January
2016

COAL COMBUSTION RESIDUAL CLASS 2 AND CLASS 3 LANDFILL INSPECTION – CROSS GENERATING STATION

Pineville, South Carolina

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Executive Summary

This assessment of the stability and functionality of the Cross Generating Station (CGS) coal combustion residual (CCR) Class 2 and Class 3 Landfill is based on a review of available documents and on-site assessment conducted by Santee Cooper engineering staff on November 16, 2015. We found the supporting technical information to be generally adequate. As detailed in Section 1.3, there are several recommendations based on field observations that may help CGS to maintain the landfill in safe condition.

In summary, the CGS CCR Class 2 Landfill is generally satisfactory for continued safe and reliable operation. No recognized existing or potential management unit safety deficiencies were noted at the time of inspection within the parameters of design and operation. The CGS CCR Class 3 Landfill is also in generally satisfactory condition for future safe and reliable operation. No recognized existing or potential management unit safety deficiencies were noted at the time of inspection within the parameters of design and operation.

Summary of Recommendations

Class 2 Landfill

1. Minor erosion noted in several locations on the active face of the Class 2 Landfill and on the northern and southern slopes of the structure should be repaired within ninety (90) days of completion of this report. (NOTE: repairs to northern and southern slopes were completed within two (2) weeks of the date of inspection. The active face will be repaired as part of closure during the 1st and 2nd quarter of 2016).
2. Clogged downdrain inlets located on the 1st and 2nd benches on the northern and southern ends of the Class 2 Landfill should be cleaned out and re-lined with sediment tubes or silt fence within sixty (60) days of completion of this report. (NOTE: this maintenance was completed within two (2) weeks of the date of inspection).
3. Minor ponding noted in several locations on the benches of the Class 2 Landfill should be monitored following cleanout of the downdrains to ensure that further ponding of storm water is eliminated.

4. Erosion and undermining of the concrete revetment channel noted along the northern access ramp for the Class 2 Landfill should be repaired within ninety (90) days of completion of this report to improve drainage in the area and to prevent potential personnel/equipment safety concerns.
5. Sediment buildup noted in the Class 2 Landfill perimeter drainage ditch should be cleaned out within sixty (60) days of completion of this report to avoid ponding of water around the toe of the landfill. (NOTE: this maintenance was completed within two (2) weeks of the date of inspection).

Class 3 Landfill

6. Minor erosion in the foundation drainage layer just above the liner noted in the Class 3 Landfill should be repaired just prior to placement of waste in these areas. (NOTE: this repair was completed within two (2) weeks of the date of inspection).

This assessment of the Class 2 and Class 3 Landfills at Cross Generating Station reported herein is based on field observations and review of readily available information provided to the inspection team of the subject coal combustion residual (CCR) management unit(s). Qualified Santee Cooper engineering staff performed the field observations and review of pertinent information and made the assessment in conformance with the requirements of Section 257.84 of the Federal Register and in accordance with reasonable and generally accepted engineering practices.

Coal Combustion Residual Class 2 and Class 3 Landfill Inspection – Cross Generating Station

1.0 General Information and Introduction

1.1 Purpose and Scope

The purpose of this report is to fulfill the requirements of Section 257.84(b) of the Federal Register regarding the safety and inspection of CCR surface impoundments. Section 257.84(b) states that "Existing and new CCR landfills and any lateral expansion of a CCR landfill must be inspected on a periodic basis by a qualified professional engineer to ensure that the design, construction, operation, and maintenance of the CCR unit is consistent with recognized and generally accepted good engineering standards." The inspection must, at a minimum, include:

i. A review of available information regarding the status and condition of the CCR unit, including, but not limited, to, files available in the operating record (e.g., the results of inspections by a qualified person, and results of previous annual inspections)
ii. A visual inspection of the CCR unit to identify signs of distress or malfunction of the CCR unit.

The inspection report must also be written by a qualified professional engineer and must address the following:

i. Any changes in geometry of the structure since the previous annual inspection
    - **No changes in the geometry of the Class 2 Landfill beyond normal filling operations**
    - **No changes in the geometry of the Class 3 Landfill (final construction inspection and approval to operate were pending at time of inspection)**
ii. The approximate volume of CCR contained in the unit at the time of the inspection
    - **The Class 2 Landfill contains approximately 7,780,000 cubic yards of CCRs**

- **The Class 3 Landfill was not certified for operation at the time of inspection and did not contain any CCRs**

iii. Any appearances of an actual or potential structural weakness of the CCR unit, in addition to any existing conditions that are disrupting or have the potential to disrupt the operation and safety of the CCR unit

- **Some maintenance items noted on Class 2 Landfill as discussed in the Executive Summary and Sections 4.2 and 5.3.1; however, landfill is safe for continued operation**
- **One (1) maintenance item noted on Class 3 Landfill as discussed in the Executive Summary and Sections 4.3 and 5.3.2; however, landfill is safe for future operation**

iv. Any other change(s) which may have affected the stability or operation of the CCR unit since the previous annual inspection

- **No other changes noted on the Class 2 Landfill that impact the stability or operation of the landfill**
- **No other changes noted on the Class 3 Landfill that impact the stability or operation of the landfill**

2.0 Description of Coal Combustion Residual Management Units

2.1 Location and General Description

The Cross Generating Station (CGS) is located on the east bank of the Diversion Canal in Berkeley County, South Carolina, approximately 5.2 miles northeast of Cross, South Carolina. CGS is located on Cross Station Road, Pineville, South Carolina, 29468. Lake Marion is northwest of CGS, and Lake Moultrie is southeast of the station.

CGS currently has a single operational CCR landfill (the Class 2 Landfill) and another entering operation by the end of 2015 (the Class 3 Landfill). Final receipt of waste for the Class 2 Landfill was December 31, 2015 and the Class 3 Landfill entered operation in mid-December 2015 (after completion of the field inspection of this report). Table 2.1 below shows a summary of the size and general dimensions of the CCR management units at CGS as well as their current capacity:

Table 2.1: Summary of Landfill Dimensions and Size

	Class 2 Landfill	Class 3 Landfill (Cell1B-1)
Base Width (ft)	1500	800
Base Length (ft)	3000	1600
Side Slopes H:V	3:1	-
Approximate Current Storage Volume (cy)	7,780,000	0

2.2 Type of CCRs Currently Stored in Landfill

The Class 2 Landfill currently accepts flue gas emissions (FGD) control residuals, bottom ash, fixated fly ash, and boiler slag. FGD residuals are limited to portions of the landfill more than 100 feet from the outside slopes to mitigate slope stability concerns with the material. All materials are carefully compacted using tracked bulldozers and a vibratory roller where needed to ensure that the landfill space is used efficiently and to minimize the risk of settlement and/or slope instability. The Class 3 Landfill will begin accepting

SCDHEC-approved waste streams before the end of 2015.

2.3 Principal Project Structures

2.3.1 Class 2 Landfill

The CGS Class 2 Landfill is regulated under SCDHEC's Solid Waste Management regulations. It was originally permitted in 1982 and began receiving CCRs in 1984. The original permit allowed placement of material up to elevation 120 feet (NGVD 1929), which is approximately 38 feet above grade. A consent agreement in 2011 allowed Santee Cooper to continue placement of material above this elevation, with a maximum top elevation of 210 feet (NGVD 1929).

The Landfill is approximately 1500 feet wide at its base and 3000 feet long. The side slopes are 3:1 (horizontal to vertical), with terraces to prevent excessive storm water runoff velocity built approximately every 20 vertical feet. Storm water is routed from the slopes to these terraces and then through downdrains at each end of the landfill, helping to minimize erosion on the slopes.

2.3.2 Class 3 Landfill

Santee Cooper is currently constructing a new Class 3 CCR landfill adjacent to the existing Class 2 landfill on its eastern and western sides. As a result, the eastern and western perimeter slopes of the Class 2 landfill are covered with Class 3-grade landfill liner. The entire top deck of the Class 2 landfill will also be closed in this manner; the liner in these areas is still under construction. This liner serves as permanent cover/closure for the Class 2 side slopes under the authorization of the Class 3 construction permit. The northern and southern ends of the landfill are both covered with a more traditional clay cap and vegetative cover.

The Class 3 Landfill cell (Cell 1B-1) currently under construction is approximately 800 feet wide at its base and 1600 feet long. This cell is the only operational cell of the Class 3 landfill at this time and as a result is the only cell analyzed in this report. Subsequent reports will include other cells as they enter service.

The landfill abuts the current Class 2 Landfill and consists of lined cells with a geocomposite drainage net and sand drainage layer to facilitate removal of leachate water from the landfill into the leachate pond to the south of the landfill. No CCRs have been placed in the Class 3 Landfill as of the date of inspection; however, an operating permit was issued by SCDHEC during December 2015.

3.0 Summary of Relevant Reports and Incidents

3.1 Summary of Reports on the Safety of CCR Units

Furnished reports of weekly inspections, conducted by CGS personnel for the period October 2015 to November 2015 indicated no major structural or operational problems at the CGS Class 2 Landfill or the CGS Class 3 Landfill. No significant deterioration was indicated in the documentation reviewed.

4.0 Field Observations

4.1 Project Overview and Significant Findings

Santee Cooper qualified engineer Michael Melchers, P.E. performed a site visit to CGS on November 16, 2015. The site visit began mid-morning. Weather conditions during the visit were approximately 65 degrees Fahrenheit, sunny, and dry, although approximately five (5) inches of rain had been received in the previous ten (10) day period.

The overall condition of the CCR Class 2 Landfill was satisfactory with no significant findings noted. Similarly, the CCR Class 3 Landfill was found to be in satisfactory condition with no significant findings noted.

All findings were discussed with station personnel following completion of the field inspection to facilitate monitoring and repair of any deficiencies noted.

Please note that field observations as outlined in Sections 4.2 and 4.3 below are indicative of conditions on-site as of November 16, 2015. Several of the observations noted have now been corrected as outlined in the Executive Summary and Section 5.3 of this report. In addition, the Class 2 Landfill has ceased to receive waste and is in the midst of closure, while the Class 3 Landfill has entered operation and is now receiving waste streams in accordance with SCDHEC regulations.

4.2 Class 2 Landfill

4.2.1 Crest/Operating Area

The crest of the Class 2 Landfill was generally found to be in satisfactory condition. The southern half of the crest area is currently being covered with Class 3 landfill liner in advance of the opening of the new Class 3 CCR landfill being constructed adjacent to the existing Class 2 landfill. The northern half was operational as of the date of inspection with material being placed and compacted by Santee Cooper personnel. Several areas on the northern end of the landfill showed signs of erosion due to excessive storm water

runoff; however, no significant areas of concern were noted during the field inspection.

4.2.2 Outside Slopes – Northern and Southern Side Slopes

The northern and southern side slopes of the Class 2 CCR landfill are covered with a clay cap and vegetative cover in accordance with SCDHEC regulations and were found to be in generally satisfactory condition. The condition of the cap and vegetative cover on the northern and southern slopes was found to be generally satisfactory with isolated areas of minor erosion and loss of grass cover. Some more significant erosion was noted at the interface between the clay cap and the Class 3 landfill liner on the southwest corner of the Class 2 Landfill. No obvious signs of slumps, slides, bulges, tension cracks, seepage, or animal burrows were observed on the slope.

4.2.3 Outside Slopes – Eastern and Western Sides

The eastern and western slopes of the Class 2 CCR Landfill are covered with Class 3-type landfill liner as a part of construction of the adjacent Class 3 landfill expansion at CGS. These slopes were found to be in generally satisfactory condition, as the liner protects the slopes from erosion resulting from rainfall. No obvious signs of slumps, slides, bulges, tension cracks, seepage, or animal burrows were observed.

4.2.4 Stormwater Conveyance Structures

Storm water on the Class 2 CCR Landfill is primarily handled with working surface grading to the perimeter slopes, where water is directed to benches built approximately every twenty (20) vertical feet. Downdrains are built into each bench on the northern and southern ends of the landfill which convey storm water into a perimeter drainage ditch at the toe of the landfill. Several of the downdrains were found to be clogged with sediment from recent significant rain events, resulting in minor ponding of water on the storm water benches, although the pipes themselves appeared to be in satisfactory condition. Heavy sedimentation was also noted in the perimeter drainage ditch in multiple locations.

4.2.5 Roads/Ramps/Other Infrastructure

Two (2) ramps are used to access the working face of the Class 2 CCR Landfill. The northern ramp runs from the northeast corner to the west, entering the working face of the landfill on the northwestern side. The access road surface was found to be in satisfactory condition. A concrete revetment channel is used to convey storm water along the interface between the ramp and the slope of the landfill. A portion of the channel was found to be undercut by erosion near the 2nd bench of the landfill, likely due to excessive flows during recent large storm events. A second ramp runs from the southwest corner towards the north. The access road surface was found to be in satisfactory condition. Some erosion damage was noted in the channel running along the interface between the ramp and the landfill.

4.3 Class 3 Landfill

4.3.1 Operating Area, Liner, and Leachate Collection System

The operating area of the Class 3 landfill was found to be in satisfactory condition upon inspection. As previously noted, no CCRs have been placed in the Class 3 Landfill as of the date of inspection. The sand drainage layer placed above the Class 3 liner was found to be in satisfactory condition overall with several isolated areas of erosion due to recent heavy rains noted, particularly along the interface between the Class 2 Landfill and the Class 3 Landfill where storm water runoff from the slopes of the Class 2 Landfill drains down the new Class 3 liner into the Class 3 drainage layer placed at the base of the structure. The drainage layer and associated leachate collection pump system appeared to be in good condition and were functioning as designed, as no ponding was noted in the new Class 3 landfill cell.

4.3.2 Outside Slopes

The outside slopes of the Class 3 Landfill cell were found to be in satisfactory condition. Construction of the containment for the base of the cell was recently completed and vegetative cover is still being established; however, no obvious signs of slumps, slides, bulges, tension cracks, seepage, or animal holes were observed on the slope.

4.2.4 Stormwater Conveyance Structures

Storm water on the Class 3 CCR Landfill is managed by collecting and pumping all

stormwater from the sand drainage layer above the Class 3 liner through HDPE outlet pipes and into the on-site leachate pond. Stormwater is directed to the pump inlets by proper grading of the drainage layer. The HDPE conveyance pipes from the pump intakes to the leachate pond appeared to be in satisfactory condition at the time of inspection. The storm water channel around the perimeter of the Class 3 Landfill cell also appeared to be in satisfactory condition and was functioning as designed at the time of inspection.

4.3 Adequacy of Maintenance, Operating, and Surveillance Procedures

4.3.1 Adequacy of Maintenance Procedures

Overall, maintenance of the Class 2 and Class 3 CCR Landfills appears to be adequate. No major maintenance issues were noted during the field inspection or in the weekly inspection reports completed by CGS personnel and reviewed by the inspection team. Some minor maintenance of storm water control structures is warranted as noted in the Recommendations section and the Field Observations section; however, most damage appeared to have occurred as a result of historic rainfall received in the weeks leading up to the inspection.

4.3.2 Adequacy of Operating Procedures

Based on field observations and discussions with CGS personnel, the operating procedures for the Class 2 and Class 3 CCR Landfills appear to be adequate.

4.3.3 Adequacy of Surveillance Procedures

CGS personnel complete daily informal inspections and weekly formal inspections on the Class 2 and Class 3 CCR Landfills in accordance with good engineering practice and Section 257.84 of the Federal Register. These inspections are being properly documented and should continue as they are currently being conducted.

5.0 Conclusions and Recommendations

Conclusions are based on visual observations from a one-day site visit on November 16, 2015, and review of technical documentation provided to the inspection team.

5.1 Conclusions Regarding the Structural Soundness of the Management Unit(s)

Based on a review of the engineering data provided and the observations of the inspection team during the site visit, the CGS Class 2 Landfill appears to be structurally sound under static loading conditions. The slopes of the landfill also appear to be structurally sound under moderate seismic loading conditions. The factor of safety associated with the stability of the Class 2 Landfill should also continue to increase as construction and initial filling of the adjoining Class 3 Landfill (entering operation in 2016) continues.

Based on a review of the engineering data provided and the observations of the inspection team during the site, visit, the CGS Class 3 Landfill appears to be structurally sound under static loading conditions. No waste had been placed into the Class 3 Landfill at the time of inspection; however, design documents appear to be soundly engineered and existing infrastructure, including liner, drainage layers, and storm water/leachate management systems appeared to be in acceptable condition.

5.2 Conclusions Regarding Field Observations

The inspection team was provided access to the CGS Class 2 Landfill and Class 3 Landfill as required to conduct a thorough field inspection. The east and west slopes of the Class 2 Landfill are currently covered by liner for the Class 3 Landfill lateral expansion and are thus properly closed in accordance with SCDHEC permit documents. The liner appeared to be in good condition and is adequately covering those portions of the Class 2 Landfill abutting the expansion. The visible (not covered by Class 3 liner) portions of the perimeter slopes were observed to have no signs of overstress, significant settlement, shear failure, or other signs of instability. Storm water controls on the landfill also appear to be generally adequate at this time. There are no apparent

indications of unsafe conditions or conditions needing emergency remedial action. Some minor maintenance is needed (see Section 1.4.1). The Class 3 Landfill was similarly found to be in good condition, with only minor erosion noted in the drainage layer directly above the liner. No CCRs had been placed in the Class 3 Landfill at the time of inspection.

This is the first annual engineering inspection of the Class 2 Landfill and Class 3 Landfill at CGS. As a result, no geometry change from a previous inspection is noted. A review of annual surveys from 2012 to 2015 also revealed no changes to geometry beyond normal filling of the landfill. The Class 2 Landfill is currently being operated in accordance with its South Carolina Department of Health and Environmental Control (SCDHEC) permit and will continue to be filled vertically until December 31, 2015, at which time placement of CCR in the landfill will cease. Closure will be completed by June 2016. No additional changes in the geometry of the Class 2 Landfill are expected after completion of closure. Operations in the Class 3 Landfill will begin on December 16, 2015.

5.3 Recommendations

A number of maintenance concerns were noted during the field inspection. These items were as follows:

5.3.1 Class 2 Landfill

1. Minor erosion was noted in several locations on the active face of the Class 2 Landfill and on the northern and southern slopes of the structure where a traditional soil and vegetative cover is being used for closure, likely due to the large volume of rain (over 30 inches) received in the six (6) weeks preceding the inspection. These areas should be repaired within ninety (90) days of completion of this report. (NOTE: repairs to northern and southern slopes were completed within two (2) weeks of the date of inspection. The active face will be repaired as part of closure during the 1st and 2nd quarter of 2016).
2. Several of the downdrain inlets located on the 1st and 2nd benches on the northern and southern ends of the Class 2 Landfill were filled with sediment at the time of inspection, again due to heavy rains received on-site in the weeks

preceding the inspection. These inlets should be cleaned out and re-lined with sediment tubes or silt fence within sixty (60) days of completion of this report to keep the discharge lines clear until final closure is complete. (NOTE: this repair was completed within two (2) weeks of the date of inspection).

3. Minor ponding in several locations on the benches of the Class 2 Landfill was noted due to clogging of the downdrains. These areas should be monitored following cleanout of the downdrains to ensure that further ponding of storm water is eliminated.
4. Erosion and undermining of the concrete revetment channel along the northern access ramp for the Class 2 Landfill was noted as a result of heavy rains on-site. This area should be repaired within ninety (90) days of completion of this report to improve drainage in the area and to prevent potential personnel/equipment safety concerns.
5. Sediment buildup was noted in the drainage ditch that runs along the perimeter toe of the Class 2 Landfill, likely resulting from surface erosion and runoff during recent heavy rains. This ditch should be cleaned out within sixty (60) days of completion of this report to avoid ponding of water around the toe of the landfill. (NOTE: this repair was completed within two (2) weeks of the date of inspection).

5.3.2 Class 3 Landfill

1. Minor erosion in the foundation drainage layer just above the liner was noted in the Class 3 Landfill. The damage should be repaired prior to placement of waste in these areas. (NOTE: this repair was completed within two (2) weeks of the date of inspection).