



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

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

January 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 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 CCR Multiunit, which are located at the Shawnee Fossil Plant (SHF) in Paducah, McCracken County, Kentucky.

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 coal combustion residuals (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 completed an evaluation of whether 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. TVA recalculated the statistical analysis in mid-2019 after incorporating additional groundwater monitoring data from the first assessment monitoring event and retest event in 2019. In late-2019, TVA updated the statistical analysis after incorporating results from the second semiannual groundwater monitoring event. After inclusion of the 2019 data in the statistical analysis, 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 future monitoring data demonstrates their necessity. TVA conducted an alternate source investigation, as allowed under 40 CFR § 257.95(g)(3)(ii) but did not identify a source other than the CCR Multiunit associated with well D-74B that caused the molybdenum SSL.

In accordance with 40 CFR § 257.96(a), TVA prepared the 2019 Assessment of Corrective Measures (ACM) Report for the CCR Multiunit at SHF, placed it in the facility operating record on July 15, 2019 and uploaded it to the public 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,
- 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

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design the remedy before making the final selection. 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 when the final remedy is selected, 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 first 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 remedy for the groundwater.

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 Multiunit. Construction of SHF began in 1951, and operations commenced in the 1960's. 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 or 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 subsurface geology at SHF is characterized into three hydro-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 Multiunit in accordance with 40 CFR § 257.91. A typical cross-section view of the subsurface geology is shown on **Figure 2**.

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 a thorough understanding of site geology and the presence of water-bearing zones. 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.

3.0 Groundwater Assessment Monitoring Program

Groundwater assessment monitoring for the CCR Multiunit 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 of the CCR Multiunit. The locations of these monitoring wells, and additional monitoring wells installed for the investigation, are presented on **Figure 1**.

3.2 Groundwater Characterization

Groundwater assessment monitoring was conducted during 2018 and 2019. Molybdenum, an Appendix IV constituent, was detected at SSLs above the GWPS. The following summarizes the 2018 and 2019 Appendix IV SSLs at the SHF CCR Multiunit:

- 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.
 - 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 Unit as required by 40 CFR 257.95(g)(1). The potential treatment zone to address the extent of molybdenum above GWPS along the unit perimeter is illustrated on **Figure 4**.

4.0 Assessment of Corrective Measures

TVA prepared the 2019 ACM Report for the CCR Multiunit 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 Multiunit which includes both Ash Pond 2 and the CWDS. To achieve TVA’s commitment to comply with regulatory requirements and timeframes under the CCR Rule, TVA will close the CCR Unit in accordance with 40 CFR § 257.102.

Closure of the CCR Unit cannot be initiated until new lined CCR units are constructed and new Process Water Basins (PWBs) are operational. Once the new lined PWBs are constructed, CCR and process water flows to Ash Pond 2 and the CDWS will cease. At that time the CCR Multiunit can be completely removed from service and dewatering operations can commence. The new PWBs are currently under construction with an anticipated completion date prior to October 31, 2020.

The initial closure methods 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 all necessary environmental reviews, the CCR Multiunit will be closed in accordance with the requirements 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).

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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 are currently considered feasible for remediating the groundwater at the CCR Multiunit.

5.0 Selection of Remedy: Current Progress

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

In support of the remedy selection process, additional investigation is needed 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 the alternative for CCR Multiunit, the currently available site-specific data is further refining the characterization of the extent of molybdenum impacts downgradient of the CCR Unit and additional investigations and activities that are described below are needed to address potential data gaps.

Current activities to further evaluate site conditions include:

- Nine soil borings are being advanced on the northeast side of the CCR Multiunit as a screening-level investigation to identify nature and extent of dissolved molybdenum (reference **Figure 5** for the approximate locations of the soil borings).
- Surface water sampling is being conducted in Ash Pond 2, Little Bayou Creek and the Ohio River to assess surface water quality and whether molybdenum is present (reference **Figure 5** for the approximate locations of the surface water samples).
- Slug testing will be performed at several existing monitoring well locations surrounding the CCR Multiunit to further evaluate hydraulic conductivity.
- Pressure transducers and data loggers will be installed in monitoring wells surrounding the CCR Multiunit to collect groundwater elevations that will refine the groundwater flow model.
- A geochemical investigation will be conducted to evaluate groundwater and aquifer solids in areas downgradient of the CCR Multiunit.

Current activities to further evaluate MNA:

- Supplemental Groundwater Flow Modeling Simulations – The existing groundwater flow model is currently being refined based on expanded groundwater elevation data gained from additional hydrogeologic characterization efforts. These flow model refinements are expected to be completed in the second quarter of 2020.
- Supplemental Groundwater Fate and Transport Modeling Simulations – The refined groundwater flow model will first be calibrated to more recent existing conditions before conducting groundwater fate and transport modeling. Fate and transport modeling is expected to start in the second quarter of 2020 following completion of the above groundwater flow simulations. The fate and transport model will be used to further evaluate the estimated time for natural attenuation mechanisms to reduce the molybdenum concentrations to below GWPS.

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Current activities to further evaluate hydraulic containment and treatment:

- Supplemental Groundwater Flow Modeling Simulations – The existing groundwater flow model developed is currently being refined based on expanded groundwater elevation data gained from additional hydrogeologic characterization efforts. These flow model refinements will incorporate several groundwater extraction scenarios to optimize hydraulic containment of molybdenum-impacted groundwater while balancing extracted groundwater treatment requirements.

Potential future activities to further evaluate hydraulic containment and treatment:

- Groundwater Treatability Study - For ex-situ treatment of extracted groundwater, treatability studies will be needed to evaluate technologies for the treatment of molybdenum.
- 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. These data would inform the feasibility, design, and implementation of any groundwater recovery systems.
- Wastewater Treatment Capacity Study – Evaluation of an on-site 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 ex-situ treatment of extracted groundwater, treatability studies will be needed to evaluate technologies for the treatment of molybdenum.
- Supplemental Hydraulic Properties Evaluation – A groundwater extraction well and three nested piezometer couplets will be installed proximal to monitoring well D-74B to conduct a 72-hour pump test to evaluate hydraulic capture geometry and potential groundwater recovery rates. These data would feed back into the groundwater flow modeling simulations for groundwater extraction to inform the feasibility, design, and implementation of any groundwater recovery systems.

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). 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 Multiunit with Background and Downgradient Wells

Figure 2 – Conceptual Geological Cross-Section

Figure 3 – Groundwater Flow Direction

Figure 4 – Monitoring Wells and Limits of COI Impacts

Figure 5 – ACM Semiannual Report 1 Assessment Activities

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- Legend**
- Background Well
 - Downgradient Well
 - Investigation Well
 - CCR Unit Subject to CCR Rule
 - SHF Site Boundary



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

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

Project Location Prepared by LMB on 2019-07-11
 West Paducah Technical Review by EP on 2019-07-11
 McCracken County, KY Independent Review by JB on 2019-07-11
Client/Project 182603475
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 Shawnee Fossil Plant
 CCR Rule

Figure No.

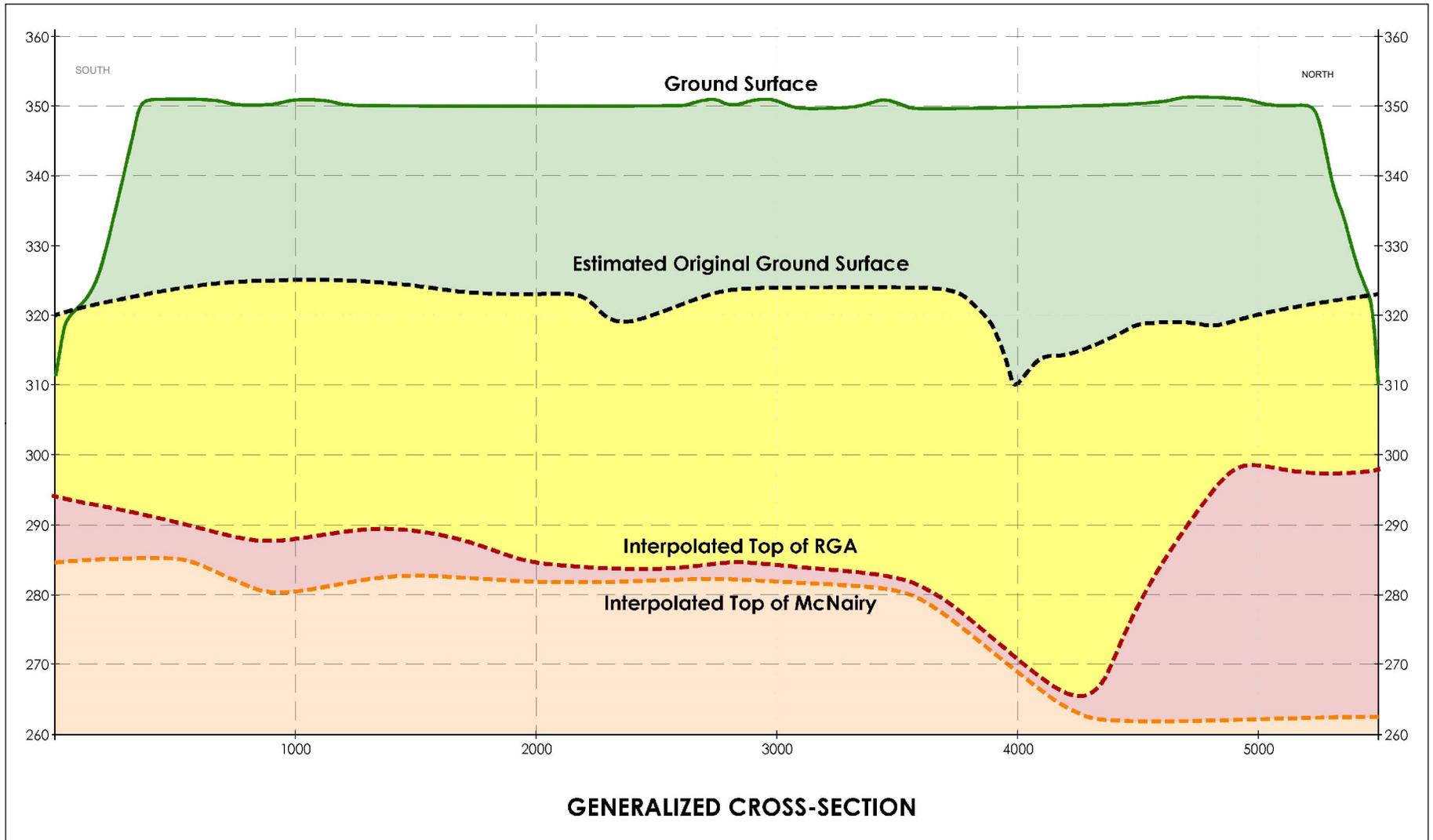
Figure 1

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



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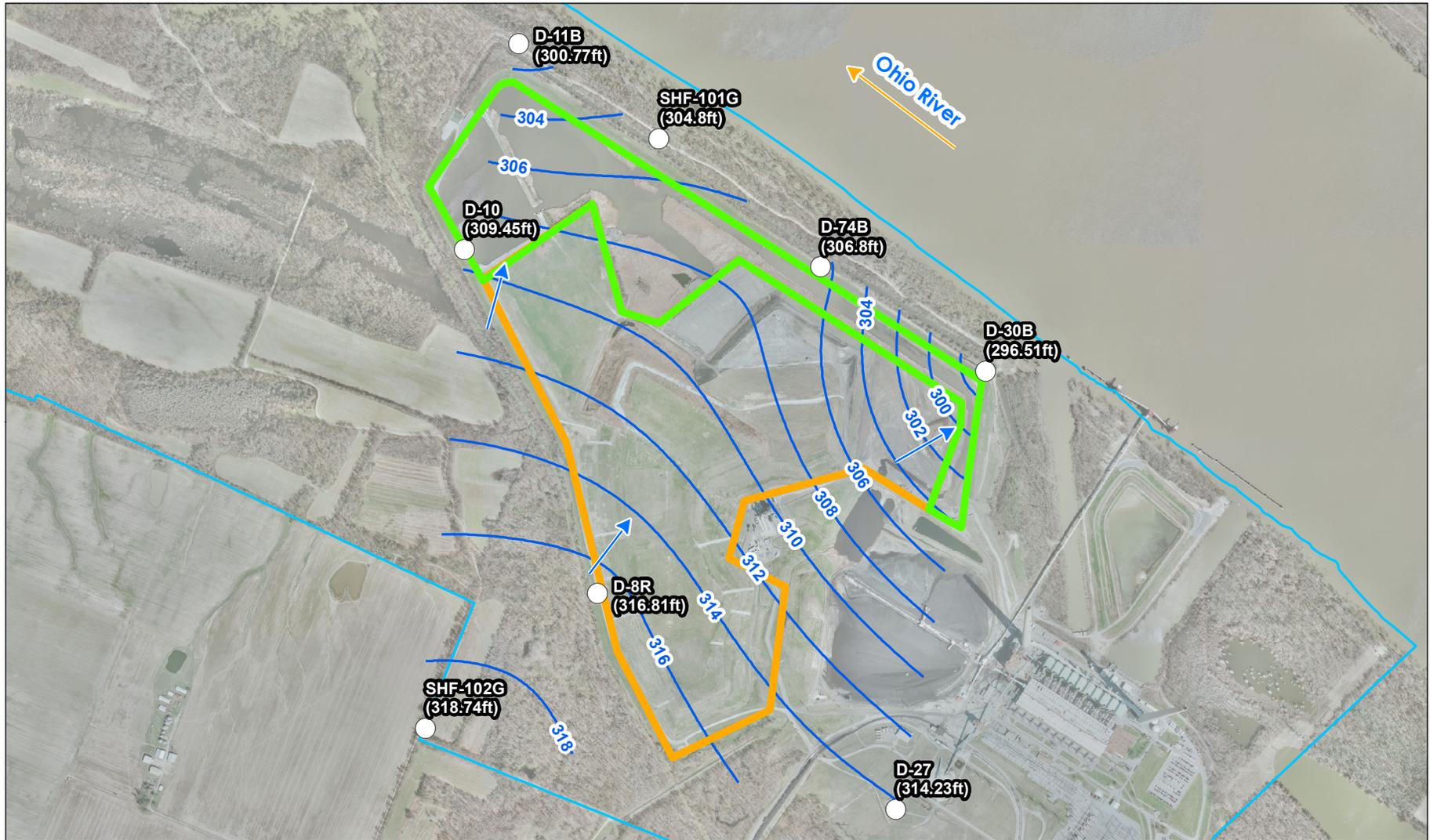
Project Location: West Paducah, McCracken County, KY
 Prepared by LMB on 2019-07-11
 Technical Review by EP on 2019-07-11
 Independent Review by JB on 2019-07-11
 Client/Project: Tennessee Valley Authority, Shawnee Fossil Plant, CCR Rule
 182603475

Figure 2
 Title: **Conceptual Geologic Cross-Section**



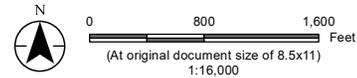
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Legend

- Monitoring Well
- CCR Ash Pond 2 (Main Ash Pond/Stilling Pond)
- Consolidated Waste Dry Stack CCR Landfill
- SHF Site Boundary
- Groundwater Elevation Contours (CI = 2 Feet)
- Groundwater Flow Direction



- Notes**
- Coordinate System: NAD 1983 StatePlane Kentucky South FIPS 1602 Feet
 - Background: TVA 2016 Imagery

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 Shawnee Fossil Plant
 CCR Rule

Figure No.
Figure 3
Title
Groundwater Flow Direction

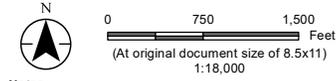


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- Legend**
- ▲ Staff Gauge
 - Investigation Well
 - Background Well
 - Downgradient Well
 - Potential Molybdenum Treatment Zone

- CCR Unit Subject to CCR Rule
- SHF Site Boundary



Notes

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Figure No.
Figure 4
Title
Monitoring Wells and Limits of COI Impacts



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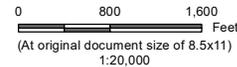
Legend

- Proposed Surface Water Samples
- Background Well
- Downgradient Well
- Investigation Well
- Stilling Well
- ▲ Proposed Geoprobe Borings
- Impacted Zone
- CCR Unit 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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Figure 5

Title
**ACM Semiannual Report 1
 Assessment Activities**

