Stantec Consulting Services Inc.
3052 Beaumont Centre Circle, Lexington KY 40513

March 26, 2018
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Tennessee Valley Authority
1101 Market Street
Chattanooga, Tennessee 37402

RE: Unstable Areas
New CCR Landfill
TVA Shawnee Fossil Plant
Paducah, McCracken County, Kentucky

1.0 PURPOSE

As described in 40 CFR § 257.64(a), an owner or operator of a new CCR landfill is required to demonstrate that the unit is not located in unstable areas unless the unit meets certain requirements. This letter documents Stantec's certification that the new CCR landfill at the TVA Shawnee Fossil Plant (SHF) complies with the location restrictions for unstable areas in the EPA Final CCR Rule at 40 CFR § 257.64(a).

2.0 SUMMARY OF FINDINGS

The attached demonstration documents that the new CCR landfill meets the requirements set forth in 40 CFR § 257.64(a).

3.0 QUALIFIED PROFESSIONAL ENGINEER CERTIFICATION

I, Michael J. Steele, being a Professional Engineer in good standing in the Commonwealth of Kentucky, do hereby certify, to the best of my knowledge, information, and belief:

1. that the information contained in this certification is prepared in accordance with the accepted practice of engineering;

2. that the information contained herein is accurate as of the date of my signature below; and

3. that the TVA Shawnee New CCR Landfill meets the requirements specified in 40 CFR § 257.64(a).

RE: **Unstable Areas**
New CCR Landfill
TVA Shawnee Fossil Plant
Paducah, McCracken County, Kentucky

SIGNATURE _____ DATE 3/26/2018

ADDRESS: Stantec Consulting Services Inc.
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ATTACHMENTS: Unstable Areas Demonstration

STATE OF KENTUCKY
MICHAEL J. STEELE
23731
LICENSED PROFESSIONAL ENGINEER

Unstable Areas Demonstration
TVA Shawnee New CCR Landfill

New CCR Landfill
TVA Shawnee Fossil Plant
Paducah, McCracken County, Kentucky

Prepared for:
Tennessee Valley Authority
Chattanooga, Tennessee

Prepared by:
Stantec Consulting Services Inc.
Lexington, Kentucky

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1.0 INTRODUCTION

On April 17, 2015, the "Disposal of Coal Combustion Residuals (CCR) from Electric Utilities" (EPA Final CCR Rule) was published in 40 CFR Parts 257 and 261 of the Federal Register. The Tennessee Valley Authority (TVA) retained Stantec Consulting Services Inc. (Stantec) to review the new coal combustion residual (CCR) landfill unit at the Shawnee Fossil Plant (SHF) for compliance with certain requirements of the EPA Final CCR Rule and, as appropriate, to provide a compliance demonstration report and certification of the unstable areas location requirements for this CCR unit pursuant to the EPA Final CCR Rule 40 CFR § 257.64.

1.1 OBJECTIVE

As required by § 257.64 of the EPA Final CCR Rule, an owner or operator of new CCR landfills is required to demonstrate that the unit is not located in unstable areas unless the unit meets certain requirements. The objective of this report is to document that the new CCR landfill complies with the location restriction for unstable areas.

1.2 UNIT DESCRIPTION

SHF is a coal-fired, electric-generating plant. The plant is located in McCracken County, Kentucky, along the south shore of the Ohio River near river mile 946, just east of the confluence of Little Bayou Creek with the Ohio River.

The new CCR landfill will be located on the Shawnee East Site, which consists of about 205 acres that TVA acquired in 2016 next to the eastern boundary of the SHF reservation. The new CCR landfill will be constructed in three stages over a total footprint of 88 acres. The embankment will be about 115 feet tall with maximum 4H:1V slopes and will accommodate about 8 million cubic yards of CCR material (fly ash, bottom ash, and gypsum) across an estimated 25-year operational life.

2.0 CRITERIA

The EPA Final CCR Rule § 257.64 requirements for unstable areas are:

> ***40 CFR § 257.64(b).*** *The owner or operator must consider all of the following factors, at a minimum, when determining whether an area is unstable:*

(1) On-site or local soil conditions that may result in significant differential settling;

(2) On-site or local geologic or geomorphologic features and;

(3) On-site or local human-made features or events (both surface and subsurface).

3.0 DEMONSTRATION

The new CCR landfill at SHF was evaluated with respect to the requirements outlined in Section 2.0. A summary of the relevant engineering analyses and results are provided in this section.

3.1 SUBSURFACE PROFILE (LANDFILL, FOUNDATION SOILS AND PHREATIC SURFACE)

A vertical profile (stratigraphic column) through the new landfill and subsurface soils down to bedrock can be divided into three primary groups:

- Landfill Materials consisting of the bottom liner, stored CCR and the final cover (cap). Planned CCR that will be stored in the landfill include fly ash, bottom ash, and rejected gypsum (Flue Gas Desulfurization or FGD product).

- Foundation Soils extend down to approximately 60 feet (average) below the current ground surface. For the engineering analyses, the Foundation Soils were subdivided into four alternating layers of clay and silts/sands. Data on these materials were obtained from site explorations.

- Deep Soils are much older depositions below the Foundation Soils. Less data are available for these materials, which were characterized using published information from geology maps and historical, deep borings at the SHF site. The deep soil materials consist of dense gravels, sands, silts, and clays that are assumed to be about 285 feet thick beneath the site.

Published information (Harris et al. 1994) from deep boreholes in the vicinity indicates that the top of bedrock is at approximately elevation +20 feet, which is (on average) 345 feet below the current ground surface.

During the site explorations, multiple instruments (standpipe piezometers) were installed to monitor phreatic conditions. The resulting data were used to define a design piezometric surface for computing static porewater pressures in the subsurface soils.

3.2 SOIL CONDITIONS

An assessment of the soil conditions was completed considering the following criteria:

- Review published soil surveys to determine whether on-site or local presence of soft or compressible soil formation(s) exist.
- Review site exploration data to determine whether the foundation materials are soft or compressible.
- Review design calculations to determine whether predicted settlements would have a negative impact on facility integrity.

3.2.1 Soft and Compressible Soils

Typically, soft and compressive soils consist of fat clays, elastic silts, organic silts and clays, or highly organic soils (peat). Available literature (USGS, 1967) and results from the site explorations do not indicate the significant presence of these soils beneath the new CCR landfill footprint.

Design requirements will be followed to construct the landfill subgrade across compacted, non-saturated surfaces to promote suitable bearing conditions.

3.2.2 Settlement

Some minor differential settlement over relatively long lengths is expected due to varying loading conditions and consolidation properties/thicknesses of foundation materials. Selection of construction materials (as defined in design requirements) are intended to accommodate calculated liner strain.

3.3 GEOLOGIC OR GEOMORPHOLOGIC FEATURES

Available literature was reviewed to determine whether certain geologic or geomorphologic features that would have a negative impact on the landfill facility exist.

The site is located within the northern limits of the Mississippi Embayment. The Mississippi Embayment is a deep basin within the bedrock of the central United States. Extending from the Gulf of Mexico to southern Illinois, the basin is filled with hundreds of feet of soil deposition. Most of these sediments accumulated beneath an inland sea over millions of years. Shallower soils represent more recent alluvial and aeolian deposits.

The sediments in the Paducah area can be described as "a surficial veneer of loess, alluvial continental deposits that consist of gravel, sand, silt and clay, overlying Tertiary-age deposits of predominantly clay interbedded with sands and silts" (Sykora and Davis 1993). As stated above, the depth to bedrock is about 345 feet below ground surface at the site.

Due to the depth of bedrock and documented overburden characteristics, the landfill facility will not be affected by items such as rock mass orientation, patterns, fissures, etc. Further discussion of other geologic and geomorphologic items related to the potential for unstable areas are discussed below.

3.3.1 Karst

No karst activity or associated features is indicated by the USGS Joppa, Kentucky Geological Quadrangle Map (1967) or the USGS Joppa, IL-KY 7.5-minute map. Also, a map titled Karst Occurrence in Kentucky, compiled by the University of Kentucky, labels McCracken County as an "area underlain by bedrock with limited or no potential for karst development" (Kentucky Geological Survey, 2001).

Since the potential for karst development is unlikely, characteristic physiographic features that could pose a negative impact on the landfill facility are not anticpated.

3.3.2 Springs

If springs exist within a landfill footprint, the potential for a negative impact on the landfill facility could be realized. Based on data obtained from Kentucky Ground-Water Data Repository (KGWDR), no springs were identified at the new CCR landfill site.

Site explorations do not indicate phreatic conditions characteristic of spring development.

3.3.3 Landslides

No evidence of natural landslides exists because the site is relatively flat with little topographic relief (little to no driving force that would result in slope instability).

3.4 PRIOR HUMAN-MADE FEATURES OR EVENTS

The site appears to have been historically used for agricultural purposes. Available literature and/or site observations do not indicate that the site has ever been mined for commercial/industrial purposes. No evidence exists that large-scale groundwater extraction has been conducted at (or adjacent to) the site.

4.0 CONCLUSION

Based on this assessment, the new CCR landfill located at SHF meets the requirements of § 257.64 of the EPA Final CCR Rule.

5.0 REFERENCES

Harris, J. B., Street, R. L., Kiefer, J. D., Allen, D. L., Wang, Z. M. (1994). "Modeling Site Response in the Paducah, Kentucky Area". Earthquake Spectra. Vol 10, No. 3.

Kentucky Division of Water – Groundwater Wells, available on the World Wide Web (ftp://data.gis.eppc.ky.gov/shapefiles/dow_groundwater_wells.zip), accessed [March 10, 2017]

Kentucky Geological Survey. (2001). Karst Occurrence in Kentucky. University of Kentucky.

Kentucky Ground-Water Data Repository (KGWDR) database, available on the World Wide Web (http://kgs.uky.edu/kgsweb/DataSearching/Water/WaterWellSearch.asp), accessed [March 10, 2017].

Kentucky Mine Mapping Information System, available on the World Wide Web (http://eppcgis.ky.gov/minemapping/), accessed [January 6, 2017]

Pree, H.L. Jr., Walker, W.H., and MacCary, L.M., (1957). "Geology and Ground-Water Resources of the Paducah Area Kentucky." Prepared in cooperation with the Agricultural and Industrial Development Board, Commonwealth of Kentucky.

Stantec Consulting Services Inc. (2018). "Geotechnical/Hydrogeologic Report" – Proposed CCR Landfill, Shawnee Fossil Plant.

Sykora, D. W., and Davis, J. J. (1993). "Site-Specific Earthquake Response Analysis for Paducah Gaseous Diffusion Plant, Paducah, Kentucky." Miscellaneous Paper GL-93-14, USACE, August.

U.S. Geological Survey. (1967). Geologic Quadrangle Map, Joppa Quadrangle McCracken County, Kentucky. Kentucky Geological Survey, GQ-652. (U. o. The Commonwealth of Kentucky, Ed.) McCracken County, Kentucky: Kentucky Geological Survey.

United States Department of Agriculture Soil Conservation Service. (1976). Soil Survey of Ballard and McCracken Counties, Kentucky. Paducah.