

**2022 Annual Groundwater  
Monitoring and Corrective  
Action Report**



Tennessee Valley Authority  
Allen Fossil Plant East Ash Disposal  
Area CCR Unit

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# 2022 ANNUAL GROUNDWATER MONITORING AND CORRECTIVE ACTION REPORT

TVA Allen Fossil Plant East Ash Disposal Area CCR Unit

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In accordance with 40 CFR § 257.90(e) of the Disposal of Coal Combustion Residuals from Electric Utilities final rule (CCR Rule), this 2022 Annual Groundwater Monitoring and Corrective Action Report (2022 Annual Report) documents 2022 groundwater monitoring and corrective action activities at the East Ash Disposal Area CCR Unit at the Tennessee Valley Authority (TVA) Allen Fossil Plant (ALF).

## OVERVIEW

An overview of the current status of the groundwater monitoring and corrective action program for the East Ash Disposal Area is provided below in accordance with 40 CFR § 257.90(e)(6).

- At the start of the current 2022 annual reporting period, the East Ash Disposal Area was operating under an assessment monitoring program in accordance with 40 CFR § 257.95. The assessment monitoring program for the East Ash Disposal Area was initiated on July 16, 2018.
- At the end of the current 2022 annual reporting period, the East Ash Disposal Area was operating under a corrective action monitoring program in accordance with 40 CFR § 257.98(a)(1). The corrective action monitoring program for the East Ash Disposal Area was initiated on June 2, 2022. The corrective action groundwater monitoring program includes the requirements of the assessment monitoring program under 40 CFR § 257.95.
- Constituents listed in Appendix III with statistically significant increases (SSIs) over background and the names of the monitoring wells are summarized in Table 1.
- During the 2018 assessment monitoring sampling, statistically significant levels (SSLs) above the groundwater protection standard (GWPS) were observed at monitoring wells: ALF-202, ALF-203 and ALF-204 for arsenic; ALF-203 for fluoride and lead; and ALF-202, ALF-203 and ALF-205 for molybdenum. As a result, an assessment of corrective measures was initiated for the East Ash Disposal Area on April 15, 2019 and was completed on July 15, 2019.
- During the 2022 assessment monitoring and corrective action monitoring events, SSLs above the GWPS were observed for arsenic in monitoring wells ALF-202, ALF-203, ALF-204, ALF-212, ALF-213, and ALF-217, and for molybdenum in monitoring wells ALF-202 and ALF-203.
- A public meeting was held on November 17, 2020, to discuss the results of the assessment of corrective measures, in accordance with 40 CFR § 257.96(e).
- A remedy was selected pursuant to 40 CFR § 257.97, and the Selection of Remedy Report (TVA, 2022) was placed in the operating record on June 2, 2022, in accordance with 40 CFR § 257.97(a) and § 257.105(h)(12). Remedial activities have been initiated for the East Ash Disposal Area pursuant to 40 CFR § 257.98(a) during the current 2022 annual reporting period as discussed herein.

# 2022 ANNUAL GROUNDWATER MONITORING AND CORRECTIVE ACTION REPORT

TVA Allen Fossil Plant East Ash Disposal Area CCR Unit

January 31, 2023

## 2022 AND PROJECTED 2023 GROUNDWATER MONITORING ACTIVITIES

During 2022, TVA performed the following groundwater monitoring activities:

- Completed the statistical evaluation of the 2021 second semiannual assessment monitoring data for Appendix IV constituents in accordance with 40 CFR § 257.95(g) in January 2022 and determined that there were SSLs over the GWPS for arsenic in monitoring wells ALF-202, ALF-203, ALF-204, ALF-212, ALF-213, and ALF-217, and for molybdenum in monitoring wells ALF-202 and ALF-203.
- Prepared and placed in the operating record a Semiannual Report on the Progress of Remedy Selection on January 14, 2022, in accordance with 40 CFR § 257.97(a) to document the progress made toward selection and design of the remedy.
- Selected a remedy pursuant to 40 CFR § 257.97, and the Selection of Remedy Report was placed in the operating record on June 2, 2022, in accordance with 40 CFR § 257.97(a) and § 257.105(h)(12). Remedial activities have been initiated for the East Ash Disposal Area pursuant to 40 CFR § 257.98(a).
- The horizontal and vertical extents of the impacts of Appendix IV constituents of interest (arsenic and molybdenum) at the EADA have been largely characterized as a result of the Remedial Investigation conducted between 2017 and 2019 by TVA under the oversight of the Tennessee Department of Environment and Conservation (TDEC).<sup>1</sup>
- The East Ash Disposal Area is located on property owned by the City of Memphis and Shelby County. TVA provides updates regarding groundwater conditions to the owners of the property upon which the East Ash Disposal Area is located. Thus, notification pursuant to 40 CFR § 257.95(g)(2) has occurred, and documentation of the notification has been placed in the facility's operating record and posted to the CCR Rule Compliance Data and Information website (<https://www.tva.com/environment/environmental-stewardship/coal-combustion-residuals/allen>).

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<sup>1</sup> As a result of groundwater impacts discovered during groundwater monitoring under the EPA CCR Rule, TVA initiated a remedial investigation (RI) in 2017 to investigate groundwater conditions near the East Ash Disposal Area (EADA). The RI was conducted and completed under the direction of TDEC Division of Remediation (DoR). The results of the RI indicated uniquely elevated concentrations of CCR-related constituents of concern (primarily arsenic) in groundwater in two areas north and south of the EADA. Following completion of the RI, TVA conducted a Feasibility Study (FS, Stantec, 2020) to develop, screen, and evaluate remedial alternatives for the EADA and the nearby groundwater. The FS was prepared in accordance with TDEC DoR Chapter 0400-15-01 Hazardous Substance Remedial Action, section 0400-15-01-.09(3) Feasibility Study. The FS was completed to evaluate various options to address CCR storage within the EADA and the two areas of shallow groundwater with elevated concentrations of arsenic, which also encompass the areas with elevated concentrations of other CCR parameters. The FS concluded by recommending removal of CCR from the EADA and off-site disposal, and extraction and treatment of impacted groundwater. The recommended remedial approach was further documented in a Record of Decision (ROD). On August 16, 2021, the ROD was issued by TDEC documenting the decision to remove CCR materials from the EADA (closure-by-removal or CBR), and to remediate groundwater by extraction and treatment (TVA, 2021).

## 2022 ANNUAL GROUNDWATER MONITORING AND CORRECTIVE ACTION REPORT

TVA Allen Fossil Plant East Ash Disposal Area CCR Unit

January 31, 2023

- Sampled and analyzed wells in the updated certified monitoring system for CCR constituents (Appendix III and Appendix IV constituents) for the first half 2022 semiannual assessment monitoring event and retest event in accordance with 40 CFR § 257.95(d)(1).
- Sampled and analyzed wells in the updated certified monitoring system for CCR constituents (Appendix III and Appendix IV constituents) for the second half 2022 semiannual corrective action monitoring event and retest event in accordance with 40 CFR § 257.98(a)(1) and § 257.95(d)(1).
- Placed the sampling results in the operating record as required by 40 CFR § 257.95(d)(1), 257.98(a)(1), and 257.105(h)(6). Additionally, these results are included in Table 2 of this 2022 Annual Report in accordance with 40 CFR § 257.95(d)(3).
- Placed notification of statistical exceedances of GWPS in the facility operating record in accordance with 40 CFR § 257.95(g) and 257.105(h)(8); provided notification to the State of Tennessee in accordance with 40 CFR § 257.106(h)(6); and placed the notification on the CCR Rule Compliance Data and Information website (<https://www.tva.com/environment/environmental-stewardship/coal-combustion-residuals/allen>) in accordance with 40 CFR § 257.107(h)(6).
- Continued TVA's third-party Quality Assurance Program to evaluate groundwater analytical data using best practices concerning field methods and validation techniques, as well as the application of appropriate statistical methods.
- Reviewed new data as it became available to maintain compliance with 40 CFR § 257.90 through 257.98.
- Complied with recordkeeping requirements as 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).

No problems were encountered during the 2022 Groundwater Quality Monitoring Program; therefore, no additional action has been recommended, except for the planned key activities for 2023 that are outlined below.

The projected key activities for 2023 are:

- Continue semiannual corrective action monitoring at the certified monitoring system consistent with 40 CFR § 257.98 and § 257.95(d)(1) and place the sampling results in the operating record as required by 40 CFR § 257.95(d)(1), 257.98(a)(1), and 257.105(h)(6).
- Evaluate whether one or more Appendix IV constituents are detected at SSLs above the established GWPS in accordance with 40 CFR § 257.95(g).
- Place notification of statistical exceedances of GWPS in the facility operating record in accordance with 40 CFR § 257.95(g) and 257.105(h)(8); provide notification to the State of Tennessee in accordance with 40 CFR § 257.106(h)(6); and place the notification on the CCR Rule Compliance

## 2022 ANNUAL GROUNDWATER MONITORING AND CORRECTIVE ACTION REPORT

TVA Allen Fossil Plant East Ash Disposal Area CCR Unit

January 31, 2023

Data and Information website (<https://www.tva.com/environment/environmental-stewardship/coal-combustion-residuals/allen>) in accordance with 40 CFR § 257.107(h)(6).

- Continue to implement remedial activities for the East Ash Disposal Area pursuant to 40 CFR § 257.98.
- Continue to refine the characterization of the nature and extent of the release and site characterizations that may affect remedy selection.
- Continue TVA's third-party Quality Assurance Program to evaluate groundwater analytical data using best practices concerning field methods and validation techniques, as well as the application of appropriate statistical methods.
- 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.
- Comply with recordkeeping requirements as 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).

### GROUNDWATER MONITORING SYSTEM

The East Ash Disposal Area is located east of the power plant building and formerly received sluiced CCR materials from the fossil plant. The sluiced material entered the disposal area from the west side of the facility where particle settlement occurred. Water then flowed eastward to the Stilling Pond (east side of the disposal area) where further particle settlement occurred. The water ultimately discharged through a permitted National Pollutant Discharge Elimination System (NPDES) outfall located in the northeast corner of the Stilling Pond. The plant ceased coal firing operations in 2018.

The groundwater monitoring system for the ALF East Ash Disposal Area CCR Unit consists of two background wells (ALF-216 and ACC-5B), one cross-gradient well (ALF-210), and nine downgradient wells (ALF-201, ALF-202, ALF-203, ALF-204, ALF-205, ALF-206, ALF-212, ALF-213 and ALF-217).<sup>2</sup> Figure 1

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<sup>2</sup> In 2021, TVA evaluated potential changes to the background well at ALF which was used in the calculation of GWPS. Based upon further hydrogeologic evaluation, the ALF groundwater monitoring system was re-certified to designate monitoring well locations ALF-216 and ACC-5B as more appropriately representative of upgradient background conditions, compared to the previous background location ALF-210. ALF-210 was redesignated as a cross-gradient well and has been evaluated similar to a downgradient location for purposes of statistical analysis of groundwater data. ALF-217 was also added and is treated as an additional downgradient monitoring location. The certified monitoring system was updated in December 2021. When added to the CCR Rule certified groundwater monitoring system, wells ALF-216, ALF-217, and ACC-5B were already in existence as they are included in the Remedial Investigation (RI) and Interim Remedial Action (IRA) Groundwater Monitoring Plan (GWMP) under the TDEC DoR and are sampled quarterly, typically during the months of February, May, August, and December.

## 2022 ANNUAL GROUNDWATER MONITORING AND CORRECTIVE ACTION REPORT

TVA Allen Fossil Plant East Ash Disposal Area CCR Unit

January 31, 2023

is an aerial photograph that shows the groundwater monitoring well locations. The downgradient wells are installed at the waste boundary. The groundwater monitoring system was designed for a single CCR Unit (East Ash Disposal Area).

No monitoring wells in the CCR Rule groundwater monitoring system were installed or decommissioned during the 2022 reporting period. The certification of the groundwater monitoring system required under 40 CFR § 257.91(f) is included in the facility operating record and on the CCR Rule Compliance Data and Information website (<https://www.tva.com/environment/environmental-stewardship/coal-combustion-residuals/allen>).

### GROUNDWATER SAMPLING AND LABORATORY ANALYTICAL TESTING

A groundwater sampling and analysis program was developed and includes procedures and techniques for sample collection, sample preservation and shipment, analytical procedures, chain-of-custody control, and quality assurance and quality control (QA/QC) required by 40 CFR § 257.93(a). The groundwater monitoring program includes sampling and analysis procedures designed to provide monitoring results that are an accurate representation of groundwater quality at background and downgradient wells.

The 2022 assessment monitoring and corrective action monitoring sampling was conducted between January and August 2022 and the results are summarized in Table 2. A summary of groundwater sample locations, well designations, analytes sampled, sampling dates and monitoring program status is provided in Table 3.

Groundwater elevations were measured in each monitoring well immediately prior to purging during each sampling event as required by 40 CFR § 257.93(c). Groundwater elevations for monitoring wells in the certified monitoring system and McKellar Lake surface water elevations are summarized in Table 4.<sup>3</sup> Groundwater flow directions were determined for each sampling event, and a depiction of groundwater flow direction for August 15, 2022, is illustrated on Figure 2.<sup>4</sup> The groundwater directional flow at the ALF East Ash Disposal Area is influenced by the surface water elevation in McKellar Lake to the north of the site. The primary groundwater flow direction is to the north toward McKellar Lake; however, two of the four groundwater level measurement events in 2022 indicated a flow direction to the south.

Testing for hydraulic conductivity at the background or downgradient groundwater monitoring wells, as summarized in Table 5, was estimated in a 2018 hydrogeologic evaluation (Terracon, 2019).<sup>5</sup> The uppermost aquifer at the ALF CCR Unit is the Alluvial aquifer. These alluvial deposits are composed of a fine to medium-grained silty sand with intervals of fine-grained silts and clays in the upper portion of the unit and fine to coarse-grained sand with trace fine to coarse-grained gravel in the lower portion. The alluvial deposits are underlain by the fine-grained Cook Mountain Formation (also referred to as the upper

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<sup>3</sup> Groundwater elevations were collected at additional monitoring wells during each sampling event and are summarized in Table A-1 in Appendix A.

<sup>4</sup> Groundwater flow direction maps for the January, February, June, and August 2022 sampling events are included in Appendix B.

<sup>5</sup> Additional hydraulic conductivity data for wells ALF-216, ALF-217, and ACC-5B were added to Table 5 and the geometric mean hydraulic conductivity was updated.

## 2022 ANNUAL GROUNDWATER MONITORING AND CORRECTIVE ACTION REPORT

TVA Allen Fossil Plant East Ash Disposal Area CCR Unit

January 31, 2023

Claiborne confining unit in this location). The Cook Mountain Formation is underlain by the Memphis Sand, which is characterized by predominantly very fine to very coarse-grained sand with lenses of fine-grained material and is referred to as the Memphis aquifer. Based on exploratory drilling in the vicinity of ALF-202, the upper Claiborne confining unit is absent and the Alluvial aquifer directly overlies the Memphis Sand in that area. Testing data indicates that the Alluvial aquifer has a geometric mean hydraulic conductivity of  $1.0 \times 10^{-3}$  centimeters per second (cm/sec). Linear groundwater flow velocity was calculated for the uppermost aquifer using:

- The geometric mean hydraulic conductivity calculated from hydraulic testing ( $1.0 \times 10^{-3}$  cm/sec)
- Horizontal hydraulic gradients measured during the implementation of the groundwater sampling and analysis program, ranging from 0.0012 to 0.0045 feet per foot (ft/ft), and
- An effective porosity of 22% in the native sand (Jazaei et al., 2018).

The average linear flow velocity in the uppermost aquifer ranges from approximately 5.9 to 22 feet per year. The rate and direction of groundwater flow for each groundwater sampling event is summarized in Table 6 in accordance with 40 CFR § 257.93(c).

### STATISTICAL ANALYSIS OF GROUNDWATER DATA

The groundwater monitoring data for the 2022 assessment monitoring and corrective action monitoring events were evaluated using statistical procedures as required by 40 CFR § 257.93(f)-(h). The statistical method certification is included in the facility operating record and the CCR Rule Compliance Data and Information website. GWPS were established in accordance with 40 CFR § 257.95(h), as the larger of published regulatory limits or screening criteria (e.g., maximum contaminant levels (MCLs) and upper tolerance limits (UTLs) derived from background). MCLs may or may not be considered the appropriate GWPS depending on background well concentrations for each Appendix IV<sup>6</sup> constituent.<sup>7</sup> The 2022 Statistical Analysis Report is included in Appendix C.

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<sup>6</sup> Appendix IV CCR Constituents: antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, fluoride, lead, lithium, mercury, molybdenum, selenium, thallium, radium 226 and radium 228 combined

<sup>7</sup> USEPA has published Maximum Contaminant Limits (MCL) or alternate regulatory limits for each of the Appendix IV constituents. Consequently, in most cases the GWPS is equal to the MCL. However, there may be cases where background levels of a constituent exceed the MCL. In these instances, an alternate GWPS must be derived from on-site background levels. On July 30, 2018, USEPA provided alternate regulatory limits (i.e., that could be used as potential GWPS) for four of the Appendix IV chemical Constituents of Interest (COIs) for which the agency has not assigned MCLs to date. If site-specific background levels are lower, then these may be used in place of background levels under 40 CFR § 257.95(h)(2). Specifically, those alternate COIs include threshold values at the following levels: 1.) Cobalt - 6 µg/L; 2.) Lithium - 40 µg/L; 3.) Molybdenum – 100 µg/L; and, 4.) Lead - 15 µg/L.

# 2022 ANNUAL GROUNDWATER MONITORING AND CORRECTIVE ACTION REPORT

TVA Allen Fossil Plant East Ash Disposal Area CCR Unit

January 31, 2023

The sampling results used to identify potential GWPS exceedances were obtained during monitoring events that were performed between January and August of 2022.<sup>8</sup> Comparisons were made against a fixed GWPS via a confidence interval band. Retesting was conducted after each semiannual sampling event, and none of the individual compliance point measurements were directly compared against the GWPS. The Appendix IV monitoring data collected from 2017 through 2022 were used to construct the confidence interval bands. Cross-sections of each confidence interval band were then compared to the GWPS for the most recent assessment monitoring event in each case for the purpose of identifying any SSLs. A well-constituent pair is considered out of compliance only if its average constituent levels, as estimated via the confidence interval cross-section, currently exceed the GWPS.

## SUMMARY OF 2022 GROUNDWATER REMEDIATION SYSTEM CONSTRUCTION ACTIVITIES

The groundwater remediation system has been designed to extract shallow impacted groundwater, treat the groundwater in an on-site treatment building, and discharge the treated groundwater to the T.E. Maxson wastewater treatment plant. The groundwater treatment system primarily consists of particle settling, pH adjustment and filtration. This groundwater remediation system was approved by TDEC through the Remedial Investigation process.

A general description of the progress of remediation system construction in 2022 is provided below:

- The Treatment Building foundation and above ground equalization (EQ) tank foundation were completed.
- Construction of the above ground portion of the EQ tank, installation of water treatment equipment within the Treatment Building, construction of the Treatment Building, and installation of discharge and conveyance piping was completed.
- The above ground EQ tank was completed and cleaned, and installation of conveyance and discharge piping was completed.
- Treatment building construction was completed.
- The discharge piping was connected to the municipal sewer discharge at Manhole C.
- Extraction well testing and remediation system startup are currently scheduled for 2023.

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<sup>8</sup> The CCR rule requires a minimum of two semiannual sampling events per well once the required background data has been obtained. In 2022, semiannual assessment monitoring and semiannual corrective action groundwater monitoring sampling events were each followed by retesting groundwater sampling events for wells ALF-201 through ALF-206, ALF-210, ALF-212, ALF-213. Wells ALF-216, ALF-217, and ACC-5B were sampled three times in 2022.



## 2022 ANNUAL GROUNDWATER MONITORING AND CORRECTIVE ACTION REPORT

TVA Allen Fossil Plant East Ash Disposal Area CCR Unit

January 31, 2023

### NARRATIVE DISCUSSION OF ANY TRANSITION BETWEEN MONITORING PROGRAMS

An Assessment Monitoring Program was established on July 16, 2018 and implemented as specified in 40 CFR § 257.95. The notification of the establishment of the assessment monitoring program was placed in the operating record on August 15, 2018, in accordance with 40 CFR § 257.105(h)(5). Notification of the assessment monitoring program was provided to the State of Tennessee and placed on the CCR Rule Compliance Data and Information website on September 14, 2018 in accordance with 40 CFR § 257.106(h)(4) and 40 CFR § 257.107(h)(4), respectively. (<https://www.tva.com/environment/environmental-stewardship/coal-combustion-residuals/allen>)

A remedy was selected pursuant to 40 CFR § 257.97, and the Selection of Remedy Report was placed in the operating record on June 2, 2022, in accordance with 40 CFR § 257.97(a) and § 257.105(h)(12). Notification of the Selection of Remedy Report was provided to the State of Tennessee and placed on the CCR Rule Compliance Data and Information website on July 1, 2022, in accordance with 40 CFR § 257.106(h)(9) and 40 CFR § 257.107(h)(9), respectively. Remedial activities have been initiated for the East Ash Disposal Area pursuant to 40 CFR § 257.98 during the current 2022 annual reporting period. The East Ash Disposal Area is operating under a corrective action monitoring program in accordance with 40 CFR § 257.98(a)(1). The corrective action monitoring program for the East Ash Disposal Area was initiated on June 2, 2022.

In accordance with assessment monitoring and corrective action program requirements, subsequent sampling and analysis of all wells in the certified monitoring system for Appendix III and IV constituents occurred in accordance with 40 CFR § 257.95(d)(1) and 257.98(a)(1). Appendix III and IV constituent concentrations from 2022 assessment monitoring and corrective action sampling events are summarized in Table 2. GWPS were established in accordance with 40 CFR § 257.95(d)(2) and are summarized along with Appendix IV SSLs in Table 7. Evaluations of whether there are SSLs over established GWPS for one or more Appendix IV constituents were completed in accordance with 40 CFR § 257.95(g). During the 2022 semiannual assessment monitoring and corrective action monitoring events, there were SSLs above the GWPS for arsenic in wells ALF-202, ALF-203, ALF-204, ALF-212, ALF-213, and ALF-217, and for molybdenum in wells ALF-202 and ALF-203. 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.

# 2022 ANNUAL GROUNDWATER MONITORING AND CORRECTIVE ACTION REPORT

TVA Allen Fossil Plant East Ash Disposal Area CCR Unit

January 31, 2023

## LIMITATIONS

This document entitled 2022 Annual Groundwater Monitoring and Corrective Action Report was prepared by Stantec Consulting Services Inc. ("Stantec") for the Tennessee Valley Authority (the "Client"). The material in it reflects Stantec's professional judgment in light of the scope, schedule and other limitations stated in the document. The opinions in the document are based on conditions and information existing at the time the document was published and do not take into account any subsequent changes. In preparing the document, Stantec relied upon data and information supplied to it by the client.



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# 2022 ANNUAL GROUNDWATER MONITORING AND CORRECTIVE ACTION REPORT

TVA Allen Fossil Plant East Ash Disposal Area CCR Unit

January 31, 2023

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Jazaei, F., Waldron, B., Schoefernacker, S. and Larsen, D. 2018. *Application of Numerical Tools to Investigate a Leaky Aquitard beneath Urban Well Fields* Center for Applied Earth Science and Engineering Research (CAESER), University of Memphis, Memphis, TN 38152, USA - Water 2019, 11(1), 5; <https://doi.org/10.3390/w11010005>

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Terracon, 2019. *Aquifer Testing and Equipment Blank Results*. TVA CCR Rule – Allen Fossil Plant (ALF). Terracon Consultants, Inc. January 15, 2019.

TVA, 2021. *Record of Decision (ROD) Tennessee Valley Authority – Allen Fossil Plant*, Shelby County, Tennessee, August 12, 2021.

TVA, 2022. *TVA Allen Fossil Plant Selection of Remedy Report*. June 2, 2022.

## Attachments:

Figure 1 – Map with CCR Unit Background and Downgradient Wells

Figure 2 – Groundwater Elevation Contour Map - August 15, 2022

Table 1 – Summary of Appendix III Constituent Statistically Significant Increases

Table 2 – Assessment and Corrective Action Monitoring Groundwater Sampling Results

Table 3 – Groundwater Sampling Summary

Table 4 – Groundwater and Surface Water Elevation Summary

Table 5 – Hydraulic Conductivity Data Summary

Table 6 – Rate and Direction of Groundwater Flow Summary

Table 7 – Appendix IV Constituent Statistically Significant Levels Above GWPS

Appendix A – Groundwater and Surface Water Elevation Summary - Additional Monitoring Wells

Appendix B – Groundwater Elevation Contour Maps

Appendix C – 2022 Statistical Analysis Report

## **FIGURES**

## **TABLES**

**APPENDIX A  
GROUNDWATER AND SURFACE WATER  
ELEVATION SUMMARY - ADDITIONAL  
MONITORING WELLS**

**APPENDIX B**  
**GROUNDWATER ELEVATION CONTOUR MAPS**

**APPENDIX C**  
**2022 STATISTICAL ANALYSIS REPORT**