releases of Appendix IV constituents above their GWPS, to remediate releases of Appendix IV constituents detected during groundwater monitoring above their GWPS that have already occurred, and to restore groundwater in the affected area to conditions that do not exceed the GWPS for these Appendix IV constituents.

The corrective measures evaluation that is discussed below and subsequent sections provides an analysis of the effectiveness of six potential corrective measures in meeting the requirements and objectives of remedies as described under 40 CFR 257.97. Corrective measures can terminate when groundwater impacted associated with the FAI does not exceed the Appendix IV GWPS for three consecutive years of groundwater monitoring.

Potential groundwater corrective measures must meet, at a minimum, the following remedial threshold criteria as provided in the CCR Rule (40 CFR 257.97(b)).

1. Be protective of human health and the environment;
2. Attain the groundwater protection standard as specified pursuant to 40 CFR 257.95(h);
3. Control the source(s) of release so as to reduce or eliminate, to the maximum extent feasible, further releases of constituents in Appendix IV to this part 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 standards for management of wastes as specified in 40 CFR 257.98(d).

Potential corrective measures alternatives that meet the requirements of the threshold criteria listed above were identified based on information available during development of this ACM. The potential corrective measure alternatives that were identified are discussed in subsequent paragraphs. Continued evaluation of site conditions may identify additional corrective measures based on new information regarding the nature and extent of the impacts. As additional information and data is acquired during this process, periodic updates may occur to various components of this ACM to reflect the most recent status.

5.1 CORRECTIVE MEASURES ALTERNATIVES

Five potential corrective measures alternatives have been preliminarily identified to address groundwater impacts at the FAI. The major component of all five corrective measures alternative is removal of the CCR material; which has already been completed as part of the closure by removal process (CBR). Because the primary source has already been removed, there is no potential for further releases. Therefore, the remaining components of each corrective measure's alternative target the residual groundwater impact. Each of the following five potential corrective measures alternatives, preliminarily identified to address residual groundwater impacts at the FAI, meet the requirements of the remedial threshold criteria listed above in Section 5:

Alternative 1: Closure by Removal with MNA (Risk Based)

Alternative 2: Closure by Removal with Groundwater Pumping and NPDES Discharge (no treatment)

a) Vertical Wells
b) Horizontal Trench

Alternative 3: Closure by Removal with Groundwater Pumping and POTW Discharge or Ex-Situ Treatment Prior to NPDES Discharge

Alternative 4: Closure by Removal with Barrier Wall, Groundwater Pumping, and NPDES Discharge (no treatment), POTW Discharge (no treatment) or Ex-Situ Treatment Prior to NPDES or POTW Discharge

a) Trenched slurry wall
b) Reagents mixed with soil
c) Sheet piles

Alternative 5: Closure by Removal with In-Situ Groundwater Treatment

a) Chemical injection to promote sorption (assumes can find an appropriate chemical that promotes molybdenum to bind to site soils)
b) Permeable Reactive Barrier (assumes can find an appropriate reactive media)

These alternatives were developed and selected based on reasonable and appropriate corrective measures components. However, because of the large scale CCR removal activities by excavation followed by regrading the clay bottom of the FAI, the short- and long-term groundwater geochemistry was likely altered. Therefore, because the CCR removal activities were recently completed, it will likely take some time for a new groundwater geochemical equilibrium to be established. Additional alternatives may be identified based on the continued evaluation of groundwater conditions.

5.1.1 Alternative 1: Closure by Removal with Monitored Natural Attenuation

Alternative 1 includes no additional source control component or containment component as CCR source removal has already been completed. With Alternative 1, the post-closure groundwater monitoring program will be supplemented with MNA. MNA may include the analysis of groundwater samples for additional parameters and potentially increased sampling frequency over and above the minimum program. Additional monitoring is intended to assist with understanding, monitoring, predicting, and documenting natural attenuation processes affecting groundwater quality. MNA will track groundwater impacts and the effects of attenuation mechanisms, if present, on groundwater concentrations over time.

MNA is a viable remedial technology recognized by both state and federal regulators that is applicable to inorganic compounds in groundwater. MNA as defined by the USEPA, is "the reliance on natural attenuation processes to achieve site-specific remediation objectives within a time frame that is reasonable compared to that offered by other more active methods." The natural attenuation processes include a variety of physical, chemical, or biological processes that, under favorable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in soil or groundwater. These in-situ processes could include biodegradation; dispersion; dilution; sorption; volatilization; radioactive decay; and chemical or biological stabilization, transformation, or destruction of contaminants (USEPA, 2015b).

This alternative acknowledges that closure of the CCR unit is not attained until groundwater is in compliance with the GWPS. Monitoring of groundwater will continue in accordance with all CCR regulation requirements along with performance monitoring of the MNA process until such time that groundwater conditions return to below the GWPS.

5.1.2 Alternative 2: Closure by Removal with Groundwater Pumping and NPDES Discharge

Alternative 2 differs from Alternative 1, in that it provides additional containment components to address residual groundwater contaminants. Under this alternative, residual contaminants in groundwater would be addressed by pumping to provide hydraulic control and containment, to prevent or reduce migration of residual contaminants downgradient. Only the uppermost aquifer in the unconsolidated materials would be pumped and the extracted groundwater would be discharged to the receiving water body (Missouri River) in accordance with a modification to the existing National Pollutant Discharge Elimination System (NPDES) Permit Number MO-0004871, or by obtaining a new NPDES Permit.

Extracted groundwater would not be treated prior to discharge. Discharge without treatment of the extracted groundwater would need to be verified as permissible under the current permit or application for and approval of a modified or new permit would be required. This option will likely require discharge effluent testing and/or modeling to support the modified or new permit application.

Implementation of a hydraulic control and containment system would require detailed design including pilot testing, such as pumping tests and groundwater modeling to verify the hydraulic capture zone. Extraction methods could include vertical or horizontal wells or an extraction trench with vertical riser. In addition to the extraction system, a conveyance system from the extraction system to the discharge point would have to be designed and constructed. As opposed to Alternatives 1, Alternative 2 will have energy requirements which create a carbon footprint.

This alternative will require post-implementation care activities including ongoing operation and maintenance (O&M) of the extraction and conveyance systems and continued monitoring of groundwater in accordance with the CCR regulation requirements, along with performance monitoring of the extraction system until such time that groundwater conditions return to below the GWPS.

5.1.3 Alternative 3: Closure by Removal with Groundwater Pumping and Ex-Situ Treatment

This alternative is the same as Alternative 2 in that it provides additional containment components to address residual groundwater impacts (secondary source); however, with this alternative the extracted groundwater is treated prior to discharge. Following treatment, discharge may be accepted at a POTW, or onsite discharge would require a discharge permit as discussed for Alternative 2.

Potential treatment options capable of achieving acceptable levels include: coagulation-flocculation-filtration, ion exchange, and reverse osmosis. Implementation of any of these options would require detailed design and potentially include bench and/or pilot testing. The design and construction would also require additional development of an enclosure, ancillary equipment and space that adds complexity to this alternative. These treatment systems would have ongoing O&M and energy requirements which create a carbon footprint, and would generate a secondary waste stream. Additionally, coagulants and polymers would be required for the coagulation-flocculation-filtration system and the ion exchange system would require regeneration/replacement of the ion exchange media.

Following the installation of the groundwater extraction and treatment system, this alternative would also require continued monitoring of groundwater in accordance with CCR regulation requirements, along with performance monitoring of the extraction and treatment systems until such time that groundwater conditions return to below the GWPS.

5.1.4 Alternative 4: Closure by Removal with Barrier Wall, Groundwater Pumping, Discharge

This alternative includes the components of Alternatives 2 and/or 3 with the addition of a barrier wall to improve the efficiency of the extraction system. A low permeability subsurface barrier wall would be installed downgradient from the extraction system, between the northern boundary of the FAI and the Missouri River. The low permeability barrier wall could potentially limit the capture zone of the groundwater extraction system, thereby significantly reducing the amount of unwanted river water being extracted with the groundwater. This would allow the extraction system to operate at a lower pumping rate to achieve hydraulic containment and contaminant removal. However, Appendix IV constituents already present in groundwater downgradient from the barrier wall would not be addressed by this alternative but would be addressed through processes of natural attenuation as discussed in Alternative 1.

Implementation of this alternative would require detailed design including additional investigation for feasibility of installing a barrier wall, pilot testing, such as pumping tests, and groundwater modeling to verify the hydraulic capture zone. Extraction methods could include vertical or horizontal wells or an extraction trench with vertical riser. Extracted water could be discharged without treatment under an NPDES as described for Alternative 2, or treated prior to discharge as described for Alternative 3. The barrier wall could be one of several types including: slurry installed in a trench (soil-bentonite, cement-bentonite, soil-cement-bentonite), reagents mixed with soil in-situ (one pass trenching, deep soil mixing, high pressure injection), and sheet piles. In addition to the extraction system and barrier system, a conveyance system from the extraction system to the discharge point would have to be designed and constructed. As opposed to Alternatives 1, Alternative 4 will have energy requirements which create a carbon footprint.

Following the installation of the barrier wall, groundwater pumping well network, and treatment system (if required), this alternative will require care activities including ongoing operation and maintenance (O&M) of the extraction, treatment, and conveyance systems and continued monitoring of groundwater in accordance with CCR regulation requirements, along with performance monitoring of the extraction system until such time that groundwater conditions return to below the GWPS.

5.1.5 Alternative 5: Closure by Removal with In-Situ Groundwater Treatment

This alternative would address residual groundwater impact through in-situ addition of a groundwater treatment amendment(s) to alter the subsurface conditions. This can include the injection of chemicals/air or installing a permeable reactive barrier (PRB). Chemical injections would promote sorption to aquifer solids within the plume. A PRB would create a reactive zone downgradient of the FAI. Groundwater would naturally flow through the PRB by gravity and the added amendment(s) would treat the groundwater, accelerating the time required to achieve the GWPS and prevent the contaminant from migrating to the Missouri River.

Implementation of this alternative would require detailed design including additional investigation for feasibility of installing injections or a PRB, bench scale testing for treatability and amendment selection, pilot testing, such as pumping tests, and groundwater modeling to verify flow through the PRB and sufficient resident times for treatment. The bench scale testing would evaluate the efficacy of in-situ treatment, while factoring in potential adverse changes in groundwater geochemistry which may affect the stability of other CCR-related constituents.

Injections could occur at a horizontal trench or multiple vertical injection wells. Installation of the PRB could be accomplished by trenching, deep soil mixing, or injection. Adding amendments would require an underground injection permit from the state of Missouri prior to construction and installation of this alternative.

Following installation of the PRB, this alternative would require continued monitoring of groundwater in accordance with CCR regulation requirements, along with performance monitoring of the PRB until such time that groundwater conditions return to below the GWPS.

6.0 EVALUATION OF CORRECTIVE MEASURES ALTERNATIVES

As required by 40 CFR 257.96(c), the following sections provide an analysis of the effectiveness of potential corrective measure alternatives in meeting the requirements and objectives outlined in 40 CFR 257.97. The evaluation addresses the requirements and objectives identified in 40 CFR 257.96(c)(1) through (3), which include:

- The performance, reliability, ease of implementation, and potential impacts of appropriate potential remedies, including safety impacts, cross-media impacts, and control of exposure to residual contamination;
- The time required to begin and complete the remedy; and
- The institutional requirements, such as state or local permit requirements or other environmental or public health requirements that may substantially affect implementation of the remedy.

The three criteria listed under 257.96(c) are addressed by the specific balancing criteria summarized below and are discussed in the referenced report sections:

257.96(c) Criteria	Associated 257.97 (c) Balancing Criteria	ACM Report Section
(1) The performance, reliability, ease of implementation, and potential impacts of appropriate potential remedies, including safety impacts, cross-media impacts, and control of exposure to any residual contamination	257.97(c)(1)(i)	Section 6.2.1.1
	257.97(c)(1)(ii)	Section 6.2.1.2
	257.97(c)(1)(iii)	Section 6.2.1.3
	257.97(c)(1)(iv)	Section 6.2.1.4
	257.97(c)(1)(vi)	Section 6.2.1.6
	257.97(c)(1)(vii)	Section 6.2.1.7
	257.97(c)(1)(viii)	Section 6.2.1.8
	257.97(c)(2)(i)	Section 6.2.2.1
	257.97(c)(2)(ii)	Section 6.2.2.2
	257.97(c)(3)(i)	Section 6.2.3.1
	257.97(c)(3)(ii)	Section 6.2.3.2
	257.97(c)(3)(iv)	Section 6.2.3.4
	257.97(c)(3)(v)	Section 6.2.3.5
(2) The time required to begin and complete the remedy	257.97(c)(1)(v)	Section 6.2.1.5

257.96(c) Criteria	Associated 257.97 (c) Balancing Criteria	ACM Report Section
(3) The institutional requirements, such as state or local permit requirements or other environmental or public health requirements that may substantially affect implementation of the remedy(s)	257.97(c)(3)(iii)	Section 6.2.3.3

6.1 EVALUATION CRITERIA

The three requirements under 40 CFR 257.96(c) are addressed by four specific balancing criteria described in 40 CFR 257.97(c). In accordance with 40 CFR 257.97(c), remedial alternatives that satisfy the five threshold criteria listed in 40 CFR 257.97(b) and Section 5 of this ACM are compared to the balancing criteria to evaluate the corrective measures alternatives. The balancing criteria allow a comparative analysis and ranking of the corrective measures alternatives, thereby assisting in the selection of the final corrective measures alternative. The four balancing criteria are listed below and subcriteria are discussed in greater detail in Section 6.2.

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;
2. The effectiveness of the remedy in controlling the source to reduce further releases;
3. The ease or difficulty of implementing a potential remedy(s); and
4. The degree to which community concerns are addressed by a potential remedy(s).

As stated in Section 1.1, the degree to which community concerns are addressed by the potential remedies will be considered following a public meeting to discuss the results of the ACM with interested and affected parties and will be held at least 30 days prior to remedy selection in accordance with 257.96(e).

6.2 COMPARISON OF ALTERNATIVES

This section compares the alternatives to each other based on evaluation of the balancing criteria listed above. The goal of this analysis is to identify the alternative that is technologically feasible, relevant and readily implementable, provides adequate protection to human health and the environment, and minimizes impacts to the community.

A chart is provided within each subsection below to provide a visual representation of the favorability of each alternative, where green represents most favorable, yellow represents less favorable, and red represents least favorable.

6.2.1 Balancing Criteria 1

Balancing Criteria 1 evaluates the long-and short-term effectiveness, protectiveness, and certainty of success of the remedial alternatives. This balancing criteria takes into consideration eight subcriteria which are each discussed in the following sections. For each of the eight subcriteria, the most favorable alternatives were assigned a value of "1", less favorable alternatives were assigned a value of "2", and least favorable alternatives were assigned a value of "3". These values also correspond to the color-coded chart for each subcriteria. The summation of the subcriteria values for each alternative are shown in the below overall summary chart for Balancing Criteria 1.

OVERALL SUMMARY CHART FOR BALANCING CRITERIA 1 The Long- and Short-Term Effectiveness and Protectiveness of the Potential Remedy, along with the Degree of Certainty that the Remedy Will Prove Successful					
Balancing Criteria 1 Long-and Short-Term Effectiveness, Protectiveness, and Certainty of Success	**Alternative 1** CBR w/ MNA	**Alternative 2** CBR w/ Groundwater Extraction w/ NPDES Discharge	**Alternative 3** CBR w/ Groundwater Extraction w/ Treatment Prior to Discharge	**Alternative 4** CBR w/ Groundwater Extraction w/ Barrier Wall w/ Alt 3 or Alt 4 Discharge	**Alternative 5** CBR w/ In-Situ Groundwater Treatment
	10	16	16	16	17

6.2.1.1 Magnitude of Reduction of Existing Risks

This criteria considers the magnitude the selected remedy will reduce existing risks. As discussed in Section 4, no unacceptable risk to human health and the environment exists with respect to the FAI. Because the CCR material has been removed from the FAI, there is no potential for additional risk from further excavation or regrading activities. Therefore, none of the remedial alternatives are necessary to reduce an assumed risk in groundwater because no such unacceptable risk currently exists. Therefore, all five alternatives could be considered favorable for this criteria.

Balancing Criteria 1 Long-and Short-Term Effectiveness, Protectiveness, and Certainty of Success	**Alternative 1** CBR w/ MNA	**Alternative 2** CBR w/ Groundwater Extraction w/ NPDES Discharge	**Alternative 3** CBR w/ Groundwater Extraction w/ Treatment Prior to Discharge	**Alternative 4** CBR w/ Groundwater Extraction w/ Barrier Wall w/ Alt 3 or Alt 4 Discharge	**Alternative 5** CBR w/ In-Situ Groundwater Treatment
Criteria 1 Subcriteria i) Magnitude of reduction of risks	1	2	2	2	2

6.2.1.2 Magnitude of Residual Risks

This criteria evaluates the magnitude of residual risk in terms of the likelihood of further releases due to CCR remaining following implementation of a remedy. Because the CCR material has already been removed from the FAI, all of the alternatives are considered favorable with respect to this subcriteria category. There are no residual risks for further releases due to CCR remaining in the FAI.

Balancing Criteria 1 Long-and Short-Term Effectiveness, Protectiveness, and Certainty of Success	**Alternative 1** CBR w/ MNA	**Alternative 2** CBR w/ Groundwater Extraction w/ NPDES Discharge	**Alternative 3** CBR w/ Groundwater Extraction w/ Treatment Prior to Discharge	**Alternative 4** CBR w/ Groundwater Extraction w/ Barrier Wall w/ Alt 3 or Alt 4 Discharge	**Alternative 5** CBR w/ In-Situ Groundwater Treatment
Criteria 1 Subcriteria ii) Magnitude of residual risk in terms of likelihood of further releases due to CCR remaining following implementation of a remedy	1	1	1	1	1

6.2.1.3 Type and Degree of Long-Term Management

This criteria considers the type and degree of long-term management required with the selected remedy, including monitoring, operation, and maintenance activities. Alternative 1 is the most favorable alternatives with respect to this criteria because mechanical systems are not part of the remedy, and these alternatives require the least amount of long-term management. Alternative 5 is less favorable than Alternative 1 because the in-situ treatment system will require performance monitoring and maintenance. The remaining alternatives (2, 3, and 4), all of which include groundwater extraction systems, will require long-term management and O&M, and therefore are the least favorable. The extraction alternatives that include ex-situ treatment will also generate a secondary waste stream requiring management, resulting in the greatest energy consumption and carbon footprint of the alternatives. It should be noted that all of the alternatives will require some type of monitoring until the GWPS is achieved.

Balancing Criteria 1 Long-and Short-Term Effectiveness, Protectiveness, and Certainty of Success	**Alternative 1** CBR w/ MNA	**Alternative 2** CBR w/ Groundwater Extraction w/ NPDES Discharge	**Alternative 3** CBR w/ Groundwater Extraction w/ Treatment Prior to Discharge	**Alternative 4** CBR w/ Groundwater Extraction w/ Barrier Wall w/ Alt 3 or Alt 4 Discharge	**Alternative 5** CBR w/ In-Situ Groundwater Treatment
Criteria 1 Subcriteria iii) Type and degree of long-term management required, including monitoring, operation, and maintenance (O&M)	1	3	3	3	2

6.2.1.4 Short-Term Risks

Short-term risks to the community or environment include general impacts due to increased truck traffic on public roads during construction and ongoing O&M of the more aggressive remedies, including transportation of generated secondary waste streams for off-site disposal. Because construction and O&M is not required for Alternative 1, it is the most favorable alternative. Due to construction and ongoing O&M, Alternative 2, Alternative 3 and Alternative 4 are the least favorable. Alternative 5 is less favorable because of the required construction and potential maintenance.

Balancing Criteria 1 Long-and Short-Term Effectiveness, Protectiveness, and Certainty of Success	**Alternative 1** CBR w/ MNA	**Alternative 2** CBR w/ Groundwater Extraction w/ NPDES Discharge	**Alternative 3** CBR w/ Groundwater Extraction w/ Treatment Prior to Discharge	**Alternative 4** CBR w/ Groundwater Extraction w/ Barrier Wall w/ Alt 3 or Alt 4 Discharge	**Alternative 5** CBR w/ In-Situ Groundwater Treatment
Criteria 1 Subcriteria iv) Short-term risks that might be posed to community or environment during implementation of the remedy	1	3	3	3	2

6.2.1.5 Timeframe

This criteria considers the expected timeframe until full protection is achieved. There is currently no unacceptable exposure to impacted groundwater associated with the FAI as discussed in Section 4 of this ACM; therefore, protection is already achieved. The required time to achieve the GWPS is anticipated to be the shortest for the alternatives with active groundwater extraction; therefore, Alternative 2, Alternative 3, and Alternative 4 are the most favorable alternatives. Alternative 5 is slightly less favorable because it is anticipated to require more time to achieve the GWPS, as groundwater flow through the injection points or the PRB treatment system would be controlled by the natural groundwater gradient. Alternative 1 is considered the least favorable because it is anticipated to require the longest time for groundwater to reach the GWPS. However, with further evaluation and groundwater flow and transport modeling, which would be required for detailed design of the alternatives, there is the potential that the extraction alternatives and the in-situ alternative will only be slightly more favorable than the passive alternatives. This is based on the limited yield of the aquifer, the limited saturated thickness, the relatively low permeability of the majority of the aquifer, and fluctuations of the Missouri River.

Balancing Criteria 1	**Alternative 1** CBR w/ MNA	**Alternative 2** CBR w/ Groundwater Extraction w/ NPDES Discharge	**Alternative 3** CBR w/ Groundwater Extraction w/ Treatment Prior to Discharge	**Alternative 4** CBR w/ Groundwater Extraction w/ Barrier Wall w/ Alt 3 or Alt 4 Discharge	**Alternative 5** CBR w/ In-Situ Groundwater Treatment
Criteria 1 Subcriteria v) Time until full protection is achieved	3(a)	1	1	1	2

(a) Potential to be less favorable following further evaluation and detailed designs.

6.2.1.6 Potential for Exposure to Remaining Wastes

This criteria considers the 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. All of the alternatives are favorable with respect to the potential for exposure to remaining wastes. The CCR materials (remaining wastes) have already been removed; therefore, there is no potential exposure to remaining wastes (CCR material). However, Alternative 1 is most favorable because the other alternatives have potential for indirect exposure in the form of remedial waste streams (effluent, spent treatment media). Therefore, Alternative 2 through Alternative 5 are less favorable.

Balancing Criteria 1 Long-and Short-Term Effectiveness, Protectiveness, and Certainty of Success	**Alternative 1** CBR w/ MNA	**Alternative 2** CBR w/ Groundwater Extraction w/ NPDES Discharge	**Alternative 3** CBR w/ Groundwater Extraction w/ Treatment Prior to Discharge	**Alternative 4** CBR w/ Groundwater Extraction w/ Barrier Wall w/ Alt 3 or Alt 4 Discharge	**Alternative 5** CBR w/ In-Situ Groundwater Treatment
Criteria 1 Subcriteria 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.	1	2	2	2	2

6.2.1.7 Long-Term Reliability

This criteria considers the long-term reliability of the engineering and institutional controls for each alternative. Alternative 1 is most favorable in terms of long-term reliability because it does not rely on mechanical systems or geochemical enhancements. The alternatives that include groundwater extraction (Alternatives 2, 3, and 4) rely on proven technologies, but are less favorable over the long-term because they rely on mechanical systems (pumping, conveyance and treatment systems. Alternative 5 is the least favorable because it is less proven and relies on geochemical enhancements which may require multiple rounds of injections or PRB media replacement to achieve the GWPS. Additionally, Alternative 5 is subject to physical and chemical changes in the subsurface.

Balancing Criteria 1 Long-and Short-Term Effectiveness, Protectiveness, and Certainty of Success	**Alternative 1** CBR w/ MNA	**Alternative 2** CBR w/ Groundwater Extraction w/ NPDES Discharge	**Alternative 3** CBR w/ Groundwater Extraction w/ Treatment Prior to Discharge	**Alternative 4** CBR w/ Groundwater Extraction w/ Barrier Wall w/ Alt 3 or Alt 4 Discharge	**Alternative 5** CBR w/ In-Situ Groundwater Treatment
Criteria 1 Subcriteria vii) Long-term reliability of the engineering and institutional controls	1	2	2	2	3

6.2.1.8 Potential Need for Replacement

This criteria evaluates the potential need for replacement activities of the selected remedy(s). Alternative 1 is the most favorable because the primary source has already been removed, the remedy is complete and permanent, and the residual groundwater impact will naturally return to concentrations below the GWPS. The alternatives which include groundwater extraction (Alternatives 2, 3, and 4) are less favorable because there are a number of components in the remedial system that may need to be replaced (wells, pumps, piping, treatment systems, and treatment chemicals). As the complexity of these alternatives increases (Alternative 2 < Alternative 3 < Alternative 4), they become progressively less favorable. Alternative 5 is the least favorable because multiple rounds of injections or PRB media replacement may be required to achieve the GWPS and it is subject to physical and chemical changes in the subsurface.

Balancing Criteria 1 Long-and Short-Term Effectiveness, Protectiveness, and Certainty of Success	**Alternative 1** CBR w/ MNA	**Alternative 2** CBR w/ Groundwater Extraction w/ NPDES Discharge	**Alternative 3** CBR w/ Groundwater Extraction w/ Treatment Prior to Discharge	**Alternative 4** CBR w/ Groundwater Extraction w/ Barrier Wall w/ Alt 3 or Alt 4 Discharge	**Alternative 5** CBR w/ In-Situ Groundwater Treatment
Criteria 1 Subcriteria viii) Potential need for replacement of the remedy	1	2	2	2	3

6.2.2 Balancing Criteria 2

Balancing Criteria 2 evaluates the effectiveness of the remedy in controlling the source to reduce further releases. This balancing criteria takes into consideration two subcriteria which are discussed in the following sections. For each subcriteria, the most favorable alternatives were assigned a value of "1", less favorable alternatives were assigned a value of "2", and least favorable alternatives were assigned a value of "3". These values also correspond to the color-coded chart for each subcriteria. The summation of the subcriteria values for each alternative are shown in the below overall summary chart for Balancing Criteria 2.

OVERALL SUMMARY CHART FOR BALANCING CRITERIA 2 The Effectiveness of the Remedy in Controlling the Source to Reduce Further Releases					
Balancing Criteria 2 The effectiveness of the remedy in controlling the source to reduce further releases	**Alternative 1** CBR w/ MNA	**Alternative 2** CBR w/ Groundwater Extraction w/ NPDES Discharge	**Alternative 3** CBR w/ Groundwater Extraction w/ Treatment Prior to Discharge	**Alternative 4** CBR w/ Groundwater Extraction w/ Barrier Wall w/ Alt 3 or Alt 4 Discharge	**Alternative 5** CBR w/ In-Situ Groundwater Treatment
	2	2	3	3	4

6.2.2.1 Extent for Reducing Further Releases

This criteria evaluates the extent to which containment practices will reduce further releases. Because the CCR material has already been removed from the FAI, all of the alternatives are most favorable for reducing further releases. Removal of the CCR material from the FAI reduced the potential for further releases from the FAI to the fullest extent possible.

Balancing Criteria 2 The Effectiveness of the Remedy in Controlling the Source to Reduce Further Releases	**Alternative 1** CBR w/ MNA	**Alternative 2** CBR w/ Groundwater Extraction w/ NPDES Discharge	**Alternative 3** CBR w/ Groundwater Extraction w/ Treatment Prior to Discharge	**Alternative 4** CBR w/ Groundwater Extraction w/ Barrier Wall w/ Alt 3 or Alt 4 Discharge	**Alternative 5** CBR w/ In-Situ Groundwater Treatment
Criteria 2 Subcriteria i) The extent to which containment practices will reduce further releases	1	1	1	1	1

6.2.2.2 Use of Treatment Technologies

This criteria evaluates the extent to which treatment technologies may be used with the selected remedy(s). Alternatives 1 and 2 are the most favorable because groundwater treatment technologies are not required nor relied upon (other than MNA for Alternative 1). The alternatives which include groundwater extraction followed by ex-situ treatment (Alternatives 3 and 4) are less favorable because the treatment technologies are relied upon to remove the contaminants prior to discharge. These alternatives will require bench scale treatability testing and once implemented, will produce a secondary waste stream. Alternative 5 is the least favorable because it is the least proven technology and would require extensive bench scale treatability testing. This technology has less control over the treatment process, because it is subject to physical and chemical changes in the subsurface. Additionally, this treatment technology may require multiple rounds of injections or PRB media replacement to achieve the GWPS.

Balancing Criteria 2 The Effectiveness of the Remedy in Controlling the Source to Reduce Further Releases	**Alternative 1** CBR w/ MNA	**Alternative 2** CBR w/ Groundwater Extraction w/ NPDES Discharge	**Alternative 3** CBR w/ Groundwater Extraction w/ Treatment Prior to Discharge	**Alternative 4** CBR w/ Groundwater Extraction w/ Barrier Wall w/ Alt 3 or Alt 4 Discharge	**Alternative 5** CBR w/ In-Situ Groundwater Treatment
Criteria 2 Subcriteria ii) The extent to which treatment technologies may be used	1	1	2	2	3

6.2.3 Balancing Criteria 3

Balancing Criteria 3 evaluates the ease or difficulty of implementing a potential remedy(s). This balancing criteria takes into consideration five subcriteria which are each discussed in the following sections. For each of the five subcriteria, the most favorable alternatives (remedy with greatest ease of implementation) were assigned a value of "1", less favorable alternatives were assigned a value of "2", and least favorable alternatives (remedy with greatest difficulty of implementation) were assigned a value of "3". These values also correspond to the color-coded chart for each subcriteria. The summation of the subcriteria values for each alternative are shown in the below overall summary chart for Balancing Criteria 3.

OVERALL SUMMARY CHART FOR BALANCING CRITERIA 3 **The Ease or Difficulty of Implementing a Potential Remedy(s)**					
Balancing Criteria 3 The Ease or Difficulty of Implementing a Potential Remedy(s)	**Alternative 1** CBR w/ MNA	**Alternative 2** CBR w/ Groundwater Extraction w/ NPDES Discharge	**Alternative 3** CBR w/ Groundwater Extraction w/ Treatment Prior to Discharge	**Alternative 4** CBR w/ Groundwater Extraction w/ Barrier Wall w/ Alt 3 or Alt 4 Discharge	**Alternative 5** CBR w/ In-Situ Groundwater Treatment
	5	10	13	14	13

6.2.3.1 Degree of difficulty associated with constructing the technology

This criteria evaluates the degree of difficulty associated with constructing the technology for the remedy. Alternative 1 is the most favorable because further construction is not required and only long-term monitoring is required. Alternatives 2 and 5 are less favorable because construction is required. Alternative 2 requires construction of a groundwater extraction and conveyance system. Alternative 5 requires injection of treatment media within the plume or injection of treatment media to create a PRB. However, if the in-situ treatment design requires trenching to create a PRB, then Alternative 5 would become least favorable due to the difficulties of trenching and notching the trench into the lower confining unit, which is not at a consistent elevation. Alternatives 3 and 4 are least favorable because of the greater complexity of constructing an ex-situ treatment system and construction of a barrier wall.

Balancing Criteria 3 The Ease or Difficulty of Implementing a Potential Remedy(s)	**Alternative 1** CBR w/ MNA	**Alternative 2** CBR w/ Groundwater Extraction w/ NPDES Discharge	**Alternative 3** CBR w/ Groundwater Extraction w/ Treatment Prior to Discharge	**Alternative 4** CBR w/ Groundwater Extraction w/ Barrier Wall w/ Alt 3 or Alt 4 Discharge	**Alternative 5** CBR w/ In-Situ Groundwater Treatment
Criteria 3 Subcriteria i) Degree of difficulty associated with constructing the technology	1	2	3	3	2

(a) Assumes use of vertical injections but has the potential to be least favorable if trenching is required by the design.

6.2.3.2 Expected Operational Reliability

This criteria evaluates the expected operational reliability of the alternative technologies. Alternative 1 is the most favorable because it does not rely on mechanical systems or geochemical enhancements, and there is no longer an operational aspect to the technology other than the required long-term monitoring. The alternatives that include groundwater extraction systems (Alternatives 2, 3, and 4) rely on the operation of proven technologies, but are less favorable over the long-term because they rely on the operation of mechanical systems (pumping and conveyance for all three and ex-situ treatment systems for Alternative 4). Alternative 5 is the least favorable because it is less proven and relies on geochemical enhancements and may require multiple rounds of injections or PRB media replacement to achieve the GWPS. Additionally, Alternative 5 is subject to physical and chemical changes in the subsurface.

Balancing Criteria 3 The Ease or Difficulty of Implementing a Potential Remedy(s)	**Alternative 1** CBR w/ MNA	**Alternative 2** CBR w/ Groundwater Extraction w/ NPDES Discharge	**Alternative 3** CBR w/ Groundwater Extraction w/ Treatment Prior to Discharge	**Alternative 4** CBR w/ Groundwater Extraction w/ Barrier Wall w/ Alt 3 or Alt 4 Discharge	**Alternative 5** CBR w/ In-Situ Groundwater Treatment
Criteria 3 Subcriteria ii) Expected operational reliability of the technologies	1	2	2	2	3

6.2.3.3 Approvals and Permits

This criteria evaluates the need to coordinate with, and obtain necessary approvals and permits from other agencies. Alternative 1 is the most favorable because it does not require coordination, approvals or permits from other agencies. Alternative 2 is less favorable because it will require coordination, approval and permitting from other agencies to allow discharge under a modification to an existing NPDES Permit or obtaining a new NPDES Permit. Alternative 3 is less favorable because it will require coordination, approval, and permitting from other agencies, regardless if the discharge is to a POTW or authorized under an NPDES Permit. Additionally, Alternative 3 is a little less favorable than Alternative 2 because it could also require coordination, approval and permitting for disposal of secondary wastes generated by the treatment process. Alternative 4 is least favorable because it will also require coordination, approval, and permitting for installation of the barrier wall, in addition to the discharge requirements for Alternatives 2 and 3. Alternative 5 is least favorable because it will require coordination for and approval of a Class V underground injection control (UIC) permit.

Balancing Criteria 3 The Ease or Difficulty of Implementing a Potential Remedy(s)	**Alternative 1** CBR w/ MNA	**Alternative 2** CBR w/ Groundwater Extraction w/ NPDES Discharge	**Alternative 3** CBR w/ Groundwater Extraction w/ Treatment Prior to Discharge	**Alternative 4** CBR w/ Groundwater Extraction w/ Barrier Wall w/ Alt 3 or Alt 4 Discharge	**Alternative 5** CBR w/ In-Situ Groundwater Treatment
Criteria 3 Subcriteria iii) Need to coordinate with and obtain necessary approvals and permits from other agencies	1	2	2	3	3

6.2.3.4 Availability of Equipment and Specialists

This criteria considers the potential availability of necessary equipment and specialists required to implement the remedy(s). Alternative 1 is the most favorable because no equipment or specialists are required outside of that required for long-term monitoring, which is included in each alternative. Alternative 2 is less favorable because of the equipment necessary to install the groundwater extraction and conveyance system. However, this equipment is generally readily available and not necessarily considered specialty equipment. Alternatives 3, 4, and 5 are considered least favorable. Alternative 3 is least favorable because it will require design, construction, and installation of a specialty treatment system, which will require bench scale testing to confirm the treatment process is capable of achieving permitted discharge limits. Alternative 5 is least favorable because it may also require the treatment system as required for Alternative 3, in addition to specialty equipment and contractors for the design and construction of the barrier wall. Alternative 5 is least favorable because it could also require specialty equipment and contractors to install the in-situ treatment amendments, in addition to requiring specialists for the design and testing of the in-situ treatment system.

Balancing Criteria 3 The Ease or Difficulty of Implementing a Potential Remedy(s)	**Alternative 1** CBR w/ MNA	**Alternative 2** CBR w/ Groundwater Extraction w/ NPDES Discharge	**Alternative 3** CBR w/ Groundwater Extraction w/ Treatment Prior to Discharge	**Alternative 4** CBR w/ Groundwater Extraction w/ Barrier Wall w/ Alt 3 or Alt 4 Discharge	**Alternative 5** CBR w/ In-Situ Groundwater Treatment
Criteria 3 Subcriteria iv) Availability of necessary equipment and specialists	1	2	3	3	3

6.2.3.5 Availability of Treatment, Storage, and Disposal Services

This criteria considers the available capacity and location of needed treatment, storage, and disposal services required to implement the remedy(s). Alternatives 1 and 2 are the most favorable because no additional capacity or location for treatment, storage, and disposal services are required. Alternatives 3 and 4 are least favorable because they will produce secondary or installation waste streams. Alternative 4 is also least favorable because installation of the barrier wall will generate wastes requiring disposal. Alternative 5 is unique and is being considered less favorable by this ranking system because it has the potential to be most favorable if the treatment media is injected and no waste is generated, or it has the potential to be least favorable if the treatment media is installed within a trench and wastes are generated during construction. Additionally, there is the potential reactive media within the trench will require removal and replacement.

Balancing Criteria 3 The Ease or Difficulty of Implementing a Potential Remedy(s)	**Alternative 1** CBR w/ MNA	**Alternative 2** CBR w/ Groundwater Extraction w/ NPDES Discharge	**Alternative 3** CBR w/ Groundwater Extraction w/ Treatment Prior to Discharge	**Alternative 4** CBR w/ Groundwater Extraction w/ Barrier Wall w/ Alt 3 or Alt 4 Discharge	**Alternative 5** CBR w/ In-Situ Groundwater Treatment
Criteria 3 Subcriteria v) Available capacity and location of needed treatment, storage, and disposal services	1	2	3	3	2

(a) Assumes use of vertical injections but has the potential to be least favorable if trenching is required by the design.

6.2.4 Balancing Criteria 4

Balancing Criteria 4 considers the degree to which community concerns are addressed by the potential remedy(s). This criteria will be addressed following a public meeting with interested and affected parties to discuss the results of this ACM. The public meeting will be held at least 30 days prior to selection of the remedy in accordance with 257.96(e).

7.0 SUMMARY OF ASSESSMENT

This ACM has evaluated the following corrective measures alternatives:

Alternative 1: Closure by Removal with MNA (Risk Based)

Alternative 2: Closure by Removal with Groundwater Pumping and NPDES Discharge (no treatment)

Alternative 3: Closure by Removal with Groundwater Pumping and POTW Discharge or Ex-Situ Treatment Prior to NPDES Discharge

Alternative 4: Closure by Removal with Barrier Wall, Groundwater Pumping, and NPDES Discharge (no treatment), POTW Discharge (no treatment) or Ex-Situ Treatment Prior to NPDES or POTW Discharge

Alternative 5: Closure by Removal with In-Situ Groundwater Treatment

In accordance with 40 CFR 257.97(b), each of these alternatives has been confirmed to meet the following threshold criteria:

1. Be protective of human health and the environment;
2. Attain the groundwater protection standard as specified pursuant to 40 CFR 257.95(h);
3. Control the source(s) of release so as to reduce or eliminate, to the maximum extent feasible, further releases of constituents in Appendix IV to this part 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 standards for management of wastes as specified in 40 CFR 257.98(d).

In addition, in accordance with 40 CFR 257.97(c), each of the alternatives has been evaluated in the context of the following balancing criteria:

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;
2. The effectiveness of the remedy in controlling the source to reduce further releases;
3. The ease or difficulty of implementing a potential remedy(s); and
4. The degree to which community concerns are addressed by a potential remedy(s).

This ACM, and the input received during the public meeting, and any additional N&E investigation work results will be used to select a final corrective measure (remedy) for implementation at the FAI. The selected final remedy could be a combination of any of the evaluated five alternatives. 40 CRR 257.97(a) requires that a semi-annual report be prepared to document progress toward remedy selection and design. Once a remedy is selected, a final remedy selection report must be prepared to document details of the selected remedy and how the selected remedy meets 40 CFR 257.97(b) requirements. The final selected remedy report must also be certified by a professional engineer, placed in the operating record and posted to the Evergy CCR website.

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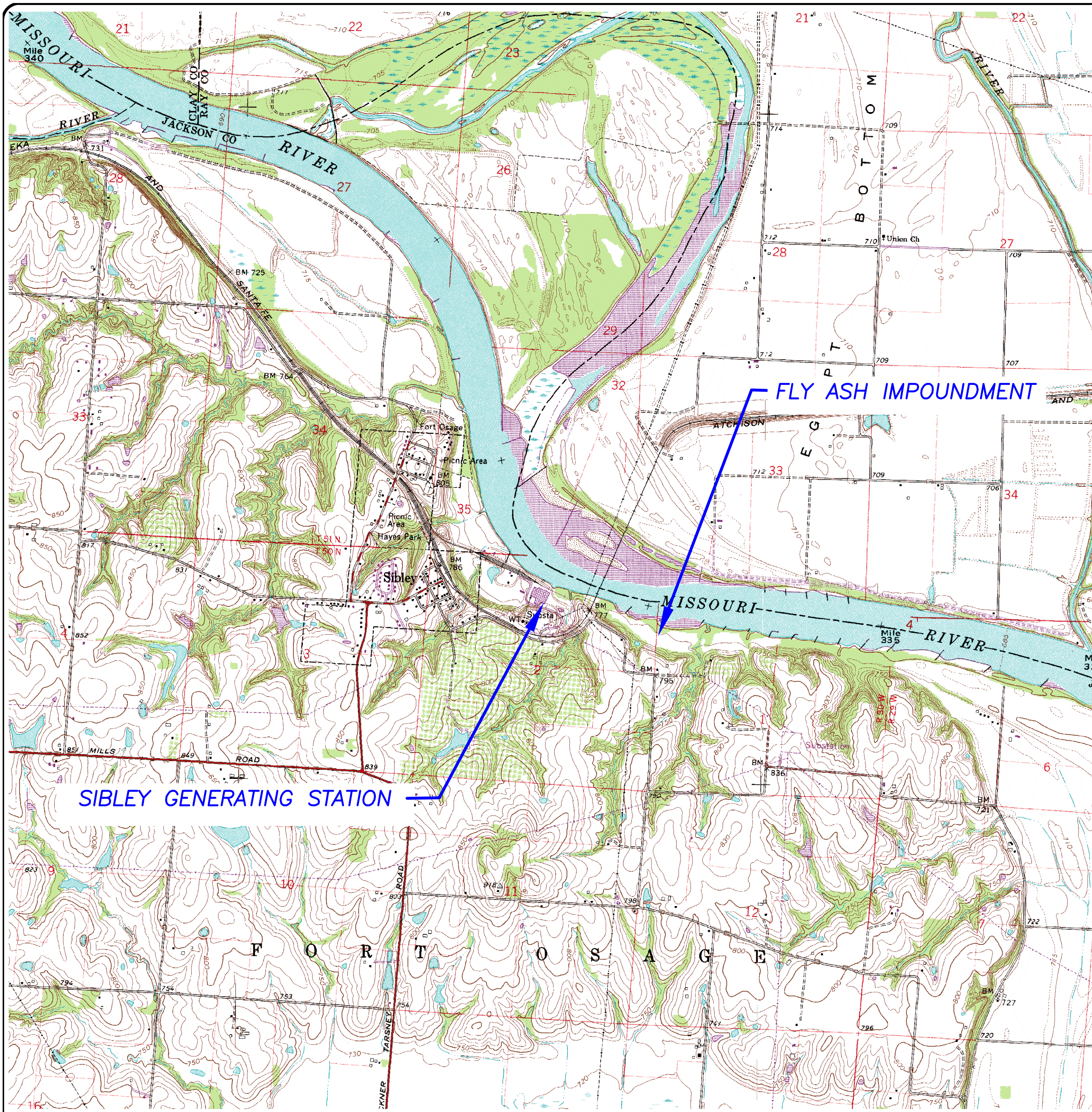
9.0 GENERAL COMMENTS

SCS Engineers does not warrant the work of regulatory agencies or other parties supplying information used in the assimilation of this work product. This work product is prepared in accordance with generally accepted environmental engineering and hydrogeological practices, within the constraints of the client's directives. It is intended for the exclusive use of the client for specific application to this project. No guarantees, express or implied, are intended or made.

FIGURES



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SCALE FEET

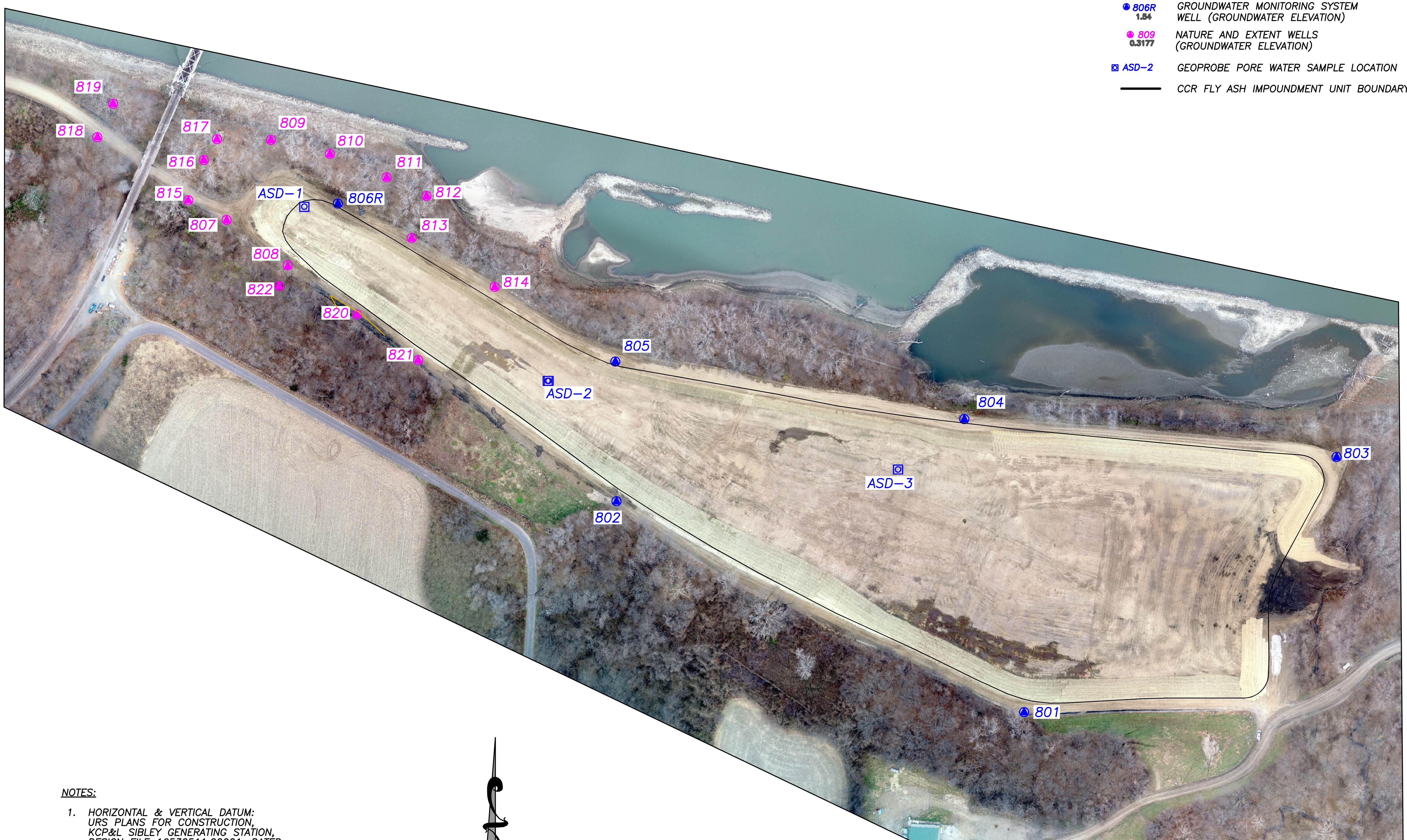
SOURCE:
1975 USGS MAP
BUCKNER QUADRANGLE
7.5 MINUTE SERIES (TOPOGRAPHIC)

SCS ENGINEERS

8575 W. 110th St, STE. 100
Overland Park, Kansas 66210
PH. (913) 681-0030 eFAX. (913) 681-0012

FIGURE 1
SITE LOCATION MAP
EVERGY MISSOURI WEST, INC. SIBLEY GENERATING STATION
FLY ASH IMPOUNDMENT, SIBLEY, MISSOURI

CHK. BY: DLD	DWN. BY: TGW	DSN. BY: TGW	PROJ. NO. 27218131.03
PROJ. MGR: DLD	DATE: 10/2018	CADD FILE: FIGURE 1_SITE MAP.DWG	DRAWING NO. 1



LEGEND:

806R 1.54 — GROUNDWATER MONITORING SYSTEM WELL (GROUNDWATER ELEVATION)

809 0.3177 — NATURE AND EXTENT WELLS (GROUNDWATER ELEVATION)

ASD-2 — GEOPROBE PORE WATER SAMPLE LOCATION

CCR FLY ASH IMPOUNDMENT UNIT BOUNDARY

NOTES:

1. HORIZONTAL & VERTICAL DATUM: URS PLANS FOR CONSTRUCTION, KCP&L SIBLEY GENERATING STATION, DESIGN FILE 16530511.00001, DATED JANUARY 2010

2. AERIAL IMAGE BY TUKUH TECHNOLOGIES ON DECEMBER 10, 2021.

3. BOUNDARY AND MONITORING WELL LOCATIONS SHOWN ARE APPROXIMATE.

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SCALE FEET

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REV.	DATE
-	-

SHEET TITLE: MONITORING WELL LOCATION MAP

PROJECT TITLE: ASSESSMENT OF CORRECTIVE MEASURES

CLIENT: EVERGY MISSOURI WEST, INC. SIBLEY GENERATING STATION SIBLEY, MISSOURI

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8575 W. 110th St, Ste. 100
Overland Park, Kansas 66210
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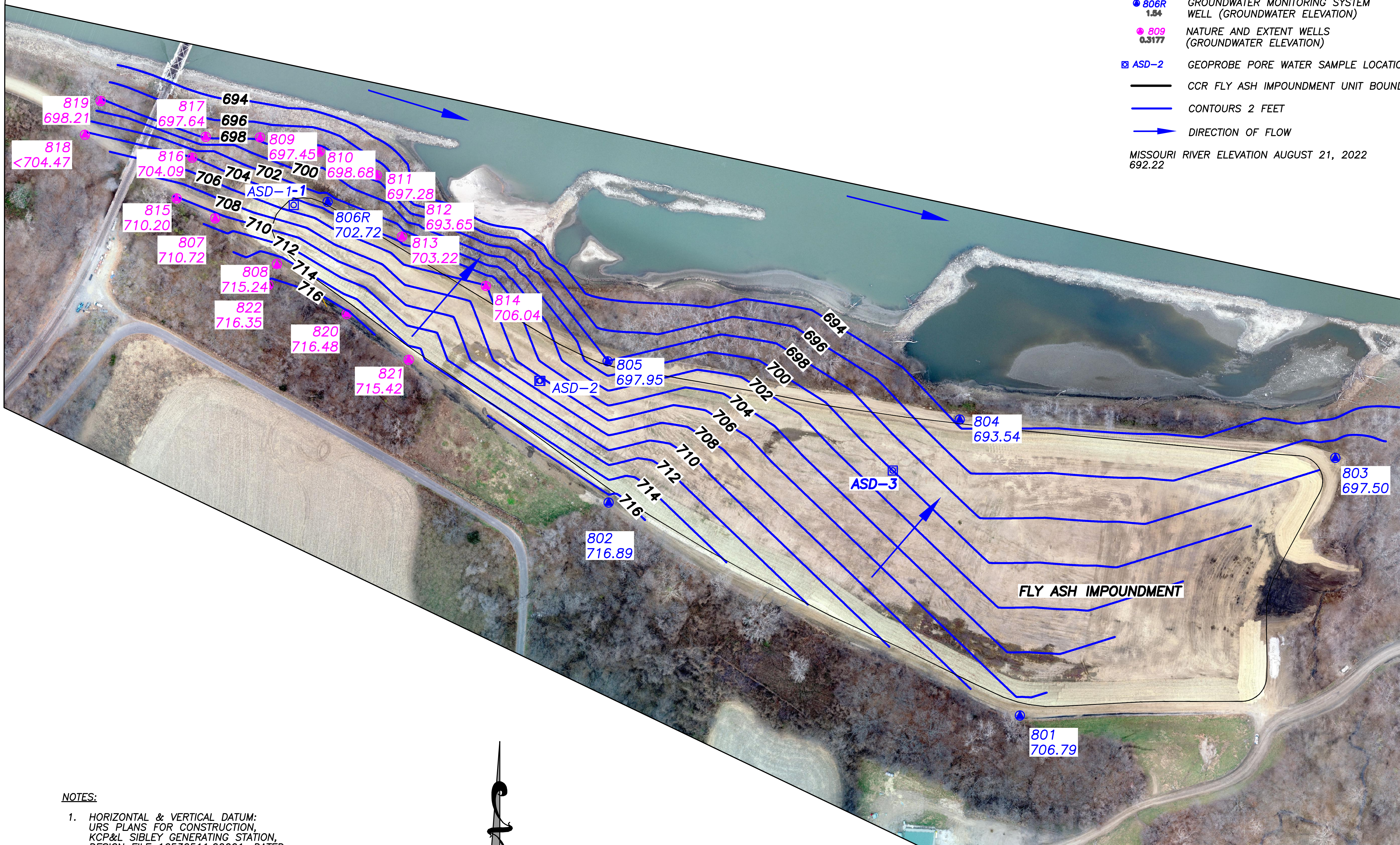
PROJ. NO. 27213169.20	DWN. BY: ALR	Q/A RVW BY: JRF
DSN. BY: ALR	CHK. BY: JRF	PROJ. MGR JRF

CADD FILE: FIGURES 2, 3, & 5.DWG

DATE: 9/9/22

FIGURE NO. 2



LEGEND:

806R 1.54 — GROUNDWATER MONITORING SYSTEM WELL (GROUNDWATER ELEVATION)

809 0.3177 — NATURE AND EXTENT WELLS (GROUNDWATER ELEVATION)

ASD-2 — GEOPROBE PORE WATER SAMPLE LOCATION

CCR FLY ASH IMPOUNDMENT UNIT BOUNDARY

CONTOURS 2 FEET

DIRECTION OF FLOW

MISSOURI RIVER ELEVATION AUGUST 21, 2022
692.22

NOTES:

1. HORIZONTAL & VERTICAL DATUM: URS PLANS FOR CONSTRUCTION, KCP&L SIBLEY GENERATING STATION, DESIGN FILE 16530511.00001, DATED JANUARY 2010

2. AERIAL IMAGE BY TUKUH TECHNOLOGIES ON DECEMBER 10, 2021.

3. BOUNDARY AND MONITORING WELL LOCATIONS SHOWN ARE APPROXIMATE.

200 0 200 400

SCALE FEET

REV.	DATE
-	-

SHEET TITLE: POTENTIOMETRIC SURFACE MAP (AUGUST 19, 2022)

PROJECT TITLE: ASSESSMENT OF CORRECTIVE MEASURES

CLIENT: EVERGY MISSOURI WEST, INC.
SIBLEY GENERATING STATION
SIBLEY, MISSOURI

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PROJ. NO. 27213169.20 | DWN. BY: ALR | Q/A RVW BY: JRF
DSN. BY: ALR | CHK. BY: JRF | PROJ. MGR: JRF

CADD FILE: FIGURES 2, 3, & 5.DWG

DATE: 9/9/22

FIGURE NO. 3

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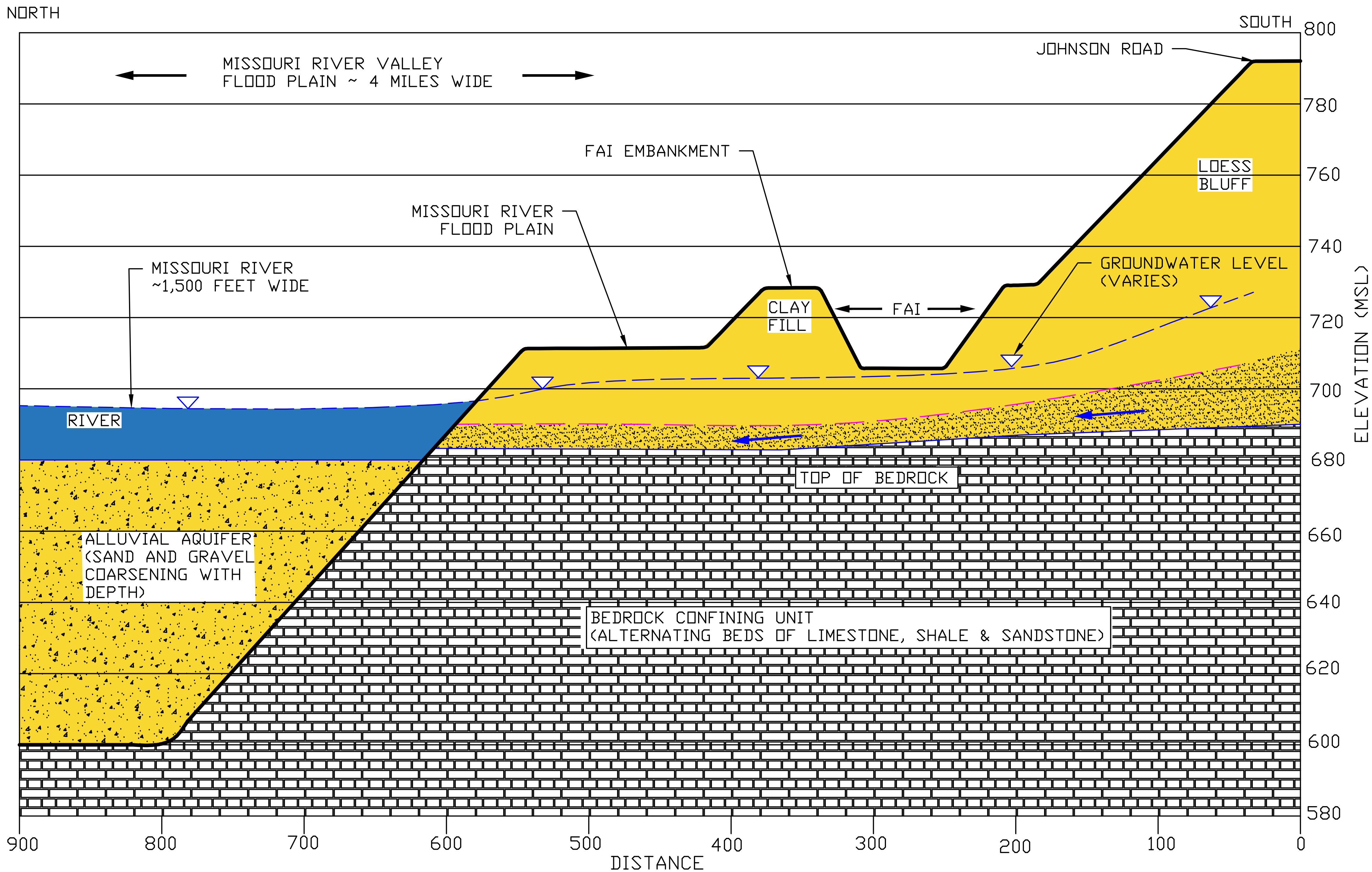

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REV.	DATE
-	-

SHEET TITLE
GROUNDWATER CONCEPTUAL SITE MODEL

PROJECT TITLE
ASSESSMENT OF CORRECTIVE MEASURES

CLIENT
EVERGY MISSOURI WEST, INC.
SIBLEY GENERATING STATION
SIBLEY, MISSOURI

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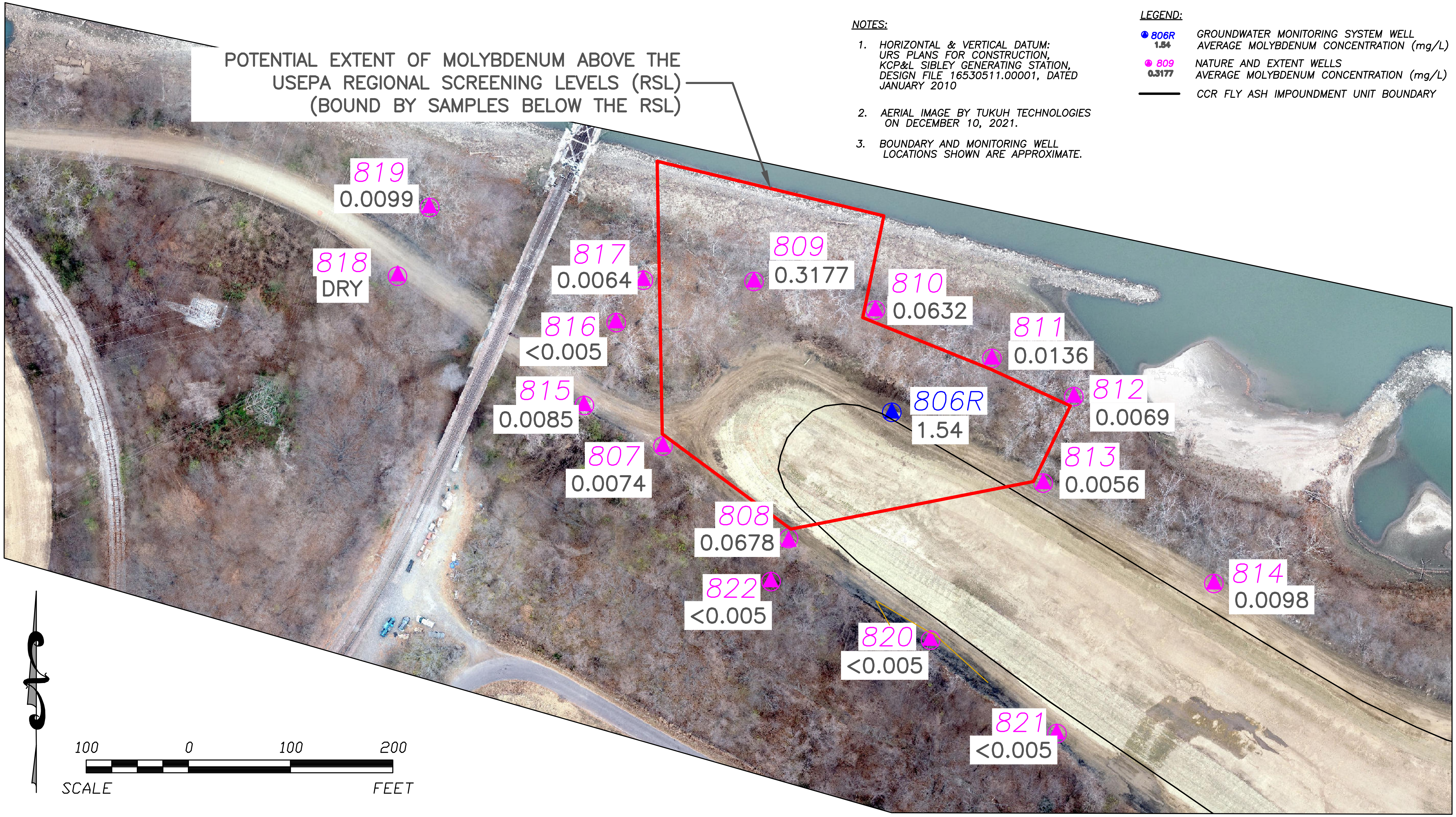
DSN. BY: ALR
DWN. BY: ALR
CHK. BY: JRF
Q/A RVW BY: JRF
PROJ. MGR: JRF

CADD FILE: FIGURES 4, 6-9.DWG

DATE: 9/8/22

FIGURE NO. 4



NOTES:

1. HORIZONTAL & VERTICAL DATUM: URS PLANS FOR CONSTRUCTION, KCP&L SIBLEY GENERATING STATION, DESIGN FILE 16530511.00001, DATED JANUARY 2010
2. AERIAL IMAGE BY TUKUH TECHNOLOGIES ON DECEMBER 10, 2021.
3. BOUNDARY AND MONITORING WELL LOCATIONS SHOWN ARE APPROXIMATE.

LEGEND:

- 806R 1.54 — GROUNDWATER MONITORING SYSTEM WELL AVERAGE MOLYBDENUM CONCENTRATION (mg/L)
- 809 0.3177 — NATURE AND EXTENT WELLS AVERAGE MOLYBDENUM CONCENTRATION (mg/L)
- CCR FLY ASH IMPOUNDMENT UNIT BOUNDARY

Date	MW-806R	MW-807	MW-808	MW-809	MW-810	MW-811	MW-812	MW-813	MW-814	MW-815	MW-816	MW-817	MW-818	MW-819	MW-820	MW-821	MW-822
11/15/2021	1.64	Not Installed	Not Installed	Not Installed	Not Installed	Not Installed	Not Installed	Not Installed	Not Installed	Not Installed	Not Installed	Not Installed	Not Installed	Not Installed	Not Installed	Not Installed	Not Installed
12/3/2021		ND	ND														
1/31/2022	1.63	NS	NS														
5/13/2022	1.50	0.0102	ND	0.405	0.0592	0.0274	0.0126	ND	0.0127								
6/15/2022	1.51	0.0075 | *0.00772*	0.319	0.0661	0.018	ND	ND	0.00723	0.00705								
8/19/2022	1.47	0.00618	ND	0.352 | *0.410*	0.0921	0.00899	ND	ND	0.0108	0.0116	ND	0.0056	dry	0.0147	ND	ND	ND
9/1/2022	1.51	0.00802	ND	0.331 | *0.342*	0.0835	0.0129	ND	ND	0.00877	0.00533	ND	0.00726	dry	ND	ND	ND	ND
Average	1.54	0.0074	0.0678	0.3177	0.0632	0.0136	0.0069	0.0056	0.0098	0.0085	ND	0.0064	dry	0.0099	ND	ND	ND

All molybdenum results reported in milligrams per liter (mg/L)

0.0075 | *0.00772* - Italics Values Are Duplicate Sample Results

NS - Not Sampled

ND - Not Detected Above Laboratory Reporting Limit 0.005 mg/L

REV. | DATE
- | -

SHEET TITLE: MOLYBDENUM CONCENTRATION MAP

PROJECT TITLE: ASSESSMENT OF CORRECTIVE MEASURES

CLIENT: EVERGY MISSOURI WEST, INC.
SIBLEY GENERATING STATION
SIBLEY, MISSOURI

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8575 W. 110th St, Ste. 100
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PROJ. NO. 27213169.20 | DWN. BY: ALR | Q/A RVW BY: JRF
DSN. BY: ALR | CHK. BY: JRF | PROJ. MGR JRF

CADD FILE: FIGURES 2, 3, & 5.DWG

DATE: 9/13/22

FIGURE NO. 5

TABLES

Table 1
Fly Ash Impoundment
Appendix IV Background Data and Groundwater Protection Standards
Evergy Sibley Generating Station

		Appendix IV Constituents														
Well Number	Sample Date	Antimony (mg/L)	Arsenic (mg/L)	Barium (mg/L)	Beryllium (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Cobalt (mg/L)	Fluoride (mg/L)	Lead (mg/L)	Lithium (mg/L)	Mercury (mg/L)	Molybdenum (mg/L)	Selenium (mg/L)	Thallium (mg/L)	Radium Combined (pCi/L)
MCL GWPS		**0.006**	**0.010**	**2**	**0.004**	**0.005**	**0.1**	**NA**	**4.0**	**0.015***	**NA**	**0.002**	**NA**	**0.05**	**0.002**	**5**
40 CFR 257.95(h) GWPS		**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**0.006**	**NA**	**NA**	**0.040**	**NA**	**0.100**	**NA**	**NA**	**NA**
MW-801	12/16/2015	<0.002	<0.002	0.146	<0.002	<0.001	<0.01	<0.01	0.182	<0.002	<0.015	<0.0002	<0.005	<0.002	<0.002	0.848
MW-801	2/17/2016	<0.002	<0.002	0.112	<0.002	<0.001	<0.01	<0.01	0.165	<0.002	0.0182	<0.0002	<0.005	<0.002	<0.002	0.028
MW-801	5/26/2016	<0.002	<0.002	0.110	<0.002	<0.001	<0.01	<0.01	0.149	<0.002	0.0274	<0.0002	<0.005	<0.002	<0.002	1.658
MW-801	8/23/2016	<0.002	<0.002	0.103	<0.002	<0.001	<0.01	<0.01	0.159	<0.002	0.0154	<0.0002	<0.005	0.00224	<0.002	0.146
MW-801	11/10/2016	<0.002	<0.002	0.114	<0.002	<0.001	<0.01	<0.01	0.182	<0.002	0.0153	<0.0002	<0.005	0.00218	<0.002	0.251
MW-801	2/9/2017	<0.002	<0.002	0.110	<0.002	<0.001	<0.01	<0.01	0.117	<0.002	<0.015	<0.0002	<0.005	<0.002	<0.002	0.170
MW-801	5/3/2017	<0.002	<0.002	0.124	<0.002	<0.001	<0.01	<0.01	0.150	<0.002	0.0159	<0.0002	<0.005	<0.002	<0.002	0.582
MW-801	8/1/2017	<0.002	<0.002	0.111	<0.002	<0.001	<0.01	<0.01	0.174	<0.002	<0.015	<0.0002	<0.005	<0.002	<0.002	0.681
MW-801	10/4/2017	<0.002	<0.002	0.127	<0.002	<0.001	<0.01	<0.01	0.104	<0.002	<0.015	<0.0002	<0.005	<0.002	<0.002	1.22
MW-801 PL/BG		**0.002**	**0.002**	**0.146**	**0.002**	**0.001**	**0.01**	**0.01**	**0.2137**	**0.002**	**0.03301**	**0.0002**	**0.005**	**0.00224**	**0.002**	**3.569**
MW-801 GWPS		**0.006**	**0.010**	**2**	**0.004**	**0.005**	**0.1**	**0.006**	**4.0**	**0.015**	**0.040**	**0.002**	**0.100**	**0.05**	**0.002**	**5**
MW-801	5/18/2020	**<0.00400	**<0.00200	**0.112	**<0.00200	**<0.00100	**<0.0100	**<0.0100	**0.162	**<0.00500	**<0.0150	**<0.000200	**<0.00500	**<0.00200	**<0.00200	0.270
MW-801	7/6/2021	**<0.00400	**<0.00200	**0.136	**<0.00200	**<0.00100	**<0.0100	**<0.00200	**0.192	**<0.00200	**0.0166	**<0.000200	**<0.00500	**<0.00200	**<0.00200	0.374 (J)
MW-801	11/15/2021	<0.004	<0.002	0.154	<0.002	<0.001	<0.01	<0.002	0.150	<0.002	<0.015	<0.002	<0.005	<0.002	<0.002	0.916
MW-802	12/16/2015	<0.002	0.00304	0.232	<0.002	<0.001	<0.01	<0.01	0.268	0.0026	<0.015	<0.0002	<0.005	<0.002	<0.002	2.334
MW-802	2/17/2016	<0.002	0.00223	0.170	<0.002	<0.001	<0.01	<0.01	0.233	<0.002	<0.015	<0.0002	<0.005	<0.002	<0.002	1.075
MW-802	5/26/2016	<0.002	0.00200	0.123	<0.002	<0.001	<0.01	<0.01	0.222	<0.002	0.0168	<0.0002	<0.005	<0.002	<0.002	4.222
MW-802	8/23/2016	<0.002	0.00257	0.172	<0.002	<0.001	<0.01	<0.01	0.202	<0.002	<0.015	<0.0002	<0.005	<0.002	<0.002	0.287
MW-802	11/10/2016	<0.002	0.00262	0.133	<0.002	<0.001	<0.01	<0.01	0.183	<0.002	<0.015	<0.0002	<0.005	<0.002	<0.002	0.144
MW-802	2/9/2017	<0.002	0.00200	0.198	<0.002	<0.001	<0.01	<0.01	0.113	<0.002	<0.015	<0.0002	<0.005	<0.002	<0.002	2.23
MW-802	5/3/2017	<0.002	0.00823	0.304	<0.002	<0.001	<0.01	<0.01	0.173	0.0042	<0.015	<0.0002	<0.005	<0.002	<0.002	1.48
MW-802	8/1/2017	<0.002	0.00206	0.162	<0.002	<0.001	<0.01	<0.01	0.174	<0.002	<0.015	<0.0002	<0.005	0.00237	<0.002	0.650
MW-802	10/4/2017	<0.002	<0.002	0.154	<0.002	<0.001	<0.01	<0.01	<0.1	<0.002	<0.015	<0.0002	<0.005	0.00266	<0.002	0.066
MW-802 PL/BG		**0.002**	**0.007646**	**0.3056**	**0.002**	**0.001**	**0.01**	**0.01**	**0.3234**	**0.0042**	**0.0168**	**0.0002**	**0.005**	**0.00266**	**0.002**	**3.569**
MW-802 GWPS		**0.006**	**0.010**	**2**	**0.004**	**0.005**	**0.1**	**0.006**	**4.0**	**0.015**	**0.040**	**0.002**	**0.100**	**0.05**	**0.002**	**5**
MW-802	5/18/2020	**<0.00400	**0.00218	**0.163	**<0.00200	**<0.00100	**<0.0100	**<0.0100	**0.176	**<0.00500	**<0.0150	**<0.000200	**<0.00500	**<0.00200	**<0.00200	1.02
MW-802	7/6/2021	**<0.00400	**0.00286	**0.165	**<0.00200	**<0.00100	**<0.0100	**<0.00200	**0.203	**0.00203	**<0.0150	**<0.000200	**<0.00500	**<0.00200	**<0.00200	0.765 (J)
MW-802	11/15/2021	<0.004	0.00267	0.160	<0.002	<0.001	<0.01	<0.002	<0.150	<0.002	<0.015	<0.002	<0.005	0.00511	<0.002	0.756 (J)
MW-803	12/15/2015	<0.002	0.00493	0.150	<0.002	<0.001	<0.01	<0.01	0.276	<0.002	<0.015	<0.0002	<0.005	<0.002	<0.002	1.11
MW-803	2/17/2016	<0.002	0.00401	0.141	<0.002	<0.001	<0.01	<0.01	0.245	<0.002	0.0197	<0.0002	<0.005	<0.002	<0.002	0.389
MW-803	5/26/2016	<0.002	0.00365	0.131	<0.002	<0.001	<0.01	<0.01	0.290	<0.002	0.0246	<0.0002	<0.005	<0.002	<0.002	0.441
MW-803	8/23/2016	<0.002	0.00296	0.129	<0.002	<0.001	<0.01	<0.01	0.295	<0.002	<0.015	<0.0002	<0.005	<0.002	<0.002	0.741
MW-803	11/10/2016	<0.002	0.00336	0.137	<0.002	<0.001	<0.01	<0.01	0.290	0.00385	<0.015	<0.0002	<0.005	<0.002	<0.002	0.817
MW-803	2/9/2017	<0.002	0.00282	0.126	<0.002	<0.001	<0.01	<0.01	0.262	<0.002	<0.015	<0.0002	<0.005	<0.002	<0.002	0.717
MW-803	5/3/2017	<0.002	0.00292	0.129	<0.002	<0.001	<0.01	<0.01	0.254	<0.002	<0.015	<0.0002	<0.005	<0.002	<0.002	0.000
MW-803	8/1/2017	<0.002	0.00257	0.125	<0.002	<0.001	<0.01	<0.01	0.281	<0.002	<0.015	<0.0002	<0.005	<0.002	<0.002	1.73
MW-803	10/4/2017	<0.002	0.00270	0.131	<0.002	<0.001	<0.01	<0.01	0.230	<0.002	<0.015	<0.0002	<0.005	<0.002	<0.002	0.826
MW-803 PL/BG		**0.002**	**0.004999**	**0.1509**	**0.002**	**0.001**	**0.01**	**0.01**	**0.319**	**0.00385**	**0.0246**	**0.0002**	**0.005**	**0.002**	**0.002**	**3.569**
MW-803 GWPS		**0.006**	**0.010**	**2**	**0.004**	**0.005**	**0.1**	**0.006**	**4.0**	**0.015**	**0.040**	**0.002**	**0.100**	**0.05**	**0.002**	**5**
MW-803	5/18/2020	**<0.00400	**0.00246	**0.119	**<0.00200	**<0.00100	**<0.0100	**<0.0100	**0.265	**<0.00500	**<0.0150	**<0.000200	**<0.00500	**<0.00200	**<0.00200	2.26
MW-803	7/6/2021	**<0.00400	**<0.00200	**0.114	**<0.00200	**<0.00100	**<0.0100	**<0.00200	**0.282	**0.0045	**0.0150	**<0.000200	**<0.00500	**<0.00200	**<0.00200	0.278 (U)
MW-803	11/15/2021	<0.004	0.00265	0.122	<0.002	<0.001	<0.01	<0.002	0.276	<0.002	<0.015	<0.002	<0.005	<0.002	<0.002	0.707 (J)
MW-804	12/15/2015	<0.002	0.0108	0.531	<0.002	<0.001	<0.01	<0.01	0.219	0.00865	0.0218	<0.0002	<0.005	<0.002	<0.002	1.257
MW-804	2/17/2016	<0.002	0.00719	0.370	<0.002	<0.001	<0.01	<0.01	0.183	<0.002	0.0257	<0.0002	<0.005	<0.002	<0.002	1.308
MW-804	5/26/2016	<0.002	0.00607	0.398	<0.002	<0.001	<0.01	<0.01	0.164	0.00402	0.0379	<0.0002	<0.005	<0.002	<0.002	4.27
MW-804	8/23/2016	<0.002	0.00403	0.329	<0.002	<0.001	<0.01	<0.01	0.168	<0.002	0.0234	<0.0002	<0.005	<0.002	<0.002	1.545
MW-804	11/10/2016	<0.002	0.00644	0.390	<0.002	<0.001	<0.01	<0.01	0.148	<0.002	0.0195	<0.0002	<0.005	<0.002	<0.002	1.00
MW-804	2/9/2017	<0.002	0.00640	0.342	<0.002	<0.001	<0.01	<0.01	0.119	<0.002	0.0204	<0.0002	<0.005	<0.002	<0.002	0.749
MW-804	5/3/2017	<0.002	0.00700	0.411	<0.002	<0.001	<0.01	<0.01	0.182	0.00230	0.0210	<0.0002	<0.005	<0.002	<0.002	0.822
MW-804	8/1/2017	<0.002	0.00418	0.365	<0.002	<0.001	<0.01	<0.01	0.206	<0.002	0.0232	<0.0002	<0.005	<0.002	<0.002	1.28
MW-804	10/4/2017	<0.002	0.00545	0.406	<0.002	<0.001	<0.01	<0.01	0.118	<0.002	0.0220	<0.0002	<0.005	<0.002	<0.002	0.511
MW-804 PL/BG		**0.002**	**0.01078**	**0.5223**	**0.002**	**0.001**	**0.01**	**0.01**	**0.2441**	**0.00865**	**0.03616**	**0.0002**	**0.005**	**0.002**	**0.002**	**3.569**
MW-804 GWPS		**0.006**	**0.01078**	**2**	**0.004**	**0.005**	**0.1**	**0.006**	**4.0**	**0.015**	**0.040**	**0.002**	**0.100**	**0.05**	**0.002**	**5**
MW-804	5/18/2020	**<0.00400	**0.00322	**0.477	**<0.00200	**<0.00100	**<0.0100	**<0.0100	**0.219	**<0.00500	**0.0210	**<0.000200	**<0.00500	**<0.00200	**<0.00200	1.03
MW-804	7/6/2021	**<0.00400	**0.00211	**0.429	**<0.00200	**<0.00100	**<0.0100	**<0.00200	**0.238	**<0.00200	**0.0228	**<0.000200	**<0.00500	**<0.00200	**<0.00200	1.12
MW-804	11/15/2021	<0.004	0.00205	0.450	<0.002	<0.001	<0.01	<0.002	0.275	<0.002	0.0196	<0.002	<0.005	<0.002	<0.002	0.949 (J)
MW-805	12/15/2015	<0.002	<0.002	0.180	<0.002	<0.001	<0.01	<0.01	0.148	<0.002	<0.015	<0.0002	<0.005	<0.002	<0.002	1.843
MW-805	2/17/2016	<0.002	<0.002	0.172	<0.002	<0.001	<0.01	<0.01	0.155	<0.002	<0.015	<0.0002	<0.005	<0.002	<0.002	0.940
MW-805	5/26/2016	<0.002	<0.002	0.181	<0.002	<0.001	<0.01	<0.01	0.191	<0.002	0.0153	<0.0002	<0.005	<0.002	<0.002	0.785
MW-805	8/23/2016	<0.002	<0.002	0.174	<0.002	<0.001	<0.01	<0.01	0.172	<0.002	<0.015	<0.0002	<0.005	<0.002	<0.002	1.705
MW-805	11/10/2016	<0.002	<0.002	0.171	<0.002	<0.001	<0.01	<0.01	0.170	<0.002	<0.015	<0.0002	<0.005	<0.002	<0.002	0.668
MW-805	2/9/2017	<0.002	<0.002	0.163	<0.002	<0.001	<0.01	<0.01	0.178	<0.002	<0.015	<0.0002	<0.005	<0.002	<0.002	0.338
MW-805	5/3/2017	<0.002	<0.002	0.170	<0.002	<0.001	<0.01	<0.01	0.161	<0.002	<0.015	<0.0002	<0.005	<0.002	<0.002	1.20
MW-805	8/1/2017	<0.002	<0.002	0.163	<0.002	<0.001	<0.01	<0.01	0.194	<0.002	<0.015	<0.0002	<0.005	<0.002	<0.002	0.387
MW-805	10/4/2017	<0.002	<0.002	0.168	<0.002	<0.001	<0.01	<0.01	0.121	<0.002	<0.015	<0.0002	<0.005	<0.002	<0.002	0.605
MW-805 PL/BG		**0.002**	**0.002**	**0.1854**	**0.002**	**0.001**	**0.01**	**0.01**	**0.2152**	**0.002**	**0.0153**	**0.0002**	**0.005**	**0.002**	**0.002**	**3.569**
MW-805 GWPS		**0.006**	**0.010**	**2**	**0.004**	**0.005**	**0.1**	**0.006**	**4.0**	**0.015**	**0.040**	**0.002**	**0.100**	**0.05**	**0.002**	**5**
MW-805	5/18/2020	**<0.00400	**<0.00200	**0.143	**<0.00200	**<0.00100	**<0.0100	**<0.0100	**0.186	**<0.00500	**<0.0150	**<0.000200	**<0.00500	**<0.00200	**<0.00200	2.74
MW-805	7/6/2021	**<0.00400	**<0.00200	**0.148	**<0.00200	**<0.00100	**<0.0100	**<0.00200	**0.220	**<0.00200	**<0.0150	**<0.000200	**<0.00500	**<0.00200	**<0.00200	1.05
MW-805	11/15/2021	<0.004	<0.002	0.14	<0.002	<0.001	<0.01	<0.002	0.213	<0.002	<0.015	<0.002	<0.005	<0.002	<0.002	1.42
MW-806R	6/2/2016	<0.002	0.00256	0.125	<0.002	<0.001	<0.01	<0.01	0.252	<0.002	0.0301	<0.0002	1.24	<0.002	<0.002	0.695
MW-806R	7/19/2016	<0.002	0.00269	0.104	<0.002	<0.001	<0.01	<0.01	0.242	<0.002	0.0170	<0.0002	1.11	<0.002	<0.002	0.034
MW-806R	8/23/2016	<0.002	0.00342	0.102	<0.002	<0.001	<0.01	<0.01	0.253	<0.002	0.0181	<0.0002	1.18	<0.002	<0.002	0.109
MW-806R	11/11/2016	<0.002	0.00388	0.0966	<0.002	<0.001	<0.01	<0.01	0.197	<0.002	0.0154	<0.0002	1.18	<0.002	<0.002	0.228
MW-806R	2/9/2017	<0.002	0.00357	0.0919	<0.002	<0.001	<0.01	<0.01	0.205	<0.002	0.0180	<0.0002	1.09	<0.002	<0.002	0.731
MW-806R	3/22/2017	<0.002	0.00634	0.103	<0.002	<0.001	<0.01	<0.01	0.224	<0.002	0.0184	<0.0002	1.24	<0.002	<0.002	0.668
MW-806R	5/3/2017	<0.002	0.00295	0.0747	<0.002	<0.001	<0.01	<0.01	0.195	<0.002	0.0163	<0.0002	1.19	<0.002	<0.002	0.131
MW-806R	8/1/2017	<0.002	0.00685	0.0930	<0.002	<0.001	<0.01	<0.01	0.223	<0.002	0.0175	<0.0002	1.33	<0.002	<0.002	0.494
MW-806R	10/4/2017	<0.002	0.00555	0.0901	<0.002	<0.001	<0.01	<0.01	0.129	<0.002	0.0182	<0.0002	1.33	<0.002	<0.002	2.35
MW-806R PL/BG		**0.002**	**0.00776**	**0.1276**	**0.002**	**0.001**	**0.01**	**0.01**	**0.2979**	**0.002**	**0.0301**	**0.0002**	**1.395**	**0.002**	**0.002**	**3.569**
MW-806R GWPS		**0.006**	**0.010**	**2**	**0.004**	**0.005**	**0.1**	**0.006**	**4.0**	**0.015**	**0.040**	**0.002**	**1.395**	**0.05**	**0.002**	**5**
MW-806R	5/18/2020	**<0.00400	**0.00555	**0.0714	**<0.00200	**<0.00100	**<0.0100	**<0.0100	**0.206	**<0.00500	**0.0163	**<0.000200	**2.16	**<0.00200	**<0.00200	0.078
MW-806R	7/6/2021	**<0.00400	**0.00546	**0.0775	**<0.00200	**<0.00100	**<0.0100	**<0.00200	**0.236	**<0.00200	**0.0176	**<0.000200	**1.73	**<0.00200	**<0.00200	1.16
MW-806R	11/15/2021	<0.004	0.00362	0.0723	<0.002	<0.001	<0.01	<0.002	0.222	<0.002	<0.015	<0.002	1.64	<0.002	<0.002	1.78
MW-806R	1/31/2022	---	---	---	---	---	---	---	---	---	---	---	*1.63	---	---	---

* Verification Sample obtained per certified statistical method and Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance, March 2009.
**Extra Sample for Quality Control Validation or per Standard Sampling Procedure
mg/L - miligrams per liter
pCi/L - picocuries per liter
--- Not Sampled

Table 2
Molybdenum Laboratory Results
(November 15, 2021 through September 1, 2022)
Sibley Generating Station - Fly Ash Impoundment

Date	MW-806R	MW-807	MW-808	MW-809	MW-810	MW-811	MW-812	MW-813	MW-814	MW-815	MW-816	MW-817	MW-818	MW-819	MW-820	MW-821	MW-822
11/15/2021	1.64	Not Installed	Not Installed														
12/3/2021		ND	ND	Not Installed	Not Installed	Not Installed	Not Installed	Not Installed	Not Installed								
1/31/2022	1.63	NS	NS							Not Installed	Not Installed	Not Installed	Not Installed	Not Installed	Not Installed	Not Installed	Not Installed
5/13/2022	1.50	0.0102	ND	0.405	0.0592	0.0274	0.0126	ND	0.0127								
6/15/2022	1.51	0.0075 *0.00772*	0.319	0.0661	0.018	ND	ND	0.00723	0.00705								
8/19/2022	1.47	0.00618	ND	0.352 *0.410*	0.0921	0.00899	ND	ND	0.0108	0.0116	ND	0.0056	dry	0.0147	ND	ND	ND
9/1/2022	1.51	0.00802	ND	0.331 *0.342*	0.0835	0.0129	ND	ND	0.00877	0.00533	ND	0.00726	dry	ND	ND	ND	ND
Average	1.54	0.0074	0.0678	0.3177	0.0632	0.0136	0.0069	0.0056	0.0098	0.0085	ND	0.0064	dry	0.0099	ND	ND	ND

All molybdenum results reported in milligrams per liter (mg/L)
0.0075 l *0.00772* - Italics Values Are Duplicate Sample Results
NS - Not Sampled
ND - Not Detected Above Laboratory Reporting Limit 0.005 mg/L

APPENDIX A

Exposure Evaluation and Assessment of Risk

EXPOSURE EVALUATION AND ASSESSMENT OF RISK
Fly Ash Impoundment

Sibley Generating Station
Evergy Missouri West, Inc.
3320 E Johnson Road
Sibley, Missouri 64088

SCS ENGINEERS

27222162.00 | September 2022

8575 West 110th Street, Suite 100
Overland Park, KS 66210
913-681-0030

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1.0 INTRODUCTION AND APPROACH

This Exposure Evaluation and Assessment of Risk is supplemental to the specific monitoring and Assessment of Corrective Measures (ACM) requirements of the CCR Rule. The purpose of this evaluation is to provide the information needed to interpret and meaningfully understand the groundwater monitoring data collected and the ACM performed for the FAI under the CCR Rule. Because the FAI's close proximity to the Missouri River, this evaluation also considers the potential groundwater-to-surface water transport and exposure pathways, and makes comparison to state and federal screening levels of constituent concentrations that are considered to be protective of specific human exposures. Additionally, this evaluation will help determine whether current and anticipated future groundwater and surface water conditions pose a risk to human health and the environment and, if so, whether the corrective measures identified in the ACM report are expected to mitigate such risk.

An Exposure Conceptual Site Model (ExCSM) was developed based on the Groundwater Conceptual Site Model (GwCSM) and the Nature and Extent (N&E) investigation discussed in in the ACM. The ExCSM is used to identify whether human populations or other organisms could come into contact with impacted groundwater and/or surface water in the area of the FAI.

2.0 GROUNDWATER CONCEPTUAL SITE MODEL

To aid in the evaluation of remedial options, a Groundwater Conceptual Site Model (GwCSM) was developed for the FAI based on data from a number of site-specific documents and information from various sources, including previous field investigations at and near the facility, published literature, recent groundwater monitoring data, and field investigations performed as part of the ACM. The GwCSM characterizes the subsurface conditions including site geology, hydrogeology, and the uppermost groundwater flow regime for the FAI site. The GwCSM is then used to evaluate and understand how groundwater and potential contaminants travel beneath the FAI, and provides the basis for assessing the efficacy of potential corrective measures to address the contaminant source, release mechanisms, and exposure routes.

The Fly Ash Impoundment (FAI) at the Sibley Generating Station is located in the northwest ¼ of Section 1 and the northeast ¼ of Section 2, Township 50 North, Range 30 West, in Jackson County, Missouri. A Site location map is provided as **Figure 1**. The FAI is located near the southern bank of the Missouri River and lies within the Central Lowlands Physiographic Province along the boundary between the Osage Plains and the Dissected Till Plains Subprovinces. Glaciation in the Pleistocene covered the northern part of Missouri southward to just past the current Missouri River depositing glacial till and drift along the Missouri River valley and in the Sibley area. The Missouri River valley walls in the Sibley area are composed of glacial till and drift overlain by thick deposits of loess; wind-blown deposits of primarily silt and very fine sand associated with the Pleistocene glaciation. The Missouri River floodplain in the vicinity of Sibley is approximately four miles wide and underlain by unconsolidated alluvial deposits estimated to be approximately 100 feet thick.

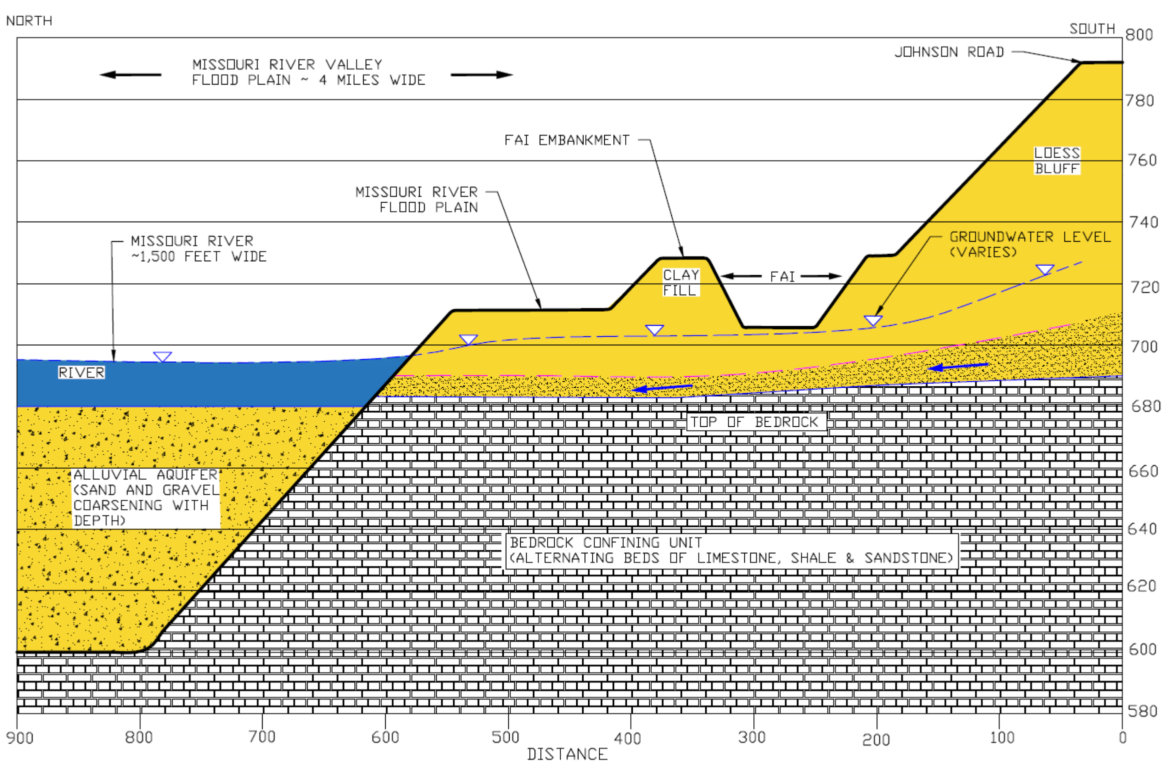
The FAI is located on the southern edge of the Missouri River floodplain between the southern river valley wall at the foot of the loess bluffs. The current river channel is located as close as 50 feet from the FAI embankment, but not further than approximately 200 feet from the FAI embankment. The elevation of the crest of the FAI embankment is approximately 725 feet above mean sea level (ft amsl). The area south of the FAI consists of undulating hills that form a series of ridges overlooking the south side of the Missouri River floodplain. The topography to the south of the FAI rises sharply to the top of the loess bluff at an elevation of approximately 780 ft amsl within a horizontal distance of approximately 150 feet. The toe of the northern embankment drops down to the floodplain at an elevation of approximately 712 ft amsl.

Generally, the alluvial deposits on the south side of the Missouri River are thin, between 25 and 50 feet thick, and mostly fine grained with a coarsening sequence of primarily clay, with silt, sand, and some gravel. Alluvial deposits on the north side of the Missouri River are estimated to be approximately 100 feet deep, and have a more pronounced transition from the overlying clay to sand to boulders with depth (Gentile, 2014).

Figure 2 is an aerial view site map showing the FAI, the bluff to the south, the river to the north and the locations of the groundwater monitoring wells.

Based on groundwater monitoring events since December 2015, the depth to groundwater ranges from approximately 10 to 34 feet bgs and can fluctuate by over 20 feet depending on precipitation in the drainage basin and the Missouri River stage. During the observed period, groundwater elevations have ranged from approximately 692 to 720 ft amsl. The groundwater flow direction is generally to the northeast, toward the Missouri River. As part of the nature and extent (N&E) portion of this ACM, several new wells were installed downgradient from the FAI groundwater monitoring network wells in the flood plain near the riverbank, with an approximate ground elevation of 713 ft amsl. **Figure 3** is the most recent, August 19, 2022, potentiometric surface contour map for the FAI.

A visual representation of the GwCSM for the FAI is provided in the schematic below and in **Figure 4**. The FAI is positioned on a narrow strip of the Missouri River flood plain, consisting of relatively thin sequence of overbank deposits sitting on bedrock and/or a thin till layer above the bedrock. The overbank deposits are typically approximately 20 to 30 feet thick and composed of primarily silt and fine sand with a coarser basal sand along the bottom. The FAI embankments were constructed of clay material brought onto the site. The Missouri River alluvial channel deposits to the north are reported to be approximately 100 feet thick and consist of much coarser sand, gravel, and boulders with depth. Groundwater beneath the FAI is primarily recharged from offsite groundwater entering the site from the south. Groundwater flows from the south valley wall beneath the FAI, north to the Missouri River. Flow is primarily within the coarser basal sand near the bottom of the overbank deposits.



3.0 NATURE AND EXTENT OF GROUNDWATER ABOVE GWPS

Molybdenum was identified at a statistically significant level (SSL) at monitoring well MW-806R within the Sibley FAI Monitoring Well Network. As a result, Evergy directed SCS to initiate an N&E investigation for molybdenum as required by the CCR Rule. Additional groundwater monitoring wells (MW-807 through MW-822) were installed upgradient, cross-gradient, and downgradient of MW-806R and the FAI to determine the nature and extent (N&E) of the molybdenum impact. Four of the new N&E wells (MW-809, MW-810, MW-811, and MW-812) were installed within approximately 180 feet downgradient of MW-806R in the flood plain, and approximately 50 feet from the river bank. Of these four downgradient monitoring wells, only one well (MW-809) repeatedly demonstrated molybdenum above the USEPA Regional Screening Level (RSL). For the June 15, 2022 groundwater sampling event, the reported molybdenum concentration for upgradient monitoring well MW-808 exceeded the RSL with a concentration of 0.319 mg/L; however, prior and subsequent sampling has shown well MW-808 to be below the RSL.

Table 1 presents the laboratory results for molybdenum beginning with the closure sample collected from MW-806R on November 15, 2021, and subsequent sampling events for MW-806R and the newly installed N&E monitoring wells. The below image and Figure 5 identifies the estimated boundaries of the groundwater plume at the FAI. This estimated boundary is based on molybdenum concentrations at wells consistently present at levels above a GWPS or RSL. MW-808 is not currently included in the boundary as the one RSL exceedance at that location is considered an anomaly. This boundary may be modified based on future sampling.

A summary of the samples collected, the number of molybdenum detections above the laboratory reporting limits, and the number of detections exceeding either a GWPS or RSL is provided below.

Well ID	MW-801	MW-802	MW-803	MW-804	MW-805	MW-806R	MW-807	MW-808	MW-809	MW-810	MW-811
Samples	13	15	13	13	13	18	5	5	4	4	4
Detections	0	0	0	0	0	18	4	1	4	4	3
GWPS or RSL Exceedances	0	0	0	0	0	**18**	0	**1**	**2**	0	0

Well ID	MW-812	MW-813	MW-814	MW-815	MW-816	MW-817	MW-818	MW-819	MW-820	MW-821	MW-822
Samples	4	4	4	2	2	2	0	2	2	2	2
Detections	1	1	4	2	0	2	0	1	0	0	0
GWPS or RSL Exceedances	0	0	0	0	0	0	0	0	0	0	0

4.0 EXPOSURE EVALUATION AND ASSESSMENT OF RISK

An Exposure Conceptual Site Model (ExCSM) was developed based on the Groundwater Conceptual Site Model (GwCSM) and the Nature and Extent of Groundwater Above the GWPS (groundwater protection standard) discussed in the ACM. The ExCSM is used to identify whether human populations or other organisms could come into contact with impacted groundwater and/or surface water in the area of the FAI.

The USEPA has provided guidelines for performing a human health risk assessment (USEPA 1989, *Risk Assessment Guidance for Superfund: Volume I Human Health Evaluation Manual* (RAGS)). There are four general components to the process:

1. Hazard Identification
2. Toxicity Assessment
3. Exposure Assessment
4. Risk Characterization

Additionally, the USEPA and the MoDNR have developed contaminant screening levels for constituents in groundwater (and other media) that are considered to be protective of specific human exposures. The USEPA screening levels are known as Regional Screening Levels (RSLs) and the MoDNR screening levels are known as the Missouri Water Quality Standards (MWQS)). These screening levels are developed using the four general components of the human health risk assessment process, as detailed below.

1. A specific target risk level (component 4)
2. An assumed exposure scenario (component 3)
3. Toxicity information from USEPA (component 2)
4. An estimate of a concentration of a constituent in an environmental medium that is protective of human health in that exposure scenario (component 1)

RSLs and MWQSs are a conservative estimate of the concentration (based on federally or state approved acceptable risk) to which a receptor (human or ecological) can be exposed without experiencing adverse health effects. Due to the conservative methods used to derive these screening levels, it can reasonably be assumed that concentrations below the screening levels will not result in adverse health effects, and that no further evaluation is necessary. Concentrations above these conservative screening levels do not necessarily indicate that there is a potential risk, but indicate that further evaluation may be warranted.

4.1 EXPOSURE CONCEPTUAL SITE MODEL DEVELOPMENT

An ExCSM is used to evaluate the potential for human or ecological exposure to constituents that may have been released to the environment. It provides a framework for identifying potential sources, potential exposure pathways, and potential receptors. Potential exposure pathways are the media and transport mechanisms the CCR impacts might utilize to reach potential receptors. Potential receptors are people or other organisms potentially affected by the CCR impacts through various exposure routes. The exposure pathway is the key mechanism by which an environmental contaminant can come into contact with a potential receptor. Therefore, if the exposure pathway is incomplete, the contaminant cannot reach a potential receptor and there is no risk to the receptor.

For an exposure pathway to be complete, the following conditions must exist (as defined by USEPA (1989)):

1. A source and mechanism of chemical release to the environment;
2. An environmental transport medium (e.g., air, water, soil);
3. A point of potential contact with the receiving medium by a receptor; and
4. A receptor exposure route at the contact point (e.g., inhalation, ingestion, dermal contact).

4.1.1 Potential Sources

The first component of a complete exposure pathway is a source and mechanism of chemical release to the environment. In this ACM, the potential primary source of contamination was the fly ash and process water within the FAI prior to its removal. Constituents present in fly ash can leach into the process water, groundwater (if it is in contact with fly ash), and surface water (precipitation or run-on if it comes into contact with fly ash), and then become mobile by infiltration, groundwater flow, or by run-off. These constituents can potentially enter the shallow groundwater beneath and adjacent to the FAI or surface water adjacent to the FAI.

Potential constituents within infiltrating water will flow downward until reaching groundwater and then will move horizontally downgradient with the groundwater flow toward the Missouri River. The Missouri River ranges from approximately 50 to 200 feet from the FAI's northern berm, depending on the specific location. Potential constituents in surface water can flow over the ground surface during precipitation events and eventually reach the Missouri River near the FAI, unless contained.

Because the FAI has already been closed by removal of the CCR material, the primary source of contamination has also already been removed. Therefore, there is no exposure to the primary source CCR material in the vicinity of the FAI. However, based on groundwater monitoring results, molybdenum, presumably leached from CCR materials, has been observed in groundwater downgradient from the FAI at concentrations above the GWPS. Because there is no longer a primary source, there is no longer potential for continued infiltration of molybdenum impacted water. As such, the existing residual molybdenum impacted groundwater becomes a secondary source.

The only FAI groundwater monitoring network well with an Appendix IV constituent (molybdenum) above the GWPS at a statistically significant level (SSL) is MW-806R located on the berm of the FAI. Additional groundwater monitoring wells were installed upgradient, cross-gradient, and downgradient of MW-806R and the FAI to determine the nature and extent (N&E) of the molybdenum impact. Four of the additional N&E wells (MW-809, MW-810, MW-811, and MW-812) were installed within approximately 180 feet downgradient of MW-806R in the flood plain, and approximately 50 feet from the riverbank. Of these four downgradient monitoring wells, only one well (MW-809) contains molybdenum above the GWPS at a SSL. None of the other downgradient N&E groundwater monitoring wells have molybdenum concentrations above the GWPS.

4.1.2 Potential Exposure Pathways

The second component of a complete exposure pathway is an environmental transport medium. The direction of groundwater flow in the vicinity of the FAI has been observed at least semi-annually since 2016. These observations were based on groundwater elevation data from the FAI groundwater monitoring network. Throughout this recorded time period, the direction of groundwater flow has been relatively consistent, primarily north-northeast toward the Missouri River with a slightly more easterly component at times. Although the direction of flow does not vary much, the flow gradient fluctuates depending on the river stage. Typically, the higher the river level, the smaller the gradient; and the lower the river level, the greater the gradient. This observation is based only on data from the groundwater monitoring network wells located near the boundaries of the FAI.

Figure 3 shows the FAI location and layout, identifies the monitoring wells and shows the direction of groundwater flow toward the Missouri River, and identifies the Missouri River flow direction.

The exposure pathway for the existing residual molybdenum impacted groundwater (secondary source) is migration of the impacted groundwater to a potential receptor. To reach a potential receptor, the impacted groundwater must reach the surface either by natural or anthropogenic means. Based on the above groundwater flow information, the groundwater naturally reaches the Missouri River where it will mix with surface water, causing the surface water to become a potential exposure pathway and media which can potentially come into contact with and potentially affect people or other organisms. The anthropogenic means by which the impacted groundwater can reach the surface is by intentionally pumping the groundwater for beneficial use, whereby it can potentially come into contact and potentially affect people or other organisms.

4.1.3 Potential Receptors

The third and fourth components of a complete exposure pathway are points of potential contact with a receiving medium by a receptor and a receptor exposure route at the point of contact. Potential receptors are people or other organisms potentially affected by the CCR impacts through various exposure routes.

4.1.3.1 Potential Human Health Receptors

In general, human health exposure routes to contaminants in the environment include ingestion, inhalation, and dermal contact with the following environmental exposure media:

- Groundwater
- Surface Water and Sediments
- Air
- Soil
- Biota/Food

The previous section determined the potential exposure pathways to both humans and other organisms to be through the groundwater and surface water. Therefore, the human exposure routes are related to how humans interact with the environmental exposure media. If people might be exposed to the molybdenum impacts via one of the environmental media listed above, a potential exposure route exists and should be evaluated further.

For the groundwater impacts at FAI, the following potential exposure pathways and routes have been identified with respect to human health:

- **Groundwater** - <u>Ingestion and Dermal Contact:</u> The potential for ingestion of, or dermal contact with, impacted groundwater from the FAI exists if a groundwater well for beneficial human use or potable water supply well is present in the area of impacted groundwater and is used for washing/bathing or as a potable water supply. The potential construction worker pathway was considered, which could include incidental ingestion and dermal contact, but was ruled out based on the proximity of the FAI to the Missouri River. Based on a review of the MoDNR well database (GeoSTRAT) and other readily available information as summarized below, potential human receptor exposure pathways for groundwater ingestion or dermal contact are not present and further evaluation is not warranted.

- The only area a groundwater well could be installed to intercept groundwater potentially impacted by the FAI is in the narrow strip of land between the north berm of the FAI and the Missouri River. This would not be feasible because the land is owned by Evergy and site access is restricted.
- No on-site or off-site groundwater wells (other than monitoring wells) or water supply wells have been identified downgradient or cross-gradient in the vicinity of the FAI. Based on available GeoSTRAT data as shown on **Figure 6,** the nearest groundwater wells (other than monitoring wells) are greater than one mile upgradient from the FAI. One of the two closest wells is completed into the underlying bedrock (at a depth of 235 feet) and the other closest well is located across the river from the FAI.
- Groundwater is not used for domestic purposes on-site and potable water is not supplied from on-site wells. Potable water in the vicinity of the Sibley Generating Station is provided by the Jackson County Public Water Supply District (PWSD) No. 16, who purchases their water directly from the City of Independence, Missouri. The Independence, Missouri well field is located approximately 16 river miles upstream from the FAI.
- Other public water supplies obtained from the Missouri River alluvial aquifer upgradient, cross-gradient, and downgradient from the FAI include the following and are shown on **Figure 7:**
  - Tri-County Water Company - approximately 5.5 miles upgradient
  - Ray County PWSD No. 2 – approximately 4.5 miles cross-gradient
  - Excelsior Springs Water - approximately 5.5 miles upgradient
  - Richman Water Supply – greater than 12 miles downgradient

  Additionally, based on groundwater flow modeling for the Missouri River alluvial aquifer (Kelly, 1996), the FAI is not located within the 1,000-year recharge area of the above upgradient or cross-gradient well fields. Furthermore, none of the recharge areas for the water supply wells modeled by Kelly extended beyond approximately six miles from the well field (see **Figure 8**). Therefore, by inference, potentially impacted groundwater from the FAI is not intercepted by the Richman Water Supply well field.

- **Surface Water** – Ingestion and Dermal Contact: The potential for ingestion or dermal contact with impacted surface water is present if impacted groundwater from the FAI interacts with the adjacent surface water of the Missouri River to the extent that molybdenum is present at concentrations that represent a risk to human health.
  - Intentional ingestion of surface water from the Missouri River is highly unlikely due to visible river conditions. However, there are surface water intakes for public water

supply systems that withdraw water from the Missouri River for treatment and distribution. The closest public water supply surface intake is approximately 19 river miles downstream at Lexington, Missouri (See **Figure 7**). This potential exposure pathway and exposure route should be evaluated further.

  - Incidental ingestion of surface water from the Missouri River is possible for swimmers, waders, boaters, and recreational fisherman. Therefore, these potential exposure routes should be evaluated further.
  - Dermal Contact with surface water from the Missouri River is possible because the river is used for recreation by swimmers, waders, boaters, and recreational fisherman. Therefore, these potential exposure routes should be evaluated further. However, access to the river from the bank adjacent to the FAI is restricted.

- **Biota/Food** – <u>Ingestion:</u> The potential for ingestion of impacted food exists if impacted groundwater from the FAI has interacted with elements of the human food chain. Elements of the food chain may also be exposed indirectly through groundwater-to-surface water interactions. The exposure pathway here is the potential transfer of molybdenum from the surface water to fish and then the human consumption of the fish. This potential exposure pathway and exposure route will be evaluated later in the report.

4.1.3.2 Potential Ecological Health Receptors

In addition to human exposures to impacted groundwater, potential ecological exposures are also considered. If ecological receptors might be exposed to impacted groundwater, the potential exposure routes are evaluated further. Ecological receptors include living organisms, other than humans, the habitat supporting those organisms, or natural resources potentially adversely affected by CCR impacts. This includes:

- Transfer from an environmental media to animal and plant life. This can occur by bioaccumulation, bioconcentration, and biomagnification.
  - Bioaccumulation is the general term describing a process by which chemicals are taken up by a plant or animal either directly from exposure to impacted media (soil, sediment, water) or by eating food containing the chemical.
  - Bioconcentration is a process in which chemicals are absorbed by an animal or plant to levels higher than the surrounding environment.
  - Biomagnification is a process in which chemical levels in plants or animals increase from transfer through the food web (e.g., predators have greater concentrations of a particular chemical than their prey).
- Benthic invertebrates within adjacent waters.

4.1.4 Exposure Conceptual Site Model

Based on the above discussion, a depiction of the ExCSM is presented as **Figure 9.** The ExCSM identifies the following:

- Primary Sources
    - FAI
- Primary Release/Transport Mechanisms
    - Runoff/Flooding
    - Leaching/Infiltration
- Secondary Source
    - Residual Groundwater Impact
- Secondary Release/Transport Mechanisms
    - Migration to Surface Water
    - Groundwater Flow
- Potential Exposure Media
    - Surface Water – Missouri River
    - Fish Tissue – Missouri River
    - Groundwater
- Potential Receptors
    - Human
    - Aquatic
- Potential Exposure Routes
    - Drinking Water
    - Incidental Ingestion
    - Dermal Contact
    - Aquatic Exposure
        - Human Ingestion

4.2 FURTHER EVALUATION AND ASSESSMENT OF RISK

Based on the lack of potential exposure to groundwater, only the potential surface water and biota/food exposure pathways and routes were retained for further evaluation and assessment of risk.

Part A of the USEPA RAGS is the Human Health Evaluation Manual, which provides guidance for evaluation activities for a baseline risk assessment (BLRA). BLRAs are site-specific and therefore may vary in both detail and the extent to which qualitative and quantitative analyses are used, depending on the complexity and particular circumstances of the site. A BLRA analyzes potential adverse health effects (current or future) caused by contaminant releases from a site in the absence of any actions to control or mitigate the release (i.e., under the assumption of no action). The BLRA enhances the site characterization and subsequent development, evaluation, and selection of appropriate corrective measures alternatives. The results of the BLRA are used to help determine whether additional corrective measures are necessary for the site, modify preliminary corrective measures goals, and document the magnitude and primary cause of the risk.

4.2.1 Contaminant of Concern

Molybdenum is the contaminant of concern at the FAI. It has been detected in the groundwater at concentrations above the RSL of 0.100 mg/L with the highest reported concentration of 2.16 mg/L in network monitoring well MW-806R on May 18, 2020. This detected high concentration occurred during the height of ash removal activities from the western end of the FAI. Since that time, the concentration in MW-806R has steadily been dropping and was reported as 1.47 mg/L in the water sample collected on August 18, 2022. The only other well for which molybdenum has been detected above the RSL is N&E monitoring well MW-809, with a high concentration of 0.410 mg/L in the duplicate sample collected on August 19, 2022.

4.2.2 Risk-Based Screening Levels

Risk-based screening levels have been compiled to assist with this evaluation of risk for the potential exposures routes identified by the ExCSM discussed in Section 4.1 above:

- Drinking Water (incorporates dermal contact as appropriate)
- Incidental Ingestions (recreational)
- Dermal Contact (recreational)
- Aquatic Exposure
  - Human Ingestion

The CCR Rule limits the evaluation of groundwater monitoring data from CCR units such as the FAI to the GWPSs, which are protective of drinking water, regardless of whether or not the groundwater is used as a source of drinking water. The GWPS for molybdenum per the CCR Rule is 0.100 mg/L, which is from the USEPA's generic RSL table.

RSLs were developed using risk assessment guidance from the USEPA Superfund program. They are risk-based concentrations derived from standardized equations combining exposure information assumptions with USEPA toxicity data. RSLs are considered to be protective for humans (including sensitive groups) over a lifetime; however, RSLs are not always applicable to a particular site and do not address non-human health endpoints, such as ecological impacts. The RSLs adopted by the CCR Rule are from the USEPA's generic RSL table; they are calculated without site-specific information. They may be re-calculated using site-specific data. (RSLs Frequent Questions https://www.epa.gov/risk/regional-screening-levels-frequent-questions)

The USEPA RSLs are used for site "screening" and as initial cleanup goals, if applicable. RSLs are not de facto cleanup standards and should not be applied as such (RSLs Frequent Questions https://www.epa.gov/risk/regional-screening-levels-frequent-questions). Once the baseline risk assessment is completed, site-specific risk-based remediation goals can be derived using the BLRA results.

4.2.2.1 Drinking Water Screening Levels

Missouri Water Quality Standards (10 CSR 20-7.031) are nearly identical to the National Primary Drinking Water Regulation's maximum contaminant levels (MCLs) with a few additional parameters. However, neither of these regulations have a standard or MCL for molybdenum. Therefore, the RSL for molybdenum for residential tapwater is used as the drinking water screening level. When developing the generic RSLs for tapwater, the USEPA used the basic assumption that tapwater is water that is delivered into a residence from sources such as groundwater or surface water. Ingestion of tapwater is an appropriate pathway for all chemicals. The inhalation exposure is not applicable for metals. However, activities such as showering, laundering, and dish washing are factors in dermal exposure and are incorporated into the RSLs as appropriate.

4.2.2.2 Recreational Screening Levels

Missouri Water Quality Standards (10 CSR 20-7.031) do not provide recreational screening levels for incidental ingestion or dermal contact for metals for surface water other than levels based on fish consumption. The screening levels based on fish consumption do not include molybdenum as one of the contaminants of concern.

The USEPA National Recommended Water Quality Criteria do not provide recreational screening levels for incidental ingestion or dermal contact for metals for surface water other than human health ambient water quality criteria (AWQC) for specific levels of chemicals or conditions in a water body that are not expected to cause adverse effects to human health. The AWQC provides recommendations for "water + organism" and "organism only" human health criteria. The AWQC does not include molybdenum as one of the contaminants of concern.

Use of the published drinking water screening levels (USEPA RSLs) to evaluate surface water are also protective of recreational uses of surface water such as swimming, wading, and boating, but are overly conservative when applied to recreational exposure because drinking water exposure is of a higher magnitude and frequency.

Potential exposures to constituents in surface water could occur through incidental ingestion and dermal contact during recreational activities at exposure rates and magnitudes commensurate with the activity. The recreational activities considered most appropriate, however unlikely, for the Missouri River in the vicinity of the FAI are wading, swimming, boating and fishing.

Along with the generic RSL tables, the USEPA also provides a calculation tool for refining screening levels based on site-specific exposure scenarios. One of those scenarios is the recreational exposure to surface water. Therefore, site-specific risk-based screening levels (RBSLs) were calculated for recreational use of the Missouri River in the vicinity of the FAI.

The RBSLs were calculated using USEPA-derived exposure factors and equations, as well as site-specific inputs where appropriate using the USEPA RSL calculator (USEPA. 2022. Risk-Based Screening Levels Calculator. August 2022. Available at: https://epa-prgs.ornl.gov/cgi-bin/chemicals/csl_search). The calculator-based recreator scenario shares the following identical default exposure parameters with the residential land use scenario: body surface area, ingestion rates, body weight, and soil adherence factors. Default recreational exposure parameters are not provided for exposure frequency, exposure time, and events per day because recreational activities vary greatly and should be derived on a site-specific basis. Exposure parameters were set as follows:

- Exposure duration
  - 0-2 year old = 2 years
  - 2-6 years old = 4 years
  - 6-16 years old = 10 years
  - 16-30 years old = 10 years
  - Adult = 20 years
- Exposure frequency
  - 0-2 year old = 0 days per year
  - 2-6 years old = 20 days per year
  - 6-16 years old = 40 days per year
  - 16-30 years old = 40 days per year

    - Adult = 40 days per year
- Exposure events = 0 per day for 0-2 years old, 1 per day for all other age groups
- Exposure time = 0 per event for 0-2 years old, 2 hours per event for all other age groups

The calculated RBSL for recreational exposure to Missouri River water near the vicinity of the FAI is 9.380 mg/L. The RBSL calculator output, including the exposure parameters used, is provided in Attachment A.

4.2.2.3 Ecological Screening Levels

Missouri Water Quality Standards (10 CSR 20-7.031) provide acute and chronic protection of aquatic life standards for many metals. However, molybdenum is not included as one of the contaminants of concern. Standards for many metals are also provided for irrigation and livestock and wildlife protection; however, molybdenum is not one of the contaminants of concern.

The USEPA National Recommended Water Quality Criteria provides acute and chronic freshwater, aquatic life AWQC standards for many metals. However, molybdenum is not included as one of the contaminants of concern.

State and Federal ecological screening levels for molybdenum are not provided most likely because molybdenum does not significantly bioaccumulate in aquatic organisms as suggested by measured bioconcentration factors of molybdenum in fish (ATSDR, 2020) and because molybdenum does not biomagnify in aquatic food chains (Regoli, et al, 2012).

4.2.2.4 Summary of Risk-Based Screening Levels

As can be concluded from the above discussions, the only readily available predetermined screening level for molybdenum is the USEPA's generic RSL for tapwater, 0.100 mg/L. If the molybdenum RSL is applied indiscriminately to various exposure pathways or exposure routes other than tapwater, the conservative nature of the derived generic RSL will be magnified.

An alternative RBSL for molybdenum of 9.380 mg/L was calculated for recreational exposure to Missouri River water near the vicinity of the FAI which incorporated incidental ingestion and dermal contact (whole body contact such as swimming). This alternative RBSL is a more realistic representative of actual recreational exposure than the generic RSL for tapwater.

4.2.3 Evaluation of Potential Surface Water Exposure Routes

First and foremost, it must be acknowledged that based upon sampling results, the Missouri River does not show evidence of molybdenum impact in the vicinity of the FAI.

4.2.3.1 Drinking Water

Because molybdenum contaminated groundwater is potentially reaching the Missouri River and the potential exposure route of the river water being used as drinking water is complete, the exposure evaluation and assessment of risk becomes a comparison of the drinking water RSL for molybdenum to the actual river water molybdenum concentrations. The Missouri River has been sampled upstream, adjacent to, and downstream of the FAI for molybdenum with a total of eight samples. None of the Missouri River water samples exhibited molybdenum above the laboratory reporting limit. Furthermore, the nearest downstream surface water intake for a public water supply is approximately 19 miles downstream. Although this exposure route is potentially complete, it is considered insignificant.

4.2.3.2 Incidental Ingestion

The exposure evaluation and assessment of risk for molybdenum to pose health risks due to incidental ingestion of Missouri River water compares the above calculated RBSL of 9.380 mg/L for recreational exposure to the actual river water molybdenum concentrations. The Missouri River has been sampled upstream, adjacent to, and downstream of the FAI for molybdenum with a total of eight samples. None of the Missouri River water samples exhibited molybdenum above the laboratory reporting limit. Furthermore, the highest molybdenum concentration observed through groundwater at the FAI is 2.16 mg/L, which is below the RBSL of 9.380 mg/L. Although this exposure route is potentially complete, it is considered insignificant.

4.2.3.3 Dermal Contact

The exposure evaluation and assessment of risk for molybdenum to pose health risk due to dermal contact with Missouri River water compares the above calculated RBSL of 9.380 mg/L for recreational exposure to the actual river water molybdenum concentrations. The Missouri River has been sampled upstream, adjacent to, and downstream of the FAI for molybdenum with a total of eight samples. None of the Missouri River water samples exhibited molybdenum above the laboratory reporting limit. Furthermore, the highest molybdenum concentration observed through groundwater at the FAI is 2.16 mg/L, which is below the RBSL of 9.380 mg/L. Although this exposure route is potentially complete, it is considered insignificant.

4.2.3.4 Aquatic Exposure

During operation of the FAI, water from the FAI was discharged under the Sibley Generating Station NPDES Permit No. MO-0004871 through Outfall No. 007. As part of the NPDES permit requirements, whole effluent toxicity (WET) testing was periodically performed on the effluent water. WET testing involves mixing the effluent water with synthetic laboratory water at various dilutions. If the effluent treatment results are not statistically different from the control results, then the effluent water is considered to have passed the WET test. WET testing provides direct aquatic organism toxicity results using the specific effluent water. Results of the WET testing indicate no evidence of aquatic toxicity of the effluent water, even at a 100% effluent exposure concentration. This is a direct biological measurement demonstrating the lack of toxicity of the FAI effluent water.

Additionally, Outfall No. 020 for the Sibley Generating Station NPDES Permit No. MO-0004871 is the outfall for the CCR landfill leachate and the active CCR landfill area contact water. Leachate is the water that has been in contact with ash and infiltrates down through the ash by gravity until it reaches the leachate collection system by which it is removed from the landfill. The leachate geochemistry from the CCR landfill should be similar to the geochemistry of the water that was in the FAI and could be considered the worst-case infiltrate from the primary source, fly ash. As part of the NPDES permit requirements, WET testing is periodically performed on the landfill leachate. WET testing provides direct aquatic organism toxicity results using the leachate. Results of the WET testing indicate no evidence of aquatic toxicity of the leachate, even at a 100% leachate exposure concentration. This is a direct biological measurement demonstrating the lack of toxicity of the FAI landfill leachate.

Although this aquatic exposure route is potentially complete, it is considered insignificant.

4.2.3.5 Evaluation of Potential Biota/Food Exposure Routes

Use of the published drinking water screening level for molybdenum (USEPA RSL) to evaluate surface water are also protective of potential biota/food exposure routes such as eating fish from the Missouri River. However, the drinking water RSL for molybdenum when applied to fish consumption is overly conservative because drinking water exposure is of a higher magnitude and frequency. Additionally, molybdenum does not significantly bioaccumulate in aquatic organisms as suggested by measured bioconcentration factors of molybdenum in fish (ATSDR, 2020), and molybdenum does not biomagnify in aquatic food chains (Regoli, et al, 2012). Furthermore, none of the Missouri River water samples exhibited molybdenum above the laboratory limit. Although this potential biota/food exposure routes is potentially complete, it is considered insignificant.

4.3 CONCLUSIONS

The above evaluations and presentation of results indicate that while there are molybdenum concentrations in groundwater samples collected from two monitoring wells (MW-806R and MW-809) at the FAI above the tapwater RSLs used to evaluate data under the CCR Rule (0.100 mg/L), there are no potential human receptor exposure pathways for groundwater ingestion or dermal contact. Where there is no exposure, there is no risk.

The surface water exposure pathway was found to be potentially complete for the drinking water, incidental ingestion and dermal contact exposure routes for various scenarios. However, further evaluation indicates the risk is considered insignificant.

The molybdenum sampling results for the Missouri River are important. Although groundwater from one network monitoring well at the downgradient edge of the FAI (MW-806R) and one N&E monitoring well approximately 100 feet downgradient of the FAI (MW-809) exhibit molybdenum concentrations above the RSL, the adjacent Missouri River does not show evidence of molybdenum impact. The absence of molybdenum concentrations above the generic RSL or an RBSL indicates there is not a significant pathway of exposure. Furthermore, although elevated molybdenum concentrations in groundwater adjacent to the FAI have been documented, impacts to the Missouri River water have not been documented.

The interaction between groundwater and the river is dependent upon a number of variables including hydraulic conductivity, gradient, flow rate, and constituent concentrations of both the groundwater and the river. Groundwater and river water flow at significantly different rates and volumes. The Missouri River in the vicinity of the FAI has an average flow of approximately 38 billion gallons per day and an approximately 11 billion gallons per day flow during low flow conditions. The groundwater flowing into the river at the FAI is significantly less than the river flow. At the river's average flow, the groundwater is diluted by a conservatively estimated factor of approximately 4,900 times. Even at low flow conditions, the groundwater is diluted by a conservatively estimated factor of approximately 1,600 times.

This conservative estimate of dilution can be used to further evaluate the molybdenum concentration level at which groundwater entering the Missouri River may pose a potential human health or ecological risk by calculating a dilution and attenuation factor (DAF). The site-specific DAF for the FAI is 1,600 to 4,900 (unitless). Calculation of the DAF is provided in **Attachment B.** The table below shows how this DAF is applied to the most conservative of the human health and ecological screening levels for surface water (the generic RSL for molybdenum of 0.100 mg/L) to effectively provide a site-specific risk-based screening level for groundwater that is protective of the Missouri River water.

<table>
<tr><th colspan="2">Site-Specific Calculated DAF* for the Missouri River</th><th>1,662</th><th colspan="3"></th></tr>
<tr><th>Constituent</th><th>Lowest of the Human Health and Ecological Screening Levels (mg/L)</th><th>Site-Specific Groundwater Risk-Based Screening Level** (mg/L)</th><th colspan="2">Highest Observed Molybdenum Groundwater Concentrations at the FAI (mg/L)</th><th>Ratio Between the Risk-Based Screening Level and the Maximum Molybdenum Groundwater Concentration at the FAI</th></tr>
<tr><td rowspan="2">Molybdenum</td><td rowspan="2">0.100</td><td rowspan="2">166.2</td><td>2.16</td><td>MW-806R</td><td>77</td></tr>
<tr><td>0.422</td><td>MW-809</td><td>701</td></tr>
</table>

* Calculation of the DAF is provided in Attachment B.

** Where the Site-Specific Risk-Based Screening Level = Screening Level x DAF

The above table shows the maximum groundwater concentration of molybdenum detected in the two monitoring wells with molybdenum concentrations at an SSL above the RSL or the GWPS. Comparison of the site-specific RBSL (166.2 mg/L) to the highest observed concentration for each well (0.422 and 2.16 mg/L) indicates a wide margin of safety between the two values. This margin shows that the molybdenum concentration in the groundwater would have to be at least 77 times higher than the maximum observed concentration before an adverse impact in the Missouri River could occur.

This evaluation demonstrates that present molybdenum concentrations in groundwater at the FAI do not pose adverse impacts on human health or the environment from either groundwater or surface water. Further, molybdenum concentrations up to at least 77 times greater than current concentrations would not pose adverse impacts to human health or the environment. Therefore, because no adverse risk currently exists, any of the remedies considered in this ACM are protective of human health and the environment.

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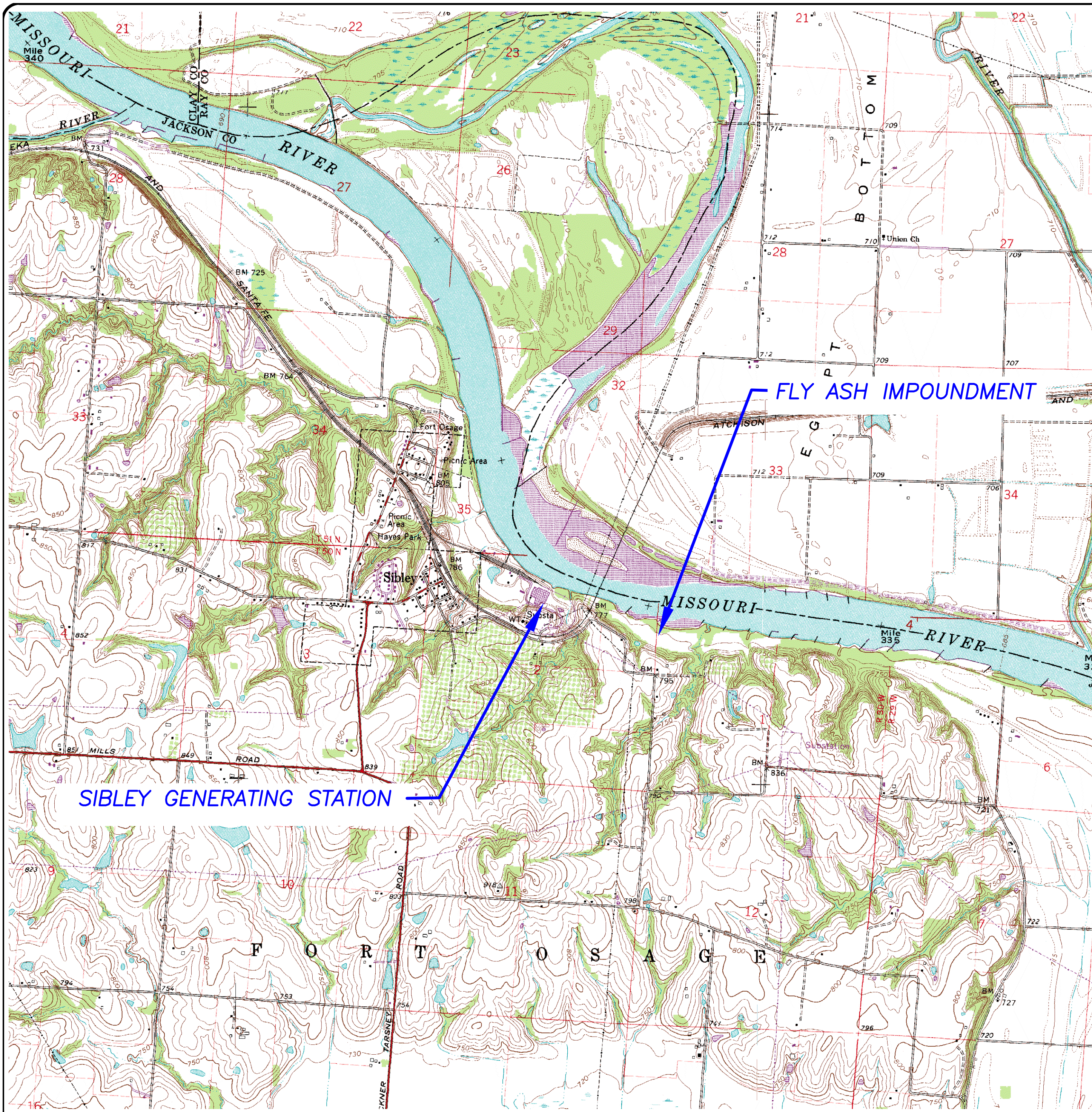
6.0 GENERAL COMMENTS

SCS Engineers does not warrant the work of regulatory agencies or other parties supplying information used in the assimilation of this work product. This work product is prepared in accordance with generally accepted environmental engineering and hydrogeological practices, within the constraints of the client's directives. It is intended for the exclusive use of the client for specific application to this project. No guarantees, express or implied, are intended or made.

FIGURES



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SCALE FEET

SOURCE:
1975 USGS MAP
BUCKNER QUADRANGLE
7.5 MINUTE SERIES (TOPOGRAPHIC)

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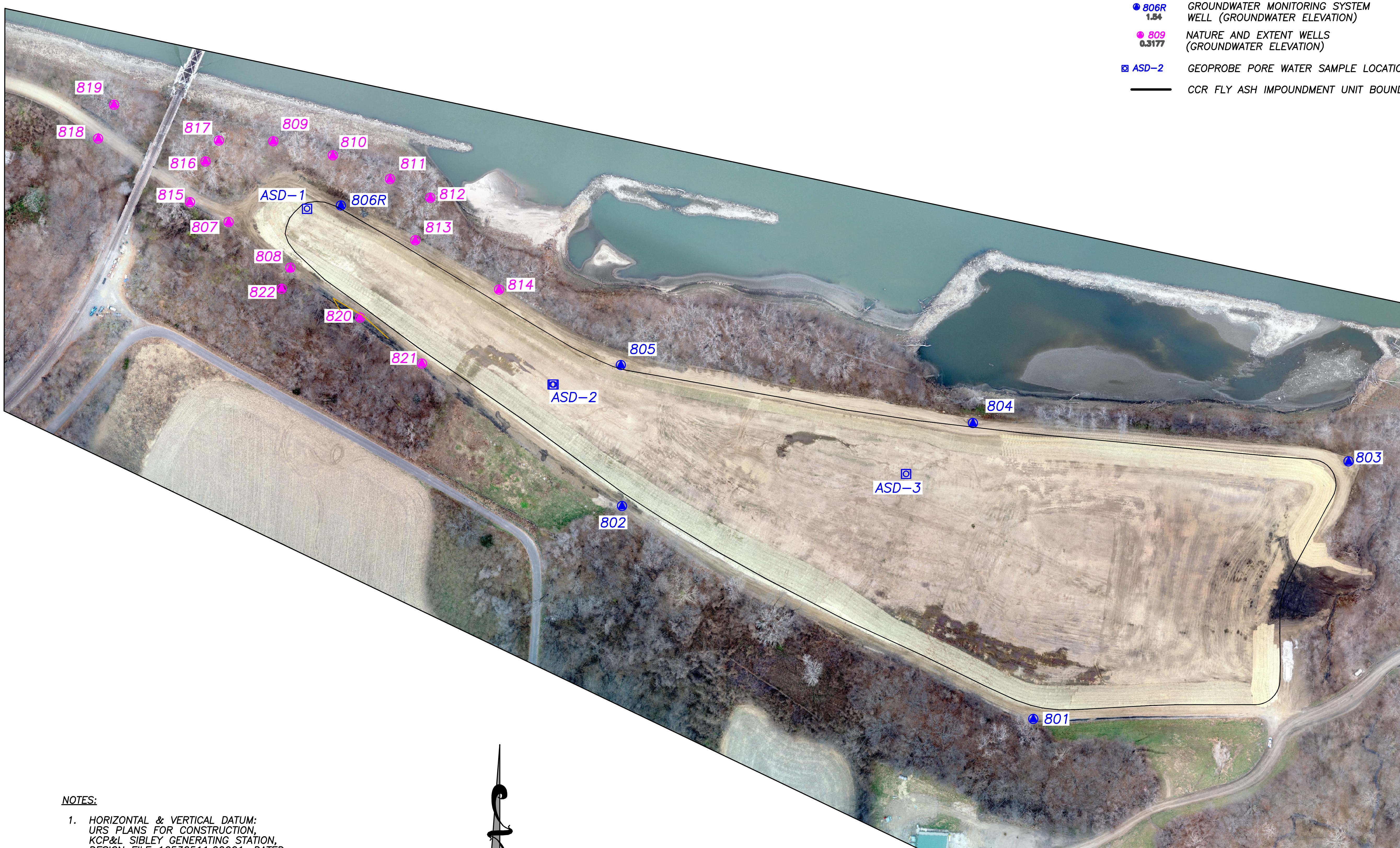
FIGURE 1
SITE LOCATION MAP
EVERGY MISSOURI WEST, INC. SIBLEY GENERATING STATION
FLY ASH IMPOUNDMENT, SIBLEY, MISSOURI

CHK. BY: DLD	DWN. BY: TGW	DSN. BY: TGW	PROJ. NO. 27218131.03
PROJ. MGR: DLD	DATE: 10/2018	CADD FILE: FIGURE 1_SITE MAP.DWG	DRAWING NO. 1



LEGEND:

806R 1.54	GROUNDWATER MONITORING SYSTEM WELL (GROUNDWATER ELEVATION)
809 0.3177	NATURE AND EXTENT WELLS (GROUNDWATER ELEVATION)
ASD-2	GEOPROBE PORE WATER SAMPLE LOCATION
	CCR FLY ASH IMPOUNDMENT UNIT BOUNDARY

NOTES:

1. HORIZONTAL & VERTICAL DATUM: URS PLANS FOR CONSTRUCTION, KCP&L SIBLEY GENERATING STATION, DESIGN FILE 16530511.00001, DATED JANUARY 2010
2. AERIAL IMAGE BY TUKUH TECHNOLOGIES ON DECEMBER 10, 2021.
3. BOUNDARY AND MONITORING WELL LOCATIONS SHOWN ARE APPROXIMATE.

200 0 200 400

SCALE FEET

REV. DATE
- -

SHEET TITLE
MONITORING WELL LOCATION MAP

PROJECT TITLE
ASSESSMENT OF CORRECTIVE MEASURES

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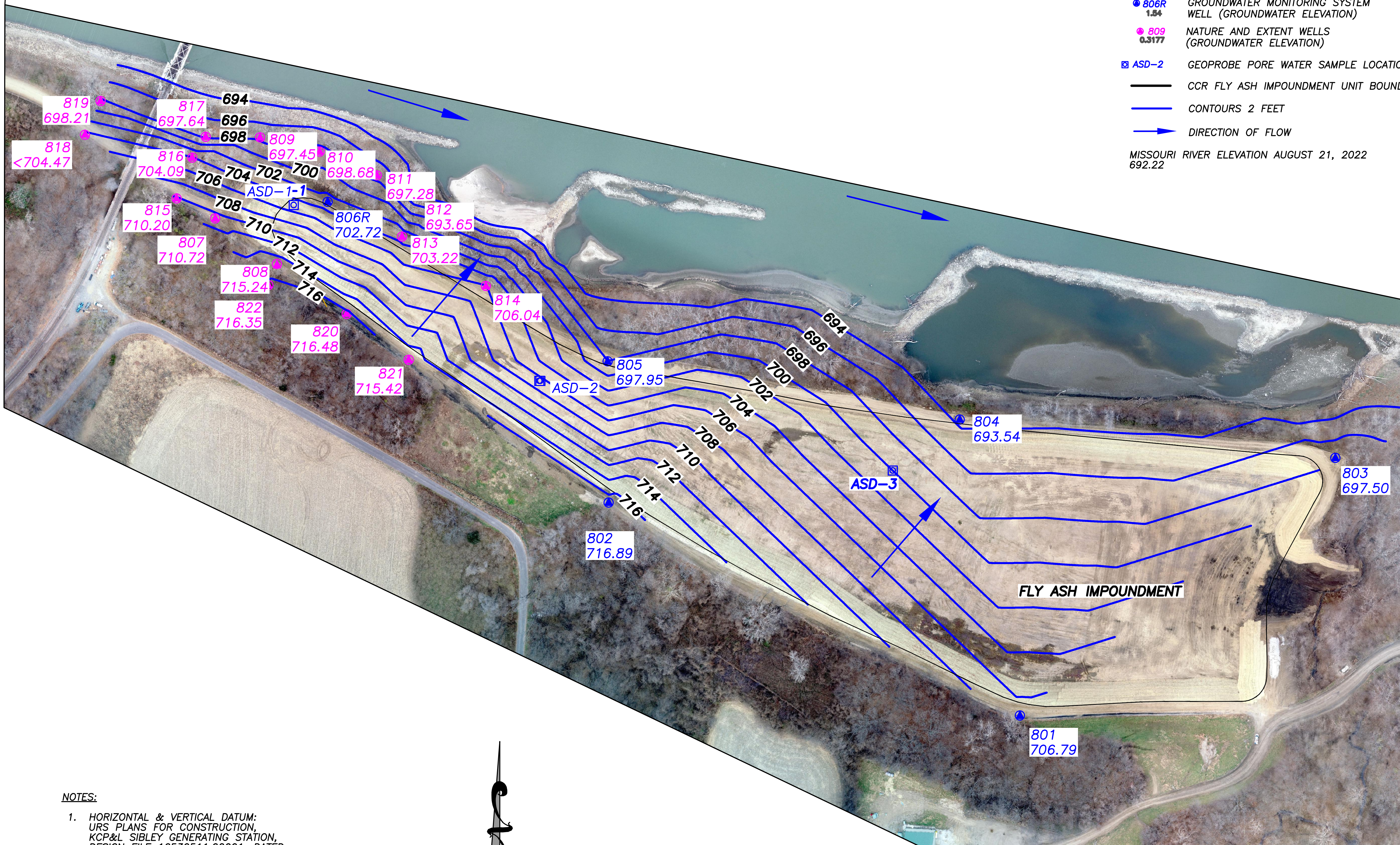
CADD FILE: FIGURES 2, 3, & 5.DWG

DATE: 9/9/22

FIGURE NO. 2



LEGEND:

806R 1.54	GROUNDWATER MONITORING SYSTEM WELL (GROUNDWATER ELEVATION)
809 0.3177	NATURE AND EXTENT WELLS (GROUNDWATER ELEVATION)
ASD-2	GEOPROBE PORE WATER SAMPLE LOCATION
	CCR FLY ASH IMPOUNDMENT UNIT BOUNDARY
	CONTOURS 2 FEET
	DIRECTION OF FLOW

MISSOURI RIVER ELEVATION AUGUST 21, 2022
692.22

NOTES:

1. HORIZONTAL & VERTICAL DATUM: URS PLANS FOR CONSTRUCTION, KCP&L SIBLEY GENERATING STATION, DESIGN FILE 16530511.00001, DATED JANUARY 2010
2. AERIAL IMAGE BY TUKUH TECHNOLOGIES ON DECEMBER 10, 2021.
3. BOUNDARY AND MONITORING WELL LOCATIONS SHOWN ARE APPROXIMATE.

200 0 200 400

SCALE FEET

REV.	DATE
-	-

SHEET TITLE
POTENTIOMETRIC SURFACE MAP (AUGUST 19, 2022)

PROJECT TITLE
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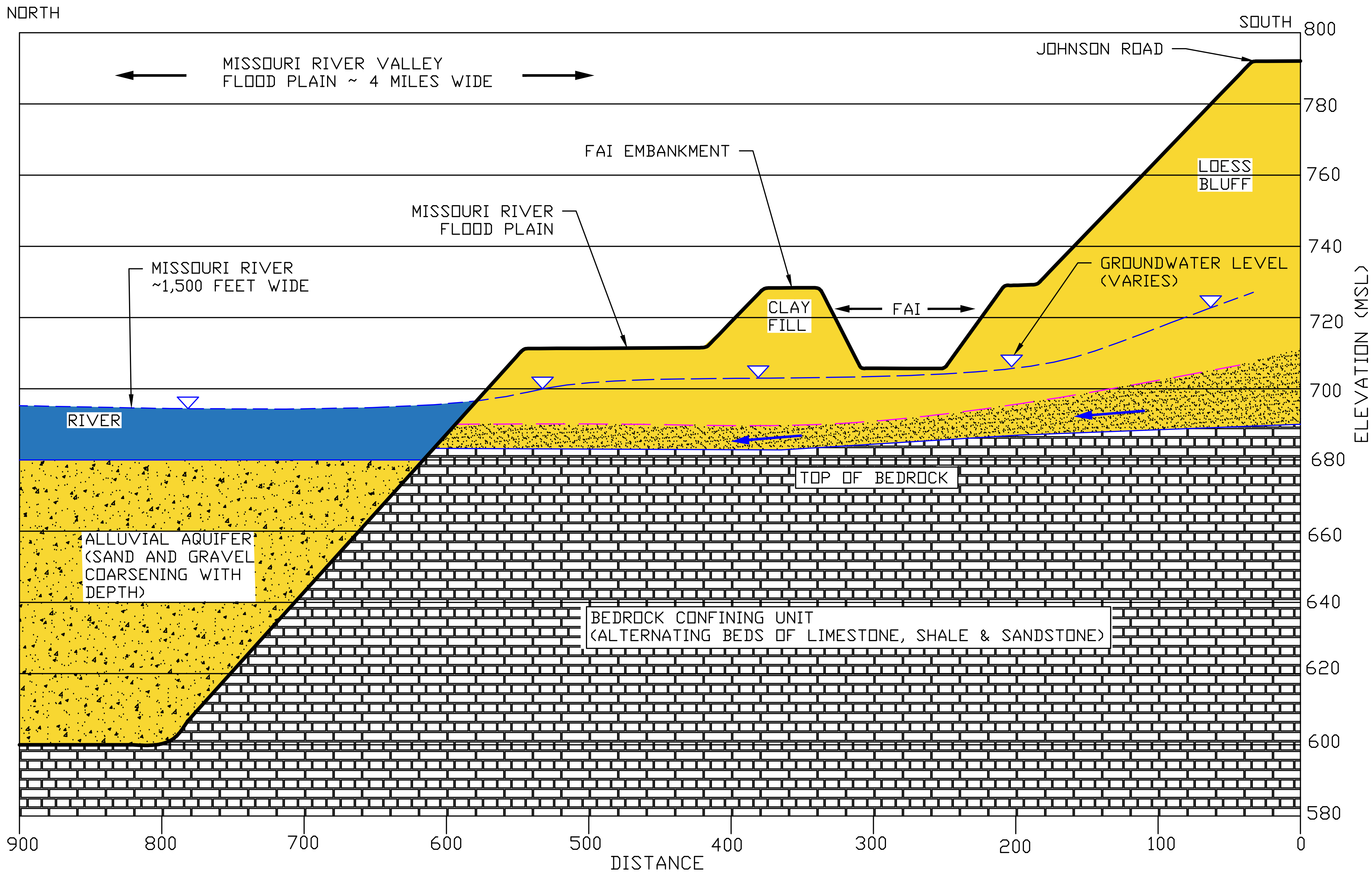
DSN. BY: ALR | PROJ. MGR JRF

CADD FILE: FIGURES 2, 3, & 5.DWG

DATE: 9/9/22

FIGURE NO.
3



REV.	DATE
-	-

SHEET TITLE
GROUNDWATER CONCEPTUAL SITE MODEL

PROJECT TITLE
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DWN. BY: ALR
CHK. BY: JRF
Q/A RVW BY: JRF
PROJ. MGR: JRF

CADD FILE: FIGURES 4, 6-9.DWG

DATE: 9/8/22

FIGURE NO. 4

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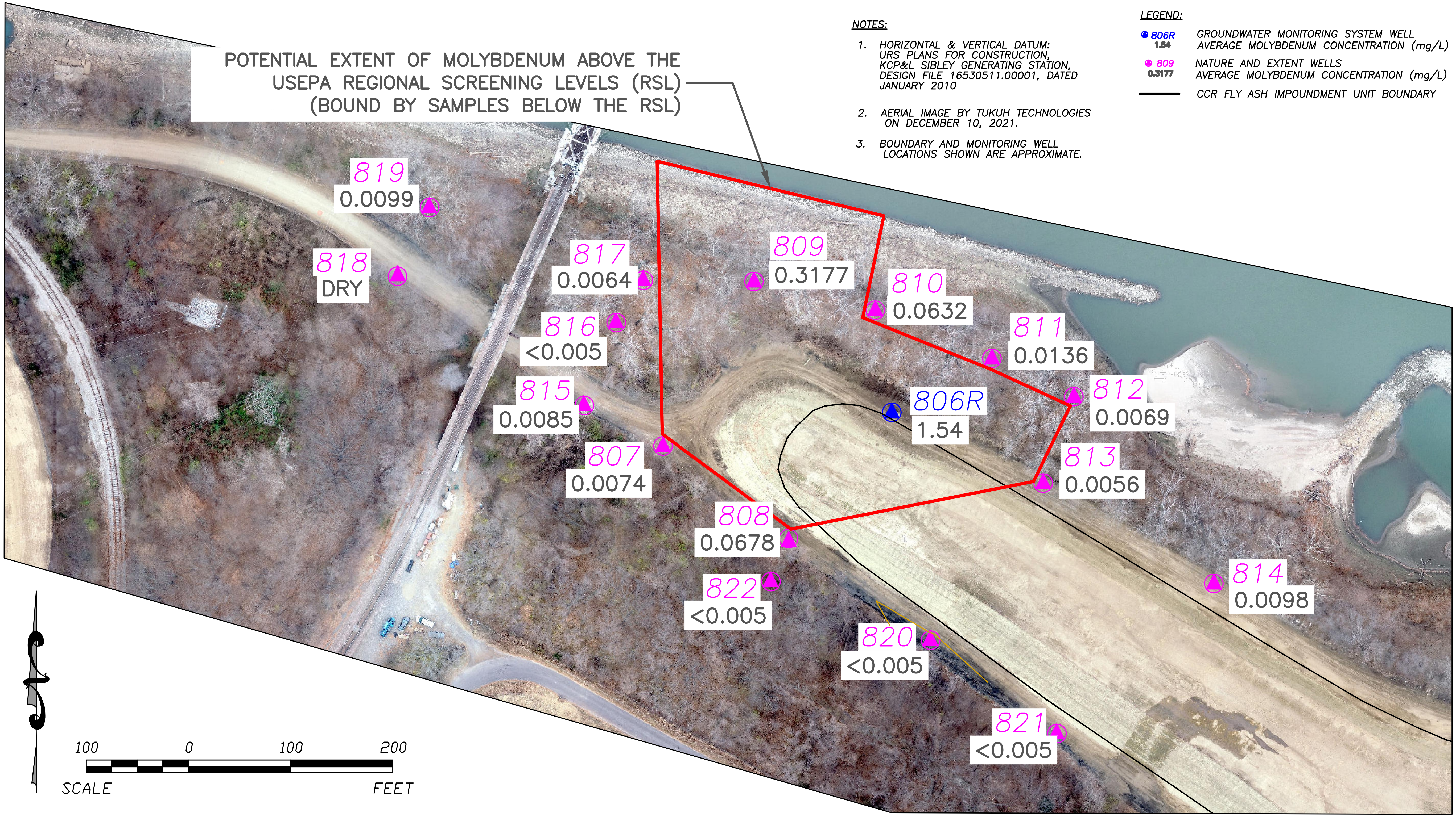

NOTES:

1. HORIZONTAL & VERTICAL DATUM: URS PLANS FOR CONSTRUCTION, KCP&L SIBLEY GENERATING STATION, DESIGN FILE 16530511.00001, DATED JANUARY 2010
2. AERIAL IMAGE BY TUKUH TECHNOLOGIES ON DECEMBER 10, 2021.
3. BOUNDARY AND MONITORING WELL LOCATIONS SHOWN ARE APPROXIMATE.

LEGEND:

- 806R 1.54 — GROUNDWATER MONITORING SYSTEM WELL AVERAGE MOLYBDENUM CONCENTRATION (mg/L)
- 809 0.3177 — NATURE AND EXTENT WELLS AVERAGE MOLYBDENUM CONCENTRATION (mg/L)
- CCR FLY ASH IMPOUNDMENT UNIT BOUNDARY

Date	MW-806R	MW-807	MW-808	MW-809	MW-810	MW-811	MW-812	MW-813	MW-814	MW-815	MW-816	MW-817	MW-818	MW-819	MW-820	MW-821	MW-822
11/15/2021	1.64	Not Installed	Not Installed	Not Installed	Not Installed	Not Installed	Not Installed	Not Installed	Not Installed	Not Installed	Not Installed	Not Installed	Not Installed	Not Installed	Not Installed	Not Installed	Not Installed
12/3/2021		ND	ND														
1/31/2022	1.63	NS	NS														
5/13/2022	1.50	0.0102	ND	0.405	0.0592	0.0274	0.0126	ND	0.0127								
6/15/2022	1.51	0.0075 | *0.00772*	0.319	0.0661	0.018	ND	ND	0.00723	0.00705								
8/19/2022	1.47	0.00618	ND	0.352 | *0.410*	0.0921	0.00899	ND	ND	0.0108	0.0116	ND	0.0056	dry	0.0147	ND	ND	ND
9/1/2022	1.51	0.00802	ND	0.331 | *0.342*	0.0835	0.0129	ND	ND	0.00877	0.00533	ND	0.00726	dry	ND	ND	ND	ND
Average	1.54	0.0074	0.0678	0.3177	0.0632	0.0136	0.0069	0.0056	0.0098	0.0085	ND	0.0064	dry	0.0099	ND	ND	ND

All molybdenum results reported in milligrams per liter (mg/L)

0.0075 | *0.00772* - Italics Values Are Duplicate Sample Results

NS - Not Sampled

ND - Not Detected Above Laboratory Reporting Limit 0.005 mg/L

REV. | DATE
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SHEET TITLE: MOLYBDENUM CONCENTRATION MAP

PROJECT TITLE: ASSESSMENT OF CORRECTIVE MEASURES

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CADD FILE: FIGURES 2, 3, & 5.DWG

DATE: 9/13/22

FIGURE NO. 5

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Missouri Geosciences Technical Resource Assesment Tool (GeoSTRAT)
(September 2, 2022)

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REV.	DATE
-	-

SHEET TITLE
NEAREST DOMESETIC AND/OR WATER SUPPLY WELLS

PROJECT TITLE
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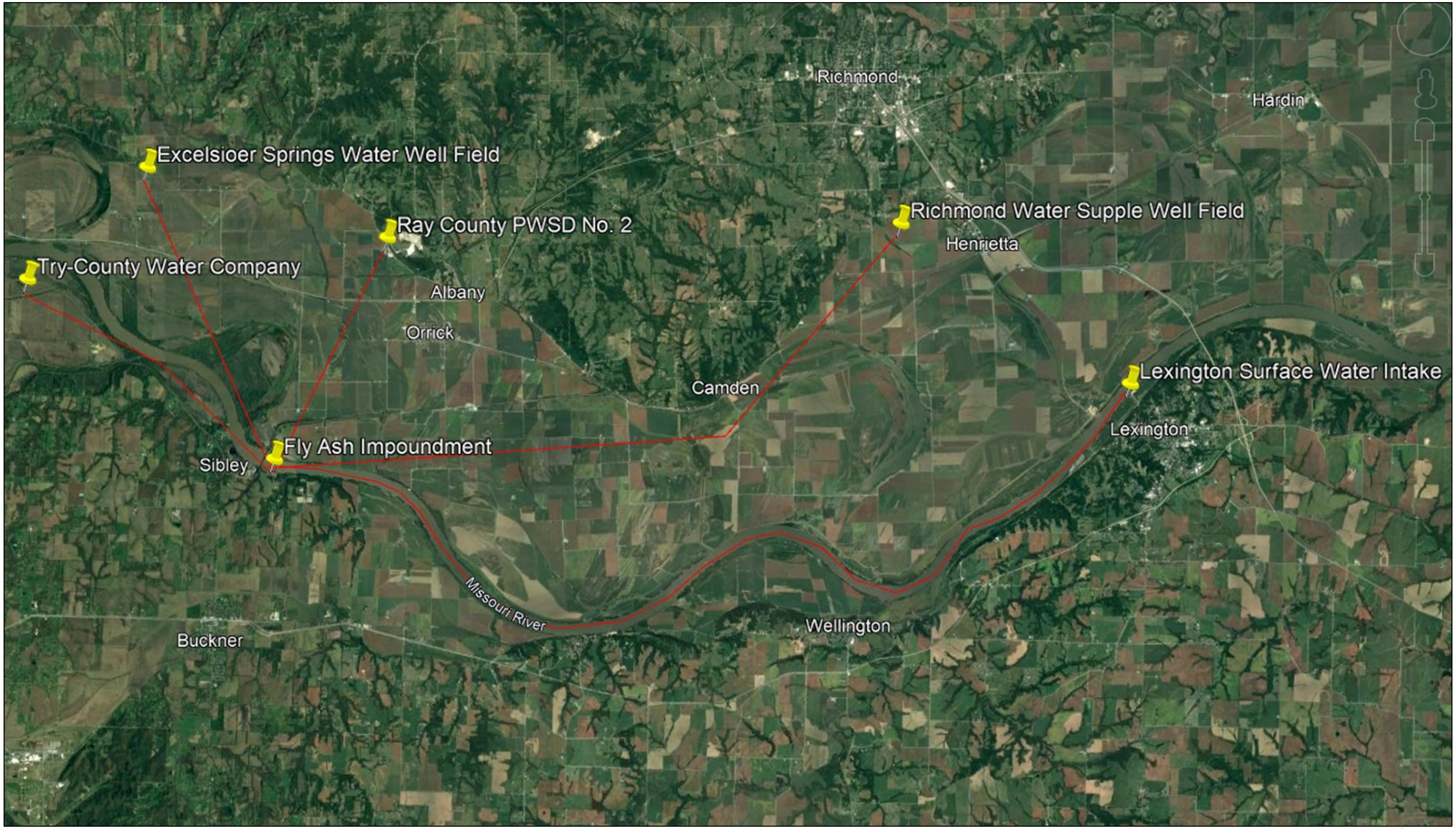
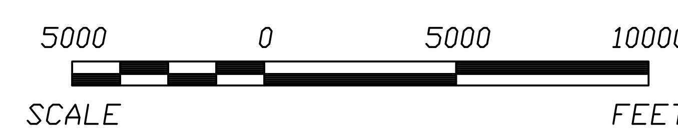
CADD FILE: FIGURES 4, 6-9.DWG

DATE: 9/8/22

FIGURE NO. 6





Google Image 9/14/2021

REV. | DATE
- | -

SHEET TITLE
NEAREST PUBLIC WATER SUPPLY AND SURFACE WATER INTAKE

PROJECT TITLE
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PROJ. MGR JRF

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DATE: 9/8/22

FIGURE NO. 7

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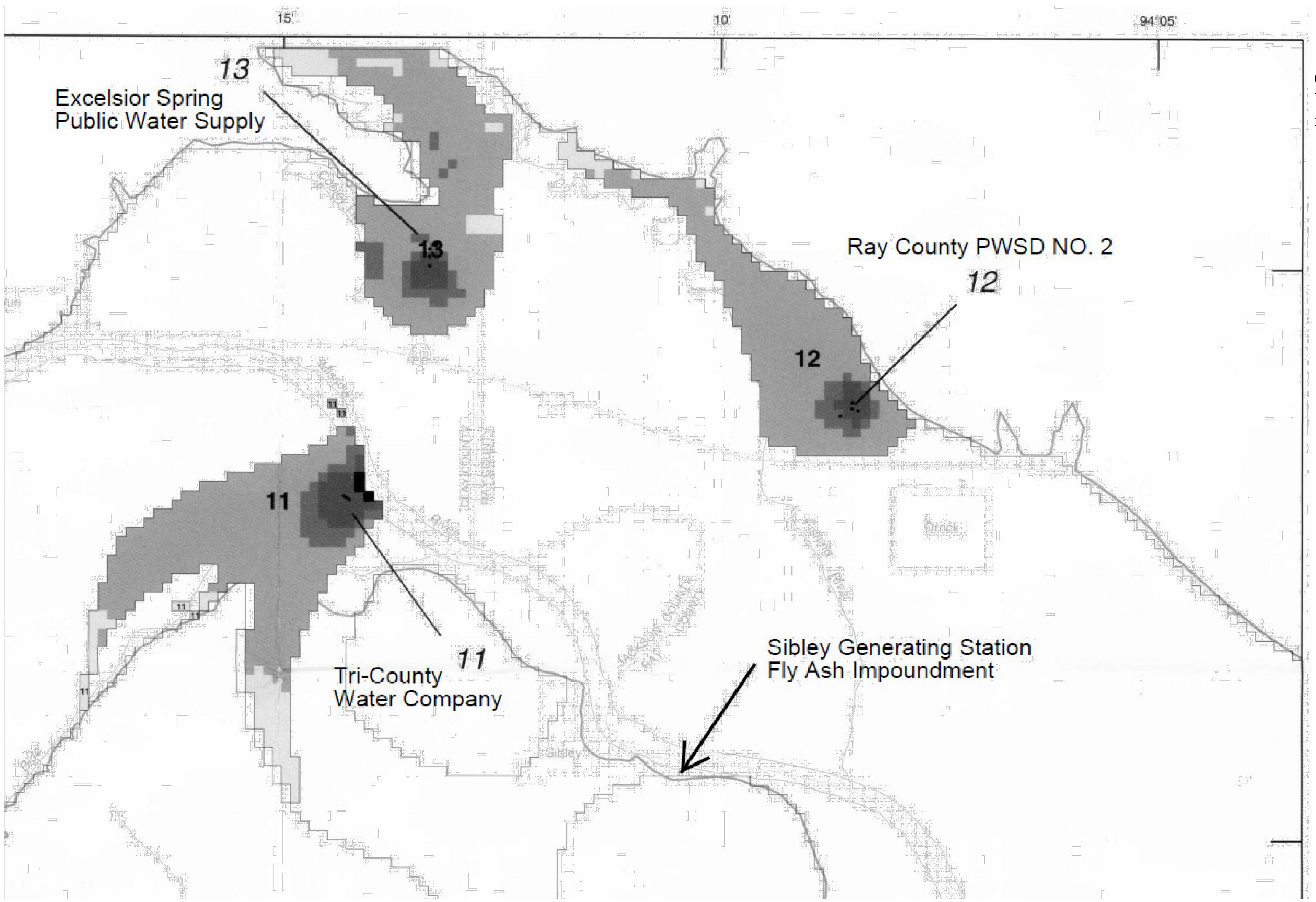
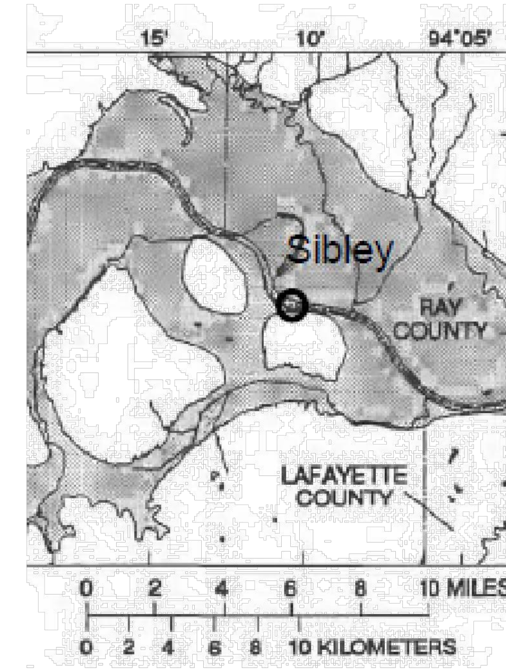


CONTRIBUTING RECHARGE AREA--Number in bold type (**5**) identifies water-supply well or well field receiving water from contributing recharge area

1-Year
100-Year
5-Year
1000-Year
10-Year

ACTIVE MODEL BOUNDARY
ALLUVIAL VALLEY BOUNDARY



Portion of Plate 6 - Map Showing Contributing Recharge Areas for the High-Pumping and High-River Stage Scenario, Missouri River Valley Alluvial Aquifer at Kansas City, Missouri and Kanas.

Kelly, Brian P., 1996, *Simulation of Ground-Water Flow and Contributing Recharge Areas in the Missouri River Alluvial Aquifer at Kansas City, Missouri and Kansas*, U.S. Geological Survey, Water-Resources Investigations Report 96-4250.

REV. DATE

SHEET TITLE PORTION OF MAP SHOWING CONTRIBUTING RECHARGE AREAS

PROJECT TITLE ASSESSMENT OF CORRECTIVE MEASURES

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PROJ. NO. 27213169.20
DSN. BY: ALR
DWN. BY: ALR
CHK. BY: JRF
Q/A RVW BY: JRF
PROJ. MGR: JRF

CADD FILE: FIGURES 4, 6-9.DWG

DATE: 9/8/22

FIGURE NO. 8

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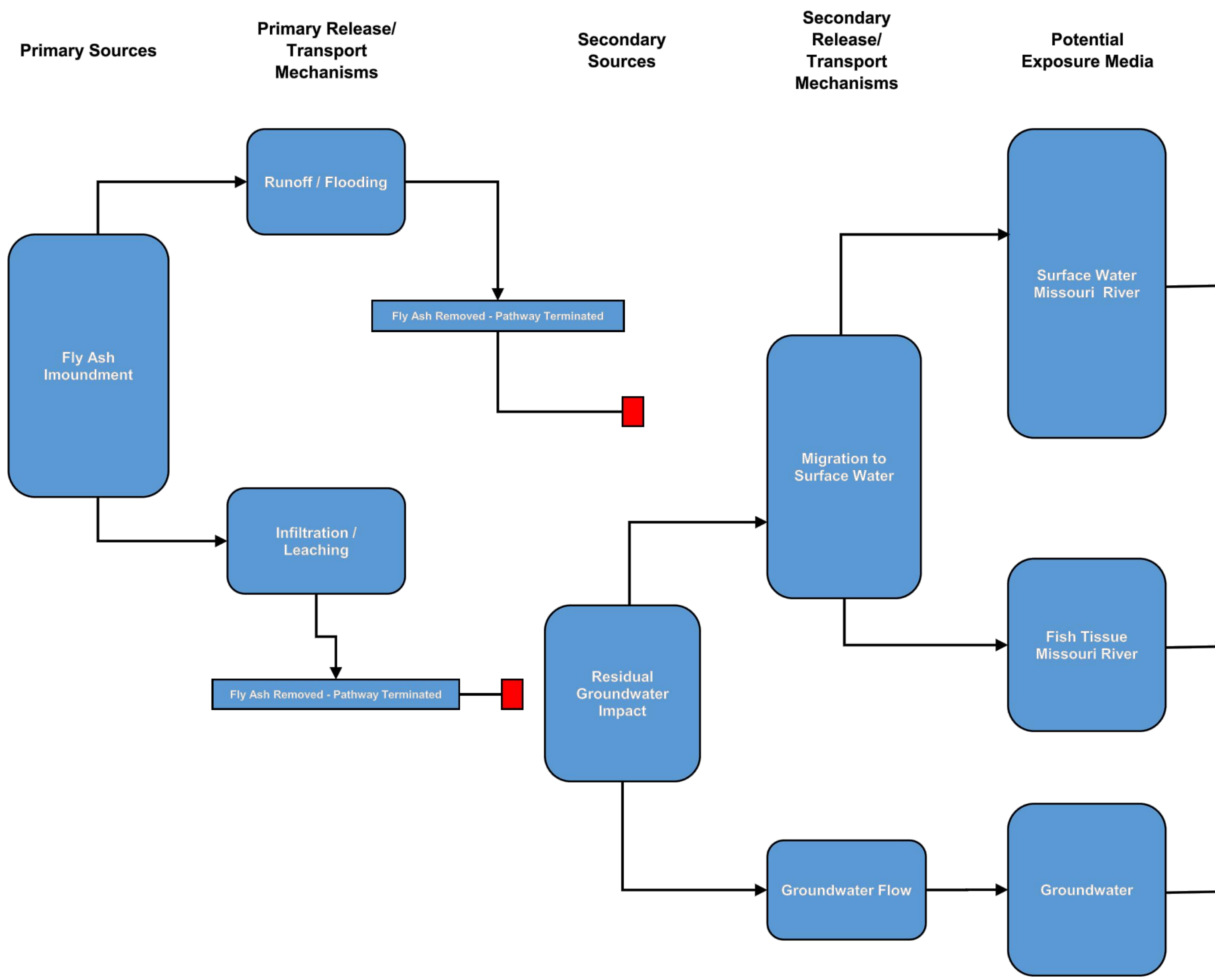
Exposure Conceptual Site Model
Sibley Generating Station, Jackson County, MO
Evergy Missouri West, Inc.



	Potential Human Health Receptors					Potential Ecological Receptors
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 Recreationl Fisher	Aquatic Receptors
Drinking Water Use	⊕ (a)	○	○	○	○	NA
Incidental Ingestion	○	⊕	⊕	⊕	⊕	NA
Dermal Contact	○	⊕	⊕	⊕	⊕	NA
Aquatic Exposure	NA	NA	NA	NA	NA	⊕

Ingestion	○	○	○	○	⊕	NA
Aquatic Exposure	NA	NA	NA	NA	NA	⊕

Drinking Water Use	○	○	○	○	○	NA
Aquatic Exposure	NA	NA	NA	NA	NA	○

● 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 approximately 19 miles downstream at Lexington, Missouri. Molybdenum was not detected above the laboratory detection limit for Missouri River samples.

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REV. DATE

SHEET TITLE EXPOSURE CONCEPTUAL SITE MODEL

PROJECT TITLE ASSESSMENT OF CORRECTIVE MEASURES

CLIENT EVERGY MISSOURI WEST, INC. SIBLEY GENERATING STATION SIBLEY, MISSOURI

SCS ENGINEERS
8575 W. 110th St. Ste. 100
Overland Park, Kansas 66210
PH. (913) 681-0030 FAX. (913) 681-0012

PROJ. NO. 27213169.20 DSN. BY: ALR DWN. BY: ALR CHK. BY: JRF Q/A RVW BY: JRF PROJ. MGR: JRF

CADD FILE: FIGURES 4, 6-9.DWG

DATE: 9/8/22

FIGURE NO. 9

TABLES

Table 1
Molybdenum Laboratory Results
(November 15, 2021 through September 1, 2022)
Sibley Generating Station - Fly Ash Impoundment

Date	MW-806R	MW-807	MW-808	MW-809	MW-810	MW-811	MW-812	MW-813	MW-814	MW-815	MW-816	MW-817	MW-818	MW-819	MW-820	MW-821	MW-822
11/15/2021	1.64	Not Installed	Not Installed														
12/3/2021		ND	ND	Not Installed	Not Installed	Not Installed	Not Installed	Not Installed	Not Installed								
1/31/2022	1.63	NS	NS							Not Installed	Not Installed	Not Installed	Not Installed	Not Installed	Not Installed	Not Installed	Not Installed
5/13/2022	1.50	0.0102	ND	0.405	0.0592	0.0274	0.0126	ND	0.0127								
6/15/2022	1.51	0.0075 *0.00772*	0.319	0.0661	0.018	ND	ND	0.00723	0.00705								
8/19/2022	1.47	0.00618	ND	0.352 *0.410*	0.0921	0.00899	ND	ND	0.0108	0.0116	ND	0.0056	dry	0.0147	ND	ND	ND
9/1/2022	1.51	0.00802	ND	0.331 *0.342*	0.0835	0.0129	ND	ND	0.00877	0.00533	ND	0.00726	dry	ND	ND	ND	ND
Average	1.54	0.0074	0.0678	0.3177	0.0632	0.0136	0.0069	0.0056	0.0098	0.0085	ND	0.0064	dry	0.0099	ND	ND	ND

All molybdenum results reported in milligrams per liter (mg/L)
0.0075 l *0.00772* - Italics Values Are Duplicate Sample Results
NS - Not Sampled
ND - Not Detected Above Laboratory Reporting Limit 0.005 mg/L

ATTACHMENT A

USEPA RSL Calculator Input and Output for Molybdenum

Site-specific
Recreator Surface Water Inputs
/HTML"Output to Spreadsheet
/HTML"Output to PDF</div>

Site-Specific RBSL
Recreator Expsoure to Surface Water

Variable	Recreator Surface Water Default Value	Site-Specific Value	
BW_{0-2} (body weight) kg	15	15	
BW_{2-6} (body weight) kg	15	15	
BW_{6-16} (body weight) kg	80	80	
BW_{16-30} (body weight) kg	80	80	
BW_{a} (body weight - adult) kg	80	80	
BW_{rec-a} (body weight - adult) kg	80	80	
$DFW_{rec-adj}$ (age-adjusted dermal factor) cm^2-event/kg	0	219161.861	calculated
$DFWM_{rec-adj}$ (mutagenic age-adjusted dermal factor) cm^2-event/kg	0	494880	calculated
ED_{rec} (exposure duration - recreator) years	26	26	
ED_{0-2} (exposure duration) years	2	2	
ED_{2-6} (exposure duration) years	4	4	
ED_{6-16} (exposure duration) years	10	10	
ED_{16-30} (exposure duration) years	10	10	
ED_{rec-a} (exposure duration - adult) years	20	20	
EF_{rec-w} (exposure frequency) days/year	0	33.846	calculated
EF_{2-6} (exposure frequency) days/year	0	20	
EF_{6-16} (exposure frequency) days/year	0	40	
EF_{16-30} (exposure frequency) days/year	0	40	
EF_{rec-a} (adult exposure frequency) days/year	0	40	
ET_{0-2} (exposure time) hours/event	0	0	
ET_{2-6} (exposure time) hours/event	0	2	
ET_{6-16} (exposure time) hours/event	0	3	
ET_{16-30} (exposure time) hours/event	0	3	
ET_{rec-a} (adult exposure time) hours/event	0	3	
EV_{0-2} (events) events/day	0	0	
EV_{2-6} (events) events/day	0	1	
EV_{6-16} (events) events/day	0	1	
EV_{16-30} (events) events/day	0	1	
EV_{rec-a} (adult) events/day	0	1	
THQ (target hazard quotient) unitless	0.1	1	
$IFW_{rec-adj}$ (age-adjusted water intake rate) L/kg	0	3.869	calculated
$IFWM_{rec-adj}$ (mutagenic age-adjusted water intake rate) L/kg	0	10.898	calculated
IRW_{0-2} (water intake rate) L/hour	0.12	0.12	
IRW_{2-6} (water intake rate) L/hour	0.12	0.12	
IRW_{6-16} (water intake rate) L/hour	0.124	0.124	
IRW_{16-30} (water intake rate) L/hour	0.0985	0.0985	
IRW_{rec} (water intake rate - adult) L/day	0.11	0.11	
IRW_{rec-a} (water intake rate - adult) L/hr	0.11	0.11	
LT (lifetime - recreator) years	70	70	
SA_{0-2} (skin surface area) cm^2	6365	6365	
SA_{2-6} (skin surface area) cm^2	6365	6365	
SA_{6-16} (skin surface area) cm^2	19652	19652	
SA_{16-30} (skin surface area) cm^2	19652	19652	
SA_{rec} (skin surface area - adult) cm^2	19652	19652	
SA_{rec-a} (skin surface area - adult) cm^2	19652	19652	
Apparent thickness of stratum corneum (cm)	0.001	0.001	
TR (target risk) unitless	0.000001	0.000001	

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Site-specific

Recreator Regional Screening Levels (RSL) for Surface Water

Key: I = IRIS; P = PPRTV; O = OPP; A = ATSDR; C = Cal EPA; X = PPRTV Screening Level; H = HEAST; D = OW; W = TEF applied; E = RPF applied; G = see user's guide; U = user provided; ca = cancer; nc = noncancer; * = where: nc SL < 100X ca SL; ** = where nc SL < 10X ca SL; SSL values are based on DAF=1; max = ceiling limit exceeded; sat = Csat exceeded.

Chemical	CAS Number	Mutagen?	Volatile?	Chemical Type	Chemical Type	SF_o(mg/kg-day)$^{-1}$	SF_o Ref	RfD (mg/kg-day)	RfD Ref	RfC (mg/m^3)	RfC Ref	RAGSe GIABS (unitless)	K_p (cm/hr)	MW	FA (unitless)	In EPD?	$DA_{event (ca)}$	$DA_{event (nc child)}$	$DA_{event (nc adult)}$	Ingestion SL TR=1E-06 (ug/L)	Dermal SL TR=1E-06 (ug/L)	Carcinogenic SL TR=1E-06 (ug/L)	Ingestion SL (Child) THQ=1 (ug/L)	Dermal SL (Child) THQ=1 (ug/L)	Noncarcinogenic SL (Child) THQ=1 (ug/L)	Ingestion SL (Adult) THQ=1 (ug/L)	Dermal SL (Adult) THQ=1 (ug/L)	Noncarcinogenic SL (Adult) THQ=1 (ug/L)	Screening Level (ug/L)
Molybdenum	7439-98-7	No	No	Inorganics	Inorganics	-		0.005	I	0.002	A	1.0	0.0	95.9	1.0	Yes	-	4.84E-01	1.86E-01	-	-	-	19200	363000	18300	11100	61900	9380	9380 nc

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ATTACHMENT B

Dilution Factor Calculation

CALCULATION SHEET – DILUTION FACTOR

Date: September 2, 2022

Project: Assessment of Corrective Measures (ACM)
Sibley Generating Station, Fly Ash Impoundment

Project No. 27222162.00

Prepared by: J. Rockhold Reviewed by: D. Doerr

The Missouri River is a large flowing river with an average daily flow in the vicinity of Sibley, Missouri of nearly 38 billion gallons per day. Even under low flow conditions, the flow can be over 11 billion gallons per day. In contrast, the conservatively high estimate of groundwater flow into the river along the bank adjacent to the Sibley FAI is just a fraction of the total river flow, at approximately 7 million gallons per day, or approximately 0.06 percent of the flow during low flow conditions and approximately 0.01 percent of the flow during average flow conditions. This ratio of flow is referred to as a "dilution factor" and is useful when assessing the relationship between smaller and larger water bodies. Below is the calculation of a dilution factor based on specific criteria and assumptions as specified.

Aquifer Discharge Length, Depth, and Area	Symbol	Value	Units
Estimated Length of Discharge Zone	L	2,500	ft
Estimated Aquifer Thickness (high water levels)	b_H	30	ft
Estimated Aquifer Thickness (low water Levels)	b_L	10	ft
Estimated Area of Discharge High ($L*b_H$)	A_H	75,000	ft^2
Estimated Area of Discharge Low ($L*b_L$)	A_L	25,000	ft^2

1. Estimated discharge length is the entire length of the FAI adjacent to the Missouri River. This is conservative given that the border of the area with elevated molybdenum concentrations is only approximately 500 feet.
2. The aquifer thickness for both high and low groundwater level scenarios are also conservative on the high side.

Groundwater Properties	Symbol	Value	Units
Hydraulic Conductivity Estimate High End (from DSI)	K	204	ft/day
Groundwater Gradient High End (from semi-annual monitoring)	i	0.06	ft/ft
Effective Porosity (from DSI)	n	30	%
Average Linear Velocity (V=Ki/n)	V	40.8	ft/day

1. A range of hydraulic conductivities was provide in the Detailed Hydrogeologic Site Investigation Report (DSI) (AECOM, 2017) and the high end estimate is used here to be conservative.
2. The groundwater gradient is from multiple years of semi-annual groundwater monitoring and the high end is used here to be conservative.

Groundwater Discharge	Symbol	Value	Units
Average Linear Velocity	V	40.8	ft/day
Estimated Area of Discharge High ($L*b_H$)	A_H	75,000	ft^2
Estimated Area of Discharge Low ($L*b_L$)	A_L	25,000	ft^2
Effective Porosity (from DSI)	n	30	%
Estimated Total Discharge High (Q_H=$V*A_H*n$)	Q_H	918,000	ft^3/day
Estimated Total Discharge Low (Q_L=$V*A_L*n$)	Q_L	306,000	ft^3/day
Estimated Total Discharge High (Q_H=$V*A_H*n$)	Q_H	6,866,640	gallons/day
Estimated Total Discharge Low (Q_L=$V*A_L*n$)	Q_L	2,288,880	gallons/day

1. A discharge estimate is provided for the for both the high and low groundwater level scenarios.
2. Discharge estimates are provided in both ft^3/day and gallons/day.

Missouri River Flow	Value	Units
1Q10 Low Flow Discharge (from NPDES Permit)	17,664	cfs
Seconds per Day	86,400	sec/day
1Q10 Low Flow Discharge in ft^3/day	1,526,152,320	ft^3/day
1Q10 Low Flow Discharge in gallons/day	11,415,619,354	gallons/day

1. 1Q10 is the lowest 1-day flow that occurs (on average) once every 10 years. It was determined from Missouri River data from 9/1/1999 through 9/2/2019 from gauging station 06893000 (Kansas City, MO). This value was obtained from the Sibley Generating Station NPDES Permit No. MO-0004871.
2. Discharge estimates are provided in both ft^3/day and gallons/day.

Dilution Factor	Value	Units
Estimated Daily Groundwater Discharge High	918,000	ft^3/day
Estimated Daily Groundwater Discharge Low	306,000	ft^3/day
Missouri River 1Q10 Low Flow Discharge	1,526,152,320	ft^3/day
Estimated Dilution Factor (River / GW_{high})	**1,662**	**Unitless**
Estimated Dilution Factor (River / GW_{low})	**4,987**	**Unitless**

1. A dilution factor is provided for both high and low groundwater level scenarios.

Conservative Assumptions

1. Calculations are based on low flow river conditions. Use of average flow river conditions would significantly increase the dilution factor.
2. The area discharging groundwater to the river is conservative in that it uses the entire length of the fly ash impoundment and not just the length with elevated molybdenum concentrations. If the shorter length were used, it would have significantly increased the dilution factor.
3. The alluvial aquifer hydraulic conductivity assumed higher permeability sands are present, resulting in higher estimates of groundwater discharge, and subsequently a lower (more conservative) dilution factor.