Structural Stability Assessment Report
Inactive CCR Surface Impoundment

City of Ames Steam Electric Plant

Ames Municipal Electric System
502 Carroll Avenue
Ames, Iowa 50010

SCS ENGINEERS

April 16, 2018

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April 16, 2018
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Mr. Brian Trower
Assistant Director – Electric Services
Ames Municipal Electric System
502 Carroll Avenue
Ames, Iowa 50010

Subject: Structural Stability Assessment Report
Inactive Coal Combustion Residuals (CCR) Surface Impoundment

Dear Mr. Trower:

SCS Engineers has prepared the Structural Stability Assessment Report for the Inactive CCR Surface Impoundment for the City of Ames Steam Electric Plant in accordance with the requirements set forth in §257.73(d) of the CCR Rule (40 CFR 257.50-107).

SCS believes the structural stability for the City of Ames Steam Electric Plant CCR Surface Impoundment meets the regulatory requirements set forth in §257.73(d) of the CCR rule.

If you have any questions regarding this document, please contact the undersigned.

Sincerely,

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PE CERTIFICATION

Certification Statement 40 CFR §257.73(d) – Structural Stability Assessment

This Structural Stability Assessment Report for the City of Ames (COA) Steam Electric Plant CCR Inactive Surface Impoundment was prepared by SCS Engineers (SCS). The document and Certification are based on and limited to information that SCS has relied on from the City of Ames and others, but not independently verified, by SCS.

I, Christine L. Collier, hereby certify that this Structural Stability Assessment Report meets the requirements of §257.73(d) and that it was prepared by me or under my direct supervision, and that I am a duly licensed Professional Engineer under the laws of the State of Iowa.

Christine L Collier

Digitally signed by Christine Collier
Date: 2018.04.17 10:16:12 -05'00'

(signature) (date)

Christine L. Collier

(printed or typed name)

License number 17963

My license renewal date is December 31, 2019.

Pages or sheets covered by this seal:
Entire Document

1 INTRODUCTION

On April 17, 2015, the Environmental Protection Agency issued the final version of the federal Coal Combustion Residuals (CCR) Rule to regulate the disposal of CCR materials generated from the combustion of coal at electric utilities and independent power producers. Inactive power plant ash impoundments containing CCR are regulated under Section 257.100 of the Code of Federal Regulations (CFR) 40 Part 257.

The City of Ames (COA) Steam Electric Plant is subject to the CCR Rule and in accordance with the rule must document the Structural Stability Assessment as specified in Section §257.73 of the rule. This document provides the Structural Stability Assessment and documentation for the existing COA CCR Surface Impoundment.

The Structural Stability Assessment must document the factor of safety of the ash impoundment for various loading conditions required in 40 CFR §257.73(d) of the CCR rule.

In accordance with § 257.73(d)(1), a CCR surface impoundment owner or operator is required to conduct initial and periodic structural stability assessments to establish whether the CCR unit can safely store the maximum volume of CCR and CCR wastewater "which can be impounded therein". The assessment must, at a minimum, document whether the CCR unit has been designed, constructed, operated, and maintained with:

- Stable foundations and abutments;
- Adequate slope protection to protect against surface erosion, wave action, and adverse effects of sudden drawdown;
- Embankments mechanically compacted to a density sufficient to withstand the range of loading conditions in the CCR unit;
- Vegetated slopes of embankments and surrounding areas not to exceed a height of six inches above the slope of the embankment, except for slopes which have an alternate form or forms of slope protection;
- A single spillway or a combination of spillways designed, constructed, operated, and maintained to adequately manage flow during and following the peak discharge from the 1,000-year flood for a significant hazard potential CCR surface impoundment.
- Hydraulic structures underlying the base of the CCR unit or passing through the embankment of the CCR unit that maintain structural integrity and are free of significant deterioration, deformation, distortion, bedding deficiencies, sedimentation, and debris which may negatively affect the operation of the hydraulic structure; and
- For CCR units with downstream slopes which can be inundated by the pool of an adjacent water body, such as a river, stream or lake, downstream slopes that maintain structural stability during low pool of the adjacent water body or sudden drawdown of the adjacent water body.

2 BRIEF DESCRIPTION OF IMPOUNDMENT

The City of Ames Steam Electric Plant is located at 200 East 5th Street, in Ames, Iowa. The City of Ames Steam Electric Plant disposed of their CCR materials in a single CCR surface impoundment located approximately 3,000 feet northeast of the generating station in Section 1, Township 83 North, Range 24 West. The approximately 9.6 acre CCR impoundment is located adjacent to and to the east of the COA Water Treatment Plant's Lime Pond. The CCR surface impoundment is approximately 900 feet in length in the east-west direction and a maximum of 675 feet in length in the north-south direction. Based on the 2017 aerial image obtained from the COA and the parcel information found on the City of Ames Beacon™ geographic information system (GIS) site, the area to the north and immediate northeast of the impoundment is privately-owned crop land, to the northeast beyond the privately owned crop ground is the COA South River Valley Park, to the east (ranging from 450 to 950 feet) is the South Skunk River, to the south is COA property and the railroad embankment for the Union Pacific Railroad, and to the west is the lime pond.

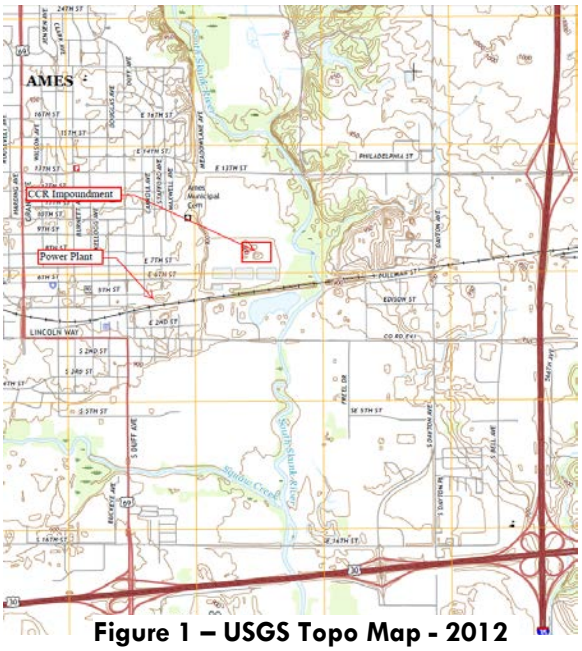


Figure 1 – USGS Topo Map - 2012

The CCR impoundment was designed by Lutz, Daily & Brain Consulting Engineers (LDB) in 1980 and was used for disposal of CCR until October 19, 2015. The embankments for the impoundment were constructed of clay soils obtained from an adjacent borrow area and from within the impoundment footprint. The bottom and interior side slopes of the impoundment were lined with a 3-foot thick impervious liner with a permeability ranging between 7.3×10^{-9} and 4×10^{-10} centimeters per second (cm/sec). Construction of the CCR surface impoundment was overseen by Lutz, Daily & Brain personnel. Density and permeability testing during construction was performed by Patzig Testing Laboratories Co., Inc.

The design plans indicated the top of the impoundment liner in the bottom of the impoundment is at city datum[1] elevation EL 59 (EL 882.5 MSL)[1], the top of the impoundment embankments is at city datum EL 74 (EL 897.5 MSL), and the ground surface elevation around the impoundment ranged from EL 64 to 62 (EL 887.5 to 885.5 MSL). The maximum depth from the crest of the embankment to the base of the impoundment is 15 feet. The maximum exterior height of the embankment (12 feet) occurs in the southeast corner of the impoundment where the ground surface is at city datum EL is 62. The impoundment berms have a varying crest width ranging from approximately 20 feet (west embankment), to 13 feet (east embankment), to approximately 19 feet (south embankment), and to 25 feet (north embankment). The embankments were constructed to 3 horizontal to 1

[1] City Datum = 823.55 MSL

vertical (3:1) side slopes on both exterior and interior slopes of the impoundment. Two non-CCR impoundments (clear water basins) are located to the south of the CCR surface impoundment.

3 STRUCTURAL STABILITY ASSESSMENT

3.1 STABLE FOUNDATIONS

The CCR Rule requires the CCR unit be designed, constructed, operated, and maintained with stable foundations and abutments.

As discussed above, the CCR impoundment was designed by LDB in 1980. Copies of the design plans, specification, and design correspondence were reviewed by SCS. As part of the design process, Patzig Testing Laboratories Co. Inc. (Patzig) completed two soil investigations for LDB:

- Soil Investigation, Proposed Lagoon System and Pump House, June 27, 1980
- Geotechnical Investigation, Lagoon System and Borrow Area, September 12, 1980.

During construction, LDB personnel oversaw construction and Patzig provided quality control testing. SCS has reviewed compaction and permeability testing on the embankment and liner. SCS analysis of the embankment stability shows that the CCR embankments meets the factor of safety requirements in Section §257.73 of the rule. Additionally, the embankments have demonstrated satisfactory performance over the 37 year life of the structures, including external flood events from the nearby South Skunk River.

The CCR impoundment was constructed with a continuous ring embankment; therefore there are no abutments.

3.2 SLOPE PROTECTION

The CCR Rule requires the CCR unit be designed, constructed, operated, and maintained with adequate slope protection to protect against surface erosion, wave action and adverse effects of sudden drawdown.

The external embankments of the CCR impoundment are vegetated to protect against erosion. The CCR impoundment has been subjected to several significant flood events (1975, 1990, 1993, 1996, 2008, 2010) including the 2010 flood (with an exceedance probability of <0.2 or greater than a 500 year event) on the South Skunk River, when the flood crest at the East 13th Street bridge reached EL 895, approximately 2.5 feet below the top of the CCR embankments. The embankments performed as designed without any erosion in any of the flood events on the South Skunk River.

The 2017 annual inspection of the embankments revealed some erosion on the interior embankment slopes. The COA is continuing the process of addressing the erosion and removing the remaining trees from the embankment slopes. In the area were erosion of the interior slope remains, the crest width of the embankment is greater than 20 feet, and the erosion is not posing a

failure risk for the embankments. The majority of the interior embankments are covered with either vegetation or deposited ash.

It is SCS' opinion the embankment slope protection is sufficient to protect the embankments from an erosion failure as demonstrated by the historic performance of the system. Continued on-going maintenance of the interior slopes is required.

3.3 EMBANKMENT COMPACTION

The CCR Rule requires the CCR unit be designed, constructed, operated, and maintained with dikes mechanically compacted to a density sufficient to withstand the range of loading conditions in the CCR unit

During construction of the CCR impoundment in 1980, Patzig personnel performed construction quality testing. In a November 18, 1980 letter to the COA, Patzig stated that density and moisture content testing was performed during the construction period and "densities were 95 percent compaction or greater in all cases."

In April 2016, Wenck Associates, Inc. of Maple Plain, Minnesota, completed a "Dike Stability Investigation Report" for the Ames Municipal Electric System. As part of the investigation, Wenck (and it's subcontractor, Braun Intertec) completed four standard soil borings through the CCR and Lime Pond embankments and eight cone penetrometer test (CPT) soundings to characterize the embankment and foundation soils. Four of the CPT soundings were co-located with the soil borings. SCS reviewed the boring and CPT logs. Standard Penetration Tests (SPT) performed through the embankment soils ranged from 4 to 12 blows per foot (bpf) and averaged 9 bpf in the CCR embankments. A consolidated undrained triaxial compression test on a sample of embankment soil indicated total stress strength parameter of 26.6 for the friction angle and 452 pounds per square foot for the cohesion.

It is SCS' opinion the embankments were designed and constructed in a manner to be stable under the maximum loading.

3.4 VEGETATED SLOPES

The CCR Rule requires the CCR unit be designed, constructed, operated, and maintained with vegetated slopes of dikes and surrounding areas, except for slopes which have an alternate form or forms of slope protection

The adequacy of the embankment vegetation was evaluated by SCS' reviewing of the design drawings, operation history, COA maintenance procedures, and the performance of the embankments during historic flooding events. Based on this evaluation, the vegetation on the exterior slopes is adequate and no substantial bare or overgrown areas were observed during the 2017 annual inspection. The vegetation on the interior slopes of the impoundment is good, but marginal in some areas. The crest width on the embankment varies from 13 to 25 feet as detailed

in Section 2 above. In area where the erosion is the worst case, the crest width allows for some erosion of the embankment prior to the completion of maintenance on the slopes.

Adequate operational and maintenance procedures are in place to regularly manage vegetation growth, including mowing and seeding any bare areas, as evidenced by the conditions observed by SCS. Therefore, the Ash Pond meets the requirements in §257.73(d)(1)(iv).

3.5 SPILLWAY CAPACITY AND UNDERLYING HYDRAULIC STRUCTURES

CCR unit designed, constructed, operated, and maintained with a single spillway or a combination of spillways configured as specified in [paragraph (A) and (B)]:

(A) All spillways must be either:

(1) of non-erodible construction and designed to carry sustained flows; or

(2) earth- or grass-lined and designed to carry short-term, infrequent flows at non-erosive velocities where sustained flows are not expected.

(B) The combined capacity of all spillways must adequately manage flow during and following the peak discharge from a:

(1) Probable maximum flood (PMF) for a high hazard potential CCR surface impoundment; or

(2) 1000-year flood for a significant hazard potential CCR surface impoundment; or

(3) 100-year flood for a low hazard potential CCR surface impoundment.

The COA CCR impoundment does not have a spillway, outfall, or any other external discharge process. The discharge from the CCR impoundment is internal with flow from the CCR impoundment to a series of two clear water ponds. Discharge from the CCR impoundment is through a concrete weir discharge structure connected to an 18-inch diameter steel pipe. The 3.5 foot by 3.5 foot structure has a top local site datum elevation of 71 and a flow line elevation of 59.17. The east side of the structure consists of 4" by 6" wolmanized wood planks with sealtight sponge rubber strips between the planks. Currently the elevation of the top of the stop logs is elevation 69.5.

SCS conducted a storm routing of the 100 year 24-hour storm through the CCR impoundment. The peak pool level during the storm event is dependent on the amount of pumping that occurs during the storm event. A 2-foot freeboard is maintained with the consideration of pump support. Sufficient capacity exists such that the dikes will not be overtopped under the 100-year, 24-hour storm event even if pump failure occurs. Supporting calculations and documentation are provided in Appendix A of the Initial Inflow Design Flood Control Plan.

The CCR Rule requires the CCR unit be designed, constructed, operated, and maintained with hydraulic structures underlying the base of the CCR unit or passing through the dike of the CCR unit that maintain structural integrity and are free of significant deterioration, deformation, distortion, bedding deficiencies, sedimentation, and debris which may negatively affect the operation of the hydraulic structure.

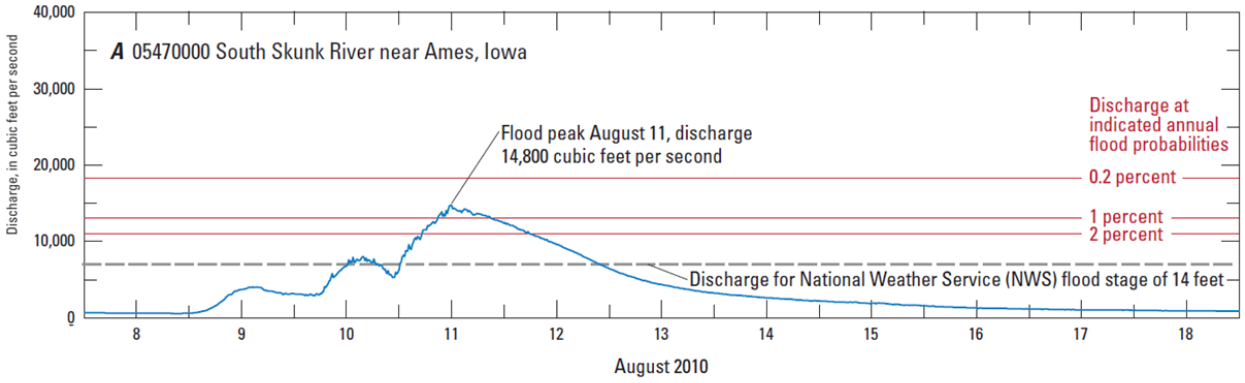
There are no hydraulic structures underlying the base of the CCR unit. The discharge structure includes an 18-inch steel discharge pipe that penetrates the embankment between the CCR impoundment and the first of two clear water basins in series. The annual inspection of the CCR unit

has not identified seepage or the lack of seepage through the pipe that could indicate deterioration of the pipe. During the next annual inspection, COA plans to visually inspect the pipe for signs of deterioration, deformation, distortion, sedimentation, or debris which may negatively affect the operation of the hydraulic structure.

3.6 ADJACENT WATER BODIES

The CCR Rule requires the CCR unit be designed, constructed, operated, and maintained with, for CCR units with downstream slopes which can be inundated by the pool of an adjacent water body, such as a river, stream or lake, downstream slopes that maintain structural stability during low pool of the adjacent water body or sudden drawdown of the adjacent water body,

The external slopes of the CCR impoundment were subject to flooding on the South Skunk River as discussed in Section 3.2 above. Major flooding occurred August 11–16, 2010, in the South Skunk River Basin as a result of the intense rain (9.61 inches) that fell in Ames between August 8th and 11th. The 2010 flood represents the highest peak river stage and the highest peak discharge rate in the 74 year history of the stream gage. The storm hydrograph for stream gage 05470000, located near the northern Ames city limit, is shown below.



Discharge hydrographs for four streamgages on the South Skunk River, August 8–18, 2010.

The above discharge hydrograph shows the South Skunk River was above flood stage for approximately 2.5 days. The project specifications and the construction testing data specified the embankments were constructed using compacted CL-CH soils and the borings and CPT tests confirm the embankment soils are CL-CH soils. The soils are expected to have a permeability in the range of 10^{-6} to 10^{-7} centimeters per second.

Rapid draw down analyses of these types of soils for flooding events in not applicable as the flood waters are not present for a sufficient length of time to alter the phreatic surface in the embankment from the equilibrium conditions.

The water level inside the impoundment is controlled by a weir structure. If the stop logs in the weir structure were to fail, ash and water would flow into the clear water basin (2,000,000 gallon capacity). The potential 2,000,000 outflow from the impoundment would lower the water level in the

current ash pond by approximately 2.6 feet. A 2.6 foot elevation change is not sufficient to cause a rapid drawdown condition. A slope stability analysis of an exterior rapid drawdown was conducted and the calculated factor of safety was 1.21. Based on a review of available material and additional analyses performed for this report, at this time no deficiencies were detected in the structural stability analysis of the COA inactive CCR surface impoundment and no corrective measures are required.

4 CONCLUSIONS

It is SCS's opinion, based on a review of available material and additional analyses performed for this report, that the COA inactive CCR surface impoundment design, construction, and operations and maintenance procedures are consistent with good engineering practices for the maximum volume of CCR and CCR wastewater which can be impounded and meet the requirements of 40 CFR 257.73(d).

5 REVISIONS, RECORDKEEPING, AND REPORTING

The Structural Stability Assessment Report is required to be updated every five years, from the date of placement of the previous assessment in to the operating record as required by §257.105(f)(10). The initial and subsequent reports must be certified by a qualified professional engineer stating that the Structural Stability Assessment meet the requirements of §257.73(d).

The COA will place this initial Structural Stability Assessment Report in the CCR Operating Record and on the COA's CCR Rule Compliance Data and Information website by April 17, 2018. The COA will notify the Iowa Department of Natural Resources (IDNR) that this report has been completed and placed in the facility's operating record and on the COA CCR Rule Compliance Data and Information website. Further, the COA will notify the IDNR of subsequent updates to the Structural Stability Assessment Report.