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November 11, 2022

Tennessee Valley Authority
1101 Market Street
Chattanooga
Tennessee, 37402-2801

Subject: Engineer's Certification of Demonstration of Compliance with Design Criteria
South Rail Loop Landfill
Tennessee Valley Authority Gallatin Fossil Plant
Gallatin, Tennessee

1.0 PURPOSE

The purpose of this document is to certify that the Tennessee Valley Authority (TVA) Gallatin Fossil Plant (GAF) coal combustion residuals (CCR) South Rail Loop (SRL) Landfill is in compliance with the design criteria for new CCR landfills and any lateral expansion of a CCR landfill requirements specified in 40 CFR § 257.70 of the United States Environmental Protection Agency (USEPA) CCR Rule (CCR Rule).

2.0 BACKGROUND

In accordance with 40 CFR § 257.70, all new and existing CCR impoundments, new CCR landfills, and lateral expansions of units must be designed with either a composite liner that meets the requirements of paragraph 40 CFR § 257.70(b) or an alternative composite liner that meets the requirements in paragraph 40 CFR § 257.70(c). In addition, the leachate collection and removal system must meet the requirements of paragraph 40 CFR § 257.70(d).

3.0 SUMMARY OF FINDINGS

A Design Criteria (Demonstration) has been prepared and is provided in **Attachment A**. The Demonstration shows that the SRL Landfill meets the requirements set forth in 40 CFR § 257.70(a)(1).

4.0 CERTIFICATION

I, David Skeggs, being a Professional Engineer in good standing in the State of Tennessee, do hereby certify, to the best of my knowledge, information, and belief that the information contained in this certification has been prepared in accordance with the accepted practice of engineering; that the information contained herein is accurate as of the date of my signature below; and that the SRL Landfill meets the requirements of 40 CFR § 257.70.

SIGNATURE: _____ **DATE:** November 11, 2022
David Skeggs, PE

ADDRESS: 5438 Wade Park Blvd.
Suite 200
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TELEPHONE: 919-461-1100

ATTACHMENTS: A – Design Criteria Demonstration

Attachment A
Design Criteria Demonstration

TVA GALLATIN FOSSIL PLANT – SUMNER COUNTY, TENNESSEE

COMPLIANCE WITH DESIGN CRITERIA DEMONSTRATION 40 CFR § 257.70 SOUTH RAIL LOOP LANDFILL

Prepared for

Tennessee Valley Authority
1101 Market St.
Chattanooga, TN 37402-2801

Revision 0
November 11, 2022

Prepared by

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1.0 INTRODUCTION

1.1 OBJECTIVE

This Design Criteria Demonstration (Demonstration) has been prepared for the proposed South Rail Loop (SRL) coal combustion residuals (CCR) Landfill located at the Tennessee Valley Authority's (TVA) Gallatin Fossil Plant (GAF) in Sumner County, Tennessee.

The purpose of this Demonstration is to document compliance with the liner and leachate collection and removal system design requirements set forth in 40 CFR § 257.70 of the United States Environmental Protection Agency (USEPA) CCR Rule.

1.2 SITE BACKGROUND

The SRL Landfill is located on land currently owned by TVA at GAF. GAF is located at 1499 Steam Plant Road in Sumner County, on the north bank of the Cumberland River, approximately four miles southeast of the juncture of U.S. Route 31E and Tennessee State Route 109 in Gallatin. The proposed SRL Landfill footprint (**Figure 1**) is located within the GAF reservation, just south of the existing North Rail Loop (NRL) Landfill, north of the GAF plant, and west of Steam Plant Road. Existing ground surface elevation across the disposal site ranges from approximately 475 ft to 575 ft National Geodetic Vertical Datum of 1929 (NGVD29).

1.3 LANDFILL DESCRIPTION

The SRL is being developed in a series of 5 cells, to support CCR removal from other CCR units on-site. These 5 cells will be referenced as Cell 4, Cell 5, Cell 6, Cell 7, and Cell 8 and will be constructed sequentially, moving generally west to east as additional disposal capacity is needed. The SRL Landfill is scheduled to begin construction in late November 2022. The SRL Landfill is subject to complete design criteria demonstrations per 40 CFR § 257.70, which states the CCR Rule requirements for design criteria for new CCR landfills and any lateral expansion of a CCR landfill. These regulations require the CCR unit owner or operator to obtain a certification from a qualified professional engineer that the design of the composite liner (or, if applicable, alternative composite liner) and the leachate collection and removal system meets the requirements of § 257.70. This certification must be obtained prior to construction of the CCR landfill or any lateral expansion of a CCR landfill.

The limit of waste proposed for the GAF SRL Landfill will cover a disposal area of approximately 100.5 acres divided into 5 overall development phases constructed sequentially. The leachate management system will be subdivided into the cells by sub-cell division berms. CCR waste will be deposited to the maximum disposal grade and elevation as permitted. Given the nature of the waste, daily cover material is not required. Waste grades that have achieved final development grades along the outer slopes of the landfill will ultimately receive the final cap and cover.

1.4 REGIONAL GEOLOGY

GAF is located within the Nashville Basin physiographic province near the border with the Highland Rim physiographic province, both formed from the uplift of the Nashville Dome. Bedrock of the Nashville Basin nearest the surface generally consists of Ordovician limestones, dolomites, and shales, while the surrounding Highland Rim region generally consists of younger (less eroded) Silurian, Devonian, and Mississippian limestones, cherts, shales, and sandstones. These sedimentary rocks are underlain by approximately 2,500 ft of Cambrian sedimentary rocks and a Precambrian igneous and metamorphic basement complex (Wilson, 1991).

Despite the tectonic processes creating the Nashville Dome, bedrock formations are generally nearly flat lying. Regional dips for bedrock surrounding the Site are approximately 15 to 25 ft per mile (less than 1 degree) to the northwest (Wilson, 1991). The bedrock stratigraphy at the Site, from youngest to oldest and in the order that the units are encountered from the surface, is as follows:

Nashville Group	Bigby-Cannon Limestone – comprises the *Bigby* facies (0 ft to 10 ft thick), the *Cannon* facies (40 ft to 80 ft thick), and the *dove-colored* facies (10 ft to 20 ft thick).
	Hermitage Formation – comprises the *silty nodular* facies (0 ft to 5 ft thick), the *granular phosphatic* facies (10 ft to 20 ft thick), and the *laminated argillaceous* facies (40 ft to 70 ft thick).
Stones River Group	Carters Limestone – comprises the *Upper Carters* (10 ft to 20 ft thick), the *T-3 bentonite* deposit (0.5 ft to 1 ft), and the *Lower Carters* (60 ft to 70 ft thick).
	Lebanon Limestone – consists of a single facies, approximately 80 to 125 ft thick.
	Ridley Limestone – consists of a single facies of dolomitic limestone (approximately 100-150 ft thick).

The most recognizable geologic contacts occurring in this sequence are the Hermitage/Carters contact (e.g., contrasting clay content) and the Upper/Lower Carters contact (e.g., the T-3 bentonite). This regional geology information was submitted to TDEC as part of a hydrogeological report in support of the SRL Landfill permit application.

1.5 REGIONAL HYDROGEOLOGY

GAF is located within the Central Basin Aquifer system of Middle Tennessee. This aquifer system is formed in Devonian to Ordovician age carbonates and shales through the erosion of the Nashville Dome. The base of the Central Basin Aquifer is defined by the top of the Knox Group. This aquifer system is an important source of drinking water for Middle 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 relatively shallow flow system of solution-enhanced fracture zones. These water-bearing zones are highly irregular in their distribution throughout the solid rock mass and generally occur within 300 ft of the land surface. They consist of fractures or openings along joints and bedding planes that have been enlarged by dissolution of the limestones. These water-bearing zones 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 water-bearing zones, which have typically been found to be horizontally elongated (Brahana and Bradley, 1986).

At GAF, the Devonian and Silurian formations have eroded, leaving the Ordovician formations present, as described above. The water-bearing characteristics of these formation are as follows:

Hermitage Formation – The high clay/shale content of the Hermitage limits the development of water-bearing zones. It functions as a confining unit and restricts downward movement of groundwater to underlying formations. (Brahana and Bradley, 1986; Newcome, 1958)

Carters Limestone – The Carters is a relatively pure limestone and is subject to solution and karst development where water has access to the rock. However, development of water-bearing zones is hindered by the overlying Hermitage, where present. The presence of the Hermitage restricts the downward seepage of water to the Carters Limestone, forming an almost impervious cap

(Newcome, 1958). Bentonite zones in the Carters Limestone also play a significant role in the hydrology. In areas where the bentonite layers are laterally continuous, the downward movement of groundwater is restricted. Where the bentonite zones are breached by open joints or intersecting stream valleys, solution openings can form in the underlying limestone. The Carters Limestone forms an important aquifer where it is exposed (where the Hermitage Formation has been eroded) and where the T-3 bentonite is weathered. (Brahana and Bradley, 1986; Newcome, 1958)

Lebanon Limestone – The thin bedding and shale beds in the Lebanon Limestone limit the development of water-bearing zones, but not to same extent as the Hermitage. (Brahana and Bradley, 1986; Newcome, 1958) The most important and consistent water-bearing zones in the vicinity of the SRL Landfill are found in the Lebanon Limestone.

Ridley Limestone – The Ridley Limestone is another relatively pure limestone that is susceptible to solution and karst development, especially with the absence of clay or bentonite zones (Brahana and Bradley, 1986; Newcome, 1958). However, at GAF, it is a relatively deep formation, and underlies the other formations listed above.

Due to the presence of the Cumberland River on the east, south, and western boundaries of GAF, groundwater at GAF is expected to ultimately discharge to the River. This regional hydrogeology information was submitted to TDEC as part of the hydrogeological report in support of the SRL Landfill permit application.

2.0 CCR Rule Requirements – 40 CFR § 257.70

§ 257.70 Design criteria for new CCR landfills and any lateral expansion of a CCR landfill.

(a)(1) New CCR landfills and any lateral expansion of a CCR landfill must be designed, constructed, operated, and maintained with either a composite liner that meets the requirements of paragraph (b) of this section or an alternative composite liner that meets the requirements in paragraph (c) of this section, and a leachate collection and removal system that meets the requirements of paragraph (d) of this section.

…

(b) A composite liner must consist of two components; the upper component consisting of, at a minimum, a 30-mil geomembrane liner (GM), and the lower component consisting of at least a two-foot layer of compacted soil with a hydraulic conductivity of no more than 1×10^{-7} centimeters per second (cm/sec). GM components consisting of high density polyethylene (HDPE) must be at least 60-mil thick. The GM or upper liner component must be installed in direct and uniform contact with the compacted soil or lower liner component. The composite liner must be:

(1) Constructed of materials that have appropriate chemical properties and sufficient strength and thickness to prevent failure due to pressure gradients (including static head and external hydrogeologic forces), physical contact with the CCR or leachate to which they are exposed, climatic conditions, the stress of installation, and the stress of daily operation;

(2) Constructed of materials that provide appropriate shear resistance of the upper and lower component interface to prevent sliding of the upper component including on slopes;

(3) Placed upon a foundation or base capable of providing support to the liner and resistance to pressure gradients above and below the liner to prevent failure of the liner due to settlement, compression, or uplift; and

(4) Installed to cover all surrounding earth likely to be in contact with the CCR or leachate.

(c) If the owner or operator elects to install an alternative composite liner, all of the following requirements must be met:

(1) An alternative composite liner must consist of two components; the upper component consisting of, at a minimum, a 30-mil GM, and a lower component, that is not a geomembrane, with a liquid flow rate no greater than the liquid flow rate of two feet of compacted soil with a hydraulic conductivity of no more than 1×10^{-7} cm/sec. GM components consisting of high density polyethylene (HDPE) must be at least 60-mil thick. If the lower component of the alternative liner is compacted soil, the GM must be installed in direct and uniform contact with the compacted soil.

…

(d) The leachate collection and removal system must be designed, constructed, operated, and maintained to collect and remove leachate from the landfill during the active life and post-closure care period. The leachate collection and removal system must be:

(1) Designed and operated to maintain less than a 30-centimeter depth of leachate over the composite liner or alternative composite liner;

(2) Constructed of materials that are chemically resistant to the CCR and any non-CCR waste managed in the CCR unit and the leachate expected to be generated, and of sufficient strength and thickness to prevent collapse under the pressures exerted by overlying waste, waste cover materials, and equipment used at the CCR unit; and

(3) Designed and operated to minimize clogging during the active life and post-closure care period.

> *(e) Prior to construction of the CCR landfill or any lateral expansion of a CCR landfill, the owner or operator must obtain a certification from a qualified professional engineer . . . that the design of the composite liner (or, if applicable, alternative composite liner) and the leachate collection and removal system meets the requirements of this section.*
>
> *…*
>
> *(g) The owner or operator of the CCR unit must comply with the recordkeeping requirements specified in § 257.105(f), the notification requirements specified in § 257.106(f), and the Internet requirements specified in § 257.107(f).*

3.0 DEMONSTRATION OF COMPLIANCE WITH DESIGN CRITERIA

The SRL Landfill was evaluated with respect to the requirements set forth in 40 CFR § 257.70. A summary of the relevant engineering analyses and results are provided in this section.

3.1 LINER

The proposed liner system for the SRL Landfill is consistent with the requirements set forth in the Tennessee Department of Environment and Conservation's (TDEC) Solid Waste Management Rules 0400-11-01-.04(4)(a)1.(i) and 0400-11-01-.04(4)(a)2.(ii). The proposed liner system consists of, from top to bottom, the following:

- 2-ft thick protective cover layer;
- Double sided geocomposite drainage layer (high density polyethylene, HDPE, geonet drainage layer bonded with non-woven geotextile on each side);
- 60-mil HDPE flexible membrane layer (FML);
- 2-ft thick compacted clay liner (CCL) with a maximum hydraulic conductivity of $1x10^{-7}$ cm/sec; and
- Minimum 5-ft thick geologic buffer with a maximum hydraulic conductivity of $1x10^{-6}$ cm/sec.

The proposed liner system includes the required 2-ft thick compacted clay liner and a 60-mil HPDE geomembrane, and therefore meets the requirements of the CCR Rule. In addition, a minimum 5-ft thick geologic buffer is included in the liner system.

In accordance with the CCR Rule, the SRL Landfill liner shall be:

- Constructed of materials that have appropriate chemical properties and sufficient strength and thickness to prevent failure due to pressure gradients (including static head and external hydrogeologic forces), physical contact with the CCR or leachate to which they are exposed, climatic conditions, the stress of installation, and the stress of daily operation, as demonstrated by a Stability Analysis in the State Part II Permit Application.

- Constructed of materials that provide appropriate shear resistance of the upper and lower component interface to prevent sliding of the upper component including on slopes, as demonstrated by a Stability Analysis in the State Part II Permit Application.
- Placed upon a foundation or base capable of providing support to the liner and resistance to pressure gradients above and below the liner to prevent failure of the liner due to settlement, compression, or uplift, as demonstrated by a Stability Analysis in the State Part II Permit Application.
- Installed to cover all surrounding earth likely to be in contact with the CCR or leachate, as shown on the drawings in in the State Part II Permit Application.

3.1.1 Chemical Resistance

Literature suggests that HDPE exhibits satisfactory resistance to chemical attack from compounds associated with CCR (INEOS, 2012).

3.1.2 Liner Integrity

The liner will be constructed across a suitable subgrade to promote uniform bearing conditions. Material selection and installation procedures are intended to reduce the potential for damage during construction and operations, and protect the liner from climatic conditions.

The liner subgrade was designed to achieve a minimum 5-ft separation above the hydrostatic impact from the design phreatic condition. This reduces the potential for damage to the liner due to uplift forces.

The liner will be covered by a minimum of two-ft of protective cover that will act as a buffer between any heavy equipment and geosynthetics prior to operations within the SRL.

3.1.3 Shear Resistance

The proposed liner system includes a 60-mil thick textured HDPE liner. The layers of the composite liner system were evaluated and determined to meet shear resistance requirements. The design provides for conformance testing of materials used to construct the bottom liner to meet required shear resistance. Based on available manufacturer's data (Koerner & Narejo, 2005), the required interface strength between various layers is attainable.

3.1.4 Liner Extents

The design limits of the liner placed within the SRL Landfill extend past the limits of waste.

3.1.5 Upper Component Liner Thickness

The upper component of the liner is a 60-mil thick HDPE liner, which exceeds the 30-mil minimum set forth in 40 CFR § 257.70(b).

3.2 LEACHATE COLLECTION AND REMOVAL SYSTEM

The SRL Landfill leachate management system consists of a geocomposite drainage layer with an 8-inch (in.) diameter perforated leachate collection pipe that directs collected leachate to the perimeter of the landfill. In addition, a 2-ft thick protective cover layer, will be placed over the geocomposite drainage layer. This layer serves to protect both the geocomposite drainage layer as well as the underlying geomembrane. Together, the protective cover layer and the top geotextile filter layer will serve to prevent fines (particles smaller than U.S. Sieve No. 200) from clogging the system.

In accordance with 40 CFR § 257.70(d)(1), the SRL Landfill leachate management system has been designed to maintain less than a 30-centimeter (approximately 1-ft) depth of leachate over the composite liner.

Leachate generated within the SRL is carried by the geocomposite layer to the collection system (collection pipes, sumps, extraction pumps, and riser pipes). Leachate will be collected at low points, or sumps within the cells. Once waste is placed within the cells, any water collected from the leachate collection and removal system will be handled as leachate and will be collected and pumped to the on-site wastewater treatment facility prior to discharge through an appropriate permitted outfall in accordance with the existing NPDES permit.

Details and the locations of all sumps and side slope risers associated with the leachate collection system are depicted in the Engineering Plans submitted as part of the State Part II Permit Application.

Calculations associated with the leachate management system, including generation calculations, pipe sizing and spacing, leachate storage sizing, leachate pump sizing, and pipe strength and deflection calculations are provided in the State Part II Permit Application (AECOM, 2022a). Calculations indicate that the materials selected are of sufficient strength and thickness to prevent collapse under the pressures exerted by overlying waste, waste cover materials, and equipment anticipated to be used at the SRL Landfill.

3.2.1 LEACHATE DEPTH AND CONVEYANCE

The United States Environmental Protection Agency's (USEPA) Hydrologic Evaluation of Landfill Performance (HELP) model (Schroeder et al., 1994), version 3.07, was used to estimate runoff, evapotranspiration, and leachate collection rates (drainage rates) under initial open, intermediate, and closed conditions. The HELP model analysis performed under these conditions indicate that leachate generation is expected to be greatest under initial open conditions, which is typically expected for most landfill facilities. The peak daily leachate generation rate under this condition was estimated to be approximately 11,135 gallons/acre/day. The geocomposite was sized such that the head on the liner system was calculated to be less than 12-in. In addition, the pipe system was sized to accommodate predicted flows from the HELP model. Calculation packages were included in the State Part II Permit Application.

3.2.2 Chemical Resistance and Structural Strength

The materials used in the leachate collection and removal system are HDPE pipes, HDPE drainage netting, geotextiles, non-calcareous washed river gravels and granular drainage media. HDPE has satisfactory chemical resistance properties (INEOS, 2012) to chemical attack from compounds associated with CCR. Granular drainage media and river gravels are generally inert.

The HDPE pipe system was determined to meet criteria for crushing, deflection, ring bending, etc. Designed protective cover thickness over the liner and leachate components is in accordance with manufacturer recommendations.

3.2.3 Design Mitigative Measures Against Clogging

The leachate system has been designed with access through manholes for cleanout of the system. Geotextile material surrounds the gravel envelope around the collection pipes to reduce sediment infiltration.

TVA will maintain the integrity and effectiveness of the leachate collection and removal system, and properly operate it in accordance with 40 CFR § 257.70.

3.3 Certification and Recordkeeping Requirements – 40 CFR § 257.70(e), .70(g), .105(f), .106(f), and .107(f)

Prior to construction of the SRL Landfill, a qualified professional engineer must certify that the design of the liner and the leachate collection and removal system meet the requirements of 40 CFR § 257.70. This certification will be placed in SRL Landfill operating record. The certification must then be posted to TVA's CCR website within 60 days of commencing construction.

4.0 Conclusions

Based on this assessment, the SRL Landfill located at GAF meets the requirements of 40 CFR § 257.70.

5.0 REFERENCES

AECOM (2021), *TVA Gallatin Fossil Plant, Part II Permit Application, CCR Disposal Facility – Rail Loop Site, South Rail Loop Landfill, Hydrogeological Report*, October 2021

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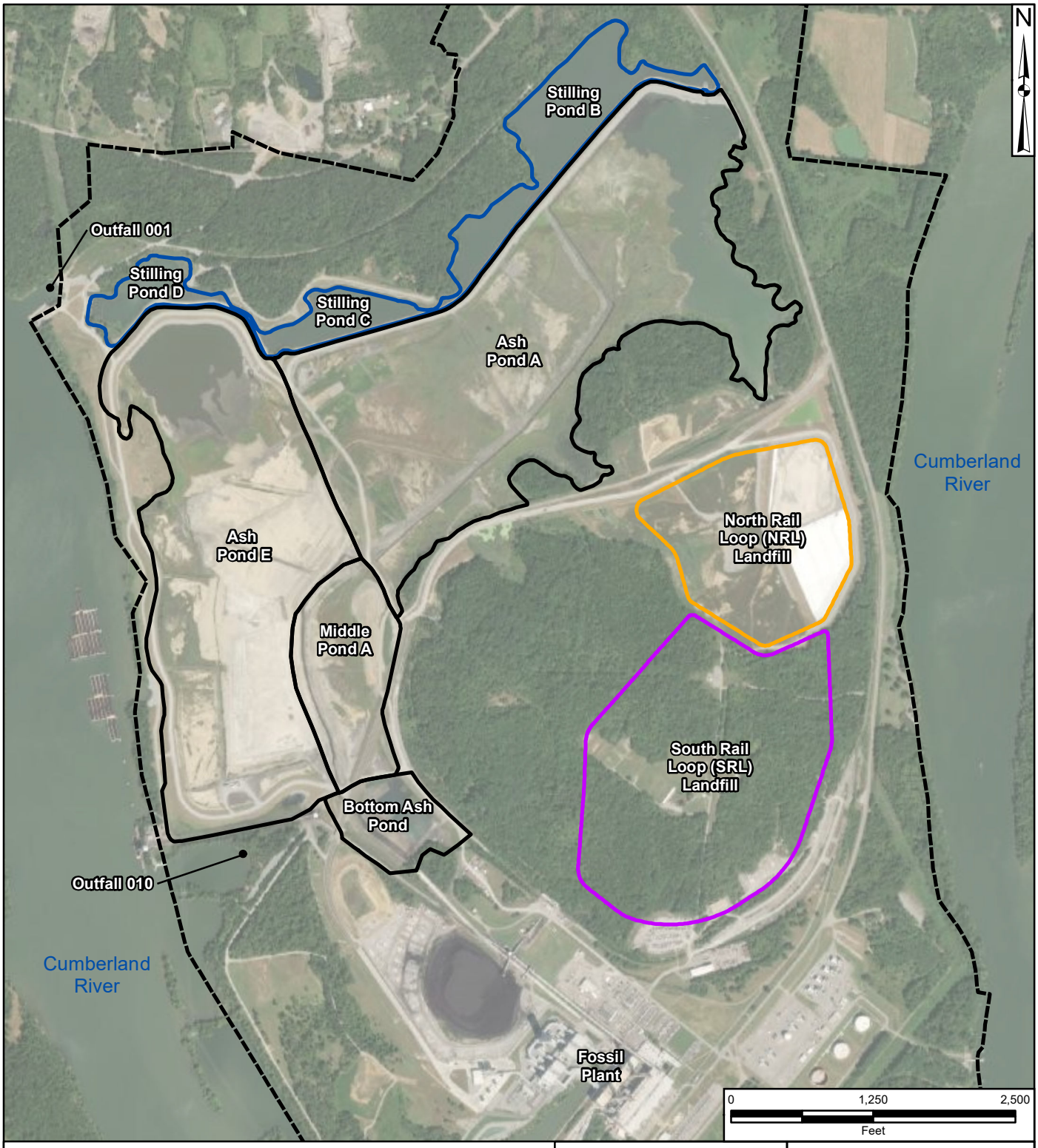
FIGURES



LEGEND

- CCR Management Units
- North Rail Loop (NRL) Landfill
- Stilling Ponds
- South Rail Loop (SRL) Landfill
- TVA Gallatin Fossil Plant Property Boundary (Approximate)

NOTE: Aerial image dated February 2017

AECOM

Figure 1

SITE LOCATION MAP

DRAWN BY:	REVIEWED BY:	APPROVED BY:	REVISION NUMBER:
J.COLLEY	D.SKEGGS	-	REV. 0

GALLATIN FOSSIL PLANT
TENNESSEE VALLEY AUTHORITY

DATE:	DEPT:
JAN 2020	FOSSIL AND HYDRO ENGINEERING