Report

Structural Stability Assessment - CCR Surface Impoundment 3B

MidAmerican Energy Company
Neal North Energy Center – Sergeant Bluff, Iowa

Revision 1
October 2021

Project I.D.: 18M014.00

Solving our clients' toughest science and engineering challenges.

Structural Stability Assessment

Project ID: 18M014.00

Prepared for

MidAmerican Energy Company

1151 260th Street
Sergeant Bluff, IA 51054

Prepared by

Foth Infrastructure & Environment, LLC

Revision 1
October 2021

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Structural Stability Assessment
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List of Abbreviations, Acronyms, and Symbols

§	Section
3B NOI	*Notice of Intent to Close Neal North Surface Impoundment 3B*
CCR	Coal Combustion Residual
CFR	Code of Federal Regulations
Closure Plan Rev1	*Closure Plan – Coal Combustion Residuals Surface Impoundments 1, 2, 3A, and 3B (Revision 1)*
Foth	Foth Infrastructure & Environment, LLC
IDNR	Iowa Department of Natural Resources
Impoundment 3B	CCR Surface Impoundment 3B
MEC	MidAmerican Energy Company
NNEC	Neal North Energy Center
P.E.	Professional Engineer
RCRA	Resource Conservation and Recovery Act
U.S.C.	United States Code
USEPA	United States Environmental Protection Agency

Certifications

LICENSED PROFESSIONAL ENGINEER
GLENN R.
LEO
23233
IOWA

I hereby certify that this engineering document was prepared by me or under by direct personal supervision and that I am a duly licensed Professional Engineer under the laws of the State of Iowa.

10/4/2021

Glenn Leo, P.E. Date

Iowa P.E. No. 23233

My license renewal date is: December 31, 2021

Pages or sheets covered by this seal: *Structural Stability Assessment – CCR Surface Impoundment 3B (Revision 1).*

1. Introduction

On April 17, 2015, the United States Environmental Protection Agency (USEPA) issued the final version of the Federal Coal Combustion Residual (CCR) Rule to regulate the disposal of CCR materials generated at coal-fired units. The rule is administered as part of the Resource Conservation and Recovery Act [RCRA, 42 United States Code (U.S.C.) (Section) §6901 et seq.], using the Subtitle D approach.

CCR Surface Impoundment 3B at the MidAmerican Energy Company (MEC) Neal North Energy Center (NNEC) is subject to the CCR Rule. Per the requirements of 40 Code of Federal Regulations (CFR) 257.73(d), an *Initial Structural Stability Assessment of Neal North Safety Impoundment 3B* was completed in October 2016 (Burns & McDonnell, 2016), which is provided in Appendix A.

40 CFR 257.73(f) states that a periodic structural stability assessment must be completed every 5 years for existing surface impoundments. The seal on this document certifies that the structural stability assessment provided herein meets the requirements of 40 CFR 257.73(d). Once closure of CCR Surface Impoundment 3B is complete, the requirements in 40 CFR 257.73 for structural integrity criteria for existing CCR surface impoundments, including this report, will no longer be applicable.

2. Background

NNEC is located on the east bank of the Missouri River and is approximately five miles south of Sergeant Bluff, Iowa as shown in Figure 1. NNEC has four inactive CCR surface impoundments (Impoundments 1, 2, 3A, and 3B) located to the south of the NNEC plant site as shown in Figure 2.

CCR Surface Impoundment 1 (north) was previously closed by removal of CCR (Iowa Department of Natural Resources [IDNR] - Doc #86660), and lined non-CCR wastewater ponds were constructed in the closure by removal area. CCR Surface Impoundments 1 (south), 2, and 3A were previously closed with a final cover system over in-place CCR in accordance with 40 CFR Section 257.102(d). Construction of the final cover system for CCRF Surface Impoundments 1 (south), 2, and 3A was completed in December 2017.

At the time of the previous report in 2016 CCR Surface Impoundment 3B was an active CCR unit. Since the previous report was completed MEC ceased operation of CCR Surface Impoundment 3B and initiated closure as described in the *Notice of Intent to Close Neal North Surface Impoundment 3B* (*3B NOI*), dated July 27, 2018.

In 2019 MEC elected to modify the cap-in-place closure of CCR Surface Impoundments 1, 2, 3A to closure-by-removal in accordance with 40 CFR Section 257.102(c), and consolidate CCR within CCR Surface Impoundment 3B in accordance with 40 CFR Section 257.102(d). The combined closure of CCR Surface Impoundments 1 (south), 2, 3A and 3B includes CCR material in CCR Surface Impoundment 3B to be excavated and stockpiled within the impoundment footprint, and clean fill soil to be placed at the base of CCR Surface Impoundment 3B to the high-water elevation prior to consolidation of CCR. The consolidated CCR in the footprint of CCR Surface Impoundment 3B will be capped with an alternative cover system in accordance with the CCR Rule (257.102(d)(3)(ii)).

MEC obtained a closure permit (Permit No. 97-SDP-22-16C) for the combined closure of the CCR Surface Impoundments at NNEC from IDNR, dated February 25, 2020, and subsequently posted to the operating record the *Closure Plan – Coal Combustion Residuals Surface Impoundments 1, 2, 3A, and 3B (Revision 1)*, dated April 17, 2020 (*Closure Plan Rev1*).

Construction for closure of CCR Surface Impoundments 1 (south), 2, 3A, and 3B commenced in June 2020 and is significantly underway. Figure 3 shows an aerial photograph, taken August 2021, of construction progress for closure of CCR Surface Impoundment 3B. Closure construction for CCR Surface Impoundment 3B is anticipated to be completed by November 2022.

3. Structural Stability Assessment

The primary object of the structural stability assessment in Section 257.73(d) of the CCR Rule is to "document whether the design, construction, operation and maintenance of the CCR unit is consistent with recognized and generally accepted good engineering practices for the maximum volume of CCR and CCR wastewater which can be impounded therein." The 2016 Initial Structural Stability Assessment of Surface Impoundment 3B (Burns & McDonnell, 2016) evaluated the foundations and abutments, slope protection, dikes, slope vegetation, spillway, hydraulic structure, and downstream slopes in accordance with 40 CFR Section 257.73(d)(i) through (vii). The findings of these evaluations satisfied the regulatory requirements. This 2016 report is provided in Appendix A.

Since the decommissioning of CCR Surface Impoundment 3B, effluent discharges ceased, and the structural stability risks associated with the impoundment of fluids have been removed. Closure activities have rendered Surface Impoundment 3B a dry-stack CCR disposal facility (i.e., consolidated CCR facility). As part of the consolidated CCR facility construction the CCR fluids, CCR, spillways, and internal dikes were removed from CCR Surface Impoundment 3B. Clean fill was placed to raise the floor elevation built within CCR Surface Impoundment 3B, and CCR is being placed above the clean fill in compacted lifts. Cement additive was used in many of the CCR lifts to augment bearing for compaction, while also providing long-term strength gain of the consolidated CCR.

40 CFR Section 257.73(a) associates the structural stability requirements to existing CCR surface impoundments. Existing CCR surface impoundments are described as areas designed to hold an accumulation of CCR and liquids to treat, store, or dispose of CCR. 40 CFR Section 257.73(d)(1)(i) through (v) identifies structural elements within the CCR unit for assessment based on the maximum volume of CCR and CCR wastewater to be impounded. The structural elements include foundations and abutments (i), abutment slope protection (ii), dikes (iii), dike slope protection (iv), and spillways (v). The abutment slope protection, dikes, dike slope protection, and spillways assume the presence of fluids or are operational elements of an active CCR unit.

These conditions are not present in the consolidated CCR. Therefore, the regulatory requirements associated with 40 CFR Section 257.73(d)(1)(ii, iii, iv and v) do not apply to the consolidated CCR. However, the structural integrity of the foundation and abutments do apply to the consolidated CCR. A foundation and abutment stability analysis is provided as part of the *Safety Factor Assessment – CCR Surface Impoundment 3B (Revision 1)* (Foth, 2021).

4. Report Limitations

Discussions regarding structural stability were based on site observations during construction and anticipated closure design conditions at the time of this report. Significant changes from anticipated closure design conditions should be communicated to Foth Infrastructure & Environment, LLC (Foth) for evaluation of potential impact to the structural integrity.

5. Periodic Assessment and Amendment

MEC placed the Initial Structural Stability Assessment in the CCR Operating Record on October 10, 2016. MEC may amend the plan at any time and is required to do so whenever there is a change in conditions which would substantially affect the written plan in effect.

MEC must conduct periodic structural stability assessments every five years. Preparing the periodic assessments may be achieved by reviewing the current assessment in effect and amending the assessment as required. In all cases, the date for completing the previous plan is the basis for establishing the deadline to complete the subsequent periodic plan. Each periodic plan shall be certified by a qualified professional engineer (P.E.) in the State of Iowa. A record of revisions made to this document is included in Section 6.0.

Once closure of CCR Surface Impoundment 3B is complete, the requirements in 40 CFR 257.73 for structural integrity criteria for existing CCR surface impoundments, including this report, will no longer be applicable.

6. Record of Revisions and Updates

Revision Number	Date	Revision(s) Made	By Whom
0	10/10/2016	Initial Issue	Burns & McDonnell
1	10/4/2021	Periodic assessment	Foth Infrastructure & Environment, LLC

7. References

Burns & McDonnell, 2016. *Initial Structural Stability Assessment of Neal North Safety Impoundment 3B*. October 10, 2016.

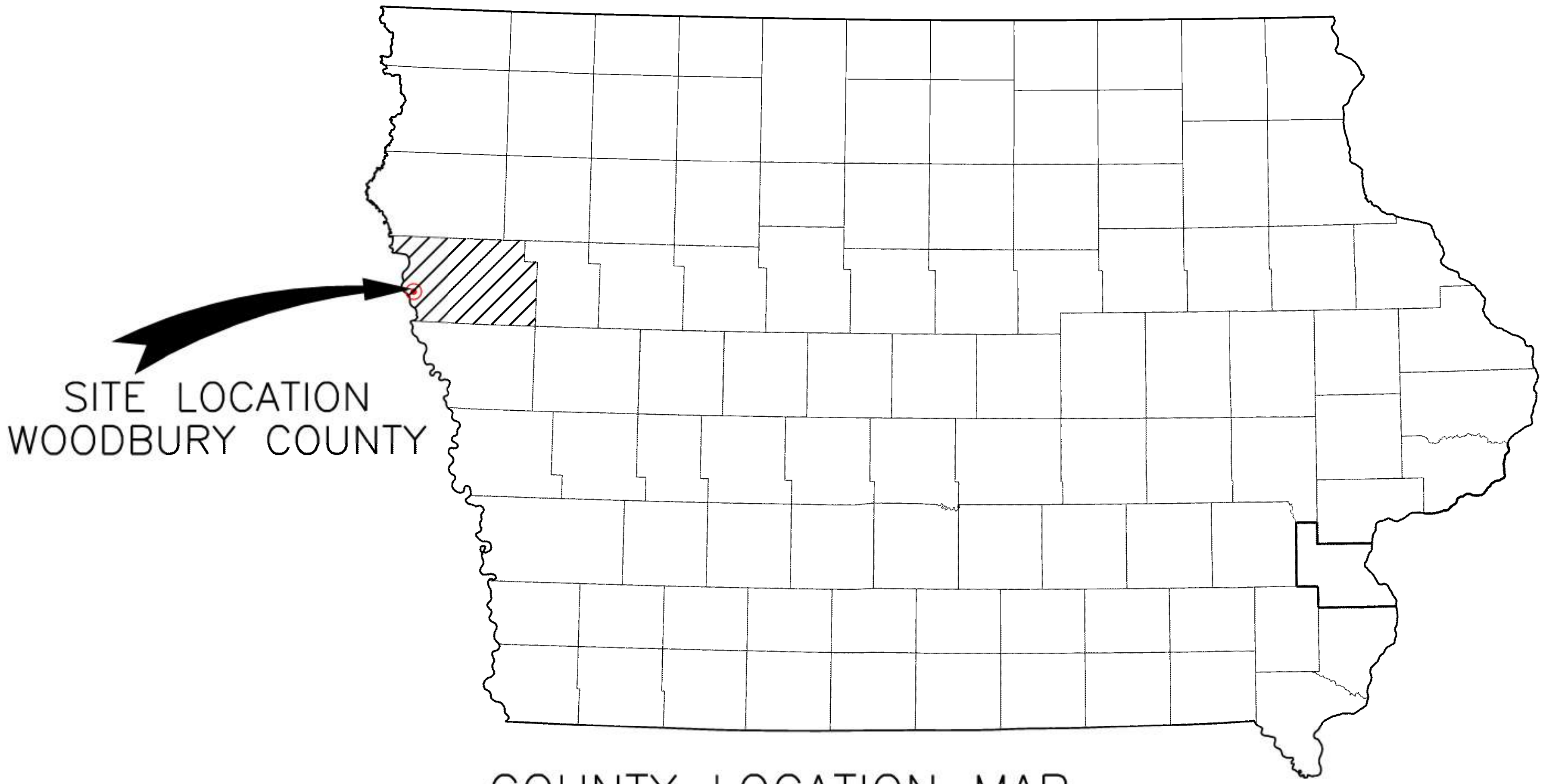
Foth Infrastructure & Environment, LLC (Foth), 2018. *Notice of Intent to Close Neal North Surface Impoundment 3B* (*3B NOI*). July 2018.

Foth, 2020. *Closure Plan – Coal Combustion Residuals Surface Impoundments 1, 2, 3A, and 3B (Revision 1)* (*Closure Plan Rev1*). April 17, 2020.

Foth, 2021. *Safety Factor Assessment – CCR Surface Impoundment 3B (Revision 1)* (*SFA Rev1*). October 2021.

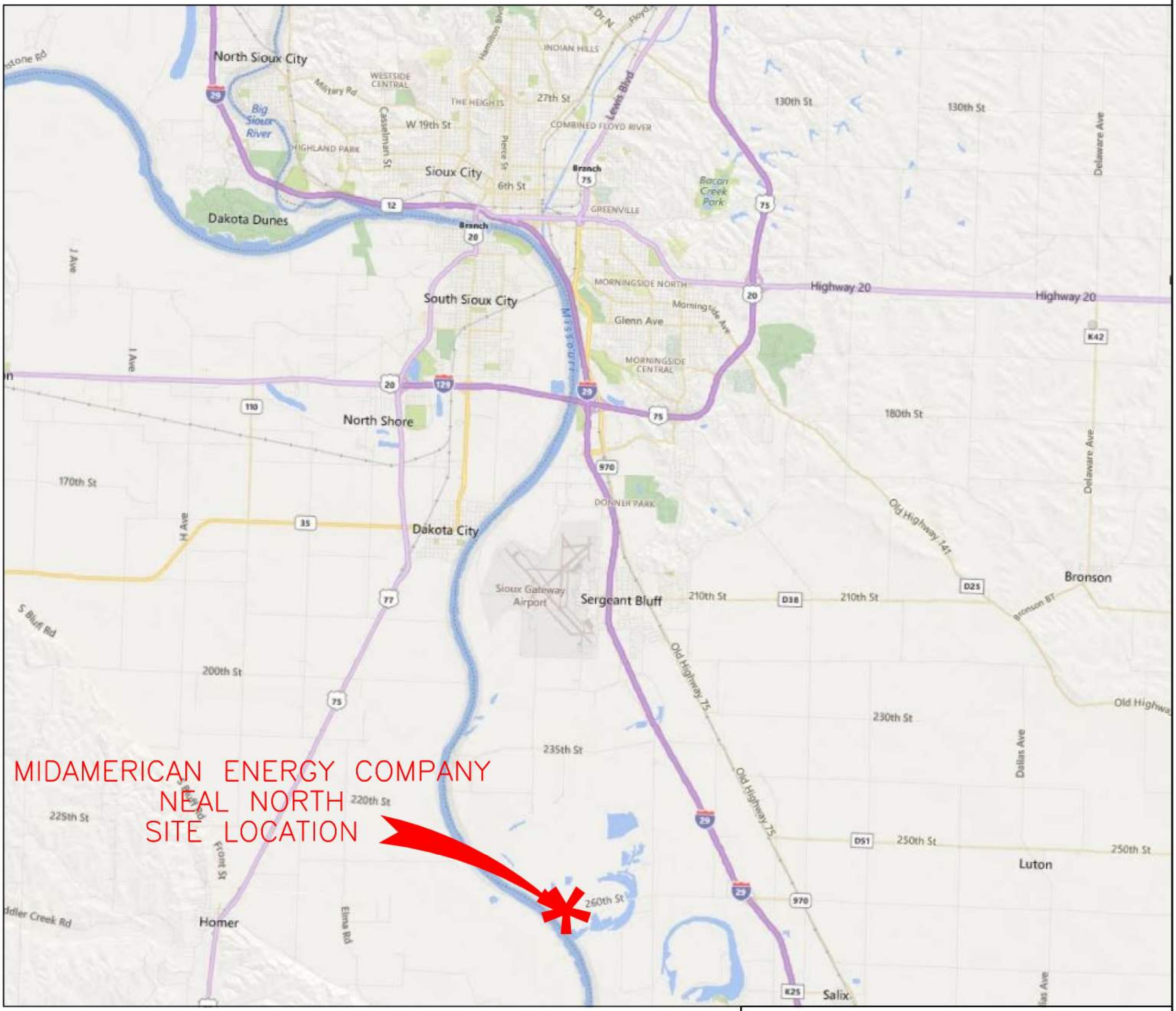
Iowa Department of Natural Resources (IDNR), 2017. *Sanitary Disposal Project Closure Permit* (*SDP Closure Permit*). MidAmerican Energy Company, Neal North Energy Center, CCR Surface Impoundments 1, 2, & 3A Closure. Permit No. 97-SDP-22-16C.

Figures



COUNTY LOCATION MAP

NOT TO SCALE



MIDAMERICAN ENERGY COMPANY - NEAL NORTH

FIGURE 1

SITE LOCATION

Foth

0' 5,000' 10,000'
BAR SCALE

Date: September 2021	Revision Date:	
Drawn By: CKV	Checked By: GRL	Project: 18M014

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MIDAMERICAN ENERGY COMPANY

CONSTRUCTION DRAWINGS FOR CLOSURE OF IMPOUNDMENTS 1, 2, 3A & 3B NEAL ENERGY CENTER NORTH SERGEANT BLUFF, IOWA

WOODBURY, CO — IOWA

REVISIONS

NO	BY	DATE	DESCRIPTION
△			
△			
△			
△			

RECORD DRAWING OF COMPLETED CONSTRUCTION BY:
RECORD DRAWINGS OF COMPLETED CONSTRUCTION, CONFORMING TO CONTRACTOR AND/OR OWNERS RECORDS.
BY ______ DATE ______

DATE OF PREPARATION

	BY	DATE
SURVEYED		
DRAWN	MRS	APR., 2019
DESIGNED	MRS	APR., 2019
CHECKED	BKH	APR., 2019

SITE PLAN

HORIZONTAL SCALE:
0 300' 600'

PROJECT ID: 18M014

FIGURE 2

pw:\\PW-APS1.foth.com:PW_IE\Documents\Clients\MidAmerican Energy\Secured\0018M014.00\CAD\Drawings\construction drawings\issued for construction\18m014_G03_site layout.dgn
4/14/2020 12:51:20 PM mrs

NOTES:
1. Horizontal coordinate system used was NAD83 Iowa State Plane North Zone
2. *Inaccessible due to ground conditions.

LEGEND
Surface Impoundment 3B

Foth

N

This drawing is neither a legally recorded map nor a survey and is not intended to be used as one. This drawing is a compilation of records, information and data used for reference purposes only.

0 300 600 Ft

MIDAMERICAN ENERGY COMPANY

FIGURE 3

CLOSURE CONSTRUCTION PROGRESS AUGUST 2021

Date: SEPTEMBER 2021	Revision Date:	
Drawn By: JRS6	Checked By: BMS	Project: 19MO14

Path: Q:\Midamerican\GIS\mxd\Figure 3 Closure Construction Progress August 2021t.mxd Date: 9/9/2021

Appendix A

***Initial Structural Stability Assessment of Neal North Safety Impoundment 3B* (Burns & McDonnell, 2016)**

Initial Structural Stability Assessment of Neal North Surface Impoundment 3B

MidAmerican Energy Company
Neal North Energy Center

Final
October 10, 2016

Initial Structural Stability Assessment of Neal North Surface Impoundment 3B

Prepared for

MidAmerican Energy Company
Neal North Energy Center
Sergeant Bluff, Iowa

Final
October 10, 2016

Prepared by

Burns & McDonnell Engineering Company, Inc.
Kansas City, Missouri

INDEX AND CERTIFICATION

MidAmerican Energy Company
Neal North Energy Center
Initial Structural Stability Assessment of Neal North Surface Impoundment 3B

Report Index

Certification

I hereby certify, as a Professional Engineer in the State of Iowa, that the information in this document was assembled under my direct personal charge. This report is not intended or represented to be suitable for reuse by the MidAmerican Energy Company Neal North Energy Center or others without specific verification or adaptation by the Engineer.

Nathan Textor, P.E.

Date: 10/10/16

Nathan Textor
License Number 23013

My license renewal date is December 31, 2016

Sections covered by this seal: Sections 3.1, 3.2, 3.3 and 3.7.

LICENSED PROFESSIONAL ENGINEER
NATHAN TEXTOR
23013
IOWA

10-10-16

LICENSED PROFESSIONAL ENGINEER
RICHARD E.
BESANCON
18229
IOWA

Richard E. Besancon 10/10/16
License Number 18229

Richard E. Besancon, P.E.

Date: OCTOBER 10, 2016

My license renewal date is December 31, 2016

Sections covered by this seal: Sections 3.3, 3.4, 3.5 and 3.6.

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LIST OF ABBREVIATIONS

Abbreviation	**Term/Phrase/Name**
BMcD	Burns & McDonnell
CFR	Code of Federal Regulations
CCR	Coal Combustion Residual
EPA	Environmental Protection Agency
FS	Factor of Safety
Impoundment	Surface Impoundment 3B
MEC	MidAmerican Energy Company
NPDES	National Pollution Discharge Elimination System
NNEC	Neal North Energy Center
RCRA	Resource Conservation and Recovery Act
U.S.C.	United States Code

1.0 SUMMARY OF OBJECTIVES

On April 17, 2015, the Environmental Protection Agency (EPA) issued the final version of the Federal Coal Combustion Residual (CCR) Rule to regulate the disposal of coal combustion residual materials generated at coal-fired units. The rule is administered as part of the Resource Conservation and Recovery Act [RCRA, 42 United States Code (U.S.C.) §6901 et seq.], using the Subtitle D approach. MidAmerican Energy Company (MEC) is subject to the CCR Rule. An excerpt from the CCR Rule describing the requirements that are addressed in this report is included in Appendix A.

Per the requirements of 40 CFR Section 257.73(d), the Initial Structural Stability Assessment of all Active CCR Impoundments must be completed. A qualified professional engineer must determine that the result of the assessment meets the requirements of 257.73(d). On behalf of MEC, Burns & McDonnell (BMcD) has completed the Initial Structural Stability Assessment of the Neal North Energy Center (NNEC) Surface Impoundment 3B.

This report contains a description of the site, subsurface information obtained to support the evaluation and the results of the structural stability assessment performed. The seals on this document certify that the Surface Impoundment meets the requirements of 40 CFR Section 257.73(d).

2.0 IMPOUNDMENT DESCRIPTION

Surface Impoundment 3B (referred to herein as Impoundment) is located to the southeast of the main plant area at NNEC, as shown in Figure 1. The Impoundment contains CCR and process water within a perimeter embankment system. This embankment was originally designed by Ebasco Services, Inc. in 1975 to have interior slopes of 2H:1V, exterior slopes of 3H:1V and a crest elevation of 1085 feet. The original design drawing notes that Impoundment "bottom to be excavated to 1072.5 or to such a lower elevation as may be necessary to obtain sufficient fill material for construction of access roads and ash dikes." To the west of the Impoundment are other surface impoundments that have since been deemed inactive and will be capped and closed per the CCR Rule. Water within the Impoundment drains through Outfall 003 to the Missouri River under National Pollution Discharge Elimination System (NPDES) Permit No. #97-00-1-02. At the southeast corner of the Impoundment is New Lake as shown in Figure 1. This is an oxbow lake created by past meandering of the Missouri River.

Figure 1: General Location of Surface Impoundment 3B

Since initial construction, the original design geometry of the perimeter embankment of the Impoundment has been modified. Historical modifications include raising the crest elevation along the west perimeter embankment to a maximum elevation of 1092 feet in some locations and steepening the outer slope of the southern and southeastern perimeter embankments as steep as 2H:1V slope. As part of work related to meeting the requirements of 257.73(e) of the CCR Rule (see Initial Safety Factor Assessment of Neal North Surface Impoundment 3B report), the southern and southeastern embankments were re-graded to a 4H:1V slope and/or covered with rip rap to increase stability.

3.0 STRUCTURAL STABILITY ASSESSMENT

The primary object of the structural stability assessment in Section 257.73(d) of the CCR Rule is to "document whether the design, construction, operation and maintenance of the CCR unit is consistent with recognized and generally accepted good engineering practices for the maximum volume of CCR and CCR wastewater which can be impounded therein." Existing documents, site investigations, site visits and hydraulic design were all reviewed/performed to assess different aspects of the Impoundment as discussed within the CCR Rule. A discussion for each of these aspects are provided below.

3.1 Stable Foundations and Abutments

Section 257.73(d)(i) of the CCR Rule requires that the foundations and abutments be stable. As part of work done at the site, a geotechnical investigation was performed by Terracon Consultants, Inc. in July and August of 2015. BMcD used information from this investigation to perform the Initial Safety Factor Assessment of the Impoundment. General subsurface conditions indicate that the foundation materials are fat clays underlain by sands for the south half of the Impoundment and only sands for the north half of the Impoundment. The fat clays were found to be soft to stiff in consistency. The sands were generally medium dense to dense. The clay soils are susceptible to settlement. However, given the age of the Impoundment, settlement from the embankment would have occurred already and thus additional settlement is not anticipated.

Results of the Initial Safety Factor Assessment indicated that appropriate slope stability factors of safety could be met with modifications to the south and southeast sides of the Impoundment. These modifications were performed by JB Holland Construction, Inc. in August and September 2016. Quality assurance of construction was performed by HGM Associates, Inc. Based on the stability evaluation and the minimal expected future settlement, the foundations are considered stable.

The Impoundment does not have any abutments, so no evaluation of abutments was performed.

3.2 Adequate Slope Protection

Section 257.73(d)(ii) of the CCR Rule requires that there be adequate slope protection to protect against surface erosion, wave action and adverse effects of sudden drawdown. Because of differences in conditions surrounding the Impoundment, different areas will have different considerations.

For the southeastern embankment, New Lake is directly adjacent to the embankment toe and thus wave action on the exterior side of the embankment is a concern. During the 2016 Annual Inspection, erosion was noted at the toe. It was also found during the Initial Safety Factor Assessment that there were deficient slope stability factors of safety along this area. Based on this, rip-rap was added in this area in August and September 2016 as part of the Impoundment modifications.

For all areas of the Impoundment, adequate vegetation was noted on weekly inspections. During the 2016 Annual Inspection, erosion on the interior faces of the embankments were noted and MEC personnel repaired those areas. Based on the observed conditions and required modifications, there is adequate slope protection.

3.3 Dikes Mechanically Compacted

Section 257.73(d)(iii) of the CCR Rule requires that the dikes, or embankments, be mechanically compacted to a density sufficient to withstand the range of load conditions in the CCR unit. No information in the form of specifications or construction documentation is available to show that the embankments were mechanically compacted. Based on this, it cannot be certified that the embankments were mechanically compacted. However, based on results of the Initial Safety Factor Assessment, the embankments with some modifications have adequate stability factors of safety for the range of loading conditions possible. These modifications were performed as discussed above and in more detail in the Initial Safety Factor Assessment report. Based on this, the embankments are adequately compacted.

3.4 Slope Vegetation Height

Section 257.73(d)(iv) of the CCR Rule requires that the vegetated slopes of the dikes and surrounding areas not exceed a height of six (6) inches above the slope of the dike. However, based on the following discussion, this is no longer a requirement of the CCR Rule.

On June 14, 2016, the U.S. Court of Appeals for District of Columbia Circuit (D.C. Circuit) granted the unopposed motion in the CCR litigation to remand and remand/vacate certain elements of the CCR Rule as a result of the settlement between industry and environmental petitioners. See the below text from the oral argument (USCA Case #15-1219, Document #1619358):

> "Upon consideration of the unopposed motion for voluntary remand of specific regulatory provisions, it is ORDERED that the motion be granted. The following provisions are hereby remanded with vacatur to the agency for further proceedings: 1) the phrase "not to exceed a height of 6 inches above the slope of the dike" within 40 C.F.R. §§ 257.73(a)(4), 257.73(d)(1)(iv), 257.74(a)(4), and 257.74(d)(1)(iv)."

3.5 Spillway

Section 257.73(d)(v) of the CCR Rule requires that the spillway be constructed of non-erodible material, designed to carry sustained flows and must have a capacity with the ability to adequately manage a design flood event which is based on the Impoundment's hazard classification.

The Impoundment does not have a spillway but instead the system operates Outfall 003 to the Missouri River. Outfall 003 is a reinforced concrete pipe culvert that runs under the southwest corner of the Impoundment.

Based on previous work, the Impoundment's hazard classification has been determined to be low. Therefore, the spillway must adequately manage a 100-year flood event. BMcD performed a study to evaluate the watershed, runoff, discharge and impounded depth during a 100-year flood event. The results indicate that there is adequate storage within the Impoundment and that overtopping the embankment is not a concern using the existing operation and infrastructure.

3.6 Hydraulic Structure Integrity

Section 257.73(d)(vi) of the CCR Rule requires that any hydraulic structures underlying the base of the CCR unit or passing through the dike of the CCR unit 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. Outfall 003 flows through a reinforced concrete pipe culvert that runs under the southwest corner of the Impoundment. According to Page 21394 of the preamble to the CCR Rule, "abnormal discharges from hydraulic structures are often an indication of potential issues with the sub-surface or internal integrity of the structure". Site personnel have not observed or encountered surficial subsidence, discolored discharge, or other indications that the discharge pipe is corroding or failing in any way.

3.7 Downstream Slope Stability

Section 257.73(d)(vii) of the CCR Rule requires that any downstream slopes adjacent to a water body should maintain structural stability during low pool of the adjacent water body or sudden drawdown of the adjacent water body. The only portion of the Impoundment slope that is adjacent to a body of water is the southeastern side of the Impoundment that is directly adjacent to New Lake.

Lower pool elevations for New Lake were assessed to determine their effect on the embankment stability. These evaluations calculated a minimum factor of safety (FS) of 1.80 for the lower pool elevation case. This FS is greater than minimum required FS per the CCR Rule. Based on this, there was an adequate FS for the downstream slope during low pool conditions.

Possible flood events were also evaluated as part of this assessment. It was determined that the 100-year flood elevation for New Lake will only slightly inundated the toe of the embankment. Based on the limited area affected by flooding, sudden drawdown is not considered a concern.

4.0 REPORT LIMITATIONS

Discussions regarding site conditions that apply to adequate slope protection, hydraulic structure integrity and slope stability were based on observations made at the time of this Initial Structural Stability Assessment by BMcD and MEC personnel. Any changes to embankment geometry, cracking, settling or observed indications of possible issue with the underground culvert, such as turbidity in the outfall water or settlement at the ground surface, should be communicated to BMcD.

APPENDIX A – EXCERPT FROM CCR RULE (§257.73)

paragraphs (c)(1)(i) through (xi) of this section.

(i) The name and address of the person(s) owning or operating the CCR unit; the name associated with the CCR unit; and the identification number of the CCR unit if one has been assigned by the state.

(ii) The location of the CCR unit identified on the most recent U.S. Geological Survey (USGS) 7½ minute or 15 minute topographic quadrangle map, or a topographic map of equivalent scale if a USGS map is not available.

(iii) A statement of the purpose for which the CCR unit is being used.

(iv) The name and size in acres of the watershed within which the CCR unit is located.

(v) A description of the physical and engineering properties of the foundation and abutment materials on which the CCR unit is constructed.

(vi) A statement of the type, size, range, and physical and engineering properties of the materials used in constructing each zone or stage of the CCR unit; the method of site preparation and construction of each zone of the CCR unit; and the approximate dates of construction of each successive stage of construction of the CCR unit.

(vii) At a scale that details engineering structures and appurtenances relevant to the design, construction, operation, and maintenance of the CCR unit, detailed dimensional drawings of the CCR unit, including a plan view and cross sections of the length and width of the CCR unit, showing all zones, foundation improvements, drainage provisions, spillways, diversion ditches, outlets, instrument locations, and slope protection, in addition to the normal operating pool surface elevation and the maximum pool surface elevation following peak discharge from the inflow design flood, the expected maximum depth of CCR within the CCR surface impoundment, and any identifiable natural or manmade features that could adversely affect operation of the CCR unit due to malfunction or mis-operation.

(viii) A description of the type, purpose, and location of existing instrumentation.

(ix) Area-capacity curves for the CCR unit.

(x) A description of each spillway and diversion design features and capacities and calculations used in their determination.

(xi) The construction specifications and provisions for surveillance, maintenance, and repair of the CCR unit.

(xii) Any record or knowledge of structural instability of the CCR unit.

(2) *Changes to the history of construction.* If there is a significant change to any information compiled under paragraph (c)(1) of this section, the owner or operator of the CCR unit must update the relevant information and place it in the facility's operating record as required by § 257.105(f)(9).

(d) *Periodic structural stability assessments.* (1) The owner or operator of the CCR unit must conduct initial and periodic structural stability assessments and document whether the design, construction, operation, and maintenance of the CCR unit is consistent with recognized and generally accepted good engineering practices for 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:

(i) Stable foundations and abutments;

(ii) Adequate slope protection to protect against surface erosion, wave action, and adverse effects of sudden drawdown;

(iii) Dikes mechanically compacted to a density sufficient to withstand the range of loading conditions in the CCR unit;

(iv) Vegetated slopes of dikes and surrounding areas not to exceed a height of six inches above the slope of the dike, except for slopes which have an alternate form or forms of slope protection;

(v) A single spillway or a combination of spillways configured as specified in paragraph (d)(1)(v)(A) of this section. The combined capacity of all spillways must be designed, constructed, operated, and maintained to adequately manage flow during and following the peak discharge from the event specified in paragraph (d)(1)(v)(B) of this section.

(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.

(vi) 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; and

(vii) 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) The periodic assessment described in paragraph (d)(1) of this section must identify any structural stability deficiencies associated with the CCR unit in addition to recommending corrective measures. If a deficiency or a release is identified during the periodic assessment, the owner or operator unit must remedy the deficiency or release as soon as feasible and prepare documentation detailing the corrective measures taken.

(3) The owner or operator of the CCR unit must obtain a certification from a qualified professional engineer stating that the initial assessment and each subsequent periodic assessment was conducted in accordance with the requirements of this section.

(e) *Periodic safety factor assessments.* (1) The owner or operator must conduct an initial and periodic safety factor assessments for each CCR unit and document whether the calculated factors of safety for each CCR unit achieve the minimum safety factors specified in paragraphs (e)(1)(i) through (iv) of this section for the critical cross section of the embankment. The critical cross section is the cross section anticipated to be the most susceptible of all cross sections to structural failure based on appropriate engineering considerations, including loading conditions. The safety factor assessments must be supported by appropriate engineering calculations.

(i) The calculated static factor of safety under the long-term, maximum storage pool loading condition must equal or exceed 1.50.

(ii) The calculated static factor of safety under the maximum surcharge pool loading condition must equal or exceed 1.40.

(iii) The calculated seismic factor of safety must equal or exceed 1.00.

(iv) For dikes constructed of soils that have susceptibility to liquefaction, the calculated liquefaction factor of safety must equal or exceed 1.20.

(2) The owner or operator of the CCR unit must obtain a certification from a qualified professional engineer stating

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