Semiannual Report on the Progress of Remedy Selection – Ash Pond Complex

Gallatin Fossil Plant
Gallatin, Tennessee

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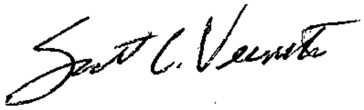

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Acronyms

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Acronyms

ACM	Assessment of Corrective Measures
APC	Ash Pond Complex
ASD	Alternate Source Demonstration
bgs	Below ground surface
CARA	Corrective Action/Risk Assessment
CAGWMP	Corrective Action Groundwater Monitoring Program
CBR	Closure by Removal
CCR	Coal Combustion Residuals
CFR	Code of Federal Regulations
COC	Constituent of Concern
CRM	Cumberland River Mile
EAR	Environmental Assessment Report
EI	Environmental Investigation
Ft	Feet
GAF	Gallatin Fossil Plant
GWPS	Groundwater Protection Standards
MNA	Monitored Natural Attenuation
Msl	Mean sea level
Mg/L	Milligram per liter
Min	Minute
NPDES	National Pollutant Discharge Elimination System
NRL	North Rail Loop
PRB	Permeable Reactive Barrier
SSL	Statistically Significant Levels
TDEC	Tennessee Department of Environment and Conservation
TVA	Tennessee Valley Authority
USEPA	United States Environmental Protection Agency

1.0 Introduction

In accordance with the requirements in 40 CFR § 257.97(a), this report has been prepared to describe the current progress in selecting and designing a remedy for the Ash Pond Complex (APC) (including Ash Pond A, Ash Pond E, Middle Pond A, and Bottom Ash Pond) (hereinafter collectively referred to as CCR Multiunit or APC Multiunit) at the Tennessee Valley Authority (TVA) Gallatin Fossil Plant (GAF) in Gallatin, Sumner County, Tennessee.

1.1 Regulatory Background

On April 17, 2015, the U.S. Environmental Protection Agency (USEPA) published a rule that set 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 (40 CFR) Part 257, Subpart D. The rule includes requirements for monitoring groundwater, assessing corrective measures, and selecting a remedy if constituents listed in Appendix IV of the rule are detected in groundwater samples collected from downgradient monitoring wells at statistically significant levels (SSL) greater than 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 APC Multiunit, assessment monitoring events in 2018 detected an SSL greater than the GWPS for arsenic in one well (GAF-410U), for cobalt in two wells (GAF-450C and GAF450L), and for lithium in one well (GAF-452C). TVA has successfully demonstrated that a source other than the APC Multiunit caused the SSLs above GWPS for cobalt and lithium at wells GAF-450C/-450L and GAF-452C, respectively as allowed under 40 CFR § 257.95(g)(3)(ii). TVA has not been able to demonstrate that a source other than the APC Multiunit caused the SSL of arsenic. There were no new SSLs identified in 2019 or so far in 2020. In the first assessment sampling event of 2020 (performed during April), the results included a new unconfirmed exceedance of the Arsenic GWPS at well GAF-450L. This unconfirmed exceedance is being further evaluated via confirmation sampling. The confirmation sampling was completed in late-June 2020 but analytical results are not yet available. The results of this further evaluation will be explained in the next semiannual progress report.

In accordance with 40 CFR § 257.96(a), TVA prepared the 2019 Assessment of Corrective Measures (ACM) Report for the APC Multiunit, added it to the operating record on July 15, 2019 and uploaded it to the 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). As described in Section 1.2, closure of the APC Multiunit is integrated into the ACM process. Four primary strategies were evaluated to address groundwater exhibiting concentrations above the arsenic GWPS:

- Monitored Natural Attenuation (MNA);
- In-Situ Physical/Chemical Treatment;
- Permeable Reactive Barriers (PRB); and
- Hydraulic Containment and Treatment.

Following preparation of the ACM Report, TVA began the process to select a remedy. Semiannual reports are required pursuant to 40 CFR § 257.97(a) to document progress toward remedy selection and design. TVA's first semiannual progress report was added to the operating record on January 15, 2020 and uploaded to the CCR Rule Compliance Data and Information website on February 14, 2020. The CCR Rule contemplates that more investigation and consideration may be needed to 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 the selection of the remedy, the owner/operator must discuss the results of the ACM in a public meeting required by 40 CFR § 257.96(e). The selected remedy must, at a minimum, meet the requirements of 40 CFR § 257.97(b) and must consider the evaluation factors set forth in 40 CFR § 257.97(c) in the selection process. 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 also provide a schedule for implementing the selected remedy that takes into account the factors set forth in 40 CFR § 257.97(d).

1.2 Overview of July 2019 Closure Plan

A revised Closure Plan has been prepared for the APC Multiunit as a result of an agreement between TVA and the Tennessee Department of Environment and Conservation (TDEC) as noted in Section 1.2.1. This Closure Plan was added to the operating record on July 19, 2019, and was posted on TVA's CCR Rule Compliance Data and Information website on August 19, 2019.

Based on conceptual plans, and subject to the completion of all necessary environmental reviews, TVA intends to close the APC Multiunit by following a closure-by-removal approach pursuant to 40 CFR § 257.102(c). Closure activities are anticipated to include pond drawdown, CCR dewatering, and CCR excavation and removal. CCR is expected to be transported and disposed of in an on-site permitted landfill or transported to a beneficial re-use facility for recycling and encapsulated beneficial use with the potential for some unusable CCR to be disposed of in an on-site or off-site landfill.

Consistent with the requirements of 40 CFR § 257.102(c), potentially impacted underlying material will be addressed. Post-excavation surfaces will be graded to promote positive drainage, and permanent vegetation or permanent stabilization will be established. Where needed, the APC Multiunit perimeter berms may be excavated to allow the adjacent Cumberland River to combine with the area of the existing ponds.

Implementation of the revised Closure Plan will serve as source control by the CCR materials from the APC Multiunit impoundments.

1.2.1 Summary of State Required Investigation and Remedy Selection Process

Since 2016, TVA has been conducting an environmental investigation of CCR disposal sites at its GAF coal-fired site in Tennessee under the oversight of TDEC. With the State required investigation and the agreement to close the APC Multiunit by removal of the CCR materials, TVA is working to bring together the agreement's required Corrective Action/Risk Assessment (CARA) Plan and the CCR Rule Remedy Selection process. The CARA Plan will focus on corrective action for groundwater. Both the CARA Plan and CCR Rule Remedy Selection process have requirements for public participation.

1.3 Report Contents

Following this introduction, the progress report provides summaries of the GAF site characteristics, the groundwater assessment monitoring program, the findings of the ACM process, and the current progress of groundwater remedy selection.

2.0 Site Background and Characteristics

GAF is located at 1499 Steam Plant Road in Gallatin, Sumner County, Tennessee. The facility is located on the north bank of the Cumberland River and between Cumberland River Mile (CRM) 246 and 241.5. The Cumberland River is impounded by the Old Hickory Dam located approximately 23 miles downstream (CRM 216.2). GAF construction began in 1953. GAF began operations in 1956 with full operation in 1959, following completion of the fourth generating unit.

The coal combustion process at GAF historically generated by-products that included fly ash and bottom ash. CCR management units at GAF are depicted in **Figure 1**. The fly ash and bottom ash were managed at the former Non-Registered Site (NRS) from 1956 until approximately 1970. The NRS was closed in 1997 (TVA and Arcadis, 2014) and is not subject to the CCR Rule. In approximately 1970 until 2019, CCR was managed in the APC Multiunit in accordance with National Pollutant Discharge Elimination System (NPDES) Permit No.TN0005428 issued by TDEC. Approximately 11,440,000 cubic yards of CCR material is currently present in the APC Multiunit, with the majority present in Ash Pond A. The APC Multiunit covers approximately 383 acres.

The recently-constructed scrubber system (2013-2016) produces dry CCR material. The dry CCR material is managed in the 52-acre Class II Landfill (Tennessee Solid Waste Permit IDL83-0219) called the North Rail Loop (NRL) Landfill. Cell 1 of the landfill, which includes both a soil and geosynthetic liner system and groundwater monitoring well network, has been approved by TDEC for operation and began receiving CCR in June 2016. The NRL Landfill is subject to the CCR Rule and remains in detection monitoring under the CCR Rule.

With the completion of the new Flow Management System, the APC Multiunit has been removed from service. In accordance with 40 CFR § 257.102(g), the Notice of Intent to Close the APC Multiunit was placed in the Operating Record on July 19, 2019, and posted to the CCR Rule Compliance Data and Information website on August 19, 2019. Process flows and NRL Landfill leachate have been rerouted to the Flow Management System. The Flow Management System effluent is released at Outfall 010.

2.1 Conceptual Site Model Summary

A hydrogeologic conceptual site model (CSM) is needed to support decision making during Remedy Selection. This section of the report provides a summary of the hydrogeologic conceptual site model.

2.1.1 Geology

The geology and hydrology of the GAF site have been characterized during implementation of multiple investigations, including the NRL landfill hydrogeologic investigation, the EI, CCR Rule monitoring network development, and the NRL landfill lateral expansion hydrogeologic investigation. These investigations provide a thorough understanding of the site geology and presence of water-bearing zones in which groundwater and potential contaminants would be present and migrating.

GAF is located within the Central Basin Aquifer area of Middle Tennessee. Groundwater in Central Tennessee that occurs within the stratigraphic interval between the bottom of the Devonian age Chattanooga Shale and the top of the Cambrian-Ordovician age Knox Group is known as the Central Basin Aquifer system. This aquifer system is an important source of drinking water for Central Tennessee, as it supplies most of the rural domestic wells and many public drinking wells in the Central Basin and surrounding region (Brahana and Bradley, 1986).

Groundwater in the Central Basin Aquifer system occurs primarily in a shallow flow system of solution channels. These channels are highly irregular in their distribution throughout the solid rock mass and generally occur within 300 feet of the land surface. The solution channels are openings along joints and bedding planes that locally may be enlarged by dissolution of the limestone. These channels represent zones of secondary porosity and permeability in an otherwise nonporous and impermeable rock mass. Bedding planes are thought to be the major control in the formation of solution cavities, which have typically been found to be horizontally elongated (Brahana and Bradley, 1986).

The primary bedrock units at GAF that have developed water-bearing zones are the Carters and Lebanon Limestones, both members of the Stones River Group. Bentonite zones in the Carters

Limestone play a significant role in the hydrology of the Central Basin Aquifer system. In areas where the bentonite layers are present, the downward movement of groundwater is restricted.

Where the bentonite zones are eroded or otherwise breached by open joints or intersecting stream valleys, solution openings can form in the underlying limestone. Groundwater in these openings can receive recharge from precipitation. In contrast, shale units within the formations comprising the aquifer system typically act as local confining units for groundwater (Brahana and Bradley, 1986). As noted in a Tennessee Division of Geology publication (Newcome,1958): “Practically all ground water in the Central Basin of Tennessee is confined under artesian pressure in solution channels in the limestone. When a well penetrates the channel the confining pressure is released and the water rises in the well.”

Site-wide geology consists of a series of relatively flat-lying units comprised of the following materials, from the surface downward: unconsolidated units including fill, alluvium, and residuum; and underlying bedrock units consisting of various limestone formations. The presence and distribution of the unconsolidated units is largely controlled by surface topography, historical regional erosional processes, and development activities by TVA.

Unconsolidated Units

Unconsolidated units at the site consist of fill related to TVA’s development of the peninsula, alluvial soils associated with the Cumberland River floodplain, and residuum soils associated with in-place weathering of bedrock at or near the surface.

Disturbed and filled areas of the site primarily include areas around the main plant and dikes surrounding the current and former ash disposal areas. Fill material is generally lean silty clay (CL) and is comprised of reworked native material.

Alluvial soils are primarily lean silty clay (CL) with isolated zones of higher permeability materials ranging from silty sand (SM) to sandy gravel (GP). Alluvial deposits are largely positioned along the south and west edges of the peninsula as a result of floodplain deposits from the adjacent river. Alluvial deposits are up to approximately 50 feet in thickness near the river and thin away from the river.

Residual soils are primarily lean clay (CL), with lesser amounts of silty clay (CL), clayey silt (ML), high-plasticity clay (CH), and silty sand (SM). These soils are derived from in-place weathering of limestone. The soils range in thickness from less than 1 foot to approximately 30 feet. Generally, soils are less than 15 feet thick, but may be highly variable over a short distance. This is likely a result of a pinnacle and cutter bedrock surface, typical of weathering in karstic environments. These surfaces that represent contact between bedrock and unconsolidated units are very irregular due to the natural preferential dissolution of rock along planar features such as bedding, joints, and fractures. The bottom of the soil transitions abruptly from materials with low to moderate standard penetration test blow counts to auger refusal and weathered rock. Numerous rock outcrops occur across the GAF site. Notably, these outcrops cluster north of the stilling ponds, where soils are thin.

Bedrock Units

Bedrock beneath the GAF site consists of limestone of the Nashville Group (Bigby-Cannon and Hermitage) and the Stones River Group (Carters, Lebanon, and Ridley).

The Bigby-Cannon Limestone was encountered in limited borings at the site, those typically at the highest elevations on the GAF site. It was also observed in an outcrop at the top of the hill in the center of the peninsula and along Steam Plant Road. The formation is a medium- to dark-gray, microcrystalline to medium-grained, fossiliferous limestone with shaly and fossil-hash beds.

The Hermitage Formation has been observed in numerous borings on the higher elevations of the peninsula, in borings north of the APC Multiunit, and in outcrops along Steam Plant Road. The formation is a medium- to dark-gray, slightly fossiliferous, very fine-grained argillaceous limestone that is laminated to thinly bedded.

The Carters Limestone was encountered in borings throughout the peninsula, except in the far south and southwest portions of the peninsula, where the formation is completely eroded. The formation consists of two units (designated Upper Carters and Lower Carters) separated by a distinctive and continuous layer of bentonite. The Upper Carters is a gray to dark-gray, microcrystalline to medium-grained, thinly bedded, fossiliferous limestone with shaly laminations and trace fossils. A formation thickness of approximately 31 feet was logged from geophysical logs of borings that intersected the base of the overlying Hermitage Formation and the underlying bentonite layer. The bentonite layer is consistent with the T-3 bentonite as described by Hanchar (1988) and Wilson (1991). The thickness of the bentonite deposit varied slightly across the site but was present in every boring intersecting the Upper and Lower Carters Limestone. The average thickness of the bentonite deposit was 1 to 3 inches; however, up to 5-inches has been noted. The Lower Carters is lithologically distinctive from the Upper Carters by its more massive and thicker beds that contain chert, and having clean beds with stylolites near the bottom of the unit. Formation thickness is approximately 64 feet based on site drilling information.

The Lebanon Limestone was encountered across the entire site, and it is a medium-gray to olive-gray, very fine- to medium-grained, fossiliferous limestone with thin shaly beds. The unit is similar in appearance to the Lower Carters Limestone but contains slightly more clay content.

Bedrock Fractures

The bedrock underlying the peninsula tends to be locally, but not extensively, fractured. Most fractures are nearly horizontal, parallel to bedding. These fractures are generally developed along bedding planes, shaly layers, or other natural weaknesses in the rock. Within the Hermitage, Carters, and Lebanon formations, these fractures are generally tight, although they may show slight to moderate weathering at shallow depths or at prominent fracture zones.

There is no apparent correlation of fractures with stratigraphic intervals in the Hermitage or Carters formations between boreholes. However, fractures in the Lebanon Limestone do appear to have some stratigraphic correlations. Based on gamma response, there are two zones relatively enriched in clay content in the Lebanon Limestone, approximately 30 feet and 70 feet into the Lebanon Limestone. In each interval, a fracture zone is present that is commonly water-bearing. The upper fracture zone (L1) occurs approximately 26 to 42 feet below the top of the Lebanon Limestone, and the lower fracture zone (L2) occurs approximately 67 to 75 feet below the top of the Lebanon Limestone. Fractures within these zones have been identified at numerous boreholes across the site.

While the L1 and L2 fracture zones may be correlated between numerous boreholes, they are not interpreted to be single continuous fractures. Rather, they each represent a 10 to 15-foot thick section of the Lebanon Limestone that may contain one or more fractures. The lateral extent of individual fractures within the zones is not known; the fractures may be highly localized or could extend tens or hundreds of feet. The interconnection of fractures is not known, but it appears to be sufficient to allow lateral groundwater flow, and for the zone to be described as an aquifer.

2.1.2 Hydrogeology

Three water-bearing units are described below as they pertain to the APC Multiunit.

Unconsolidated

The extent of groundwater present in unconsolidated materials and hydraulic heads is shown on **Figure 2** based upon manual water level gauging performed on April 13, 2020. The unconsolidated materials are primarily alluvium, but water is also locally present in residuum, such as at Well 23. The alluvium generally has a high percentage of fines (silts and clays) and many wells have very poor yield. The alluvium was deposited by the Cumberland River on the south and southwest portions of the site, so its extent is limited to these areas.

Within the clay alluvium, occasional lenses of sandy, more permeable materials are encountered (e.g., well S3, GAF-410U). Drilling data indicates the sand does not occur as a simple, laterally continuous sand lens, but rather that it is encountered sporadically and not at predictable depths or horizons. Where groundwater is present in these sand lenses within the clay alluvium, it is generally confined by the overlying and underlying clays.

Lower Carters Limestone

Beneath the APC Multiunit and adjacent areas to the north and west, groundwater is present in fractures within the Carters Limestone. Although the Carters Limestone is present over a large area of the site, it is not necessarily water-bearing throughout this extent. Where the T-3 bentonite is present, it appears that the bentonite and overlying Hermitage Formation have limited the vertical infiltration of water and thus limited the development of solution-enhanced water-bearing zones in the Carters Limestone. Therefore, the groundwater is generally present in the Lower Carters Limestone only where the T-3 bentonite is absent and the Lower Carters is exposed near the ground surface.

Groundwater within the Lower Carters Limestone flows through secondary porosity consisting of a network of water-bearing fracture zones that have been developed and enhanced by dissolution of the limestone. The majority of these are developed parallel to nearly flat-lying bedding planes. The shallowest water-bearing zones in the Lower Carters Limestone were encountered at elevations between approximately 441 and 463 ft msl, and the deepest is at elevation 388 ft msl. Groundwater in these zones is generally under confined or semi-confined conditions. In the vicinity of sinkholes and swallow holes where recharge occurs, Lower Carters Limestone groundwater may be locally unconfined.

The estimated extent of groundwater present in the Lower Carters Limestone and hydraulic heads is shown on **Figure 3** based upon manual water level gauging performed on April 13, 2020. The area of low hydraulic head north of the APC Multiunit is a dominant feature shown on the groundwater contour map. The low head of approximately 444.5 ft msl occurs in wells close to the Cumberland River (well 24) and as far away as GAF-414C, approximately 5,000 linear feet from the Cumberland River. This is a large area with a low hydraulic head and a virtually flat gradient that suggests relatively high permeability and interconnectivity of water-bearing zones through this area.

The hydraulic conductivity values for water-bearing zones in the Carters Limestone were calculated using data from injection packer tests in open boreholes and from slug testing of screened wells. The lowest conductivities are associated with unfractured, unweathered limestone, which may yield little or no water at all, and these values are on the order of 1x10-6 ft/min. The highest calculated hydraulic conductivities range between 3.4x10-3 and 1.2 x 10-2 ft/min.

Groundwater in the Lower Carters Limestone discharges to the Cumberland River through a network of secondary porosity features (e.g., fractures, solution-enlarged bedding planes, etc.). A likely location for a primary pathway is where the low hydraulic heads are present north of the ash ponds (e.g. hydraulic trough). The relatively low hydraulic head and flat gradient in this area indicate high permeability and relative ease of draining.

Lebanon Limestone

The Lebanon Limestone is present beneath the entire peninsula and the area to the north. Where groundwater is encountered within the Lebanon Limestone, it is most commonly in the L1 and/or L2 fracture zones, although these zones are not always water-bearing. Throughout much of the peninsula, the water-bearing zones within the Lebanon Limestone are confined, with overlying limestone acting as a confining unit. However, in the northwest portion of the site, the Lower Carters Limestone has been eroded or is thin. In this area, the Lebanon Limestone is closer to the ground surface and connected with the Lower Carters aquifer, and the fracture zone may be locally unconfined.

The depth to the primary Lebanon Limestone water-bearing fracture zone (L1) ranges from approximately 40 feet bgs in the northwest corner of the plant, where the Lebanon is near the ground surface to approximately 190 feet bgs beneath the NRL Landfill and other high areas on site. There are also locations where the L1 fracture zone has been shown not to be water-bearing based on packer or slug testing.

The estimated extent of groundwater present in the Lebanon Limestone and hydraulic heads is shown on **Figure 4** based upon manual water level gauging performed on April 13, 2020. Hydraulic heads in the Lebanon Limestone, depicted on the figure, are highest in areas that also had high heads in the Lower Carters (GAF-405L, over 470 ft msl). Hydraulic heads are also relatively high in wells on the southeast side of the APC Multiunit (GAF-433L and GAF-437L, over 460 ft msl). From these highs, the hydraulic heads decrease roughly radially to the east, south and west toward the Cumberland River, and to the north beneath the APC Multiunit. North of the APC Multiunit, hydraulic heads in several wells are low, similar to the Cumberland River level and the low heads in the Lower Carters Limestone in this area. Thus, the extensive area of low hydraulic head that is present in the Lower Carters Limestone is also present in the Lebanon Limestone, although its extent appears to be smaller.

The hydraulic conductivity of the L1 fracture zone was calculated using injection packer tests in open boreholes and slug testing of screened wells. Many of the tested intervals have very low hydraulic conductivities, and yield little or no water at all. The highest calculated hydraulic conductivities for the L1 fracture zone range between 3.2x10-3 and 1.9x10-2 ft/min.

2.1.3 Groundwater Flow Direction

Groundwater monitoring data was used to evaluate vertical gradients between the Lebanon Limestone and overlying Lower Carters Limestone. At most of the well pairs located adjacent to the Cumberland River and the hydraulic trough in the north, hydraulic heads indicate a vertically upward gradient, which would be expected given the plant’s location adjacent to and surrounded by the Cumberland River; a regional location of groundwater discharge.

To further examine vertical gradients, **Figure 5** shows a generalized geologic cross-section with potentiometric (hydraulic head) contour lines added. The cross-section extends roughly north-south through the hydraulic trough area and the APC Multiunit. There is a vertical component of flow downward in the south (e.g., GAF-405C/L), and upward north of the ponds (e.g., in the trough area), and there is therefore a transition from downward to upward vertical gradients between these two areas.

In summary, the hydraulic head differences between water-bearing units are generally as expected, with downward gradients at locations away from the Cumberland River and where groundwater is perched, and upward gradients close to the Cumberland River and near the hydraulic trough north of the APC Multiunit. Due to the potentiometric surface data and horizontal hydraulic gradient, it is generally expected that the groundwater at the site flows to the Cumberland River.

With the anticipated completion of the EI in Summer 2020, the conceptual site model will be reviewed and updated based upon the results of recent EI activities including completion of additional dye trace studies, monitoring of the phreatic surface in the impoundments since process flows stopped being routed to the APC Multiunit, and numerical groundwater flow modeling to predict post-closure groundwater elevations. Finalizing the conceptual site model is an important step in continuing with remedy selection.

3.0 Groundwater Assessment Monitoring Program

Groundwater assessment monitoring for the APC Multiunit is conducted at GAF in accordance with 40 CFR § 257.95. This section of the report summarizes the results of the groundwater assessment monitoring program to date for the APC Multiunit.

3.1 Groundwater Monitoring Network

In compliance with 40 CFR § 257.91, the APC Multiunit groundwater monitoring well system contains 23 monitoring wells: 7 background monitoring wells and 16 downgradient monitoring wells. The monitoring well locations are shown on **Figure 6**.

The primary target of monitoring is the Carters Limestone, with 10 wells located along the downgradient waste boundary of the unit. At least one well in the Lebanon Limestone on each downgradient side of the unit was also included in the network, typically paired with Carters wells, or where the first water-bearing zones were encountered in the Lebanon.

The background monitoring wells (GAF-412C, GAF-412L, GAF-414L, GAF-426C, GAF-426L, GAF-427C, and GAF-427L) represent conditions unaffected by CCR (40 CFR § 257.91(a)(1) and (c)(1)). The background wells are hydraulically separated from the APC Multiunit by an area of low hydraulic head, so they represent conditions unaffected by CCR.

The downgradient monitoring wells (24, GAF-402C, GAF-402L, GAF-405C, GAF-406L, GAF-410U, GAF-416C, GAF-422C, GAF-446C, GAF-449L, GAF-450C, GAF-450L, GAF-451C, GAF-452C, GAF-452L, and GAF-453C) monitor groundwater downgradient near the waste boundary (40 CFR 257.91(a)(2) and (c)(1)). There are 10 downgradient monitoring wells completed in the Carters Limestone, five monitoring wells in the Lebanon Limestone, and one monitoring well screened in alluvium/unconsolidated materials.

The certification of the groundwater monitoring system required under 40 CFR § 257.91(f) is included in the facility operating record and on the facility CCR website: https://www.tva.gov/Environment/Environmental-Stewardship/Coal-Combustion-Residuals/Gallatin

3.2 Groundwater Characterization

Characterization of the nature and extent of the sole GWPS exceedance for arsenic in groundwater is understood from the assessment monitoring that was conducted in 2018, 2019 and the first 2020 semiannual assessment monitoring event in April 2020. Supplemental investigations may be conducted during the selection of remedy process to aid in selection and design of a remedy. Groundwater monitoring results are summarized below:

- Arsenic exceeded GWPS at GAF-410U, which is screened in alluvium/unconsolidated materials. The SSL concentration of arsenic detected at GAF-410U in the April 2020 assessment monitoring event was 0.0339 milligrams per liter (mg/L). The published GWPS for arsenic is 0.010 mg/L. **Figure 7** presents a concentration trend plot for arsenic through April 2020.
- GAF-410U is screened in alluvium, which is localized in this area (**Figure 2**). Alluvium is not present and/or water-bearing zones are not found in overburden in the areas surrounding this well. Thus, its horizontal extent is defined by the limited extent of water in alluvium.
- In the vertical direction, a nearby well is screened in the underlying Carters Limestone (GAF-446C, **Figure 3**). This well is already part of the CCR Rule monitoring network, and arsenic is not above the GWPS in this well. Thus, the vertical extent is defined by the existing well network.

Cobalt exceedances of the GWPS at GAF-450C and GAF-450L and the lithium exceedance at GAF 452C are attributed to an alternate source for the SSLs: natural groundwater variability, as presented in the Alternate Source Demonstration (ASD) in AECOM (2019).

In the first assessment sampling event of 2020 (performed in April), the results included an unconfirmed exceedance of the Arsenic GWPS at well GAF-450L. This unconfirmed exceedance is being further evaluated via confirmation sampling. The confirmation sampling was completed in late-June 2020 but analytical results are not yet available. The results of this further evaluation will be explained in the next semiannual progress report.

4.0 Assessment of Corrective Measures

TVA prepared the 2019 ACM Report for the APC Multiunit, added it to the operating record on July 15, 2019, and posted it on TVA's 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).

As described in Section 1.2, subject to all necessary environmental reviews, closure of the APC Multiunit will be by removal of the CCR, and closure represents the key source control measure for the purposes of remedy selection under § 257.97.

4.1 Planned Source Control Measures

The objectives of corrective measures under § 257.96(a) are to "prevent further releases [from the CCR Unit], to remediate any releases, and to restore affected areas to original conditions." Ultimately, in accordance with § 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 in 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. TVA has already implemented operational changes such as reducing free water in Ash Pond E, constructing a new flow management system, and rerouting flows previously sent to the APC Multiunit.

The APC Multiunit, which consists of unlined surface impoundments, has already ceased receiving flows. Stopping flows to the APC Multiunit and dewatering the ponds will lead to further control of the source and prevention of releases.

Closure-by-removal (CBR) of the APC Multiunit will serve as source control measures as required under 40 CFR § 257.97(b)(3). These measures will eliminate the potential for migration of CCR constituents to groundwater after completion of the removal efforts.

Groundwater assessment monitoring as required by 40 CFR 257.96(b) will continue until a groundwater remedy is selected. Once a remedy is selected, a Corrective Action Groundwater Monitoring Program (CAGWMP) will be instituted to document the effectiveness of the corrective action remedy.

4.2 Potential Remedial Technologies

Subject to all necessary environmental reviews, the APC Multiunit will be closed-by-removal in accordance with 40 CFR § 257.102 and applicable state law.

In addition to this source control measure, four primary strategies have been evaluated to address groundwater exhibiting concentrations above the arsenic GWPS including the following:

- Monitored Natural Attenuation (MNA);
- In-Situ Physical/Chemical Treatment;
- Permeable Reactive Barriers (PRB); and
- Hydraulic Containment and Treatment.

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

5.0 Selection of Remedy: Current Progress

A remedy to address SSLs in groundwater will be selected in accordance with 40 CFR § 257.97 and the CARA Plan required by the agreement between TDEC and TVA. At this point in the selection process, each of the corrective measures presented in Section 4.2 meets the requirements of the remedy as defined in 40 CFR § 257.97.

In support of the remedy selection process, additional investigation is needed, as described below.

5.1 Data Requirements for Design of Groundwater Corrective Action

Characterization of the arsenic impacts in accordance with 40 CFR § 257.95(g) is complete in the vicinity of well GAF-410U. However, additional data obtained through the on-going EI may further refine the characterization of the horizontal extent of arsenic impacts downgradient of the APC Multiunit. As noted in Section 1.2.1, the EI is expected to be complete in Summer 2020. TVA expects to submit the EAR to TDEC in Fall 2020. The EAR will inform the development of the CARA Plan which will be developed in parallel with Remedy Selection under the CCR Rule.

In order to further refine the targeted areas for corrective measures, develop detailed remedy cost estimates, and finalize the alternative for the APC Multiunit, the currently available site-specific data may require further refinement. To this end, some potential data gaps have been identified below. It is noted that additional data collection requirements may include on-going EI work that is reported separately.

Current and proposed activities to further evaluate MNA:

- Supplemental Groundwater Flow Modeling Simulations – The existing groundwater flow model developed for the EI is currently being refined based on expanded groundwater elevation data gained from the on-going EI and proposed NRL Landfill lateral expansion hydrogeologic investigation. These flow model refinements are expected to be completed in August 2020 following the completion of on-going dye trace studies at the site.
- Supplemental Groundwater Fate and Transport Evaluations - While numerical modeling was previously presented as a potential activity to further evaluate MNA, given the challenges of using numerical fate and transport modeling in a karst environment, it is now suggested that further geochemical evaluation of arsenic and risk assessment tools would prove more useful in considering MNA as a strategy for groundwater corrective action. Additional evaluation of available groundwater geochemical data, along with groundwater flow predicted by flow modeling and dye trace study results, will be used to assess the fate, transport, and attenuation of arsenic in the natural environment.

Potential future activities to evaluate In-situ Physical/Chemical Treatment:

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

Potential future activities to evaluate PRB:

- Groundwater Treatability Study – For in-situ treatment of groundwater, treatability studies will be needed to evaluate PRB amendments for the treatment of arsenic.
- Supplemental Geotechnical Investigation – Additional geotechnical investigation would consist of geotechnical drilling to evaluate the subsurface conditions in areas considered for a PRB. Boring data would be used to further evaluate the length and depth of the PRB.

Potential future activities to evaluate Hydraulic Containment and Treatment:

- Wastewater Treatment Capacity Study – Evaluation of the existing on-site wastewater treatment system capacity is needed to understand options for extracted groundwater treatment should the hydraulic containment and treatment option be considered.
- Groundwater Treatability Study – For ex-situ treatment of extracted groundwater, treatability studies will be needed to evaluate technologies for the treatment of arsenic.
- Supplemental Groundwater Flow Modeling Simulations –The groundwater flow model could be used to simulate a variety of groundwater extraction scenarios. Initial

extraction simulations would be based upon the existing understanding of the hydraulic characteristics of the subsurface. The purpose of this flow modeling would be to optimize hydraulic containment of the arsenic impacted groundwater while balancing physical site constraints and extracted groundwater existing treatment capacity.

- 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.

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

Progress toward the selection 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 produced 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 CRF § 257.107(h) will be complied with as required by 40 CFR § 257.96(f).

6.0 References

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TVA and Arcadis, 2014. *Groundwater Assessment Monitoring Project Summary and Risk Assessment Report. TVA Gallatin Fossil Plant. Non-registered Site #83-1324.* November 24, 2014.

Wilson, 1991. *The Geology of Nashville, TN.* State of Tennessee Department of Environment and Conservation, Division of Geology, Bulletin 52, Second Edition.

Figures

LEGEND

- Cumberland River Flow Direction
- TVA Gallatin Fossil Plant Property Boundary (Approximate)
- CCR Management Units
- North Rail Loop (NRL) Landfill
- Stilling Ponds

N

0 1,200 2,400
Feet

NOTE: Aerial image dated February 2017

AECOM

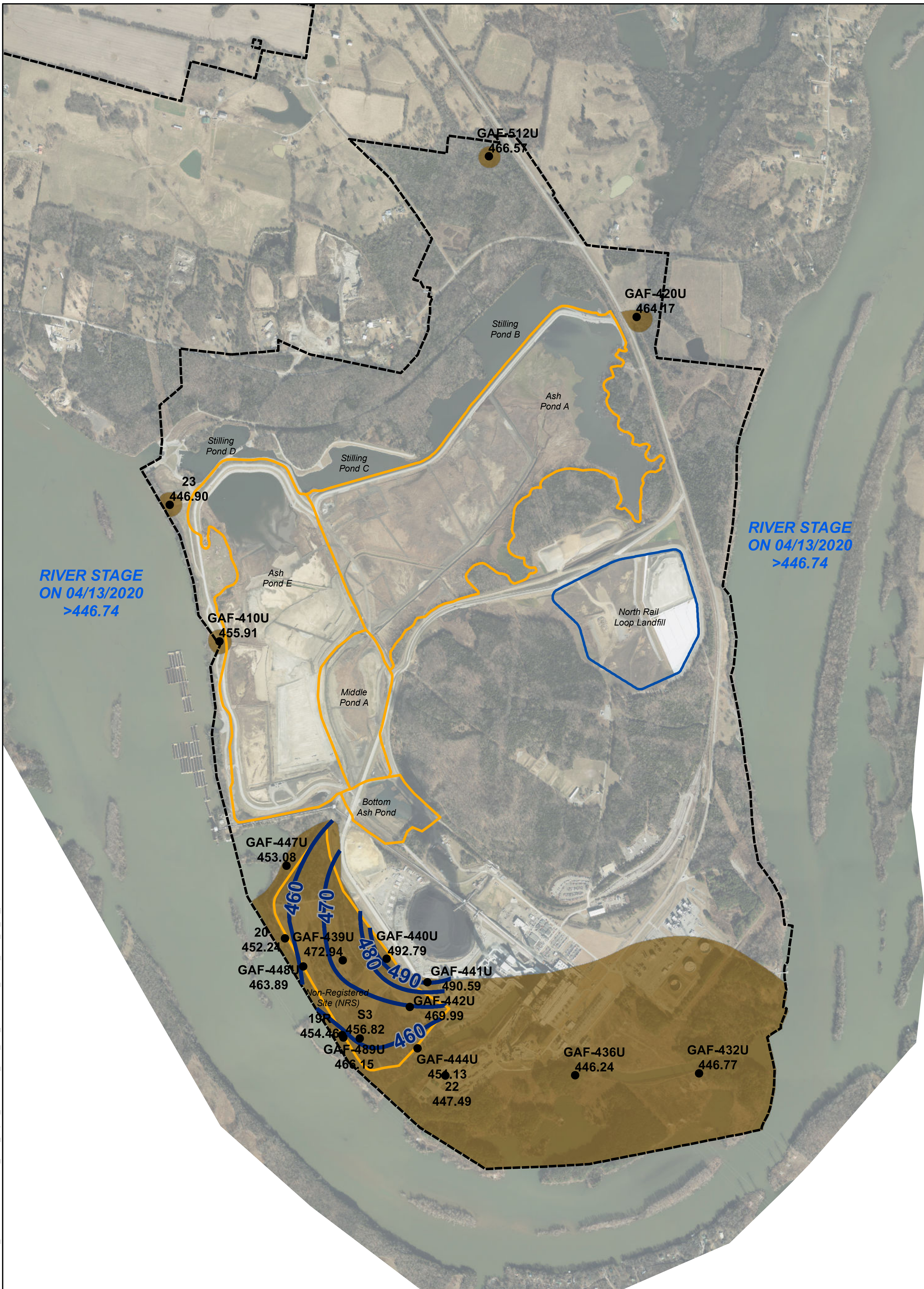
Figure 1

OVERVIEW OF
CCR MANAGEMENT AREAS

DRAWN BY:	REVIEWED BY:	APPROVED BY:	REVISION NUMBER:
MARK.P.SMITH	SCHEIPC		REV. 9

GALLATIN FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY

DATE:	DEPT:
4/24/2017	FOSSIL AND HYDRO ENGINEERING



LEGEND:

22	Well ID
447.49	Groundwater Elevation (feet MSL) on 04/13/2020
●	Well Location
	Groundwater Elevation Contour in Unconsolidated Unit, Dashed where Inferred
	TVA Gallatin Fossil Plant Property Boundary (Approximate)
	CCR Management Units
	Estimated Extent of Groundwater in Unconsolidated Unit
	Groundwater Flow Direction

N

0 1,200 2,400
Feet

NOTE: Aerial image dated February 2017

AECOM

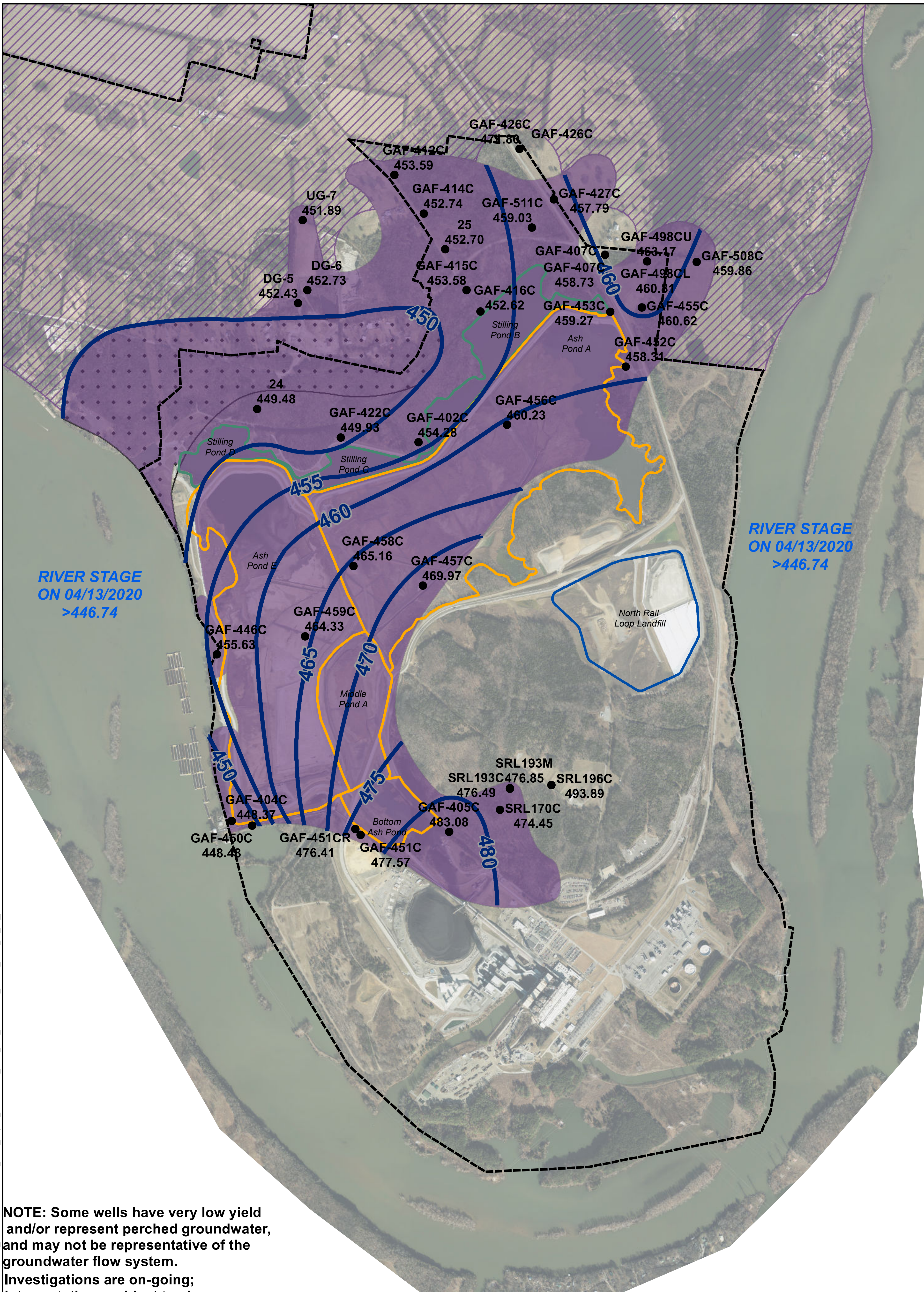
Figure 2

HYDRAULIC HEAD
UNCONSOLIDATED UNIT,
APRIL 13, 2020

DRAWN BY:	REVIEWED BY:	APPROVED BY:	REVISION NUMBER:
MARK.P.SMITH	C.GARLINGTON		REV. 0

GALLATIN FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY

DATE:	DEPT:
6/10/2020	FOSSIL AND HYDRO ENGINEERING



LEGEND:

GAF-451C Well Screened in Carters Limestone
477.57 Hydraulic Head feet MSL on 04/13/2020

- Well Screened in Carters Limestone
- Groundwater Flow Direction
- Hydraulic Head Contour in Aquifer, Dashed where Inferred
- TVA Gallatin Fossil Plant Property Boundary (Approximate)
- Ash Pond Complex
- North Rail Loop (NRL) Landfill
- Stilling Ponds
- Estimated Extent of Lower Carters Limestone Aquifer
- Presence of Carters Aquifer Unknown
- 1st Water Encountered in Lebanon; Contiguous with Carters Aquifer

NOTE: Aerial image dated February 2017

N

0 1,200 2,400
Feet

AECOM

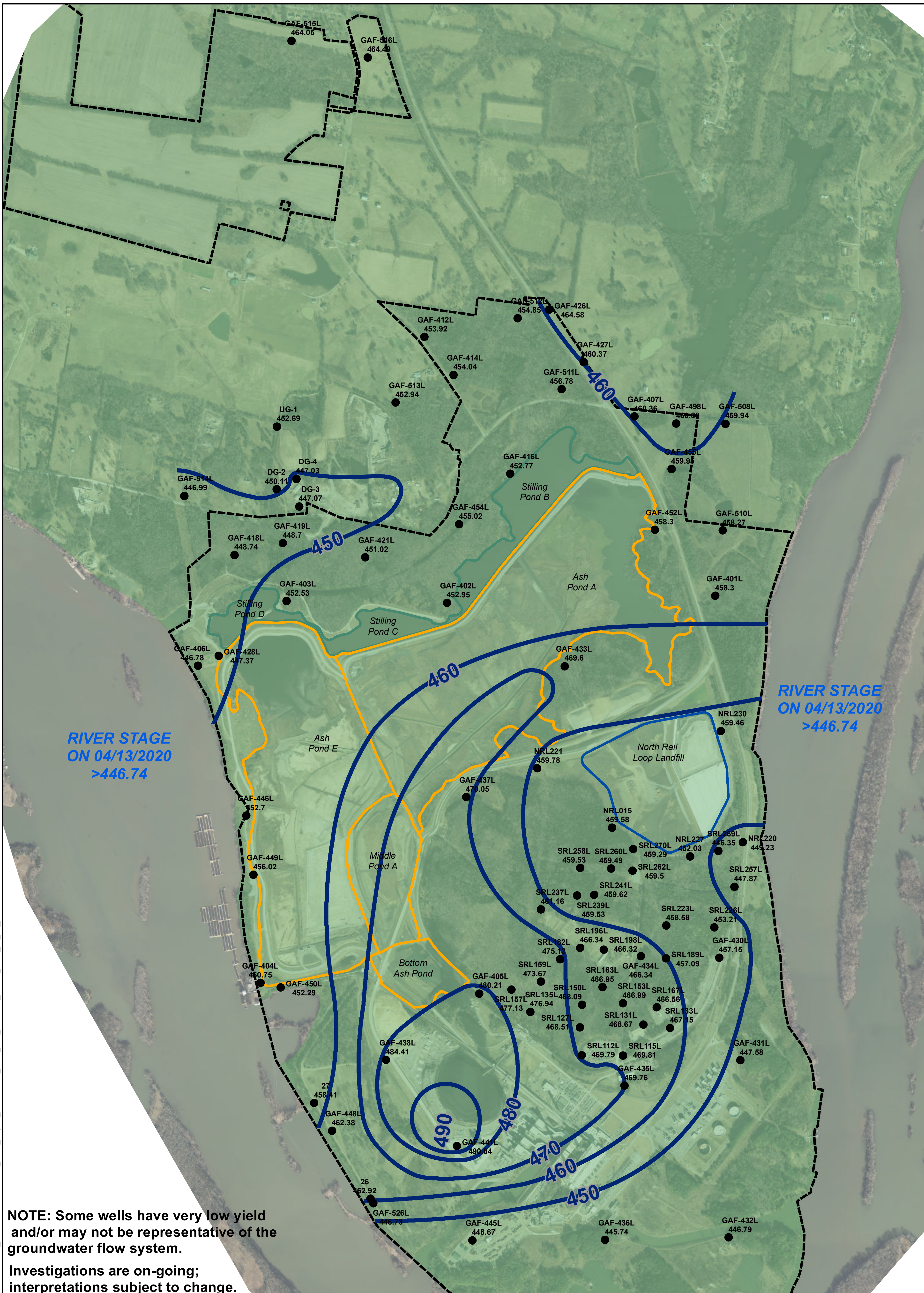
Figure 3

HYDRAULIC HEADS
CARTERS AQUIFER,
APRIL 13, 2020

DRAWN BY:	REVIEWED BY:	APPROVED BY:	REVISION NUMBER:
MARK.P.SMITH	C.GARLINGTON	E.PERRY	REV. 0

GALLATIN FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY

DATE:	DEPT:
6/10/2020	FOSSIL AND HYDRO ENGINEERING



LEGEND:

GAF-432L Well Screened in Lebanon Limestone
446.79 Hydraulic Head feet MSL on 04/13/2020

- Well Screened in Lebanon Limestone
- Hydraulic Head Contour in Aquifer
- TVA Gallatin Fossil Plant Property Boundary (Approximate)
- Ash Pond Complex
- North Rail Loop (NRL) Landfill
- Stilling Ponds
- Estimated Extent of Lebanon Limestone Aquifer

N

0 1,200 2,400
Feet

NOTE: Aerial image dated February 2017

AECOM

Figure 4

HYDRAULIC HEADS
LEBANON AQUIFER,
APRIL 13, 2020

DRAWN BY:	REVIEWED BY:	APPROVED BY:	REVISION NUMBER:
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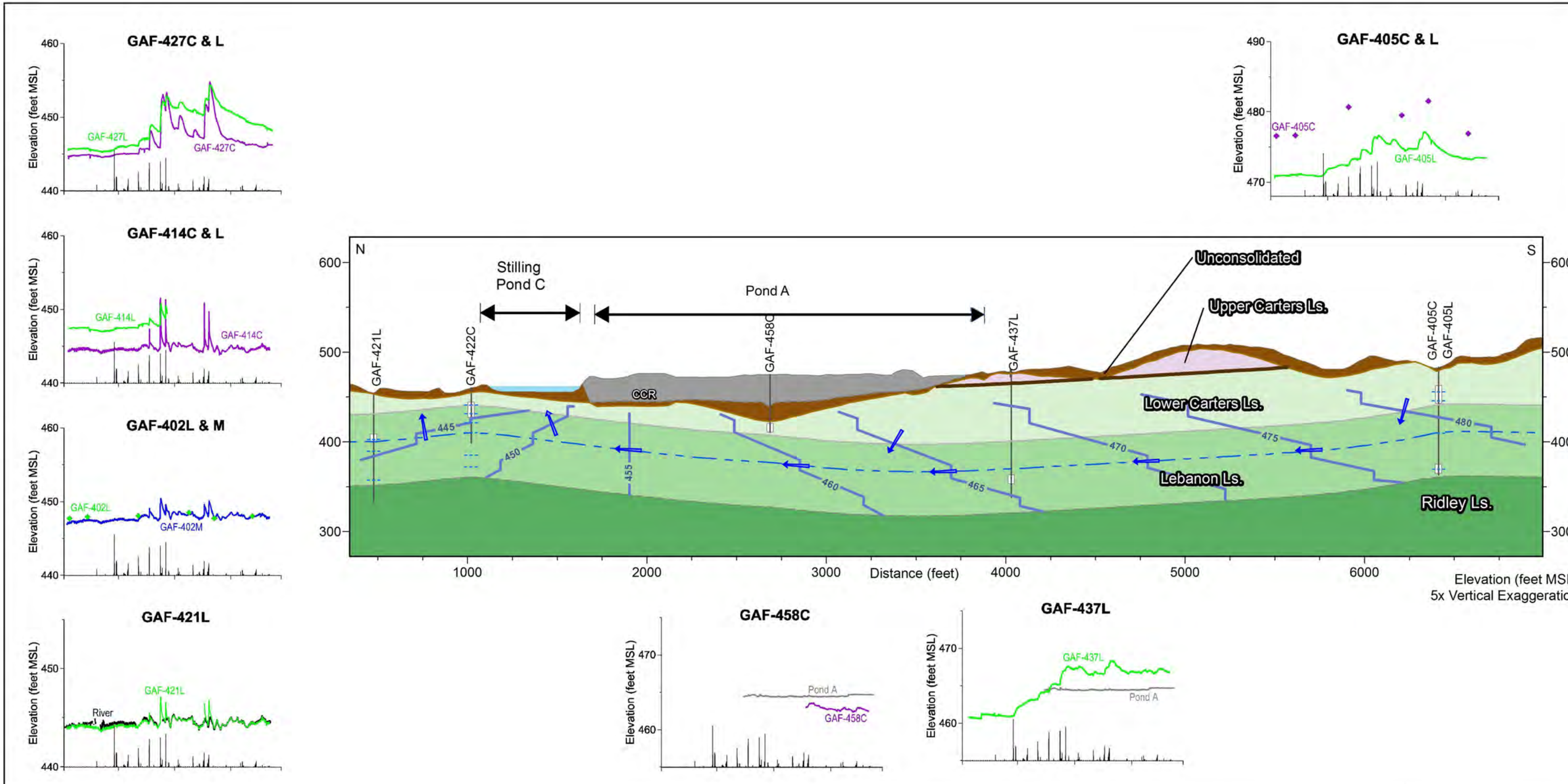
GALLATIN FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY

DATE:	DEPT:
6/10/2020	FOSSIL AND HYDRO ENGINEERING



LEGEND

- Bentonite
- Equipotential Lines
- Approximate Location of the Upper Water Bearing Lebanon Ls. Fractures (Confined)
- Boring or Well
- Well Screen
- Arrows represent direction of groundwater flow
- Water-bearing Zone

Notes:

1. Section based on Geologic Cross Section C-C' (see Appendix of EAR)
2. Equipotential lines shown here represent an interpretation of the groundwater flow system in the vicinity of the APC, based on water level data from 1/23/2017.
3. The geologic units are not all water-bearing at all locations, including locations on this section. For example, there are no water-bearing zones in the Carters Limestone in the vicinity of GAF-437L, but there are such zones elsewhere south of the APC. The L1 and L2 Lebanon fracture zones are variably water-bearing.
4. Investigations are on-going; interpretations subject to change.

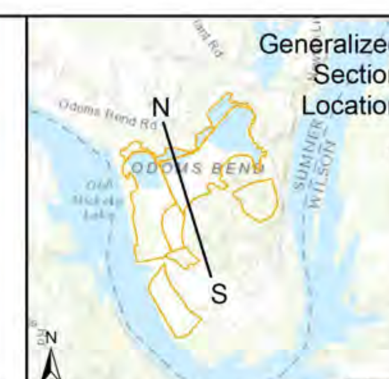


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Figure 5

EXAMPLE NORTH-SOUTH CROSS SECTION WITH HYDRAULIC HEADS

DRAWN BY:	REVIEWED BY:	APPROVED BY:	REVISION NUMBER:
MCKINNEYR	SCHEIPC	KEYSV	REV. 1

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DATE: 4/27/2017 | DEPT: FOSSIL AND HYDRO ENGINEERING

Document Path: M:\USCHA3_Data\200\TVA\GAF\RobbiGIS\CrossSectionCCSpecialReq.mxd

LEGEND

- CCR Rule Monitoring System Wells
- TVA Gallatin Fossil Plant Property Boundary (Approximate)
- Ash Pond Complex
- Stilling Ponds

NOTE: Aerial image dated February 2017

AECOM

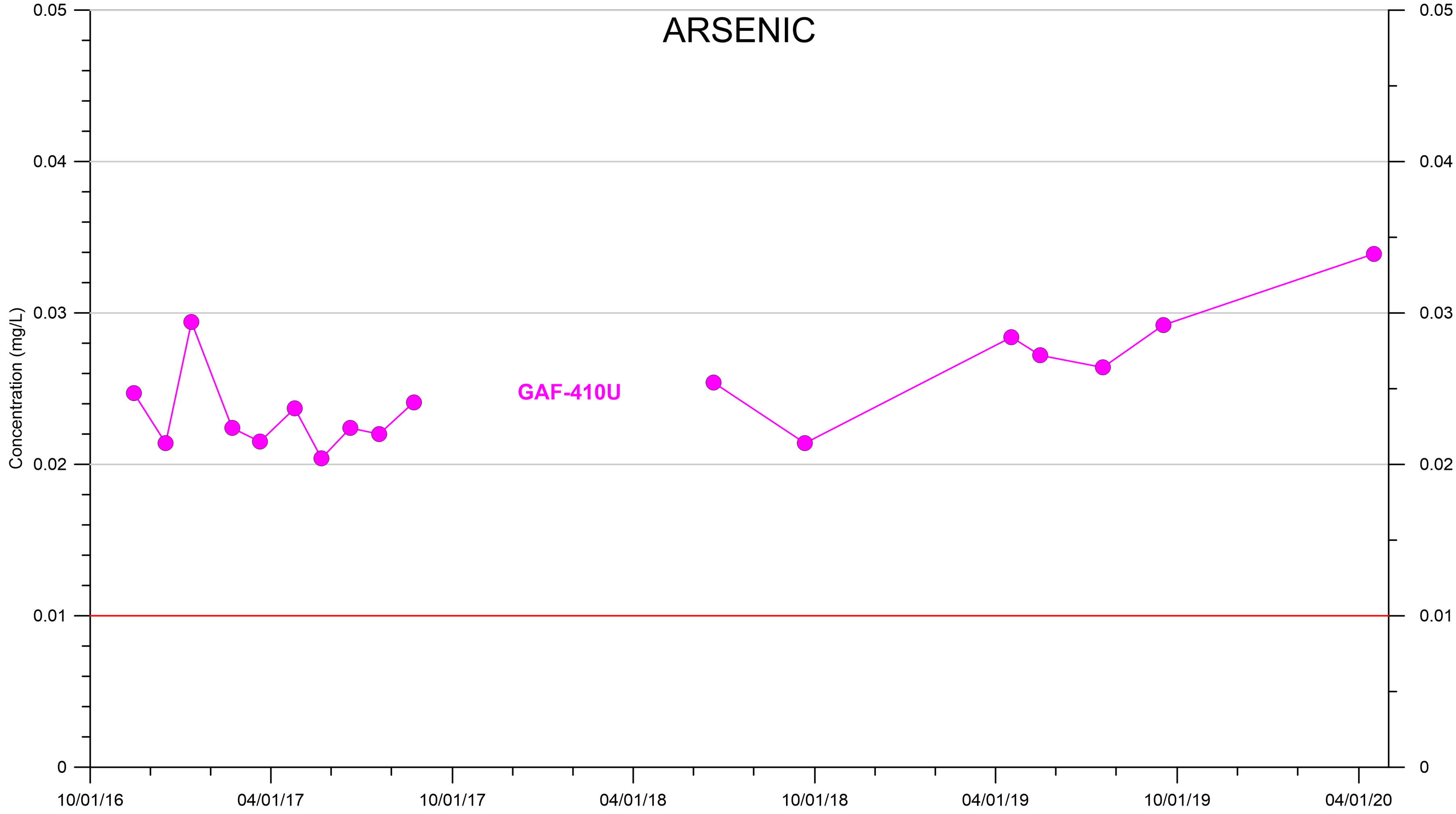
Figure 6

CCR RULE MONITORING SYSTEM
ASH POND COMPLEX (APC)

DRAWN BY:	REVIEWED BY:	APPROVED BY:	REVISION NUMBER:
MARK.P.SMITH	C.GARLINGTON		REV. 0

GALLATIN FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY

DATE:	DEPT:
10/13/2017	FOSSIL AND HYDRO ENGINEERING



Legend

GAF-410U — MCL

NOTES:
Total data only
Does not include U-flagged data

[redacted]

AECOM	Figure 7
Concentration Trend Plots	

DRAWN BY: SCOTTD	REVIEWED BY: GARLINGTONC	APPROVED BY: PERRYAE	REVISION NUMBER: REV. 0

GALLATIN FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY

DATE: 2020/06/17	DEPT: FOSSIL AND HYDRO ENGINEERING