



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

**TVA Allen Fossil Plant, Shelby
County, Memphis, Tennessee**

January 15, 2020

Prepared for:

Tennessee Valley Authority
Chattanooga, Tennessee

Prepared by:

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1.0 Introduction

In accordance with 40 CFR § 257.97(a), the Tennessee Valley Authority (TVA) has prepared this semi-annual report to document progress toward remedy selection and design at the East Ash Disposal Area (EADA) at the Allen Fossil Plant (ALF) in Memphis, Shelby County, Tennessee.

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). At the EADA, assessment monitoring in 2018 detected SSLs greater than the GWPS for arsenic at monitoring wells ALF-202, ALF-203, and ALF-204; fluoride at monitoring well ALF-203; lead at monitoring well ALF-203; and, molybdenum at monitoring wells ALF-202, ALF-203, and ALF-205. TVA recalculated the statistical analysis in mid-2019 after incorporating additional groundwater monitoring data from the first assessment monitoring event and retest event. In late-2019, TVA updated the statistical analysis after incorporating results from the second semiannual assessment monitoring event. There continues to be SSLs above the GWPS for arsenic in wells ALF-202, ALF-203, and ALF-204; for lead in well ALF-203; and for molybdenum in wells ALF-202 and ALF-203. However, unlike during 2018, there was not an SSL over the GWPS for fluoride in well ALF-203 or molybdenum in well ALF-205. As of the date of this report, TVA has not completed a demonstration that a source other than the EADA caused the SSLs, as allowed under 40 CFR § 257.95(g)(3)(ii).

In accordance with 40 CFR § 257.96(a), TVA prepared the 2019 Assessment of Corrective Measures (ACM) Report for the EADA at ALF, 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 statistical exceedances above the GWPS:

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

Following preparation of the ACM Report, TVA has initiated 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

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evaluate and 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 Summary of State Required Investigation and Remedy Selection Process

TVA is currently conducting an additional environmental investigation (EI) of ALF under the oversight of TDEC through the TDEC Commissioner's Order issued on August 6, 2015. In response to the detection of atypical arsenic concentrations in monitoring wells ALF-202, ALF-203 and ALF-204, TVA initiated site characterization actions in advance of the commissioner's order as summarized below:

- In May 2017, TVA began an investigation to delineate constituents of interest (COIs) in groundwater around the EADA.
- In June 2017, the Tennessee Department of Environment and Conservation (TDEC) requested that TVA investigate arsenic-impacted groundwater outside the scope of the TDEC Commissioner's Order, OGC 15-0177 (TDEC Order), under the oversight of the TDEC Division of Remediation.
- In July 2017, TDEC requested TVA to develop a Remedial Investigation (RI) Work Plan with respect to TVA's ongoing investigation.
- On May 31, 2019, the final RI report was submitted to TDEC.

Once the environmental investigation is complete under the TDEC Order, TVA will submit environmental assessment reports (EARs) that provide an analysis of the extent of CCR contamination, including groundwater contamination, at each site to TDEC for approval. Then, as part of the TDEC Order process, TVA will submit a Corrective Action/Risk Assessment (CARA) Plan that specifies actions that TVA plans to take at a site, including corrective measures for groundwater remediation. TDEC must approve the CARA Plans, including the CCR unit closure methodologies, selected final remedy(s) and corrective measures for groundwater remediation.

1.3 Report Contents

This first semiannual progress report provides a summary of ALF 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 the GWPS exceedances.

2.0 Site Background and Characteristics

ALF is located in Memphis, Shelby County, Tennessee. The facility lies on the south bank of McKellar Lake and the eastern bank of the Mississippi River. **Figure 1** shows an overview map of ALF including the EADA. Construction of ALF began in 1956, and ALF was fully operational by 1959. Coal-fired power generation ceased in March of 2018. The coal combustion process at ALF resulted in the production of fly ash and bottom ash. The plant most recently managed these materials in the EADA.

The EADA at ALF encompasses approximately 85 acres and is formed by perimeter dikes that rise approximately 25 feet above surrounding land. Soil borings indicate that a clay layer is present at the base of the CCR Unit. During plant operations, the EADA received sluiced fly ash and bottom ash, plant effluent, and stormwater runoff from the Coal Storage Area and the Coal Yard Runoff Pond. All flows to the EADA ceased in April 2019.

The subsurface geology at ALF is characterized by three hydro-stratigraphic units, which from surface to depth include the Alluvial aquifer, the Upper Claiborne confining unit (Claiborne), and the Memphis aquifer. The Alluvial aquifer is the upper-most aquifer at ALF and groundwater from this hydro-stratigraphic unit is monitored in accordance with 40 CFR § 257.91. A typical conceptual cross-section view of the subsurface geology is shown on **Figure 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. The geology and hydrogeology of the ALF site have been characterized during implementation of multiple investigations. These investigations provide a detailed understanding of site geology and the presence of water-bearing zones. Groundwater flow direction is highly dependent on the surface water elevation of McKellar Lake. During periods of low surface water elevation in McKellar Lake, groundwater flow is to the north, towards the lake. During periods of high surface water elevation in McKellar Lake, flow direction can be reversed and flow to the south. **Figure 3** presents a groundwater flow direction map at ALF during a period of high surface water elevation in McKellar Lake.

2.2 Potential Receptor Review

The Memphis aquifer is the primary source of drinking water in the area. The City of Memphis obtains its water supply from multiple well fields that withdraw water from the Memphis aquifer. Except for the Davis Well Field, the well fields are more than 5.5 miles east of ALF. The Davis Well Field is located approximately two miles south of ALF.

3.0 Groundwater Assessment Monitoring Program

Groundwater assessment monitoring for the EADA is conducted at ALF in accordance with 40 CFR § 257.95.

3.1 Groundwater Monitoring Well Network

In compliance with 40 CFR § 257.91, one background well (ALF-210) was established upgradient and eight monitoring wells (ALF-201, ALF-202, ALF-203, ALF-204, ALF-205, ALF-206, ALF-212, and ALF-213) were installed downgradient of the EADA. The locations of these monitoring wells, as well as locations for several additional monitoring wells being used for the RI and TDEC Order EI are presented on **Figure 1**.

3.2 Groundwater Characterization

Groundwater assessment monitoring was conducted during 2018 and 2019. Appendix IV constituents including arsenic, lead, and molybdenum were detected at SSLs above the GWPS. The following summarizes the 2018 and 2019 Appendix IV exceedances at the EADA.

- Arsenic
 - SSLs for arsenic were identified at monitoring wells ALF-202, ALF-203, and ALF-204;
 - The GWPS for arsenic is 14 µg/L;
- Fluoride
 - An SSL for fluoride was identified at monitoring well ALF-203 in 2018; however, this apparent SSL was not evident in the statistical analysis after inclusion of groundwater monitoring data collected during 2019;
- Lead
 - An SSL for lead was identified at ALF-203;
 - The lead GWPS is 15 µg/L;
- Molybdenum
 - An SSL for molybdenum was identified at monitoring well ALF-205 in 2018; however, this apparent SSL was not evident in the statistical analysis after inclusion of groundwater monitoring data collected during 2019;
 - SSLs for molybdenum were identified at ALF-202 and ALF-203;
 - The molybdenum GWPS is 100 µg/L.

The potential treatment zone to address the extent of COIs above the GWPS along the unit perimeter is illustrated on **Figure 4**. The work performed under the 2019 RI and the TDEC Order process will further inform the evaluation and selection of the remedy(s) under 40 CFR § 257.97 of the CCR Rule.

4.0 Assessment of Corrective Measures

TVA prepared the 2019 ACM Report for the EADA and placed it in 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 convert from wet to dry handling of CCR and to comply with regulatory requirements and timeframes under the CCR Rule, TVA has removed the EADA from service and has initiated closure. Subject to the necessary environmental review, the preferred alternative for closure of the EADA is closure by removal in accordance with 40 CFR § 257.102(c). In the interim through the RI process, TVA has initiated measures to control and begin treating impacted groundwater, and to remove free water and ash porewater from the EADA.

These measures will reduce the potential for migration of CCR constituents to groundwater. Continued semiannual groundwater assessment 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. Groundwater assessment monitoring as required by 40 CFR § 257.96(b) will continue until a final groundwater remedy is selected.

4.2 Potential Remedial Technologies

Subject to necessary environmental reviews, the EADA 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 COIs 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 potential effectiveness of each corrective measure identified above was assessed in accordance with 40 CFR § 257.96(c) and each is currently considered feasible for remediating the groundwater at the EADA.

5.0 Selection of Remedy: Current Progress

A remedy to address SSLs in groundwater will be selected in accordance with 40 CFR § 257.97, the RI, and the CARA Plan required by the TDEC Order.

In support of the remedy selection process, additional investigation is needed and is described below in Section 5.1. Through the RI process, TVA has initiated interim measures to control and begin treating impacted groundwater, and to remove free water and ash porewater from the EADA through a dewatering process. The following activities have been completed to date as part of the interim remedial measure:

- Completed the installation of two extraction wells situated on the north and south sides of the EADA (reference **Figure 5**);
- Completed the installation of three performance monitoring well triplets around each extraction well (reference **Figure 5**);
- Completed groundwater modeling of the two extraction wells situated on the north and south sides of the EADA;
- Characterized extracted groundwater (influent) for purposes of evaluating influent treatment options. This characterization identified arsenic and pH as the key influent criteria;
- Evaluated three influent treatment processes including 1) chemical coagulation using ferric chloride; 2) electrocoagulation; and, 3) alumina adsorption media;
- Initiated the design of a groundwater treatment system based on coagulation, settling and filtration with an estimated 93% removal rate for arsenic; and
- Obtained a pre-treatment permit from the City of Memphis with a permitted maximum flow of 360 gallons per minute (gpm).

Data collected to support the design and implementation of the interim measure will also be used to support the selection of a final remedy for groundwater.

Source control measures are being implemented for the EADA. In April 2019, the unit ceased receipt of flows from the plant, and surface water has been pumped and removed from the EADA. Porewater decanting is ongoing to facilitate removal of the CCR material from the EADA.

5.1 Data Requirements for Design of Groundwater Corrective Action

The horizontal and vertical extent of Appendix IV COI (arsenic, lead and molybdenum) impacts at the EADA has been largely characterized as a result of the 2019 RI. In order to further refine the targeted area for corrective measures, develop remedial cost estimates, and finalize the proposed alternative for the EADA, additional site-specific data may be required to address potential data gaps. It is noted that additional data collection requirements may include ongoing EI work that is reported separately.

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Potential future activities to further evaluate MNA:

- Supplemental Groundwater Fate and Transport Modeling Simulations – The refined groundwater flow model will first be calibrated to site conditions following implementation of source control measures following dewatering of the EADA and removal of the CCR material. Then, groundwater fate and transport modeling can be performed. The fate and transport model will be used to further evaluate COI migration potential and support evaluation of MNA as a potential component of the remedy.

Current activities to further evaluate hydraulic containment and treatment:

- Wastewater Treatment Capacity Study – Evaluation of the existing City of Memphis wastewater treatment system capacity is being conducted to understand options for extracted groundwater treatment should the hydraulic containment and treatment option be selected following the implementation of source control measures.
- Groundwater modeling to evaluate probable extraction rates for the interim remedial measure has been completed. Based on these simulations, capture of the area of COIs in groundwater greater than the GWPS can be achieved by operating the four extraction wells situated north of the EADA, and the five extraction wells situated south of the EADA, at sustained flow rates of approximately 81 and 124 gpm, respectively.

Potential future activities to further evaluate hydraulic containment and treatment:

- Supplemental Groundwater Flow Modeling Simulations – The existing groundwater flow model developed for the RI is currently being refined based on expanded groundwater elevation data gained from the ongoing EI and additional hydrogeologic characterization efforts. These flow model refinements will incorporate several groundwater extraction scenarios to optimize hydraulic containment of arsenic, lead, and molybdenum-impacted groundwater while balancing extracted groundwater treatment requirements following implementation of source control measures.
- Supplemental Hydraulic Properties Evaluation – Following implementation of the source control measures discussed above, this evaluation could be necessary if the existing understanding of the hydraulic characteristics of the subsurface is not sufficient to evaluate hydraulic capture geometry and potential groundwater recovery rates. Further refinement of the groundwater flow model and the CSM may be necessary in response to changes observed in response to source control measures.

Potential future activities to evaluate Enhanced In-situ Treatment:

- Groundwater Treatability Study – Following implementation of the source control measures discussed above, bench-scale treatability studies may be conducted on representative groundwater samples to inform the final selection of a groundwater corrective measure/remedy.

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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 semi-annual 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).

6.0 References

Stantec. (2019a). *Annual Groundwater Monitoring and Corrective Action Report, Allen Fossil Plant, East Ash Disposal Area CCR Unit*. January 31.

Stantec. (2019b). *Notice of Intent to Close – CCR Surface Impoundment, EOA Final CCR Rule 40 CFR 257.102), East Ash Disposal Area, TVA Allen Fossil Plant*. April 23.

TVA. (2016). *Final Ash Impoundment Closure Environmental Impact Statement Part 1 – Programmatic NEPA Review*. June.

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Attachments:

Figures

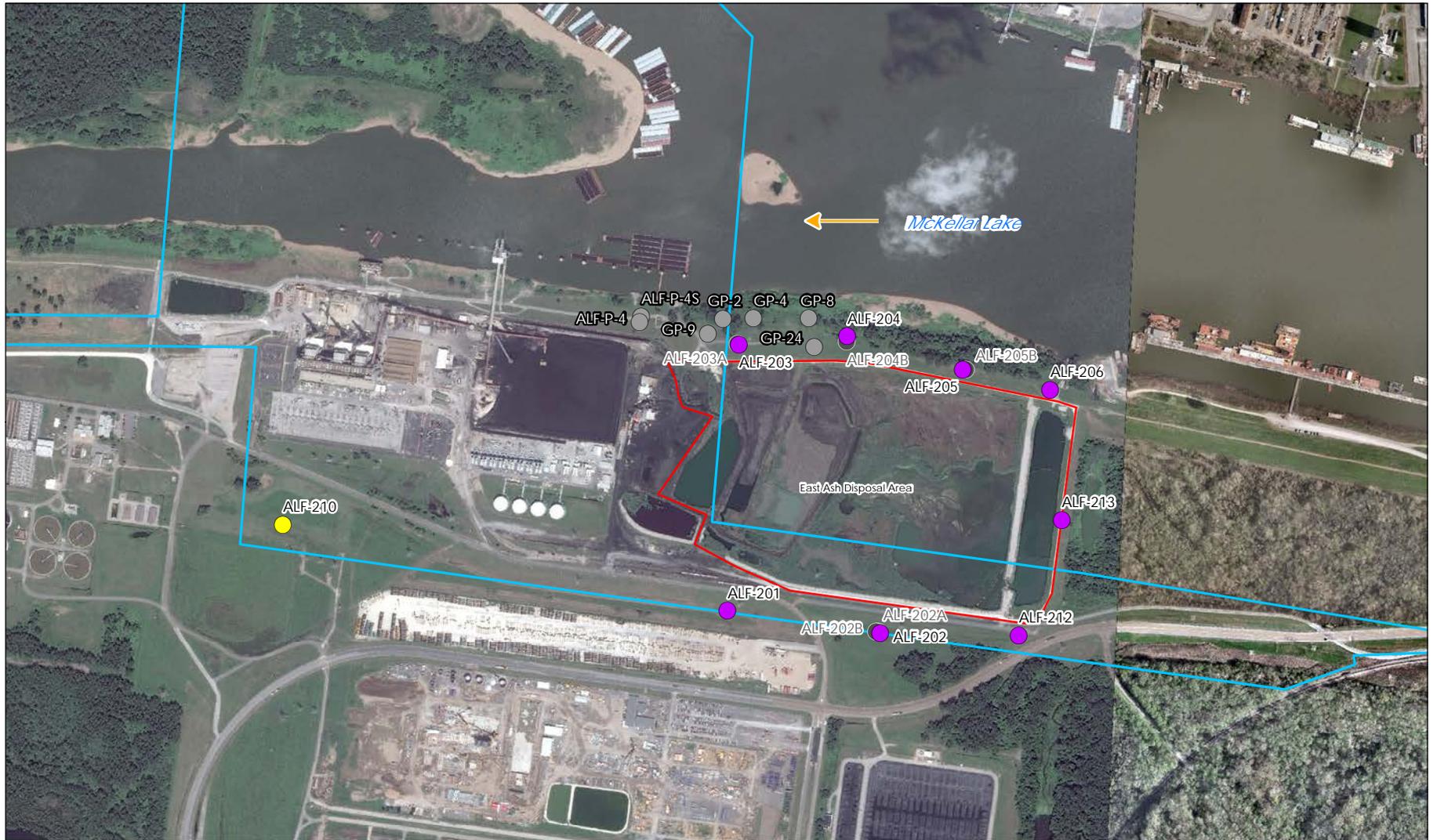
Figure 1 – CCR Unit with Background and Downgradient Wells

Figure 2 – Conceptual Geological Cross-Section

Figure 3 – Groundwater Flow Direction (Alluvial Aquifer)

Figure 4 – Monitoring Wells and Limits of COI Impacts

Figure 5 – Allen Fossil Plant Well Locations



Legend

- Piezometers or Geoprobe Borings
- Investigation Well
- Background Well
- Downgradient Well
- CCR Unit Subject to CCR Rule
- TVA Property Boundary



Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Background: TVA Imagery 2015/2016



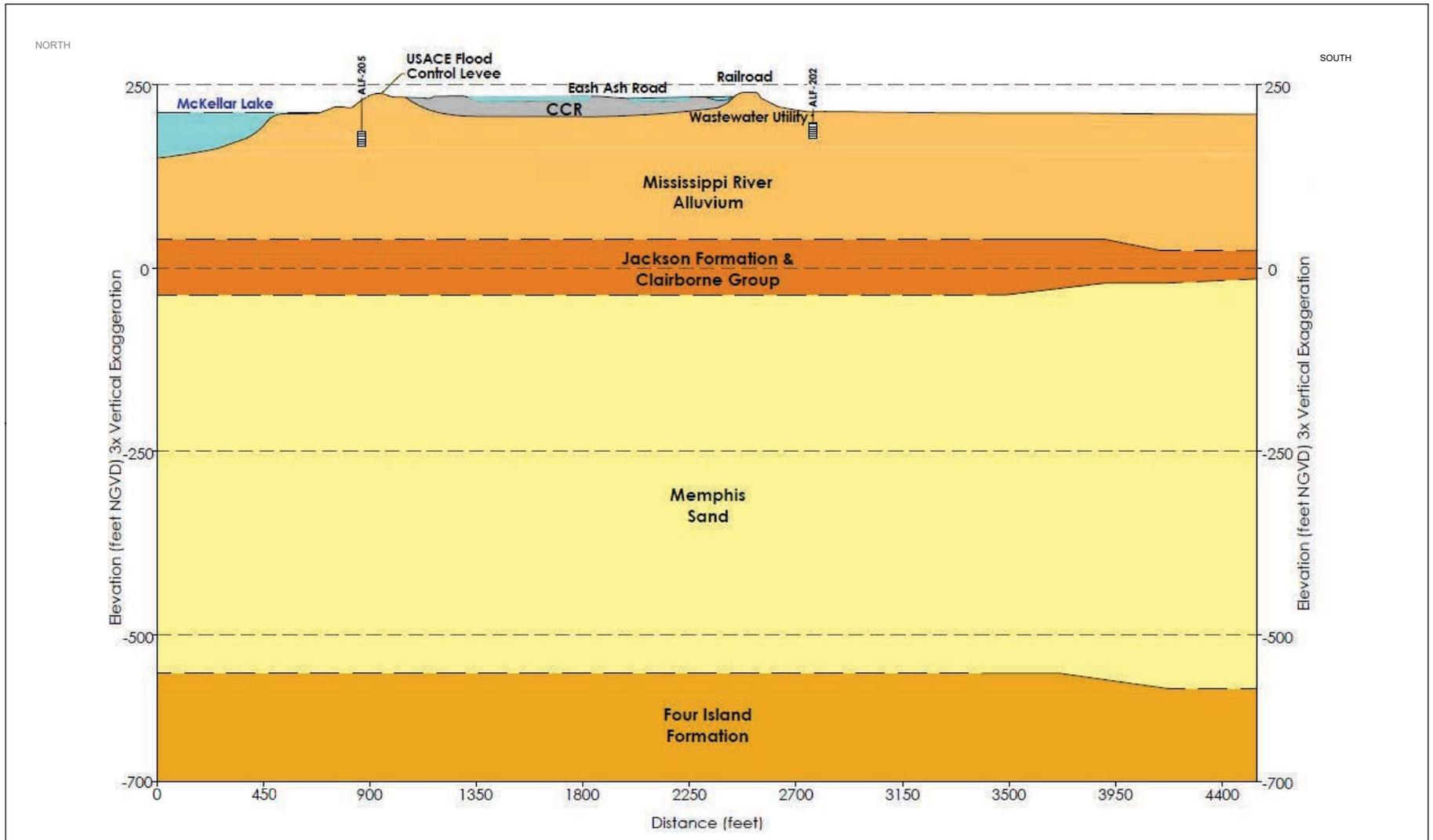
Project Location: Shelby County, TN
 Prepared by LMB on 2019-07-11
 Technical Review by EP on 2019-07-11
 Independent Review by JB on 2019-07-11
 Client/Project: Tennessee Valley Authority
 Allen Fossil Plant
 CCR Rule
 182603470

Figure 1

CCR Unit with Background and Downgradient Wells



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Project Location: Prepared by LMB on 2019-07-11
 City of Memphis: Technical Review by EP on 2019-07-11
 Shelby County, TN: Independent Review by JB on 2019-07-11
 Client/Project: Tennessee Valley Authority 182603470
 Allen Fossil Plant
 CCR Rule

Figure No. _____
Figure 2
 Title
Conceptual Geologic Cross-Section



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- ⊕ Pressure Transducer Location (Sandy Zone Shallow Wells - 12/26/18)
- ▲ McKellar Lake Gauging Station
- Inferred Groundwater Elevation Surface (C.I. = 1 ft)
- - - Dashed Where Estimated Between Wells and Lake McKellar
- - - Estimated McKellar Lake Shoreline (203.55)
- ➔ Generalized Flow Direction

N

0 425 850
Feet
(At original document size of 8.5x11)
1:10,200

- Notes**
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
 2. Background: TVA Imagery 2015/2016

Project Location
City of Memphis
Shelby County, TN

Client/Project
Tennessee Valley Authority
Allen Fossil Plant
CCR Rule

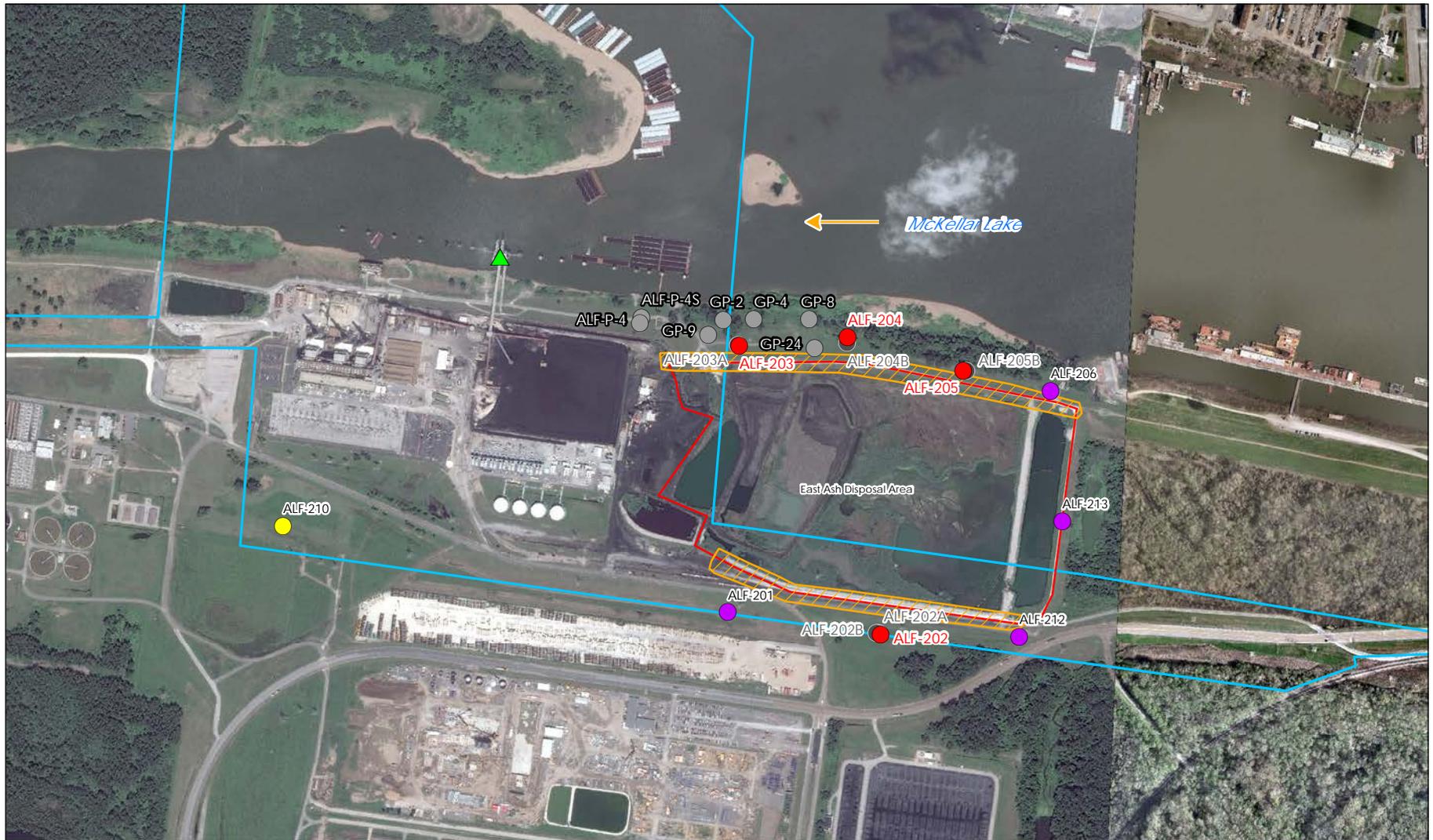
Prepared by LMB on 2019-07-11
Technical Review by EP on 2019-07-11
Independent Review by JB on 2019-07-11
182603470

Figure 3
Groundwater Flow Direction (Alluvial Aquifer)



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- Legend**
- Piezometers or Geoprobe Borings
 - Investigation Well
 - ▲ Staff Gauge
 - Background Well
 - Downgradient Well
 - GWPS Exceedance Well
 - CCR Unit Subject to CCR Rule
 - TVA Property Boundary
 - Potential Treatment Zones (Arsenic, Lead, Molybdenum)

N

0 500 1,000 Feet
(At original document size of 8.5x11)
1:12,000

Notes

1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
2. Background: TVA Imagery 2015/2016

Project Location Prepared by LMB on 2019-07-11
 City of Memphis Technical Review by EP on 2019-07-11
 Shelby County, TN Independent Review by JB on 2019-07-11
Client/Project 182603470
 Tennessee Valley Authority
 Allen Fossil Plant
 CCR Rule

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

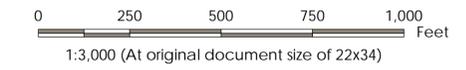




Figure No. **5**
 Title
Allen Fossil Plant Well Locations

Client/Project
 Tennessee Valley Authority
 Allen Fossil Plant

Project Location
 Memphis, Tennessee
 175577013
 Prepared by LT on 2019-10-31
 Technical Review by JJ on 2019-10-31



- ### Legend
- Inactive Harsco Production Wells (PW)
 - ▲ McKellar Lake Gauging Station
 - Performance Monitoring Well (PMW) (Shallow)
 - Performance Monitoring Well (PMW) (Intermediate)
 - Performance Monitoring Well (PMW) (Deep)
 - IRA Extraction Well (EW)
 - Monitoring Well (Shallow)
 - Monitoring Well (Intermediate)
 - Monitoring Well (Deep)
 - Production Well (Memphis Sand)
 - Sewer Manhole Location of Force Main Transition to Gravity
 - Sanitary Sewer Pipes
 - - - East Ash Pond Boundary

Wells are screened in the Alluvial Aquifer unless otherwise noted.

- Notes
1. Coordinate System: NAD 1983 StatePlane Tennessee FIPS 4100 Feet
 2. Imagery Provided by TVA (2018)

