



**Second Semiannual Report on the
Progress of Remedy Selection**

**TVA Shawnee Fossil Plant,
Paducah, McCracken County,
Kentucky**

July 15, 2020

Prepared for:

Tennessee Valley Authority
Chattanooga, Tennessee

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1.0 Introduction

In accordance with 40 CFR § 257.97(a), the Tennessee Valley Authority (TVA) has prepared this second semiannual report to document progress toward remedy selection and design at the Ash Pond 2 and the Special Waste Landfill, also known as the Consolidated Waste Dry Stack (CWDS). Hereinafter, these units are referred to as the coal combustion residuals (CCR) Units, which are located at the Shawnee Fossil Plant (SHF) in Paducah, McCracken County, Kentucky. These CCR Units share a common, multiunit groundwater monitoring well network.

1.1 Regulatory Background

On April 17, 2015, the United States Environmental Protection Agency (U.S. EPA) published a rule that sets forth national criteria for the management of CCR produced by electric utilities. The requirements can be found in Title 40, Code of Federal Regulations (CFR) Part 257, Subpart D. The rule includes requirements for monitoring groundwater and assessing corrective measures if constituents listed in Appendix IV of the rule are detected in groundwater samples collected from downgradient monitoring wells at statistically significant levels (SSLs) greater than established groundwater protection standards (GWPS).

In January 2019, TVA determined if there were SSLs over established GWPS as defined in 40 CFR § 257.95(h) for one or more Appendix IV constituents in accordance with 40 CFR § 257.95(g). This evaluation identified an SSL greater than the GWPS for molybdenum at monitoring well D-74B. Since this time, TVA has updated the statistical analysis.

- In late 2019, TVA recalculated the statistical analysis after incorporating additional groundwater monitoring data from the second assessment monitoring event in 2019.
- In mid-2020, TVA updated the statistical analysis after incorporating results from the second assessment monitoring retest event in 2019 and the first semiannual groundwater assessment monitoring event in 2020.

After inclusion in the statistical analysis of the data from 2019 and the first semiannual assessment monitoring event of 2020, the D-74B SSL for molybdenum was no longer evident. Despite the absence of an SSL in the current data set, TVA is continuing to evaluate potential remedies in accordance with 40 CFR § 257.97 in the event that future monitoring data demonstrates the need for corrective measures. TVA conducted an alternate source investigation, as allowed under 40 CFR § 257.95(g)(3)(ii) but did not identify a source for the molybdenum SSL detection other than the CCR Units associated with well D-74B.

In accordance with 40 CFR § 257.96(a), TVA prepared the 2019 Assessment of Corrective Measures (ACM) Report for the CCR Units at SHF, placed it in the facility operating record on July 15, 2019 and uploaded it to the TVA CCR Rule Compliance Data and Information website on August 14, 2019. The ACM Report provided an assessment of the effectiveness of potential corrective measures in achieving the criteria provided in 40 CFR § 257.96(c). Three primary strategies were evaluated to address groundwater exhibiting concentrations of molybdenum above the GWPS:

- Monitored Natural Attenuation (MNA);
- Hydraulic Containment and Treatment; and,

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- Enhanced In-Situ Treatment (EIST).

Following preparation of the ACM Report, TVA began the remedy selection process. Semiannual reports are required pursuant to 40 CFR § 257.97(a) to document progress toward remedy selection and design. The CCR Rule contemplates that more investigation and consideration may be needed to evaluate and design the remedy before making the final selection. TVA placed the first Semiannual Report on the Progress of Remedy Selection into the facility operating record on January 15, 2020 pursuant to 40 CFR § 257.97(a) and § 257.105(h)(12). TVA provided notification of the availability of the semiannual report describing the progress in selecting and designing the remedy and placed it on the TVA CCR Rule Compliance Data and Information website on February 14, 2020 in accordance with 40 CFR § 257.106(h)(9) and § 257.107(h)(9). TVA will continue to review new data as it becomes available and implement changes to the groundwater monitoring and corrective action program as necessary to maintain compliance with 40 CFR § 257.90 through § 257.98.

At least 30 days prior to final groundwater remedy selection pursuant to the CCR Rule, a public meeting will be held with interested and affected parties to discuss the results of the corrective measures assessment in accordance with 40 CFR § 257.96(e). The selected remedy must meet the requirements of 40 CFR § 257.97(b) and must consider the evaluation factors set forth in 40 CFR § 257.97(c). Once a final remedy is chosen, a final report describing the remedy and how it meets the standards set forth in 40 CFR § 257.97(b) will be prepared. The owner/operator must provide a schedule for implementing the selected remedy that considers the factors set forth in 40 CFR § 257.97(d).

1.2 Report Contents

This second semiannual progress report provides a summary of SHF site characteristics, the groundwater assessment monitoring program, the findings of the ACM process, and the current progress of selecting and designing a final remedy for statistically significant GWPS exceedances.

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2.0 Site Background and Characteristics

SHF is located in Paducah, McCracken County, Kentucky. The facility lies on the south bank of the Ohio River. **Figure 1** shows an overview map of SHF including the CCR Units. Construction of SHF began in 1951, and operations commenced in the 1960s. The coal combustion process at SHF has resulted in the production of fly ash, bottom ash, and flue gas desulfurization (FGD) sludge. The plant remains operational and currently manages these materials in Ash Pond 2 and the Consolidated Waste Dry Stack.

The Ash Pond 2 CCR Unit is an active CCR surface impoundment and includes the Main Ash Pond and the Stilling Pond. It encompasses approximately 100 acres and is formed by perimeter dikes along the east, north, and west, and by the CWDS to the south. It is bordered on the north by the Ohio River and the west by Little Bayou Creek. Ash Pond 2 receives sluiced bottom ash, plant effluent, and stormwater runoff from the plant, CWDS, and Coal Yard Drainage Basin. The CWDS is an active CCR landfill that is approximately 185-acres in size and rises approximately 100 feet above the surrounding terrain. The landfill currently receives dry fly ash mixed with FGD wastes from the plant, and dredged bottom ash from Ash Pond 2.

2.1 Conceptual Site Model Summary

The hydrogeologic conceptual site model (CSM) is one of the primary tools that can be used to support decisions on corrective measures. This section of the report provides a summary of the hydrogeologic CSM. The geology and hydrogeology of the SHF site have been characterized during implementation of multiple investigations. These investigations provide an understanding of site geology and the presence of water-bearing zones.

The subsurface geology at SHF is characterized into four stratigraphic units, which includes from surface to depth, the Upper Alluvium (UA), Upper Continental Deposits (UCD), the Regional Gravel Aquifer (RGA) and the McNairy Formation. The RGA is the upper-most aquifer being monitored at the CCR Units in accordance with 40 CFR § 257.91. A typical cross-section view of the subsurface geology is shown on **Figure 2**. Groundwater flow direction is primarily northeast towards the Ohio River. **Figure 3** presents a groundwater flow direction map for the RGA at SHF.

2.2 Potential Receptor Review

Most of the public water supply in the area is provided by the West McCracken County Water District (WMCWD). The WMCWD purchases its water from the Paducah Water Works (PWW), which withdraws its water from the Ohio River. The PWW plant is located upstream of SHF. The nearest identified downstream surface water intake for drinking water is located approximately 30 miles downstream. Water from this intake location serves residents of Cairo, Illinois.

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3.0 Groundwater Assessment Monitoring Program

Groundwater assessment monitoring for the CCR Units is conducted at SHF in accordance with 40 CFR § 257.95.

3.1 Groundwater Monitoring Well Network

In compliance with 40 CFR § 257.91, one RGA background well (SHF-102G) was established upgradient and four RGA monitoring wells (D-11B, SHF-101G, D-74B and D-30B) were installed downgradient and comprise the multiunit well network for the Consolidated Waste Dry Stack and Ash Pond 2. The locations of these monitoring wells are presented on **Figure 1**.

3.2 Groundwater Characterization

Groundwater assessment monitoring was conducted during 2018 and 2019, and at the time of this report, the first semiannual assessment monitoring event in 2020 had been conducted. Molybdenum, an Appendix IV constituent, was previously detected at SSLs above the GWPS. The following summarizes the Appendix IV SSLs at the SHF CCR Units for 2018, 2019, and the first semiannual assessment monitoring event in 2020.

- Molybdenum
 - An SSL for molybdenum was identified at monitoring well D-74B in 2018; however, this apparent SSL was not evident in the statistical analysis after inclusion of groundwater monitoring data collected during 2019 and for the first semiannual assessment monitoring event 2020¹
 - The molybdenum GWPS is 100 µg/L

Data from existing wells have been utilized to characterize the nature and extent of any release from the CCR Units as required by 40 CFR § 257.95(g)(1).

¹ Scheduled groundwater sampling events between January and April 2020 could not be completed due to prolonged elevated Ohio River stage.

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4.0 Assessment of Corrective Measures

TVA prepared the 2019 ACM Report for the CCR Units and added it to the operating record on July 15, 2019. The report was posted to the TVA CCR Rule Compliance Data and Information website on August 14, 2019. The ACM Report provided an assessment of the effectiveness of potential corrective measures in achieving the criteria provided in 40 CFR § 257.96(c).

4.1 Planned Source Control Measures

The objectives of corrective measures under 40 CFR § 257.96(a) are to “prevent further releases [from the CCR units], to remediate any releases, and to restore affected areas to original conditions.” Ultimately, in accordance with 40 CFR § 257.97(b)(3), the selected corrective measure must at a minimum “[c]ontrol the source(s) of releases so as to reduce or eliminate, to the maximum extent feasible, further releases of constituents of Appendix IV to this part into the environment.”

The Preamble (80 Fed. Reg. 21302, 21406) to the CCR Rule discusses that source control measures may include modifying operational procedures. To achieve TVA’s commitment to comply with regulatory requirements and timeframes under the CCR Rule, TVA will close the CCR Units which include both Ash Pond 2 and the CWDS. TVA will close the CCR Units in accordance with 40 CFR § 257.102.

Closure of the CCR Units cannot be initiated until new process water basins (PWBs) are operational. Once the new lined PWBs are constructed, CCR, and process water flows to Ash Pond 2 will cease. At that time, dewatering operations can commence at Ash Pond 2. The new PWBs are currently under construction with an anticipated completion date in early fall of 2020.

The closure described above will reduce the potential for releases and migration of CCR constituents. Groundwater assessment monitoring as required by 40 CFR § 257.96(b) will continue until a remedy is selected. The monitoring will be conducted to track changes in groundwater conditions as a result of these closures and operational changes. These data will also be considered in the selection and design of a remedy in accordance with 40 CFR § 257.97.

4.2 Potential Remedial Technologies

Subject to necessary environmental reviews, the CCR Units will be closed in accordance with the criteria set forth in 40 CFR § 257.102.

In addition to source control measures, three primary strategies were evaluated to address groundwater exhibiting concentrations of molybdenum above the GWPS including:

- Monitored Natural Attenuation (MNA);
- Hydraulic Containment and Treatment; and,
- Enhanced In-Situ Treatment (EIST).

The ACM Report provides a more detailed description of these corrective measures. The effectiveness of each potential corrective measure was assessed in accordance with 40 CFR § 257.96(c) and all measures are currently considered feasible for remediating the groundwater at the CCR Units.

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5.0 Selection of Remedy: Current Progress

Groundwater monitoring conducted through 2018 identified the presence of an SSL for molybdenum in monitoring well D-74B. However, inclusion of subsequent groundwater monitoring data collected during 2019 and 2020 did not confirm this SSL. Nevertheless, TVA is continuing to evaluate potential remedies in accordance with 40 CFR § 257.97 in the event that future monitoring data demonstrates the need for corrective measures.

If necessary, upon selection of a remedy, the owner or operator must prepare a final report (i.e., Remedy Selection Report) describing the selected remedy and how it meets the standards specified below pursuant to 40 CFR §257.97(b)(1)-(5). Remedies must: (1) Be protective of human health and the environment; (2) Attain the groundwater protection standard as specified pursuant to §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 §257.98(d).

In support of the remedy selection process, additional investigation has been conducted and is described below.

5.1 Data Requirements for Design of Groundwater Corrective Action

To further refine the targeted area for potential corrective measures, develop remedial cost estimates, and finalize alternatives for the CCR Units, recently collected site-specific data has further defined the extent of molybdenum impacts downgradient of the CCR Units.

Recent activities completed to further evaluate site conditions include:

- Nine soil borings were advanced on the northeast side of the CCR Units as a screening-level investigation to identify nature and extent of dissolved molybdenum (reference **Figure 4** for the locations of the soil borings).
- Surface water sampling was conducted in Little Bayou Creek and the Ohio River, along with sampling of water contained within Ash Pond 2, to assess water quality and whether molybdenum is present (reference **Figure 4** for the approximate locations of the surface water and ash pond water samples).
- Pressure transducers and data loggers were installed in monitoring wells surrounding the CCR Units to collect groundwater elevations that will be used to refine a groundwater flow model.

The potential treatment zone to address dissolved molybdenum along the perimeter of the CCR Units is illustrated on **Figure 5**. Additional investigations and activities that are described below are needed to address potential data gaps.

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Current and potential future activities to further evaluate MNA include:

- A geochemical investigation is being conducted to evaluate groundwater and aquifer solids in areas downgradient of the CCR Units.
- Groundwater Flow Modeling – Numerical modeling of groundwater flow based on expanded groundwater elevation data gained from the ongoing pressure transducer data collection and additional hydrogeologic characterization efforts will be used to further refine the understanding of groundwater flow direction and velocity.
- Groundwater Fate and Transport Modeling – The refined groundwater flow model might be linked to a fate and transport model to further evaluate the estimated time for natural attenuation mechanisms to reduce the molybdenum concentrations previously observed at monitoring well D-74B.

Potential future activities to further evaluate hydraulic containment and treatment:

- Groundwater Flow Modeling – The numerical groundwater flow model might be used to evaluate hydraulic containment. A calibrated groundwater model might be used to evaluate a variety of approaches (e.g., vertical wells, horizontal wells, physical barriers) and to estimate the groundwater extraction rates necessary to contain an identified target zone. The objective of hydraulic containment modeling would be to incorporate groundwater extraction scenarios to optimize hydraulic containment of molybdenum-impacted groundwater while balancing extracted groundwater treatment requirements.
- Supplemental Hydraulic Properties Evaluation – This evaluation could be necessary if the existing understanding of the hydraulic characteristics of the subsurface are not sufficient to evaluate hydraulic capture geometry and potential groundwater recovery rates. If needed, installation of new wells and performance of pumping tests to evaluate hydraulic capture geometry and potential groundwater recovery rates would feed back into the groundwater flow modeling simulations for groundwater extraction. This data would inform the feasibility, design, and implementation of any groundwater recovery systems.
- Wastewater Treatment Capacity Study – Evaluation of an on-site, temporary wastewater treatment system will be needed to understand options for extracted groundwater treatment should the hydraulic containment and treatment option be considered.

Potential future activities to evaluate Enhanced In-situ Treatment:

- Groundwater Treatability Study – For treatment of extracted groundwater, treatability studies will be needed to evaluate technologies for the treatment of molybdenum.

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5.2 Semiannual Reporting, Public Meeting, Remedy Selection and Final Report

Progress toward the selection and design of the remedy will be documented in semiannual reports in accordance with 40 CFR § 257.97(a). Semiannual reports will be placed into the facility operating record pursuant to 40 CFR § 257.105(h)(12). TVA will provide notifications of the availability of the semiannual reports describing the progress in selecting and designing the remedy and will place the reports on the TVA CCR Rule Compliance Data and Information website in accordance with 40 CFR § 257.106(h)(9) and § 257.107(h)(9) respectively 30 days after placement in the facility operating record. At least 30 days prior to selecting a remedy, a public meeting to discuss the results of the corrective measures assessment will be conducted as required by 40 CFR § 257.96(e). A final report will be prepared after the remedy is selected. This final report will describe the remedy and how it meets the standards specified in 40 CFR § 257.97(b) and 257.97(c). Recordkeeping requirements specified in 40 CFR § 257.105(h), notification requirements specified in 40 CFR § 257.106(h), and internet requirements specified in 40 CFR § 257.107(h) will be complied with as required by 40 CFR § 257.96(f).

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Attachments:

Figures

Figure 1 – CCR Units with Background and Downgradient Wells

Figure 2 – Conceptual Geological Cross-Section

Figure 3 – Groundwater Flow Direction

Figure 4 – Site Investigation Locations

Figure 5 – Monitoring Wells and Limits of COI Impacts

FIGURE 1
CCR UNITS WITH BACKGROUND AND
DOWNGRADIENT WELLS



Legend

- Background Well (CCR Rule)
- Downgradient Well (CCR Rule)
- CCR Units Subject to CCR Rule
- SHF Site Boundary



Notes

1. Coordinate System: NAD 1983 StatePlane Kentucky South FIPS 1602 Feet
2. Background: TVA 2016 Imagery

0 750 1,500 Feet
(At original document size of 8.5x11)
1:18,000

Project Location
West Paducah
McCracken County, KY

Client/Project
Tennessee Valley Authority
Shawnee Fossil Plant
CCR Rule

Prepared by LMB on 2020-07-14
Technical Review by EP on 2020-07-14
Independent Review by JB on 2020-07-14

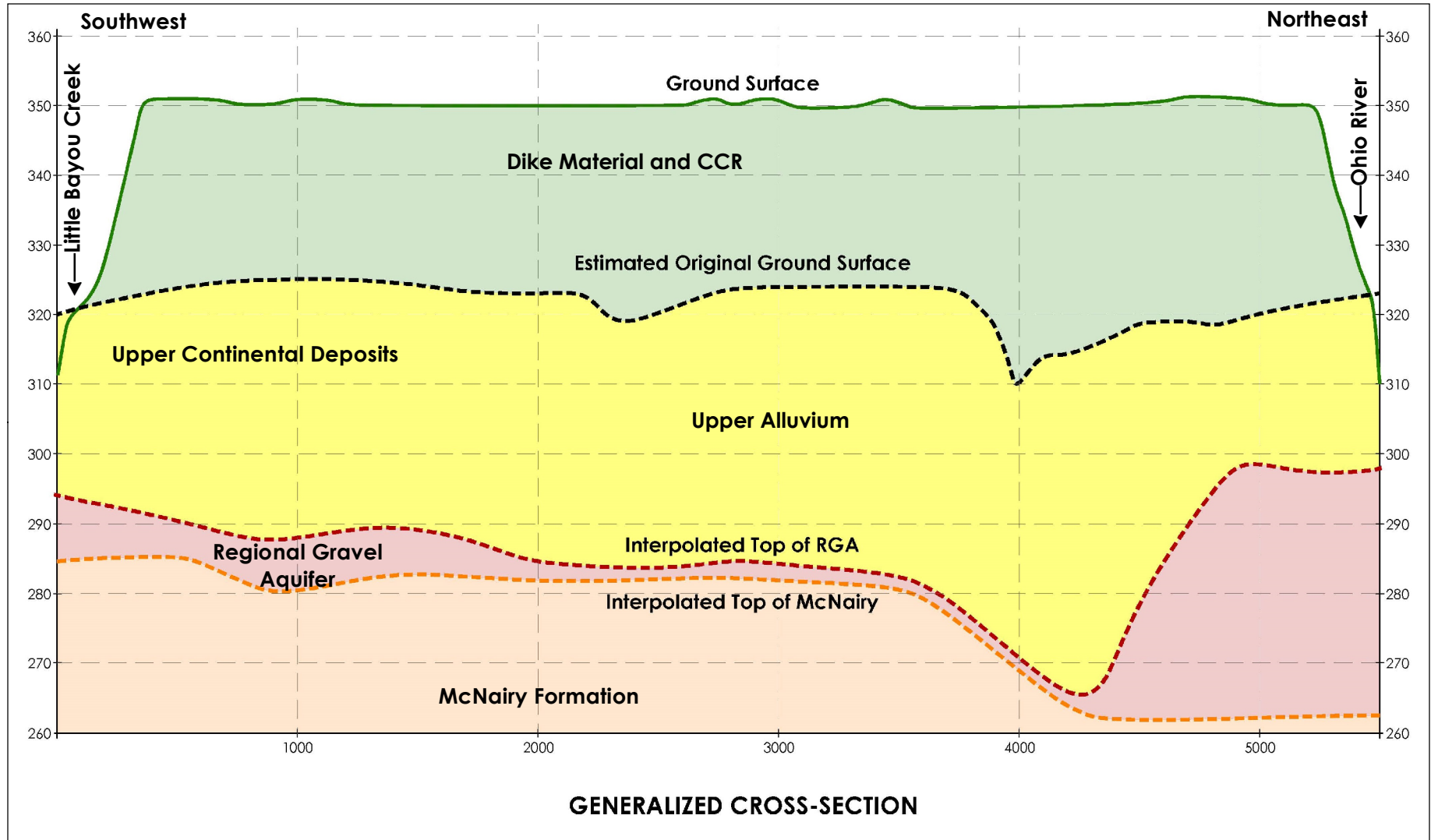
182603526

Figure No.
Figure 1

Title
**CCR Units With Background
and Downgradient Wells**



FIGURE 2
CONCEPTUAL GEOLOGICAL CROSS-SECTION



- Legend**
- Dike Material / CCR
 - Upper Continental Deposits / Upper Alluvium
 - Regional Gravel Aquifer (RGA)
 - McNairy Formation



Project Location
West Paducah
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CCR Rule

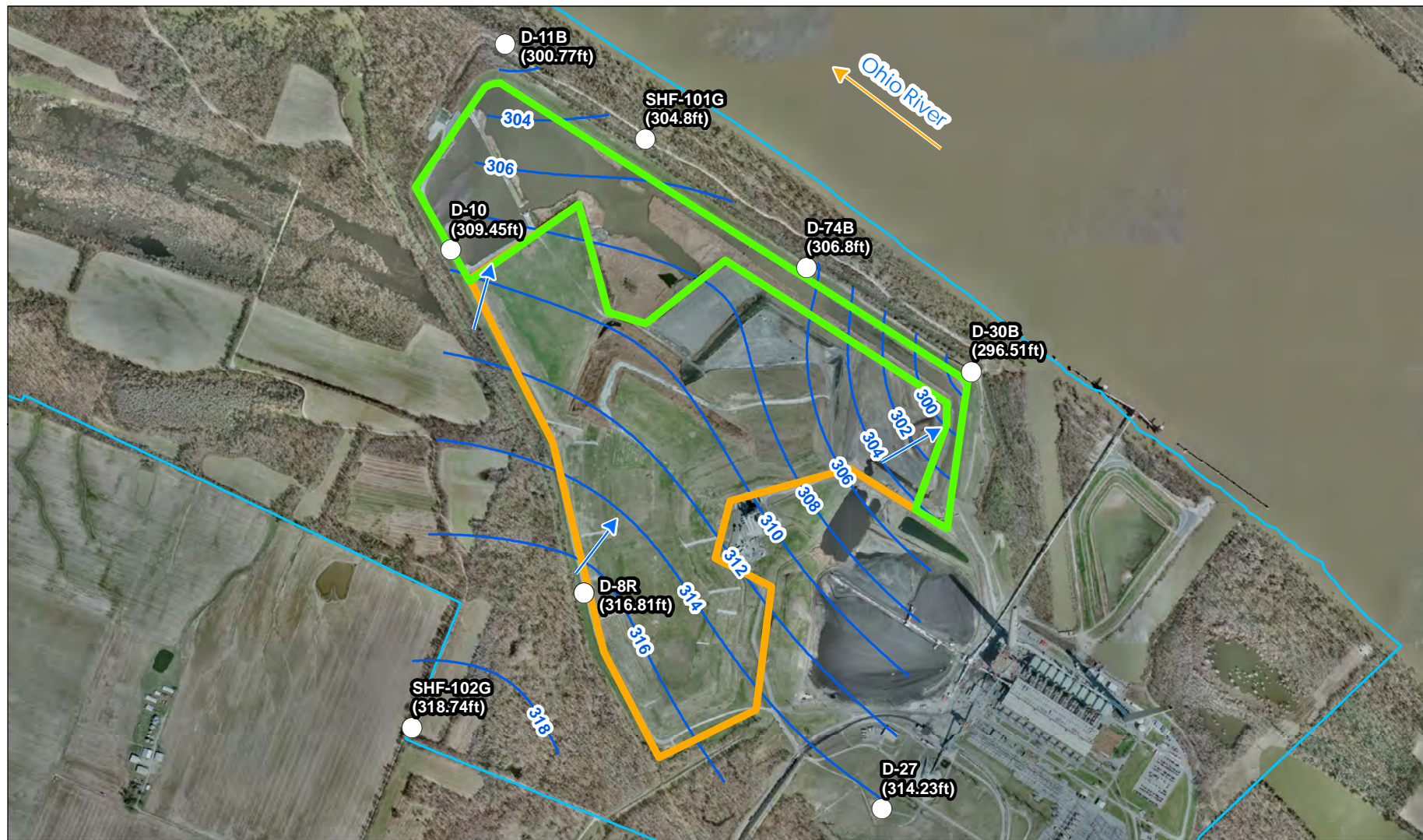
Figure No.
Figure 2

Title
**Conceptual Geologic
Cross-Section**

Prepared by LMB on 2020-07-14
Technical Review by EP on 2020-07-14
Independent Review by JB on 2020-07-14

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FIGURE 3
GROUNDWATER FLOW DIRECTION



Legend

- Monitoring Well
- Ash Pond 2 (Main Ash Pond/Stilling Pond)
- Consolidated Waste Dry Stack
- SHF Site Boundary

- Groundwater Elevation Contours (CI = 2 Feet)
- Groundwater Flow Direction



Notes

1. Coordinate System: NAD 1983 StatePlane Kentucky South FIPS 1602 Feet
2. Background: TVA 2016 Imagery

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(At original document size of 8.5x11)
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Project Location Prepared by LMB on 2020-06-10
West Paducah Technical Review by EP on 2020-06-10
McCracken County, KY Independent Review by JB on 2020-06-10
Client/Project 182603526
Tennessee Valley Authority
Shawnee Fossil Plant
CCR Rule

Figure No.

Figure 3

Title

Groundwater Flow Direction

FIGURE 4
SITE INVESTIGATION LOCATIONS



Legend

- Surface Water Samples
- Background Well (CCR Rule)
- Downgradient Well (CCR Rule)
- Investigation Well
- ▲ Geoprobe Boring
- Investigation Area
- CCR Units Subject to CCR Rule
- SHF Site Boundary



Notes

1. Coordinate System: NAD 1983 StatePlane Kentucky South FIPS 1602 Feet
2. Background: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

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Project Location
West Paducah
McCracken County, KY

Client/Project
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Shawnee Fossil Plant
CCR Rule

Prepared by LMB on 2020-07-14
Technical Review by EP on 2020-07-14
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Figure No.

Figure 4

Site Investigation Locations



FIGURE 5
MONITORING WELLS AND LIMITS OF
COI IMPACTS



Legend

- Staff Gauge
- Investigation Well
- Background Well (CCR Rule)
- Downgradient Well (CCR Rule)
- Potential Molybdenum Treatment Zone

- CCR Units Subject to CCR Rule
- SHF Site Boundary



Notes

1. Coordinate System: NAD 1983 StatePlane Kentucky South FIPS 1602 Feet
2. Background: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

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Project Location: West Paducah, McCracken County, KY
Client/Project: Tennessee Valley Authority, Shawnee Fossil Plant, CCR Rule
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Figure No.
Figure 5

Title
Monitoring Wells and Limits of COI Impacts