Cross Generating Station Bottom Ash Pond

Periodic (5-Yr) Inflow Design Flood Control System Plan

Document No.: CROSS-0-LI-044-0019 - Rev 0

14 Oct 2021

One Meridian Boulevard,
Suite 2C02, Wyomissing, PA, 19610
USA

T: +1 610 855 2000
Worley

Disclaimer

This document has been prepared on behalf of and for the exclusive use of Santee Cooper, and is subject to and issued in accordance with the agreement between Santee Cooper and Worley. Worley accepts no liability or responsibility whatsoever for it in respect of any use of or reliance upon this report by any third party. Copying this report without the permission of Santee Cooper or Worley is not permitted.

Rev	Description	Originator	Reviewer	Approver	Revision Date
0	Issued for Use	Fletcher Wood Digitally signed by Fletcher Wood DN: cn=Fletcher Wood, c=US, o=Worley, email=fletcher.wood@worley.com Reason: I am the author of this document Date: 2021.10.14 12:23:22 -05'00' F. Wood	Yingwu Xu Digitally signed by Yingwu Xu DN: cn=Yingwu Xu, c=US, o=Worley, email=yingwu.xu@worley.com Date: 2021.10.14 13:49:55 -04'00' Y. Xu	Fletcher Wood Digitally signed by Fletcher Wood DN: cn=Fletcher Wood, c=US, o=Worley, email=fletcher.wood@worley.com Reason: I am approving this document Date: 2021.10.14 13:05:39 -05'00' F. Wood	14 Oct 2021

Table of Contents

1. Introduction **1**

2. Discussion **2**

2.1 General 2

2.2 Design Flood 2

2.3 CCR Surface Impoundment Inflows 3

2.4 CCR Surface Impoundment Outflows 3

3. Conclusions **5**

4. Certification **6**

5. References **7**

Appendices

Appendix A. Calculation CROSS-0-DC-044-CE-0006

SOUTH CAROLINA
WORLEY GROUP INC.
No. C01605
CERTIFICATE OF AUTHORIZATION

SOUTH CAROLINA
LICENSED PROFESSIONAL ENGINEER
No. 24767
FLETCHER M. WOOD

Fletcher Wood

Digitally signed by Fletcher Wood
DN: cn=Fletcher Wood, c=US, o=Worley, email=fletcher.wood@worley.com
Reason: I am signing my seal
Date: 2021.10.14 13:06:07 -05'00'

1. Introduction

The United States Environmental Protection Agency (EPA) promulgated regulations regarding Coal Combustion Residuals (CCRs). These regulations (40 CFR Part 257) were published in the Federal Register on April 17, 2015. One of the requirements of the regulations (§257.82(c)(1)) is to prepare initial and periodic inflow design flood control system plans documenting how the inflow design flood control system has been designed and constructed to meet the requirements of this section, and obtain a certification from a qualified professional engineer that the requirements of this section are met.

Two sets of revisions to 40 CFR Part 257 have been published in the Federal Register since the 2015 CCR Rule was first published. The first set of revisions was published on July 30, 2018 and the second on November 12, 2020. The 2018 revisions amended §257.82(c)(5) to adopt two alternative performance standards allowing for owners or operators of CCR surface impoundments to obtain approval from either Participating State Directors (in states with approved CCR permit programs) or the EPA (where the EPA is the permitting authority) stating that the initial and periodic inflow design flood control system plans meet the requirements of §257.81(c) in lieu of a certification from a qualified professional engineer. Neither of these alternative performance standards are applicable in this case. The 2020 revisions did not include any changes to the §257.82(c) requirements addressing initial and periodic inflow design flood control system plans for CCR surface impoundments.

§257.82(c)(5) requires that inflow design flood control system plans are prepared every five years. The date of completing the initial inflow design flood control system plan is the basis for establishing the deadline to complete the first subsequent periodic inflow design flood control system plan. The initial inflow design flood control system plan for the existing Bottom Ash Pond at Cross Generating Station was placed in the operating record on October 17, 2016. The first periodic inflow design flood control system plan therefore must be completed and placed in the operating record on or before October 17, 2021.

This report presents the first periodic inflow design flood control system plan for the Bottom Ash Pond at the Cross Generating Station and provides the required certification by a qualified professional engineer.

2. Discussion

2.1 General

Cross Generating Station consists of four generating units and is located between Lakes Marion and Moultrie, in Pineville, South Carolina. All four units have undergone dry conversion, with bottom ash dewatered and stacked out locally in a containerized bunker located adjacent to each of the four units, where it is either hauled offsite for beneficial reuse, or hauled to the onsite Class Three Landfill. Prior to dry conversion, bottom ash from all four units was sluiced to the existing onsite Bottom Ash (BA) Pond.

The BA Pond is a diked CCR surface impoundment covering approximately 87 acres, with its perimeter dike comprising the CCR Unit boundary. Portions of the south and east dikes of the BA Pond are shared with the adjacent Wastewater Decant (WD) Pond, which lies outside the CCR Unit boundary.

BA Pond closure by removal of waste was initiated in August 2020. All wastewater inflows to the BA Pond were terminated at that time and the BA Pond trapezoidal weir spillway (previously located within the shared dike to convey BA Pond effluent to the WD Pond) was removed. As part of the spillway removal, the shared dike in this area was restored to its original design elevation. There are no longer any inflows to the pond other than direct rainfall, and no gravity outflows from the pond. Evaporation from the pond offsets the direct rainfall into the pond over the long term, maintaining a naturally low pool within the BA Pond. Over the short term, a temporary pump is positioned near the former spillway location and is available to convey water from the BA Pond to the WD Pond to restore the naturally low pool elevation after prolonged periods of wet weather, if necessary.

§257.82(c) requires that the inflow design flood control system plan must document how the inflow design control system has been designed and constructed to meet the applicable requirements of this section. Each plan must be supported by appropriate engineering calculations. This information is provided below.

2.2 Design Flood

§257.82(a)(3) states that the inflow design flood is determined, based on classification under §257.73(a)(2) (existing CCR surface impoundments) or §257.74(a)(2) (new CCR surface impoundments), as:

(i) For a high hazard potential CCR surface impoundment, the probable maximum flood;

(ii) For a significant hazard potential CCR surface impoundment, the 1,000-year flood;

(iii) For a low hazard potential CCR surface impoundment, the 100-year flood.

The BA Pond is classified as a low hazard potential CCR surface impoundment [Ref. 1]. Therefore, the appropriate inflow design flood is the 100-year flood.

2.3 CCR Surface Impoundment Inflows

§257.82(a)(1) states that *the inflow design flood control system must adequately manage flow <u>into</u> the CCR unit during and following the peak discharge of the inflow design flood.*

As mentioned above, with the onset of closure by removal of waste in August 2020, all wastewater inflows to the BA Pond have ceased. The impoundment is surrounded on all sides by a raised perimeter dike (i.e. it is not incised), which limits stormwater run-on to that generated within the footprint of the pond itself. Therefore, there are no longer any inflows to the pond other than rainfall that lands directly on the pond. The interior side slope of the perimeter dike is covered with concrete erosion control revetment, which protects the dike from erosion due to the portion of the design flood event that lands on the perimeter dike and flows immediately into the pond.

The entire volume of water associated with the design flood event is approximately 70 acre-ft. Refer to Calculation CROSS-0-DC-044-CE-0006 in Appendix A for more detail.

2.4 CCR Surface Impoundment Outflows

§257.82(a)(2) states that *the inflow design flood control system must adequately manage flow <u>from</u> the CCR unit to collect and control the peak discharge resulting from the inflow design flood.*

As mentioned above, the BA Pond trapezoidal weir spillway was removed with the onset of closure by removal of waste in August 2020. Therefore, there are no longer any gravity outflows from the pond. A temporary pump located near the former spillway location is used to maintain a relatively low normal pool within the BA Pond during ongoing closure activities by pumping water from the BA Pond to the WD Pond, when necessary. This pump is not used to manage or control the design flood. The entire volume (and therefore the peak flow) of the design flood is now managed using the significant storage capacity available within the BA Pond.

There is over 130 acre-ft of available water storage within the open water areas of the BA Pond alone. This means that the entire volume of water associated with the design flood event (70 acre-ft) can be stored in the BA Pond. Although the normal pool in the BA Pond typically is maintained at around EL 84, there is still sufficient available storage to retain the entire volume associated with the design flood event above EL 86.5, while maintaining 1 ft of freeboard. Refer to Calculation CROSS-0-DC-044-CE-0006 in Appendix A for more detail.

It should be noted that this storage capacity calculation is very conservative in that it does not include the significant additional water storage volume available in other areas of the pond where the top surface of the existing CCR is above the normal pool level (but still well below the top of the dike), nor does it include the available storage within the CCR itself (above the water level). Additionally, as closure proceeds and CCR is removed from the BA Pond, the available water storage volume will increase over time, while the volume associated with the design flood event will not change. Therefore, there is significant excess storage capacity within the BA Pond to store the design flood event.

§257.82(b) states that discharge from the CCR unit must be handled in accordance with the surface water requirements under §257.3-3. When the temporary pump is operated to maintain the normal pool water level in the BA Pond (after a design flood event, or as required after any prolonged period of wet weather), the effluent from the temporary pump will be discharged to the WD Pond for initial settling. The WD Pond effluent is then conveyed to the low volume waste wastewater treatment system prior to discharging to permitted outfall NPDES 002 after all water quality requirements are met. Therefore, all discharge from the CCR unit is handled in accordance with the surface water requirements under §257.3-3.

3. Conclusions

This report satisfies the requirements of §257.82 by providing an inflow design flood control system plan that documents how the design flood control systems for the existing CCR surface impoundment at Cross Generating Station have been designed and constructed to meet the applicable requirements of this section, including supporting engineering calculations.

4. Certification

I, the undersigned Professional Engineer registered in good standing in the State of South Carolina, do hereby certify under penalty of law that I have personally examined and am familiar with the information submitted in this demonstration, and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment. I certify, for the Cross Generating Station Bottom Ash Pond CCR Impoundment, that the periodic inflow design flood control system plan contained herein is in accordance with 40 CFR §257.82.

Fletcher Wood

Digitally signed by Fletcher Wood
DN: cn=Fletcher Wood, c=US, o=Worley, email=fletcher.wood@worley.com
Reason: I am signing my seal
Date: 2021.10.14 13:06:31 -05'00'

Fletcher Wood

Printed Name of Professional Engineer

5. References

1. Worley, Santee Cooper Cross Generating Station Bottom Ash Pond Periodic (5-Yr) Hazard Potential Classification Assessment, October, 2021

Appendix A. Calculation CROSS-0-DC-044-CE-0006

Bottom Ash Pond Periodic (5-Yr) Inflow Design Flood Control System Plan Calculation

Worley
energy | chemicals | resources

Project Details												
Customer	Santee Cooper											
Project Title	Cross Generating Station											
Calculation Title	Bottom Ash Pond Periodic (5-yr) Inflow Design Flood Control System Plan Calculation											
Calculation Number	CROSS-0-DC-044-CE-0006											
								Page	1	**of**	11	
Rev	**Date**	**By**	**Chk**	**Rev**	**Date**	**By**	**Chk**	**Rev**	**Date**	**By**	**Chk**	
0	14 Oct 2021	FMW	YX									

Calculation Objective

The objective of this calculation is to demonstrate how the inflow design flood control system for the Cross Generating Station Bottom Ash Pond (CCR Unit) is designed and constructed in accordance with CCR Rule 40 CFR §257.82. The system is designed for the 100-yr, 24-hr storm event.

Calculation Method

The calculation method compares the available storage volume in the bottom ash pond with the total inflow design flood volume. The inflow design flood volume is a direct calculation of the storm volume associated with a 100-yr, 24-hr rainfall event, applied across the total pond drainage area. The available storage volume is a simple direct measurement of the available storage depth applied across the total pond areas available for storing water, based on very conservative assumptions.

Assumptions

All assumptions are included in the calculation. None that require further verification.

Software Used

Title:	Version:	Validation: (Y / N / N/A)
N/A		

References

1. Worley, Santee Cooper Cross Generating Station Bottom Ash Pond Periodic (5-Yr) Hazard Potential Classification Assessment, October, 2021
2. NOAA Atlas 14, Volume 2, Version 3, PDS-based point precipitation frequency estimates with 90% confidence intervals for Pineville, South Carolina
3. SCDNR, South Carolina State Climatology Office, South Carolina Average Annual Pan Evaporation Map 1961-1990
4. SCDNR, South Carolina State Climatology Office, Annual Average Rainfall for Berkeley County
5. USEPA Final CCR Rule 40 CFR Part 257

Conclusions

A very conservative estimate of the available water storage capacity in the bottom ash pond indicates that it far exceeds the entire volume of the inflow design flood. The Cross Generating Station Bottom Ash Pond inflow design flood control system satisfies the requirements of §257.82.

Related to a Safety Critical System? **No** Status of Supplier Data used **N/A**

HOLDS

None.

			Fletcher Wood	Yingwu Xu	Fletcher Wood
0	14 Oct 2021	Issued for Use	FMW	YX	FMW
Rev	**Date**	**Description**	**By**	**Checked**	**Approved**

Project Details												
Customer	Santee Cooper											
Project Title	Cross Generating Station											
Calculation Title	Bottom Ash Pond Periodic (5-yr) Inflow Design Flood Control System Plan Calculation											
Calculation Number	CROSS-0-DC-044-CE-0006											
							Page		2	of	11	
Rev	Date	By	Chk	Rev	Date	By	Chk	Rev	Date	By	Chk	
0	14 Oct 2021	FMW	YX									

Please check boxes for all applicable items checked or mark as "N/A" if not appropriate:

Calculations:

Originator	Checker	
☒	☒	Calculation number assigned and registered.
☒	☒	All required information on Cover Sheet provided.
☒	☒	Revision history box complete and signed.
☒	☒	Table of Contents.
☐	☐	Appropriate stamp for preliminary issues.
☒	☒	Source of input data stated (with revision number and date if relevant).
☒	☒	Customer's requirements included/addressed.
☒	☒	Approach used is appropriate for problem being solved.
☒	☒	Method clear and easy to follow.
☒	☒	Input data correct.
☒	☒	Calculation is arithmetically correct, OR software previously verified
☒	☒	Calculation result within expected limits.
☒	☒	Calculation tolerances stated if significant.
☒	☒	Units used as required by customer. Unit conversions correctly performed.
☒	☒	Appropriate cross-references.
☒	☒	Sketches included and clearly labeled, where required.
☒	☒	Appendices included and referenced, as required.
☒	☒	Conclusions and recommendations are appropriate.

Checking records:

☒	☒	Checked and annotated copy of calculation filed (use "Doc Check Print" stamp).
☒	☒	Corrections made as required and calculation dated and signed on cover sheet by checker.

Revisions:

☐	☐	Changes clouded, tracked or highlighted.
☐	☐	Revision history block updated.
☐	☐	Calculation re-checked if required.

Project Details											
Customer	Santee Cooper										
Project Title	Cross Generating Station										
Calculation Title	Bottom Ash Pond Periodic (5-yr) Inflow Design Flood Control System Plan Calculation										
Calculation Number	CROSS-0-DC-044-CE-0006										
								Page	3	**of**	11
Rev	**Date**	**By**	**Chk**	**Rev**	**Date**	**By**	**Chk**	**Rev**	**Date**	**By**	**Chk**
0	14 Oct 2021	FMW	YX								

Table of Contents

1. Introduction 4

2. Design Criteria 5

3. Discussion 6

3.1 Bottom Ash Pond Inflow Design Flood 6

3.2 Bottom Ash Pond Outflow / Available Storage Volume 6

3.3 Results 8

4. Conclusions 9

Appendices

Appendix A. Pond Drainage Area and Water Surface Areas

SOUTH CAROLINA CERTIFICATE OF AUTHORIZATION WORLEY GROUP INC. No. C01505

SOUTH CAROLINA LICENSED PROFESSIONAL ENGINEER No. 24767 FLETCHER M. WOOD

Fletcher Wood

Digitally signed by Fletcher Wood
DN: cn=Fletcher Wood, c=US, o=Worley, email=fletcher.wood@worley.com
Reason: I am signing my seal
Date: 2021.10.14 12:20:46 -05'00'

Project Details											
Customer	Santee Cooper										
Project Title	Cross Generating Station										
Calculation Title	Bottom Ash Pond Periodic (5-yr) Inflow Design Flood Control System Plan Calculation										
Calculation Number	CROSS-0-DC-044-CE-0006										
							Page	4	of	11	
Rev	Date	By	Chk	Rev	Date	By	Chk	Rev	Date	By	Chk
0	14 Oct 2021	FMW	YX								

1. Introduction

§257.82(c) requires that the inflow design flood control system plan must document how the inflow design control system has been designed and constructed to meet the applicable requirements of this section. Each plan must be supported by appropriate engineering calculations. This information is provided below for the Bottom Ash (BA) Pond at Cross Generating Station.

2. Design Criteria

The following design criteria govern the flows into the BA Pond, storage within the BA Pond, and flows out of the BA Pond:

- The design flood is the 100-year flood per 40 CFR §257.82(a)(3) and based on the low hazard potential classification of the BA Pond [Ref. 1]
- The design flood corresponds to a 9.6-inch rainfall based on NOAA Atlas 14, Volume 2, Version 3 [Ref. 2]
- There are no longer any wastewater inflows to the BA Pond since it is undergoing closure by removal of waste
- The entire volume of the inflow design flood is equal to the depth of the design rainfall event multiplied by the entire drainage area of the BA Pond
- The assumed outflow from the pond during the design flood is zero (conservatively ignores any water that may be pumped from the pond)
- The top of the pond dike (at lowest surveyed spot elevation) is EL 90.46 ft
- The normal pool in the pond is assumed equal to EL 84 based on elevations measured during BA Pond inspection, which is representative of the pool that is typically maintained between rain events
- The pond is undergoing closure and therefore the current available storage volume will increase with time, as material continues to be removed

3. Discussion

3.1 Bottom Ash Pond Inflow Design Flood

With the initiation of pond closure in August 2020, there are no longer any pond inflows with the exception of rainfall that lands directly on the area inside the BA Pond perimeter dike system.

The precipitation associated with the 100-year, 24-hour flood event is 9.6 inches [Ref. 2]. The total area of the BA Pond as measured inside the centerline of the crowned perimeter dike is approximately 87 acres (see red dashed line in Appendix A). Therefore, the entire volume of water associated with the design flood event is:

Inflow design flood volume*: 87 ac x 9.6 in x 1 ft / 12 in = 69.6 ac-ft ~* ***70 ac-ft***

3.2 Bottom Ash Pond Outflow / Available Storage Volume

With the initiation of pond closure in August 2020, the former outfall weir has been removed and there no longer is a gravity outfall from the BA Pond. The available storage volume in the pond must therefore be large enough to store the entire volume of water associated with the design flood event.

A conservative estimate of the available storage in the pond can be obtained by multiplying the available water storage height (the difference in elevation between the normal pool elevation and the top of dike elevation, minus a freeboard of 1 ft) times the area of the water surface of the pond (with the pond at normal pool).

The normal pool elevation was measured to be approximately EL 84 at the time of the pond inspection in June 2021. The lowest elevation along the top of the perimeter dike system is conservatively assumed to be EL 90.4. The available water storage height is therefore:

Available Water Storage Height*: 90.4 ft – 84.0 ft – 1 ft =* ***5.4 ft***

The area of the water surface of the pond (with pond at normal pool) was determined by measuring satellite imagery obtained January 2021 (after verifying consistency with drone imagery obtained on the same day of CCR impoundment inspection in June 2021, when the normal pool was measured to be approximately EL 84, i.e. the water level at the time of the satellite imagery shown in Appendix A is approximately EL 84). The sub-areas indicated by the blue dashed lines in Appendix A are summarized in Table 1, below:

Table 1: Bottom Ash Pond Water Surface Area (SF)

Subarea ID	Area (sf)
A-1	325,000
A-1a	-7,000
A-2	35,000
A-3	54,000
A-3a	-4,000
A-3b	-1,000
A-3c	-1,000
A-4	46,000
A-5	211,000
A-6	119,000
A-7	110,000
A-8	169,000
Total Water Surface Area	1,056,000 sf
	24.2 ac

The available water storage in the BA Pond is therefore:

Available Water Storage**: 24.2 ac x 5.4 ft = 130.7 ac-ft ~ **130 ac-ft

3.3 Results

When the pond water level is at the normal pool level, the available storage (130 ac-ft) far exceeds the total inflow design flood volume (70 ac-ft). The entire volume of the inflow design flood can therefore be managed within the existing excess available storage in the pond, which satisfies the requirements of §257.82(c). It should be noted that this is a very conservative estimate of the available storage capacity of the pond because it excludes all the areas of the pond where the top surface of the existing CCR is above the water level (but still well below the top of the dike). It also excludes any available storage within the CCR itself (above the water level).

The long-term (annual) pan evaporation rate is over 62 inches [Ref. 3], which exceeds the long-term (annual) average rainfall into the pond of approximately 50 inches [Ref. 4]. However, during periods of wet weather over the short-term, the water level within the pond may increase. Temporary pumps are maintained at the former gravity weir outfall location that may be used to lower the BA Pond water level back down to the normal pool level, if needed. For example, if the pond level approaches the elevation above which the available storage volume will reduce below 70 ac-ft (excluding freeboard), the pumps should be engaged. This normal high water elevation is conservatively calculated as follows:

Normal High Water Level**: EL 90.4 ft – 1 ft – 70 ac-ft / 24.2 ac =* ***86.5 ft

4. Conclusions

A very conservative estimate of the available water storage capacity in the BA Pond indicates that it far exceeds the entire volume of the inflow design flood. Temporary pumps are available to lower the pond water level, if needed, to maintain the required minimum water storage capacity. The Cross Generating Station Bottom Ash Pond inflow design flood control system satisfies the requirements of §257.82.

Appendix A. Pond Drainage Area and Water Surface Areas

Project Details												
Customer	Santee Cooper											
Project Title	Cross Generating Station											
Calculation Title	Bottom Ash Pond Periodic (5-yr) Inflow Design Flood Control System Plan Calculation											
Calculation Number	CROSS-0-DC-044-CE-0006											
								Page	11	**of**	11	
Rev	**Date**	**By**	**Chk**	**Rev**	**Date**	**By**	**Chk**	**Rev**	**Date**	**By**	**Chk**	
0	14 Oct 2021	FMW	YX									

Pond Drainage Area and Water Surface Areas [Ref. Google Earth]