Bottom Ash Lined Impoundment Liner System Certification Report

D.E. KARN GENERATING FACILITY

BOTTOM ASH LINED IMPOUNDMENT LINER SYSTEM DESIGN CERTIFICATION REPORT

Essexville, Michigan

Pursuant to 40 CFR 257.72(c)

Submitted To: Consumers Energy Company
1945 W. Parnall Road
Jackson, Michigan 49201

Prepared By: Golder Associates Inc.
15851 South US 27, Suite 50
Lansing, Michigan 48906

April 2018 **1781451**

CERTIFICATION

Professional Engineer Certification Statement [40 CFR 257.72(c)]

I hereby certify that, having reviewed the attached documentation and being familiar with the provisions of Title 40 of the Code of Federal Regulations Section 257.72 (40 CFR Part 257.72), I attest that this Liner System Design Certification Report is accurate and has been prepared in accordance with recognized and generally accepted good engineering practices, including the consideration of applicable industry standards, and with the requirements of 40 CFR Part 257.72.

Golder Associates Inc.

Signature

6 April 2018

Date of Report Certification

Matthew Wachholz, PE

Name

6201047513

Professional Engineer Certification Number

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1.0 INTRODUCTION

On April 17, 2015, the United States Environmental Protection Agency (EPA) issued the Coal Combustion Residual (CCR) Resource Conservation and Recovery Act (RCRA) Rule (40 CFR 257 Subpart D) ("CCR RCRA Rule") to regulate the solid waste management of CCR generated at electric utilities. Section 257.72(c) of the CCR RCRA Rule requires the owner or operator of a new CCR surface impoundment to document that the unit was designed with a liner system meeting criteria outlined in Section 257.70(b) or (c). According to Section 257.72(c), the documentation must be certified accurate prior to construction of the surface impoundment by a qualified professional engineer in the State of Michigan.

Golder Associates Inc. (Golder) is submitting this report to certify that the Bottom Ash Lined Impoundment at the Consumers Energy Company (CEC) D.E. Karn Generating Facility (DE Karn) in Essexville, Michigan, was designed with a liner system that meets criteria outlined in 40 CFR 257.70(c) per the requirements of 40 CFR 257.72(c). DE Karn is located in Essexville, Michigan as presented on Figure 1 – Site Location Map and the location of the Bottom Ash Lined Impoundment is outlined on Figure 2 – General Site Plan.

2.0 LINER SYSTEM DESIGN

The DE Karn Bottom Ash Lined Impoundment was designed with an alternative composite liner system to meet the material and equivalency criteria outlined in 40 CFR 257.70(c). The liner system was designed as a double composite liner system, with the primary and secondary composite liners each consisting of 60-mil High Density Polyethylene (HDPE) geomembrane (GM) overlaying 236-mil geosynthetic clay liner (GCL). Table 2.0.1 summarizes the liner system design and RCRA criteria. A detail of the liner system components for the DE Karn Bottom Ash Lined Impoundment is provided below in Figure 1.

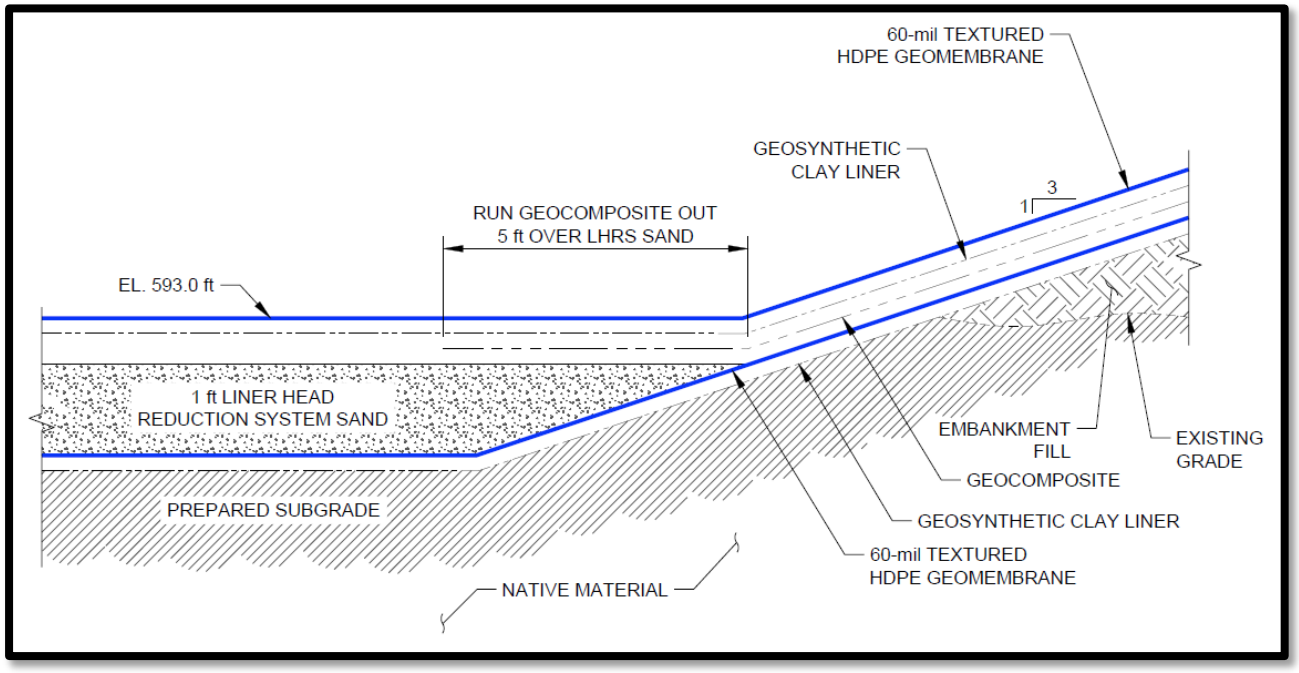
Section 257.70(c)(2) of the CCR RCRA Rule requires an equivalency calculation to demonstrate that the lower component of the alternative composite liner system meets the liquid flow rate criteria outlined in 40 CFR 257.70(c)(1). The liquid flow rate equivalency calculation is discussed in Section 3.0.

Table 2.0.1 – Liner System Design Criteria Summary

Liner Component	Surface Impoundment Design	CCR RCRA Rule Requirement	CCR RCRA Rule Section
Upper	60-mil HDPE GM	Minimum 30-mil GM (HDPE GM must be at least 60 mil)	257.70(c)(1)
Lower	236-mil GCL with *k* of 1×10^{-9} cm/s or less	Component other than GM with a liquid flow rate less than or equal to liquid flow rate through two feet of compacted soil with *k* of 1×10^{-7} cm/s	257.70(c)(1)
Liner Head Reduction System	Sand (floor)/ geocomposite (slopes)	No requirement	NA
Upper	60-mil HDPE GM	Minimum 30-mil GM (HDPE GM must be at least 60 mil)	257.70(c)(1)
Lower	236-mil GCL with *k* of 1×10^{-9} cm/s or less	Component other than GM with a liquid flow rate less than or equal to liquid flow rate through two feet of compacted soil with *k* of 1×10^{-7} cm/s	257.70(c)(1)

Notes:
HDPE – High Density Polyethylene
LLDPE – Linear-Low Density Polyethylene
GM – geomembrane
GCL – geosynthetic clay liner
k – saturated vertical hydraulic conductivity
NA – not applicable

Figure 2.0.1 – Liner System Design Detail



3.0 LIQUID FLOW RATE COMPARISON

Per 40 CFR 257.70(c)(2), an equivalency calculation was performed to verify that the liquid flow rate through the 236-mil (0.60-cm) GCL is less than or equal to the liquid flow rate through two feet (60.96 cm) of compacted soil. Equation 1 (Eq 1) shown below was used for the calculation as required in 257.70(c)(2):

$$\frac{Q}{A} = q = k\left(\frac{h}{t} + 1\right) \qquad \text{Eq 1}$$

where: Q = flow rate through the layer in cubic centimeters (cm^3) per second (cm^3/s);
A = surface area of the layer in squared centimeters (cm^2);
q = flow rate through the layer per unit area in cm^3 per second per cm^2 ($cm^3/s/cm^2$);
h = hydraulic head above the liner system in centimeters (cm); and
t = thickness of the layer in cm.

A 236-mil GCL with a hydraulic conductivity of 1×10^{-9} cm/s was determined to have a liquid flow rate less than the liquid flow rate through two feet of compacted soil with a hydraulic conductivity of 1×10^{-7} cm/s. The liquid flow rate equivalency calculation is provided in Attachment 1 – Liquid Flow Rate Equivalency Calculation.

This calculation has been completed for the sole purpose of demonstrating equivalency for the alternative composite liner system and should not be recognized as the designed infiltration rate of the CCR Unit, as the calculation does not account for the 60-mil GM and also considers a hydraulic head elevation that is the maximum elevation reasonably anticipated and higher than the normal operating level of the unit.

4.0 SUBSEQUENT REQUIREMENTS

The Bottom Ash Lined Impoundment liner system has been designed using recognized and generally accepted good engineering practices in accordance with 40 CFR 257.70(c) and 257.72. Per 40 CFR 257.72(d), the owner or operator must obtain certification from a qualified professional engineer that the alternative composite liner system has been constructed in accordance with 40 CFR 257.72 once the Bottom Ash Lined Impoundment has been completed. The certification must be placed in the facility's operating record in accordance with 40 CFR 257.105(f) and must be made available on the facility's publicly accessible internet site in accordance with 40 CFR 257.107(f) prior to first receipt of waste.

5.0 CONCLUSION AND SUMMARY

Based on the review of the liner system design and liquid flow rate equivalency calculation, Golder has determined that the DE Karn Bottom Ash Lined Impoundment was designed with an alternative composite liner system that meets the criteria provided in 40 CFR 257.70(c). This report must be placed in the facility's operating record in accordance with 40 CFR 257.105(f) and must be made available on the facility's publicly accessible internet site in accordance with 40 CFR 257.107(f) prior to construction of the surface impoundment.

Sincerely,

GOLDER ASSOCIATES INC.

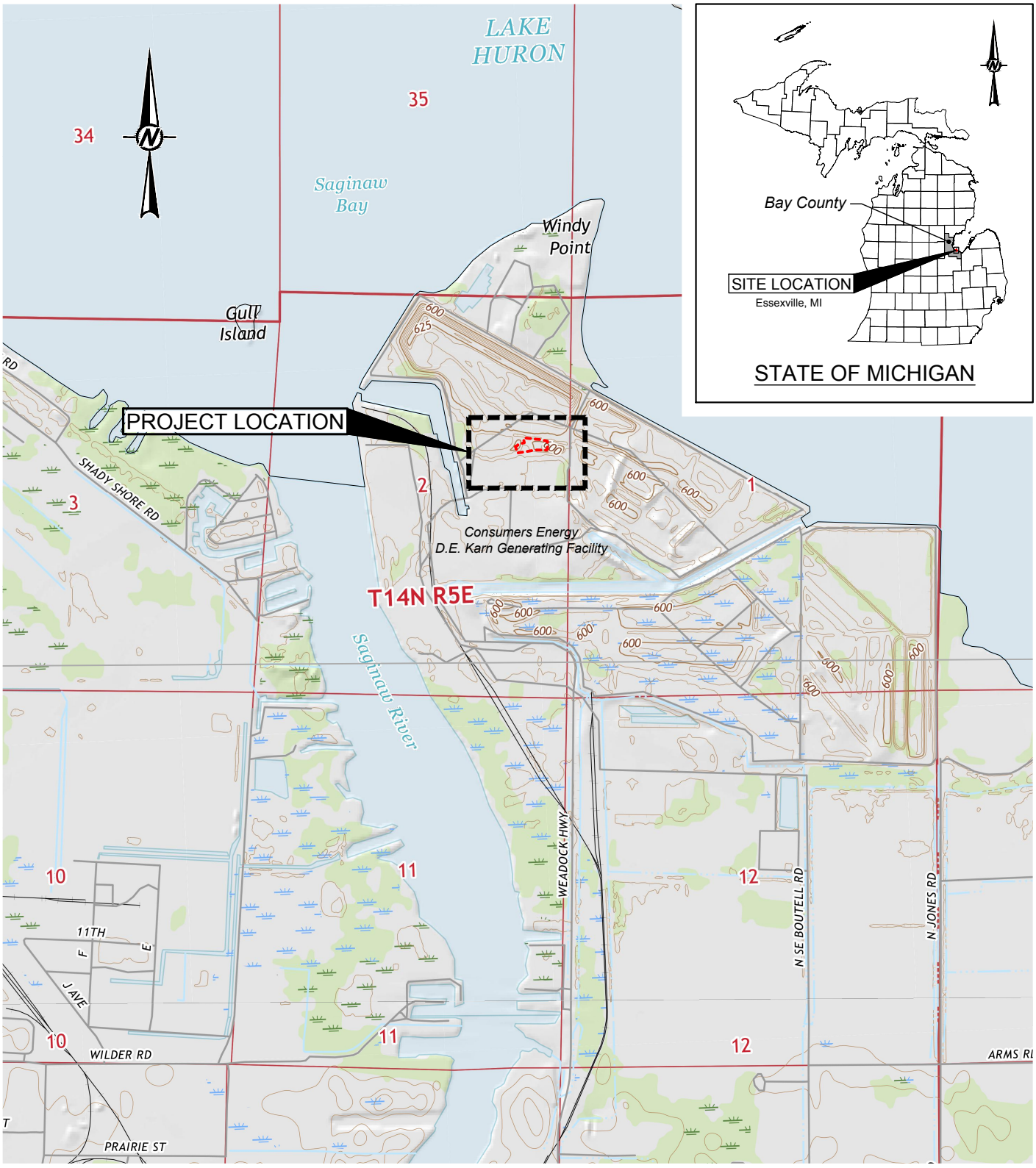
Megan Jehring, E.I.T.
Staff Geotechnical Engineer

Matt Wachholz, P.E.
Senior Consultant

6.0 REFERENCES

"Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments," Title 40 – Protection of the Environment Part 257 – Criteria for Classification of Solid Waste Disposal Facilities and Practices Subpart D – Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments.

FIGURE 1
SITE LOCATION MAP



REFERENCE

BASE MAP IMAGERY DERIVED FROM U.S. DEPARTMENT OF INTERIOR, UNITED STATES GEOLOGICAL SURVEY (USGS), MICHIGAN-BAY COUNTY, 7.5-MINUTE SERIES QUADRANGLE MAPS "BAY CITY NE" AND "ESSEXVILLE", BOTH DATED 2017.

CLIENT
CONSUMERS ENERGY COMPANY
2742 NORTH WEADOCK HIGHWAY
ESSEXVILLE, MICHIGAN 48732

CONSULTANT
Golder Associates

YYYY-MM-DD	2018-04-06
DESIGNED	MMJ
PREPARED	SDA
REVIEWED	MMJ
APPROVED	MW

PROJECT
D.E. KARN GENERATING FACILITY
BOTTOM ASH LINED IMPOUNDMENT
RCRA LINER CERTIFICATION REPORT

TITLE
SITE LOCATION MAP

PROJECT NO. 1781451.0003
REV. 0
FIGURE 1

P:\0 projects\Consumers Energy\1781451 DE Karn New BALI RCRA Compliance\950 CAD\02_FIGURES\A - Bottom Ash Lined Impoundment RCRA Closure Plan\1781451_BALI_RCRA_CP_USGS-Site-Location-Map.dwg Apr 06, 2018 - 12:08pm By: STAnderson

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ANSI A

FIGURE 2
GENERAL SITE PLAN

REFERENCES

1. AERIAL BASE MAP IMAGE FROM © CNES 2016, DISTRIBUTION AIRBUS DS GEO SA / AIRBUS DS GEO INC., PHOTO DATE: MAY 6, 2016.
2. HORIZONTAL DATUM AND COORDINATES SHOWN BASED ON MICHIGAN STATE PLANE COORDINATE SYSTEM, NORTH AMERICAN DATUM 1983 (NAD83), SOUTH ZONE, INTERNATIONAL FOOT.

REFERENCE DRAWINGS	REV	DATE	DESCRIPTION	DR	BY	CHK	APP	CO

REV	DATE	DESCRIPTION	DR	BY	CK	APP	CO
0	2018-04-06	SUBMITTED FOR OWNER'S REVIEW	MMJ	SDA	MMJ	MW	

SIGNATURE

NAME

MICHIGAN P.E. No.

Consumers Energy

D.E. KARN GENERATING FACILITY
ESSEXVILLE, MI

GENERAL SITE PLAN

BOTTOM ASH LINED IMPOUNDMENT
RCRA LINER CERTIFICATION REPORT

SCALE: AS SHOWN
JOB: 1781451.0003
DRAWING NO.
FIGURE: 2
REV.: 0

P:\0_projects\Consumers Energy\1781451 DE Karn New BAU RCRA Compliance\950 CAD\02_FIGURES\A – Bottom Ash Lined Impoundment RCRA Closure Plan\1781451_BAU_RCRA_CP_General-Site-Plan.dwg Apr 06, 2018 – 12:07pm By STAnderson

ATTACHMENT 1
LIQUID FLOW RATE EQUIVALENCY CALCULATION

Date:	4/5/2018	**Made by:**	MMJ
Project No.:	1781451	**Checked by:**	JSH
Subject:	Liquid Flow Rate Equivalency Calculation	**Reviewed by:**	MW
Project Short Title:	D.E. Karn New Surface Impoundment RCRA Compliance		

OBJECTIVE:

Verify the liquid flow rate through the lower component of the alternative composite liner is less than or equal to the liquid flow rate through 2 feet (60.96 cm) of compacted soil with a hydraulic conductivity of 1×10^{-7} cm/s.

ASSUMPTIONS:

1) The alternative composite liner design for the new surface impoundment consists of an upper component of 60-mil HDPE geomembrane and a lower component of geosynthetic clay liner (GCL). The selected GCL has a thickness of 236 mil (0.6 cm) and a hydraulic conductivity of 1×10^{-9} cm/s or less.

2) The maximum hydraulic head expected above the liner system is 6 feet (182.88 cm), occurring during the 100-year flood event as determined in the Inflow Design Flood Control System Plan per 40 CFR 257.82.

METHODS:

The liquid flow rate will be calculated using Darcy's Law per 40 CFR 257.70(c)(2):

$$\frac{Q}{A} = q = k\left(\frac{h}{t} + 1\right)$$

where:

Q	=	flow rate through layer (cm^3/s)
A	=	surface area of layer (cm^2)
q	=	flow rate through layer per unit area ($cm^3/s/cm^2$)
k	=	saturated vertical hydraulic conductivity of the layer (cm/s)
h	=	hydraulic head above the liner system (cm)
t	=	thickness of the layer (cm)

CALCULATIONS:

1) Liquid flow rate through 2 feet of compacted soil with a hydraulic conductivity of 1×10^{-7} cm/s:

k	=	1.00E-07	cm/s
h	=	182.88	cm
t	=	60.96	cm
q_1	=	4.0E-07	$cm^3/s/cm^2$

2) Liquid flow rate through 0.6-cm thick GCL with a hydraulic conductivity of 1×10^{-9} cm/s:

k	=	1.00E-09	cm/s
h	=	182.88	cm
t	=	0.6	cm
q_2	=	3.1E-07	$cm^3/s/cm^2$

3) Flow rate comparison:

	q_1	≥	q_2	
4.0E-07	$cm^3/s/cm^2$	>	3.1E-07	$cm^3/s/cm^2$

CONCLUSIONS:

The liquid flow rate through a 0.6-cm thick GCL with a hydraulic conductivity of 1×10^{-9} cm/s is less than the liquid flow rate through two feet of compacted soil with a hydraulic conductivity of 1×10^{-7} cm/s. Therefore, the alternative composite liner design for the new surface impoundment satisfies requirements outlined in 40 CFR 257.70(c)(2).

REFERENCES:

1) "Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments," Title 40 – Protection of the Environment Part 257 – Criteria for Classification Solid Waste Disposal Facilities and Practices Subpart D – Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments.

Established in 1960, Golder Associates is a global, employee-owned organization that helps clients find sustainable solutions to the challenges of finite resources, energy and water supply and management, waste management, urbanization, and climate change. We provide a wide range of independent consulting, design, and construction services in our specialist areas of earth, environment, and energy. By building strong relationships and meeting the needs of clients, our people have created one of the most trusted professional services organizations in the world.

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