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September 18, 2018

Tennessee Valley Authority
1101 Market Street
Chattanooga, Tennessee 37402

Engineer's Certification of Demonstration of Compliance with Design Criteria
New CCR Landfill
EPA Final CCR Rule
TVA Paradise Fossil Plant
Drakesboro, Kentucky

1.0 PURPOSE

The purpose of this document is to certify that the Demonstration of Design Criteria for the liner and leachate collection system for the TVA Paradise Fossil Plant New CCR Landfill is in compliance with the design criteria demonstration specified in the Final CCR Rule at 40 CFR § 257.70. Presented below is the project background, summary of findings, limitations and certification.

2.0 BACKGROUND

New CCR landfills must be designed, constructed, operated, and maintained with either a composite liner that meets the requirements of paragraph (b) of § 257.70, or an alternative composite liner that meets the requirements § 257.70(c), and a leachate collection and removal system that meets the requirements of paragraph § 257.70(d). A brief description of the alternative composite liner and leachate collection system is provided below. Both systems meet the requirements of § 257.70.

3.0 SUMMARY OF FINDINGS

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 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 to be used at the PAF CCR Landfill.

Prior to construction of the CCR landfill, a qualified professional engineer must certify that the design of the alternative composite liner and the leachate collection and removal system meet the requirements of § 257.70. This certification will be placed in the PAF CCR Landfill operating record. The certification will then be posted to TVA's CCR website within 60 days of commencing construction. The design limits of liner extend past the edge of placed CCR within the landfill. Stormwater and leachate collection ponds will be lined similar to the landfill.

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4.0 CERTIFICATION

I, M. Brian Cole, being a Registered Professional Engineer in good standing in the State of Kentucky, 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. I certify, for the above referenced CCR Unit, that the design of the alternative composite liner and leachate collection and removal system as included in the Demonstration of Compliance with Design Criteria dated September 18, 2018 meets the requirements of 40 CFR § 257.70.

M. Brian Cole
Printed Name

September 18, 2018
Date

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ATTACHMENTS: Demonstration of Compliance with Design Criteria - New CCR Landfill

TENNESSEE VALLEY AUTHORITY – PARADISE FOSSIL PLANT
NEW CCR LANDFILL
DRAKESBORO, KENTUCKY

LINER AND LEACHATE COLLECTION AND REMOVAL SYSTEM DESIGN DEMONSTRATION

NEW CCR LANDFILL

Prepared for

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

September 2018 – Rev 0

Prepared by

AECOM

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1.0 INTRODUCTION

The demonstration was prepared in accordance with 40 CFR Part 257, the Coal Combustion Residuals (CCR) final rule. Specifically, this plan addresses the requirements under Subpart D, § 257.70 from the Coal Combustion Residuals (CCR) Final Rule.

TVA owns and operates Paradise Fossil Plant (PAF) in Drakesboro, Kentucky. The plant features three units, completed between 1963 and 1970, and three large natural-draft cooling towers. Units 1 and 2 were retired in 2017. Property of the PAF facility occupies more than 3,400 acres along the western side of the Green River. The plant is located along State Route 176 inside the eastern border of Muhlenberg County.

2.0 DEMONSTRATION OF COMPLIANCE WITH DESIGN CRITERIA

2.1 DESCRIPTION OF CCR LANDFILL OPERATIONS

The residual waste to be deposited in the PAF CCR Landfill will consist of gypsum, fly ash, and boiler slag. The limit of waste proposed for the PAF CCR Landfill will cover a disposal area of approximately 80 acres divided into 8 overall development phases constructed sequentially, with each new development phase being constructed and certified prior to completion of filling operations in the current development phase. Each cell will have its own leachate management system. 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, while other slopes or areas where no active filling is expected within 180 days will receive intermediate cover consisting of twelve (12) inches of cover soil. The store capacity of the proposed landfill is approximately 14.8 million cubic yards. Additionally, the proposed landfill will have a height of approximately 230 feet with max slopes of 3H : 1V.

2.2 DEMONSTRATION OF COMPLIANCE WITH DESIGN CRITERIA

New CCR landfills must be designed, constructed, operated, and maintained with either a composite liner that meets the requirements of paragraph (b) of § 257.70, or an alternative composite liner that meets the requirements § 257.70 (c), and a leachate collection and removal system that meets the requirements of paragraph § 257.70 (d). A brief description of the liner and leachate collection system is provided below. Both systems meet the requirements of § 257.70. The design limits of liner will extend beyond the edge of placed CCR within the landfill. Stormwater and leachate ponds will be lined similar to the landfill.

2.2.1 ALTERNATIVE COMPOSITE LINER SYSTEM - § 257.70 (C)

The composite liner proposed at the PAF CCR Landfill consists of a linear low density polyethylene (LLDPE) 60-mil thickness geomembrane layer, and a geosynthetic clay liner (GCL). The hydraulic conductivity of this alternative composite liner does not exceed 1 x 10^{-7} centimeters per second (cm/sec). A calculation was completed to confirm that the liquid flow rate through the lower component of the alternative composite liner is no greater than the liquid flow rate through two feet of compacted soil with a hydraulic conductivity of 1 x 10^{-7} cm/sec. Furthermore, manufacturer testing indicates that materials which make up the GCL are chemically resistant to the facility's CCR.

In accordance with the CCR Final Rule, the PAF CCR Landfill composite liner is:

- 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 hydrogeological 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.
- 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.
- 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.
- Installed to cover all surrounding earth likely to be in contact with the CCR or leachate.

2.2.2 ALTERNATIVE LINER PERMEABILITY COMPARISON

The lower component of the proposed alternative composite liner system is GCL, with a specified permeability of 5 x 10^{-9} cm/sec or lower and a thickness of 3 to 8 mm (EPA 2001). The upper component is a 60-mil thick dual-textured LLDPE geomembrane. The CCR Rule (§257.70(c)(2)) requires the use of the modified Darcy's Law equation:

(Eq. 1)
$$\frac{Q}{A} = q = k\left(\frac{h}{t} + 1\right)$$

Where:

Q = flow rate (cubic centimeters/second);
A = surface area of the liner (squared centimeters);
q = flow rate per unit area (cubic centimeters/second/squared centimeter);
k = hydraulic conductivity of the liner (centimeters/second);
h = hydraulic head above the liner (centimeters); and

t = thickness of the liner (centimeters).

The EPA HELP model was used to demonstrate the design of the landfill bottom liner system. Modelling indicates that there will be 0.051 centimeters of head on the liner system early in the site's life and 0.0255 centimeters at the point of site closure. At project initiation the GCL is 8 mm thick and is compressed by anticipated loading for the current design down to 3 mm at the point of site closure.

For two feet of compacted clay, the flow rate per unit area (q) is defined by the CCR Rule to be 1×10^{-7} cubic centimeters/second/squared centimeter. Considering GCL with the initial modelled condition, "q" is calculated to be 5×10^{-9} cubic centimeters/second/squared centimeter and for the final condition the q for compressed GCL is still 5×10^{-9} cubic centimeters/second/squared centimeter. The GCL will contain polymers to resist chemical attack and maintain a hydraulic conductivity of 1×10^{-9} cm/sec or lower, which results in q lower than the 2 feet of 10^{-7} cm/sec for clay as prescribed by the CCR Rule. Therefore, the GCL is an acceptable design alternative.

2.2.3 LEACHATE COLLECTION SYSTEM - § 257.70 (D)

In accordance with the CCR Final Rule, 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:

- Designed and operated to maintain less than a 30-centimeter depth of leachate over the composite liner or alternative composite liner;
- 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
- Designed and operated to minimize clogging during the active life and post-closure care period.

The PAF CCR Landfill leachate management system consists of a geocomposite drainage layer: a factory bonded nonwoven geotextile cushion layer on the bottom, geonet drainage medium in the middle, and a nonwoven geotextile filter layer on top. In addition, a protective cover layer of sand 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" (i.e. particles smaller than U.S. Sieve No. 200) from clogging the system.

The leachate extraction system has been designed to ensure that no more than 30 centimeters of leachate build up on the floor of the landfill. Leachate generated by the deposited waste is carried by the geocomposite layer to the collection system (collection pipes, sumps, extraction

pumps, and riser pipes). Leachate is then pumped to a leachate storage lagoon by a series of extraction sump pumps located within each of the four cell sumps and transported through a dual-contained force main. The leachate storage lagoon was designed to accommodate total average leachate generated in 30 days, as estimated by the HELP model, and also sheet flow from the contributing watershed.

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 to be used at the PAF CCR Landfill.

Prior to construction of the lateral expansion of the PAF CCR Landfill, a qualified professional engineer must certify that the design of the alternative composite liner and the leachate collection and removal system meet the requirements of § 257.70. This certification will be placed in the PAF CCR Landfill operating record in accordance with 40 CFR § 257.105(f)(1). The certification will then be posted to TVA's CCR website within 60 days of commencing construction in accordance with 40 CFR § 257.107(f)(1).

2.2.4 LEACHATE DEPTH AND CONVEYANCE

The landfill was modelled for various scenarios under both open and closed conditions to estimate the anticipated leachate production. The critical period was found to be the open condition when 10 feet of CCR has been placed, resulting in an anticipated 0.051 cm of head on the liner system, which is less than the 30 cm maximum prescribed by the CCR Rule. The leachate collection piping was hydraulically sized to accommodate flows predicted by the HELP model and analyzed to confirm proper maximum spacing of the leachate collection pipes. Geocomposite and granular drainage media transmissivities were analyzed at the design grades with suitable reduction factors. The subgrade for the liner was designed to maintain positive drainage of the leachate collection and removal system after accounting for anticipated settlement.

3.0 CONCLUSION

Based upon the available data; the alternative composite liner and leachate collection system are in compliance with EPA Final CCR Rule § 257.70.