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Assessment of Dam Safety
Coal Combustion Surface Impoundments
Draft Report

Duke Energy
Riverbend Steam Station

Mt. Holly, North Carolina

Prepared for

Lockheed Martin

2890 Woodridge Ave #209
Edison, New Jersey 08837

July 7, 2009

CHA Project No. 20085.2000.1502

I acknowledge that the management units referenced herein:

- Primary Ash Pond
- Secondary Ash Pond

Has been assessed on June 4, 2009 and June 5, 2009.

Signature: ______________________________________
Malcolm D. Hargraves, P.E.
Senior Geotechnical Engineer
Registered in the State of North Carolina

Signature: ______________________________________
Katherine E. Adnams, P.E.
Senior Geotechnical Engineer

Reviewer: ______________________________________
Warren A. Harris, P.E.
Geotechnical Operating Manager

US EPA ARCHIVE DOCUMENT

TABLE OF CONTENTS

SECTION **PAGE NUMBER**

US EPA ARCHIVE DOCUMENT

TABLE OF CONTENTS - continued

TABLES

US EPA ARCHIVE DOCUMENT

US EPA ARCHIVE DOCUMENT

1.0 INTRODUCTION & PROJECT DESCRIPTION

1.1 Introduction

CHA was contracted by Lockheed Martin to perform site assessments of selected coal combustion surface impoundments (Project #0-381 Coal Combustion Surface Impoundments/Dam Safety Inspections). As part of this contract, CHA was assigned to perform a site assessment of Duke Energy's Riverbend Steam Station, which is located in Mount Holly, North Carolina as shown on Figure 1 – Project Location Map.

CHA made a site visit on June 4, 2009 and June 5, 2009 to inventory coal combustion surface impoundments at the facility, to perform visual observations of the containment dikes, and to collect relevant information regarding the site assessment.

CHA Engineers Malcolm Hargraves, P.E. and Katherine Adnams, P.E. were accompanied by the following individuals:

Company or Organization	Name and Title
Davy Simonson	US Environmental Protection Agency
Steve Jones	Duke Energy
Henry Taylor	Duke Energy
Chris Hallman	Duke Energy
Tim Hammond	Duke Energy
Quincy Corey	Duke Energy
Scott Harrell	North Carolina Department of Environment & Natural Resources
Tamera Eolin	North Carolina Department of Environment & Natural Resources

1.2 Project Background

The primary and secondary ash ponds at the Riverbend Steam Station are under the jurisdiction of the North Carolina Utilities Commission. These impoundments are classified by the North Carolina Utilities Commission as high hazard (Class C) under North Carolina Dam Safety rules because of potential environmental damage in the event of a failure.

1.2.1 State Issued Permits

North Carolina State Permit No. NC0004961 has been issued to Duke Energy authorizing discharge under the National Pollutant Discharge Elimination System (NPDES) to the Catawba River in accordance with effluent limitations, monitoring requirements and other conditions set forth in the permit. The permit became effective on March 1, 2005 and will expire on February 28, 2010.

1.2 Site Description and Location

Figure 2 – Site Plan shows the two management units constructed for the Riverbend Steam Station. The primary and secondary ash ponds are located side by side to the northeast of the plant, with the secondary pond to the northeast of the primary ash pond. The Catawba River is located to the north of the ponds.

The primary dike is on the west side of the primary ash pond. Figure 3 shows a typical cross section of the primary dike creating this impoundment. The intermediate dike separates the primary ash pond from the secondary ash pond on the north side, and natural ground bound the east and south sides of the primary ash pond. Figure 4 shows a typical cross section of the intermediate dike. A dry-stacked embankment of ash recently dredged ash from the primary pond creates a landfill on the south side of the primary ash pond. This ash stack has been covered with soil and vegetated with grass.

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The secondary dike is located along the north and northeast sides of the secondary ash pond. The intermediate dike is on the south side of this pond, and natural ground bounds the remaining portion of the secondary ash pond. Figures 5A and 5B show typical cross sections of the secondary dike.

A map of the region indicating the location of the Riverbend Steam Plant and identifying schools, hospitals, or other critical infrastructure located within approximately 5 miles down gradient of the primary and secondary ash ponds is provided as Figure 6.

1.2.1 Other Impoundments

No other impoundments were identified at the Riverbend Steam Station.

1.3 Previously Identified Safety Issues

Based on our review of the information provided to CHA and as reported by AEP, there have been no identified safety issues at the primary or secondary ash ponds in the last 10 years.

1.4 Site Geology

Based on a review of available surficial and bedrock geology maps, and reports by others, the Riverbend Steam Station is located in the Charlotte Geologic Belt of the Piedmont Physiographic Province in North Carolina. The soil and bedrock at the site is comprised of clayey to sandy saprolite overlying metamorphosed quartz diorite and tonalite.

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1.5 Bibliography

CHA reviewed the following documents provided by Duke Energy in preparing this report:

- *Riverbend Steam Station Ash Dike Liquefaction Triggering Evaluation*, December 2003, Devine, Tarbell & Associates, Inc.
- *Independent Consultant Inspection Report*, June 15, 1989, Trigon Engineering Consultants, Inc.
- *2008 Annual Ash Basin Dike Inspection Report*, January 13, 2009, S&ME Inc.
- Selected Original Construction Drawings, 1957, Duke Power Company
- Selected Construction Drawings for Dam Raising, 1979, Duke Power Company
- Letter from Duke Energy Corporation to US EPA (with appendices), March 29, 2009

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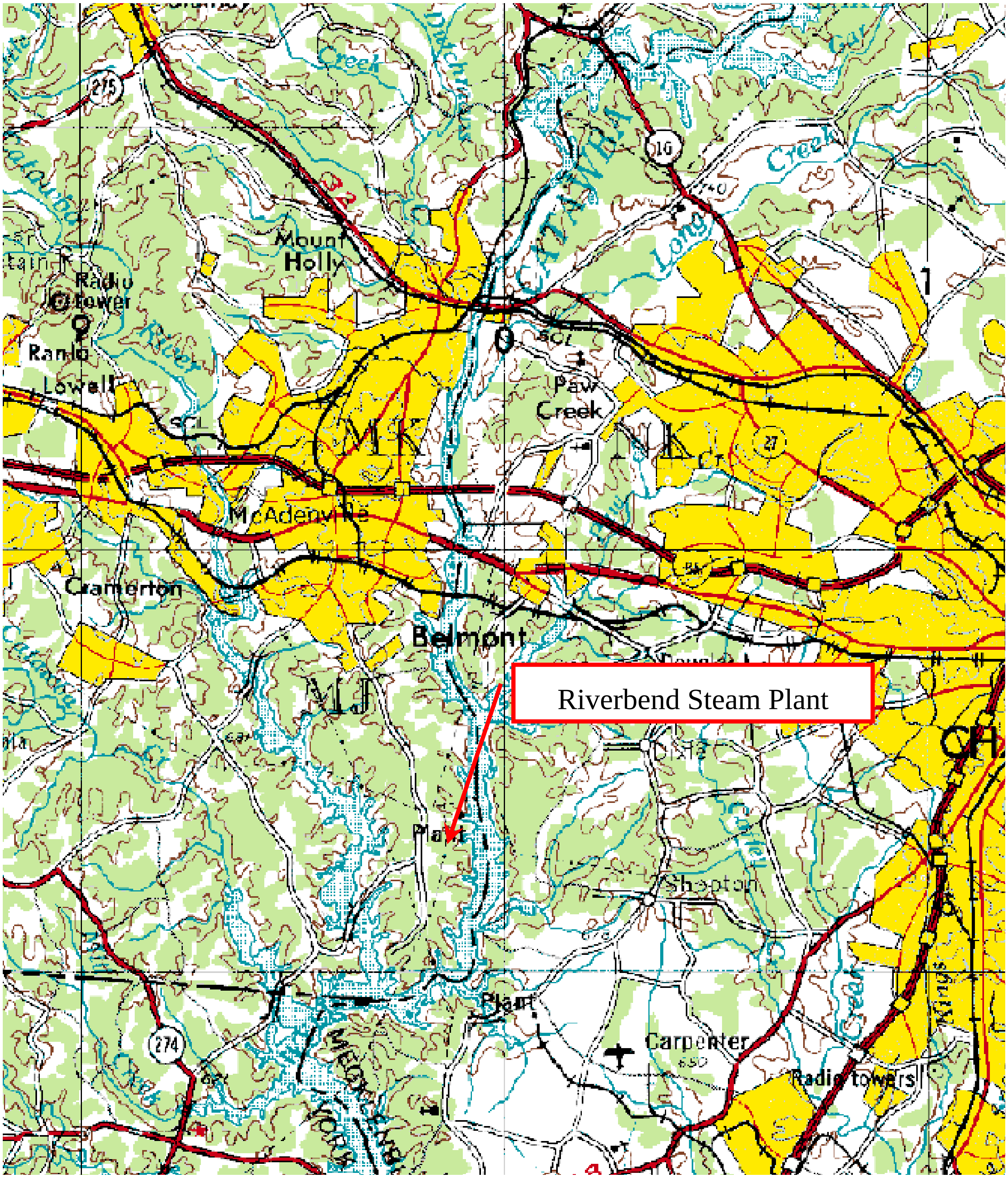

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Figure 1
Project Location Map

Scale: 1" = 2 miles

Project No.: 20085.2000.1510

Duke Energy
Riverbend Steam Plant
Mount Holly, North Carolina

IMAGE REFERENCE: GOOGLE EARTH

Drawing Copyright © 2007 CHA

CHA

SITE PLAN
RIVERBEND STEAM PLANT
DUKE ENERGY
MT. HOLLY, NORTH CAROLINA

PROJECT NO. 20085	
DATE: JULY 2009	
FIGURE 2	

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DAM #1

SECTION S-S

redacted

IMAGE REFERENCE: DUKE ENERGY RIVER BEND STEAM STATION, 2008 ANNUAL DIKE INSPECTION, DAM #1 INSPECTION, FIGURE 3, 1-13-08

Drawing Copyright © 2007 CHA

CHA

CROSS SECTION OF PRIMARY DIKE RIVERBEND STEAM PLANT DUKE ENERGY MT. HOLLY, NORTH CAROLINA	PROJECT NO. 20085.2000
	DATE: JULY 2009
	FIGURE 3

redacted

DIVIDER DIKE

SECTION AA-AA

IMAGE REFERENCE: DUKE ENERGY RIVER BEND STEAM STATION, 2008 ANNUAL DIKE INSPECTION, DAM #1 INSPECTION, FIGURE 4, 1-13-08

Drawing Copyright © 2007 CHA

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CROSS SECTION OF DIVIDER DIKE
RIVERBEND STEAM PLANT
DUKE ENERGY
MT. HOLLY, NORTH CAROLINA

PROJECT NO. 20085.2000

DATE: JULY 2009

FIGURE 4

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redacted

IMAGE REFERENCE: DUKE ENERGY RIVER BEND STEAM STATION, 2008 ANNUAL DIKE INSPECTION, DAM #2 SECTION, FIGURE 6, 1-13-08

Drawing Copyright © 2007 CHA

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CROSS SECTION OF SECONDARY DIKE
RIVERBEND STEAM PLANT
DUKE ENERGY
MT. HOLLY, NORTH CAROLINA

PROJECT NO. 20085.2000

DATE: JULY 2009

FIGURE 5A

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redacted

Figure Provided by Duke Energy. Section is from Duke drawing [illegible], Revision 2.

IMAGE REFERENCE: DUKE ENERGY RIVER BEND STEAM STATION, 2008 ANNUAL DIKE INSPECTION, DAM #2 SECTIONS, FIGURE 5, 1-13-08

Drawing Copyright © 2007 CHA

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CROSS SECTION OF SECONDARY DIKE WITH BENCH

RIVERBEND STEAM PLANT
DUKE ENERGY
MT. HOLLY, NORTH CAROLINA

PROJECT NO. 20085.2000

DATE: JULY 2009

FIGURE 5B

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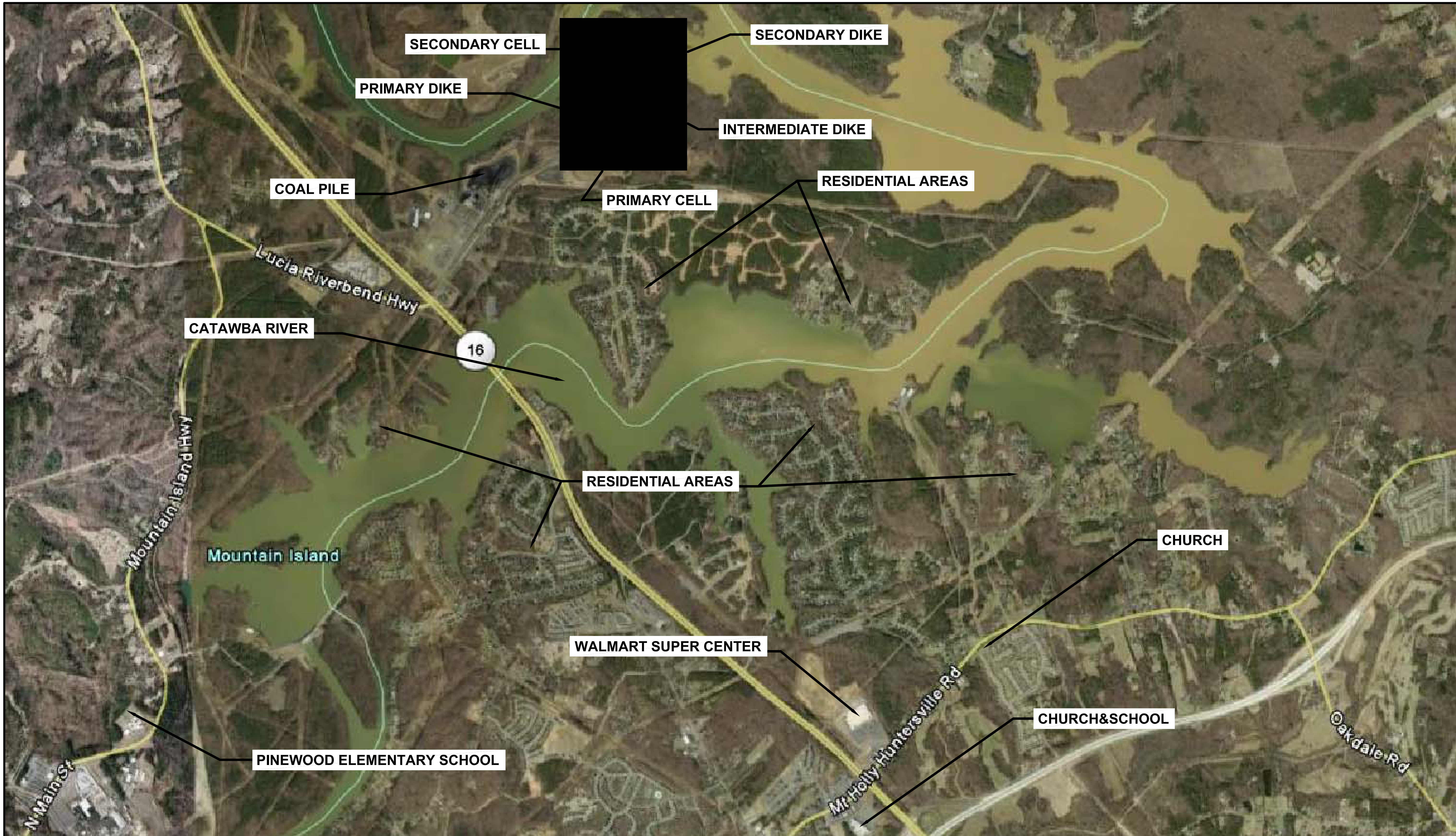

IMAGE REFERENCE: GOOGLE EARTH

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Drawing Copyright © 2007 CHA

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CRITICAL INFRASTRUCTURE MAP

RIVERBEND STEAM PLANT
DUKE ENERGY
MT. HOLLY, NORTH CAROLINA

PROJECT NO. 20085

DATE: JULY 2009

FIGURE 6

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2.0 FIELD ASSESSMENT

2.1 Visual Observations

CHA performed visual observations of the primary, secondary, and intermediate dikes following the general procedures and considerations contained in FEMA's *Federal Guidelines for Dam Safety* (April 2004), and FERC Part 12 Subpart D to make observations concerning settlement, movement, erosion, seepage, leakage, cracking, and deterioration. A Coal Combustion Dam Inspection Checklist Form, prepared by the US Environmental Protection Agency, was completed on-site during the site visit. A copy of the completed form was submitted via email to a Lockheed Martin representative approximately three days following the site visit to the Riverbend Steam Station. A copy of this completed form is included at the end of Section 2.5. A photo log and a Site Photo Location Map (Figure 7) are also located at the end of Sections 2.5.

CHA's visual observations were made on June 4, 2009 and June 5, 2009. The weather was sunny with temperatures between 50 and 90 degrees Fahrenheit. Prior to the days we made our visual observations the following approximate rainfall amounts occurred (as reported by www.weather.com).

Table 1 - Approximate Precipitation Prior to Site Visit

Date of Site Visit – June 4, 2009 & June 5, 2009		
Day	**Date**	**Precipitation (inches)**
Thursday	5/28/09	0.49
Friday	5/29/09	0.00
Saturday	5/30/09	0.00
Sunday	5/31/09	0.00
Monday	6/1/09	0.00
Tuesday	6/2/09	0.00
Wednesday	6/3/09	0.00
Thursday	6/4/09	1.62
Friday	6/5/09	0.93
Total	**Week Prior to Site Visit**	**3.04**
Total	**Month of May**	**7.24**

2.2 Visual Observation – Primary Dike

CHA performed visual observations of the primary dike, redacted

2.2.1 Primary Dike Embankments and Crest

In general, the alignment of primary dike crest does not show signs of change in the horizontal alignment as compared with design drawings. The up and downstream slopes were reasonably uniformly graded and covered with appropriate grass vegetation, which had been recently mowed at the time of our site visit. Photos 6, 9, and 10 through 15 show the general condition of the downstream embankment. There are, however, several areas where the grass growth is rather sparse typical to that shown in Photo 7. A damp area was noted at the right downstream swale which had soft soil to a depth of about 4 inches. This area appeared to be related to recent rains and Duke Energy personnel indicated this area, while often damp dries out in the summer. Sediment was evident in the toe drainage swale as the swale leveled near the lowest part of the embankment. This sediment appears related to surface runoff, not seepage.

Photo 16 shows an area downstream of the toe at the north end of the primary dike where soil is exposed. Duke Energy personnel indicated this area had remained unchanged in many years, and CHA observed signs in this exposed soil that it was natural ground and not part of the embankment. The upstream embankment is shown in Photos 17 through 19.

2.2.2 Primary Outlet Control Structure and Discharge Channel

The outlet control structure for the primary ash pond is located near the north end of the primary dike. The outlet control structure is a stop log controlled drop inlet, which discharged to the north below the intermediate dike into the secondary ash pond. Photo 20 shows the outlet tower. Photos 23 and 24 show the discharge channel into the secondary ash pond. Original construction drawings show that the discharge pipe below the intermediate dike is a 36-inch

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reinforced concrete pipe that was installed as part of upgrades in 1979. The downstream end of the pipe is submerged in the secondary ash pond and could not be observed.

2.3 Visual Observations – Secondary Dike

CHA performed visual observations of secondary dike. redacted

2.3.1 Secondary Dike Embankments and Crest

In general, the alignment of secondary dike crest does not show signs of change in the horizontal alignment as compared with design drawings. Photos 39 through 41 and 43 show the dam crest and general alignment. The upstream slope of the secondary dike was covered with rip rap in 2008 as general maintenance. Duke Energy personnel indicated that vegetation was sparse and the prevailing winds were resulting in beaching erosion at the water line. They also indicated that no major re-grading was performed when this rip rap was placed.

The downstream slope was reasonably uniform and predominantly covered with appropriate grass vegetation although areas of sparse grass were noted in isolated areas, some of which appeared related to mower wheels sliding on the slope. Photos 45 through 52 and 57 through 59 show the condition of the downstream slope. Near the tree line at the northwest edge of the high embankment, roots were noted on the ground surface. It appeared these roots were growing from trees located immediately beyond the toe.

Seepage, as shown in Photos 54 and 55, was observed from the toe drain between about redacted redacted northwest of a rip rapped swale extending beyond the toe of the dam (see photo 56). Flowing water was observed in these seepage areas, and the type of vegetation at the toe was indicative of perennially wet conditions. The observed flow was clear.

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The rip rapped swale extending from the toe as shown in Photo 56 was a drainage improvement made in 2008 by Duke Energy. This area was reportedly very wet, so the rip rap was added to collect water and divert it away from the toe of the secondary dike. There are several apparent factors contributing to this wet area. The first is possible seepage as discussed in the paragraph above. Another is a poorly diverted surface runoff swale from the lowest bench on the secondary dike, which is diverted into the woods beyond the toe to the right of this drainage feature via a culvert and drainage swale. It appears that at least some of the runoff from the bench drainage swale is being directed toward this newly rip rapped area. The third is a groundwater sampling well installed by Duke Energy for water quality sampling that is located near the end of this new drainage feature, which is under apparent artesian conditions indicating that there may be an increase in the groundwater elevation in this area.

Two groundwater sampling wells are under apparent artesian conditions. These wells are identified as MW-1S and MW-6D and are approximately shown on Figure 8**.**

2.3.2 Secondary Dike Outlet Control Structure

The outlet control structure for the secondary ash pond is a stop log controlled drop inlet which conveys outflows below the secondary dike through a 30-inch corrugated metal pipe (CMP). Photos 60 through 62 show the outlet control structure. At the request of Duke Energy, an annual inspection was performed in October 2008 of the earth embankments, and in December 2008 a video survey of the CMP was performed. According to S&ME's inspection report, "Overall, the structural integrity of the pipe appears sound. The pipe appears to be round with no bulges. There are numerous "chunks" of hardened fly ash throughout the pipe, laying in the invert, or even, adhered to it just above the invert on one side or the other. There is one infiltration runner up near the upstream end of the pipe at redacted . No other groundwater infiltration was observed."

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2.3.3 Secondary Dike Discharge Channel

The secondary dike outlet discharges into a concrete lined channel which discharges into the Catawba River. Photos 63 and 64 show the outlet discharge channel.

2.4 Visual Observation – Intermediate Dike

CHA performed visual observations of the intermediate dike. The intermediate dike is about redacted .

2.4.1 Intermediate Dike Embankments and Crest

In general, the alignment of intermediate dike crest does not show signs of change in the horizontal alignment as compared with design drawings. The up and downstream slopes of the intermediate dike were covered with appropriate grass vegetation.

Along the upstream slope, an inboard ash diverter dike was constructed during previous dredging operations and left in place to create a dewatering channel for future dredging operations. Photos 25 through 27 show this dewatering channel. A breach in this diverter dike, as shown in Photo 31, is filled in during dredging operations, and then rebreached to allow normal operating flows to reach the outlet control structure for the primary ash pond. Slight beach erosion was noted at the water line of the upstream slope.

The downstream slope, as shown in Photos 30 and 33 through 36 was reasonably uniform. Construction drawings show a bench on the downstream slope that was not visible during our site visit. There was ponded water at the toe of the east end of the intermediate dike as shown in Photo 32. Duke Energy personnel indicated this is trapped rainwater, and occasionally, the secondary pond water level rises to connect this area with the rest of the pond. The slope at the water's edge was soft to a depth of redacted , and showed signs of beach erosion. Trees up

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to about 12 inches in diameter are growing on ash deposited in the secondary pond over the toe of the intermediate dike as shown in Photo 36.

Design drawings of the intermediate dike indicate a redacted wide bench was to be constructed on the downstream slope. This bench was not observed in the field although it is possible it was submerged under the secondary pond water level at the time of our visit. Additional features on the downstream slope are four peninsulas that extend redacted feet into the secondary pond. These are located at approximately even spacing, and are not shown on the plans provided to CHA, although they are referred to in previous inspection reports as landmarks. Photos 34 and 35 show two of these peninsulas.

2.5 Monitoring Instrumentation

There are piezometers installed on both the primary and secondary dikes. Figure 8 shows the approximate piezometer locations and Figures 9A and 9B shows the plotted elevations of these piezometers.

A more complete discussion of the data collected from this instrumentation is contained in Section 3.4.

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Coal Combustion Dam Inspection Checklist Form

US Environmental Protection Agency

Site Name: Riverbend Steam Plant	Date: June 4, 2009
Unit Name: Primary Ash Disposal Pond	Operator's Name: Duke Energy
Unit I.D.:	Hazard Potential Classification: High Significant Low
Inspector's Name: Katherine Adnams/Malcolm D. Hargraves	

Check the appropriate box below. Provide comments when appropriate. If not applicable or not available, record "N/A". Any unusual conditions or construction practices that should be noted in the comments section. For large diked embankments, separate checklists may be used for different embankment areas. If separate forms are used, identify approximate area that the form applies to in comments.

	Yes	No		Yes	No
1. Frequency of Company's Dam Inspections?	monthly		18. Sloughing or bulging on slopes?		x
2. Pool elevation (operator records)?			19. Major erosion or slope deterioration?		x
3. Decant inlet elevation (operator records)?			20. Decant Pipes:		
4. Open channel spillway elevation (operator records)?			Is water entering inlet, but not exiting outlet?		x
5. Lowest dam crest elevation (operator records)?			Is water exiting outlet, but not entering inlet?		x
6. If instrumentation is present, are readings recorded (operator records)?	x		Is water exiting outlet flowing clear?		x
7. Is the embankment currently under construction?		x	21. Seepage (specify location, if seepage carries fines, and approximate seepage rate below):		
8. Foundation preparation (remove vegetation,stumps, topsoil in area where embankment fill will be placed)?	n/a		From underdrain?	x	
9. Trees growing on embankment? (If so, indicate largest diameter below)		x	At isolated points on embankment slopes?		x
10. Cracks or scarps on crest?		x	At natural hillside in the embankment area?		x
11. Is there significant settlement along the crest?		x	Over widespread areas?		x
12. Are decant trashracks clear and in place?		x	From downstream foundation area?		x
13. Depressions or sinkholes in tailings surface or whirlpool in the pool area?		x	"Boils" beneath stream or ponded water?		x
14. Clogged spillways, groin or diversion ditches?		x	Around the outside of the decant pipe?	n/a	
15. Are spillway or ditch linings deteriorated?	not	seen	22. Surface movements in valley bottom or on hillside?		x
16. Are outlets of decant or underdrains blocked?		x	23. Water against downstream toe?		x
17. Cracks or scarps on slopes?		x	24. Were Photos taken during the dam inspection?	x	

Major adverse changes in these items could cause instability and should be reported for further evaluation. Adverse conditions noted in these items should normally be described (extent, location, volume, etc.) in the space below and on the back of this sheet.

Inspection Issue #	Comments
	The Hazard Potential Classification is established by the North Carolina Utilities Commission before the site visit.
1	Duke Energy makes monthly and annual inspections of the dam and periodic piezometer measurements.
12	No obvious trashrack. Floating deck functions as trashrack.
15	The spillway has stop logs and functions as a decanting device; the entrance and outlet is submerged.
18	Isolated thinning and loss of grass cover.
20	Spillway/decanting structure conveys partially decanted water to secondary basin to finish decanting.
21	Seepage noted at toe adjacent to toe drain was generally clear, not turbid; drain appears to be functioning.

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U. S. Environmental Protection Agency

Coal Combustion Waste (CCW) Impoundment Inspection

Impoundment NPDES Permit # NC0004961 INSPECTOR Adnams/Hargraves
Date June 4, 2009

Impoundment Name Primary Ash Disposal Pond
Impoundment Company Duke Energy Carolinas, LLC
EPA Region 4
State Agency (Field Office) Addresss NC Dept. of Environment and Natural Resources
2090 US Highway 70, Swannanoa, NC 28778
Name of Impoundment Primary Ash Disposal Pond
(Report each impoundment on a separate form under the same Impoundment NPDES Permit number)

New ________ Update x

	Yes	No
Is impoundment currently under construction?		x
Is water or ccw currently being pumped into the impoundment?	x	

IMPOUNDMENT FUNCTION: Fly Ash, Bottom Ash, Boiler Slag, Stormwater, Plant Runoff

Nearest Downstream Town : Name Mountain Island, North Carolina
Distance from the impoundment 6 miles
Impoundment
Location: Longitude 80 Degrees 57 Minutes 47.86 Seconds
Latitude 35 Degrees 21 Minutes 54.73 Seconds
State NC County Gaston

Does a state agency regulate this impoundment? YES x NO ______

If So Which State Agency? North Carolina Utilities Commission

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<u>**HAZARD POTENTIAL**</u> (In the event the impoundment should fail, the following would occur):

______ **LESS THAN LOW HAZARD POTENTIAL:** Failure or misoperation of the dam results in no probable loss of human life or economic or environmental losses.

______ **LOW HAZARD POTENTIAL:** Dams assigned the low hazard potential classification are those where failure or misoperation results in no probable loss of human life and low economic and/or environmental losses. Losses are principally limited to the owner's property.

x______ **SIGNIFICANT HAZARD POTENTIAL:** Dams assigned the significant hazard potential classification are those dams where failure or misoperation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or can impact other concerns. Significant hazard potential classification dams are often located in predominantly rural or agricultural areas but could be located in areas with population and significant infrastructure.

______ **HIGH HAZARD POTENTIAL:** Dams assigned the high hazard potential classification are those where failure or misoperation will probably cause loss of human life.

DESCRIBE REASONING FOR HAZARD RATING CHOSEN:

An uncontrolled release of CCW from this impoundment would impact the Catabwa River, which becomes Mountain Island Lake, a water supply reservoir for Charlotte, NC. Environmental damage to the river and aquatic life is probable if this were to occur.

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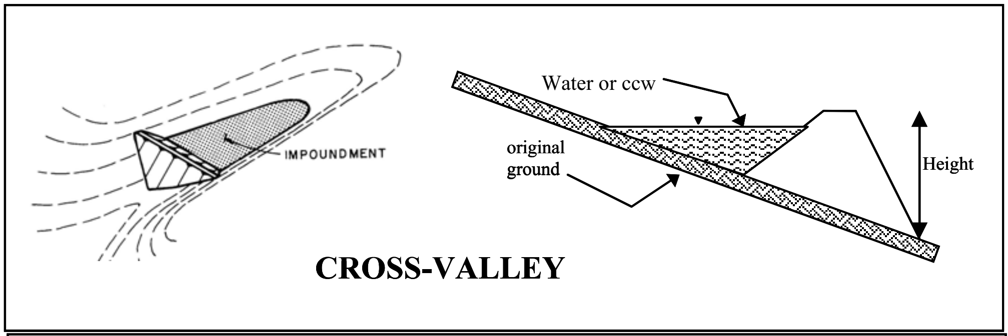
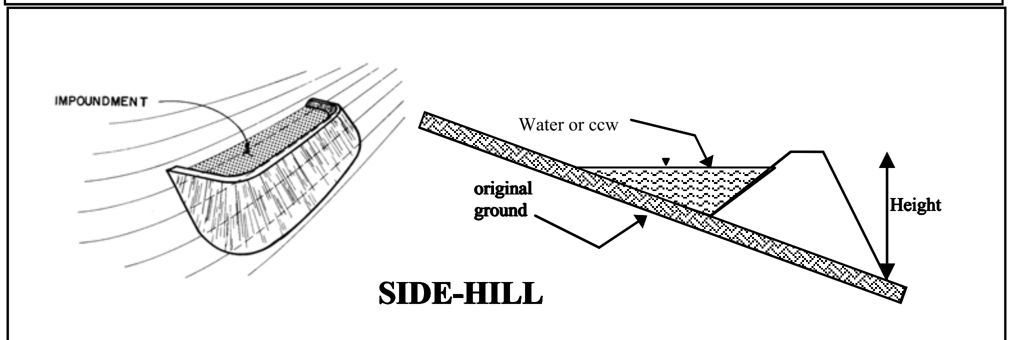
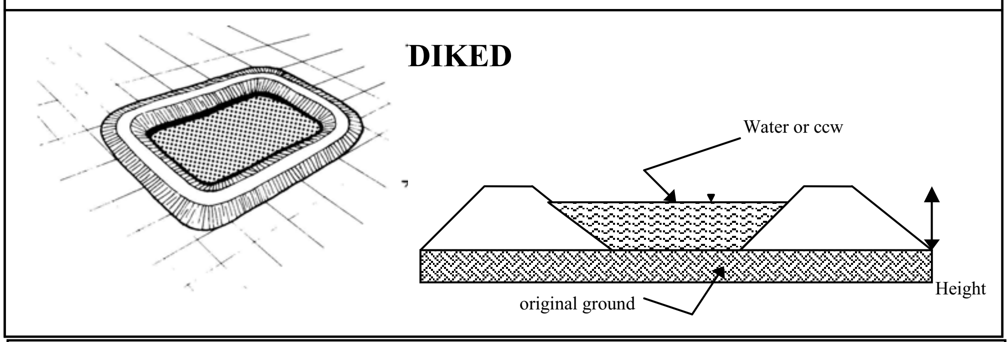
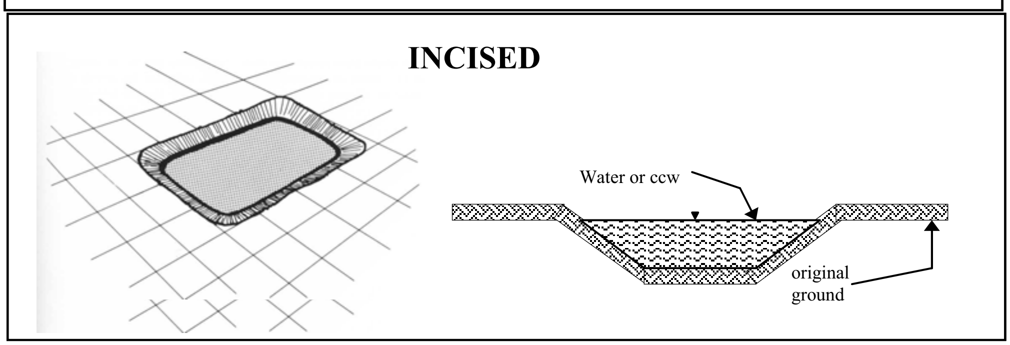
CONFIGURATION:









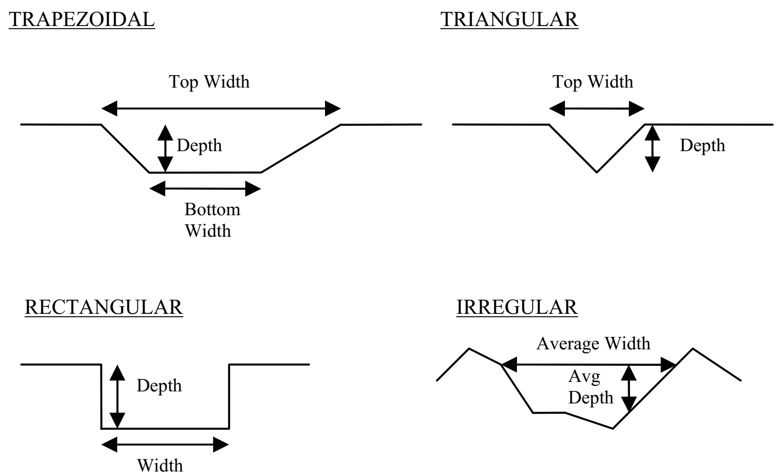
x_____ Cross-Valley
______ Side-Hill
______ Diked
______ Incised (form completion optional)
______ Combination Incised/Diked

Embankment Height redacted_____ feet   Embankment Material Native Borrow
Pool Area ____________________ acres   Liner none
Current Freeboard redacted___ feet   Liner Permeability n/a

TYPE OF OUTLET (Mark all that apply)

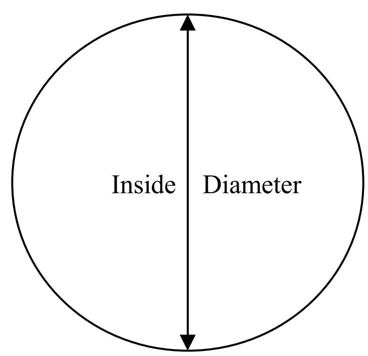
n/a **Open Channel Spillway**
______ Trapezoidal
______ Triangular
______ Rectangular
______ Irregular

______ depth
______ bottom (or average) width
______ top width



yes **Outlet**

36 inside diameter



Material
______ corrugated metal
______ welded steel
x concrete
______ plastic (hdpe, pvc, etc.)
______ other (specify) ______________________

Is water flowing through the outlet? YES x______ NO ________

n/a **No Outlet**

______ **Other Type of Outlet** (specify) ________________________________

The Impoundment was Designed By Duke Power Company Company

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Has there ever been a failure at this site? YES __________ NO x__________

If So When? ____________________________

If So Please Describe :

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Has there ever been significant seepages at this site? YES _______ NO x_______

If So When? ____________________________

IF So Please Describe:

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Has there ever been any measures undertaken to monitor/lower
Phreatic water table levels based on past seepages or breaches
at this site? YES ________ NO x________

If so, which method (e.g., piezometers, gw pumping,...)? see below

If so Please Describe :

There have been monitoring wells/piezometers installed at different times as a part of a monitoring and maintenance program. Water level measurements have been and continue to be recorded periodically at these locations.

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Site Name: Riverbend Steam Plant	Date: June 4, 2009
Unit Name: Primary Ash Disposal Pond	Operator's Name: Duke Energy
Unit I.D.:	Hazard Potential Classification: High Significant Low
Inspector's Name: Katherine Adnams/Malcolm D. Hargraves	

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3. Decant inlet elevation (operator records)?			20. Decant Pipes:		
4. Open channel spillway elevation (operator records)?			Is water entering inlet, but not exiting outlet?		x
5. Lowest dam crest elevation (operator records)?			Is water exiting outlet, but not entering inlet?		x
6. If instrumentation is present, are readings recorded (operator records)?	x		Is water exiting outlet flowing clear?		x
7. Is the embankment currently under construction?		x	21. Seepage (specify location, if seepage carries fines, and approximate seepage rate below):		
8. Foundation preparation (remove vegetation,stumps, topsoil in area where embankment fill will be placed)?	n/a		From underdrain?	x	
9. Trees growing on embankment? (If so, indicate largest diameter below)		x	At isolated points on embankment slopes?		x
10. Cracks or scarps on crest?		x	At natural hillside in the embankment area?		x
11. Is there significant settlement along the crest?		x	Over widespread areas?		x
12. Are decant trashracks clear and in place?		x	From downstream foundation area?		x
13. Depressions or sinkholes in tailings surface or whirlpool in the pool area?		x	"Boils" beneath stream or ponded water?		x
14. Clogged spillways, groin or diversion ditches?		x	Around the outside of the decant pipe?	n/a	
15. Are spillway or ditch linings deteriorated?	not	seen	22. Surface movements in valley bottom or on hillside?		x
16. Are outlets of decant or underdrains blocked?		x	23. Water against downstream toe?		x
17. Cracks or scarps on slopes?		x	24. Were Photos taken during the dam inspection?	x	

Major adverse changes in these items could cause instability and should be reported for further evaluation. Adverse conditions noted in these items should normally be described (extent, location, volume, etc.) in the space below and on the back of this sheet.

Inspection Issue #	Comments
	The Hazard Potential Classification is established by the North Carolina Utilities Commission before the site visit.
1	Duke Energy makes monthly and annual inspections of the dam and periodic piezometer measurements.
12	No obvious trashrack. Floating deck functions as trashrack.
15	The spillway has stop logs and functions as a decanting device; the entrance and outlet is submerged.
18	Isolated thinning and loss of grass cover.
20	Spillway/decanting structure conveys partially decanted water to secondary basin to finish decanting.
21	Seepage noted at toe adjacent to toe drain was generally clear, not turbid; drain appears to be functioning.

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U. S. Environmental Protection Agency

Coal Combustion Waste (CCW)
Impoundment Inspection

Impoundment NPDES Permit # NC0004961 INSPECTOR Adnams/Hargraves
Date June 4, 2009

Impoundment Name Primary Ash Disposal Pond
Impoundment Company Duke Energy Carolinas, LLC
EPA Region 4
State Agency (Field Office) Addresss NC Dept. of Environment and Natural Resources
2090 US Highway 70, Swannanoa, NC 28778
Name of Impoundment Primary Ash Disposal Pond
(Report each impoundment on a separate form under the same Impoundment NPDES Permit number)

New ________ Update x

	Yes	No
Is impoundment currently under construction?		x
Is water or ccw currently being pumped into the impoundment?	x	

IMPOUNDMENT FUNCTION: Fly Ash, Bottom Ash, Boiler Slag, Stormwater, Plant Runoff

Nearest Downstream Town : Name Mountain Island, North Carolina
Distance from the impoundment 6 miles
Impoundment
Location: Longitude 80 Degrees 57 Minutes 47.86 Seconds
Latitude 35 Degrees 21 Minutes 54.73 Seconds
State NC County Gaston

Does a state agency regulate this impoundment? YES x NO ______

If So Which State Agency? North Carolina Utilities Commission

HAZARD POTENTIAL (In the event the impoundment should fail, the following would occur):

______ **LESS THAN LOW HAZARD POTENTIAL:** Failure or misoperation of the dam results in no probable loss of human life or economic or environmental losses.

______ **LOW HAZARD POTENTIAL:** Dams assigned the low hazard potential classification are those where failure or misoperation results in no probable loss of human life and low economic and/or environmental losses. Losses are principally limited to the owner's property.

x______ **SIGNIFICANT HAZARD POTENTIAL:** Dams assigned the significant hazard potential classification are those dams where failure or misoperation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or can impact other concerns. Significant hazard potential classification dams are often located in predominantly rural or agricultural areas but could be located in areas with population and significant infrastructure.

______ **HIGH HAZARD POTENTIAL:** Dams assigned the high hazard potential classification are those where failure or misoperation will probably cause loss of human life.

DESCRIBE REASONING FOR HAZARD RATING CHOSEN:

An uncontrolled release of CCW from this impoundment would impact the Catabwa River, which becomes Mountain Island Lake, a water supply reservoir for Charlotte, NC. Environmental damage to the river and aquatic life is probable if this were to occur.

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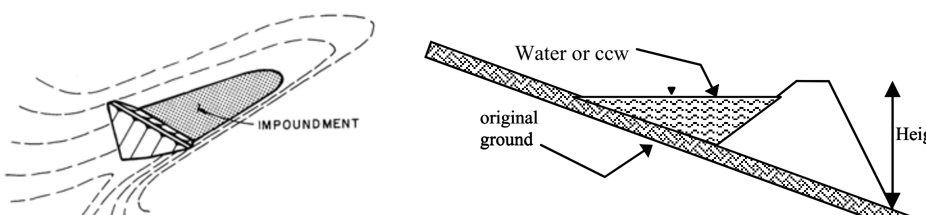
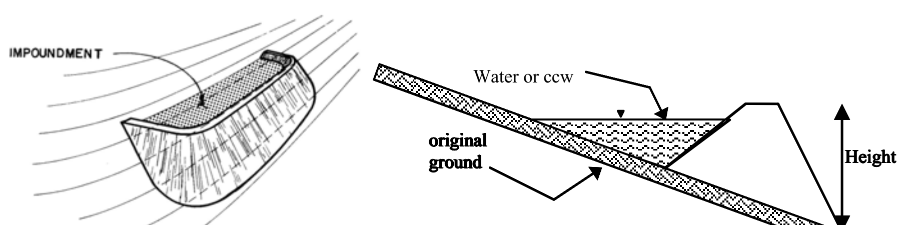
CONFIGURATION:

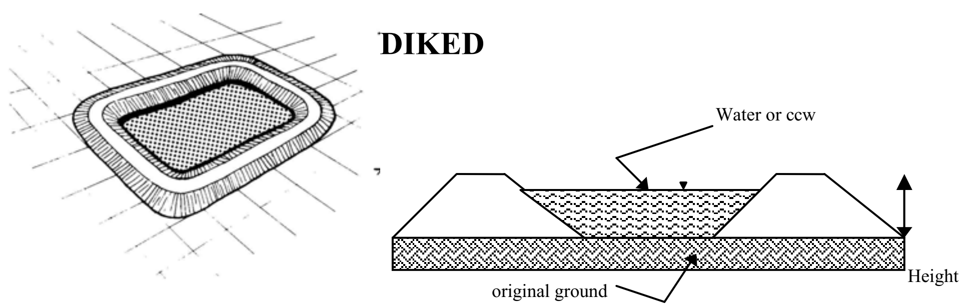


CROSS-VALLEY

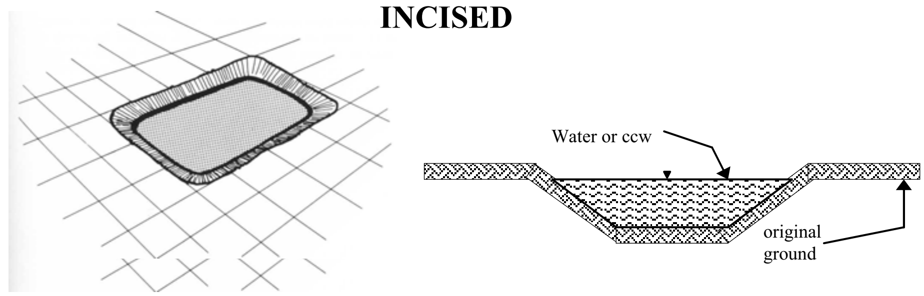


SIDE-HILL

DIKED



INCISED



x_____ Cross-Valley
______ Side-Hill
______ Diked
______ Incised (form completion optional)
______ Combination Incised/Diked

Embankment Height ___________ feet Embankment Material Native Borrow
Pool Area ____________________ acres Liner none
Current Freeboard ____________ feet Liner Permeability n/a

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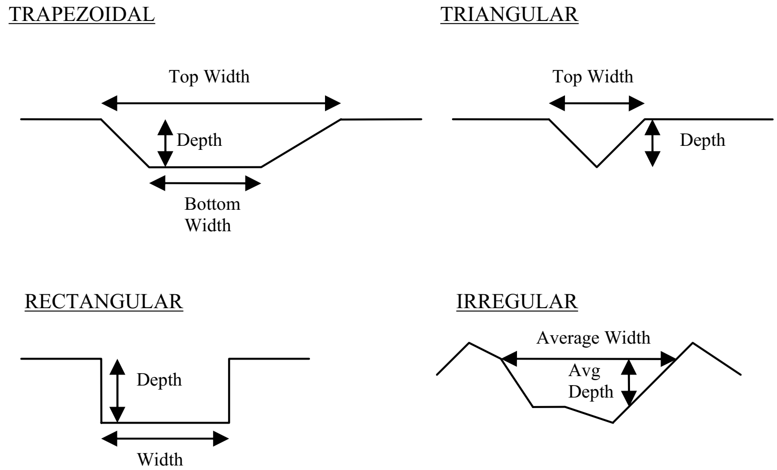
TYPE OF OUTLET (Mark all that apply)

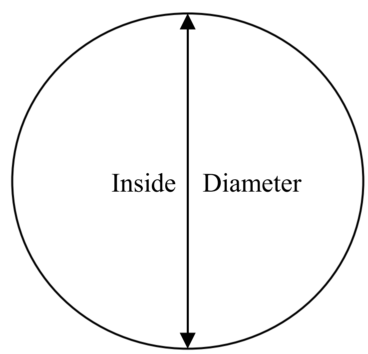
n/a **Open Channel Spillway**
______ Trapezoidal
______ Triangular
______ Rectangular
______ Irregular

______ depth
______ bottom (or average) width
______ top width



yes **Outlet**

36 inside diameter



Material
______ corrugated metal
______ welded steel
x concrete
______ plastic (hdpe, pvc, etc.)
______ other (specify) ______________________

Is water flowing through the outlet? YES x______ NO ______

n/a **No Outlet**

______ **Other Type of Outlet** (specify) ______________________________

The Impoundment was Designed By Duke Power Company Company

Has there ever been a failure at this site? YES __________ NO x__________

If So When? ___________________________

If So Please Describe :

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Has there ever been significant seepages at this site? YES _______ NO x_______

If So When? ___________________________

IF So Please Describe:

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Has there ever been any measures undertaken to monitor/lower Phreatic water table levels based on past seepages or breaches at this site? YES ________ NO x________

If so, which method (e.g., piezometers, gw pumping,...)? see below

If so Please Describe :

There have been monitoring wells/piezometers installed at different times as a part of a monitoring and maintenance program. Water level measurements have been and continue to be recorded periodically at these locations.

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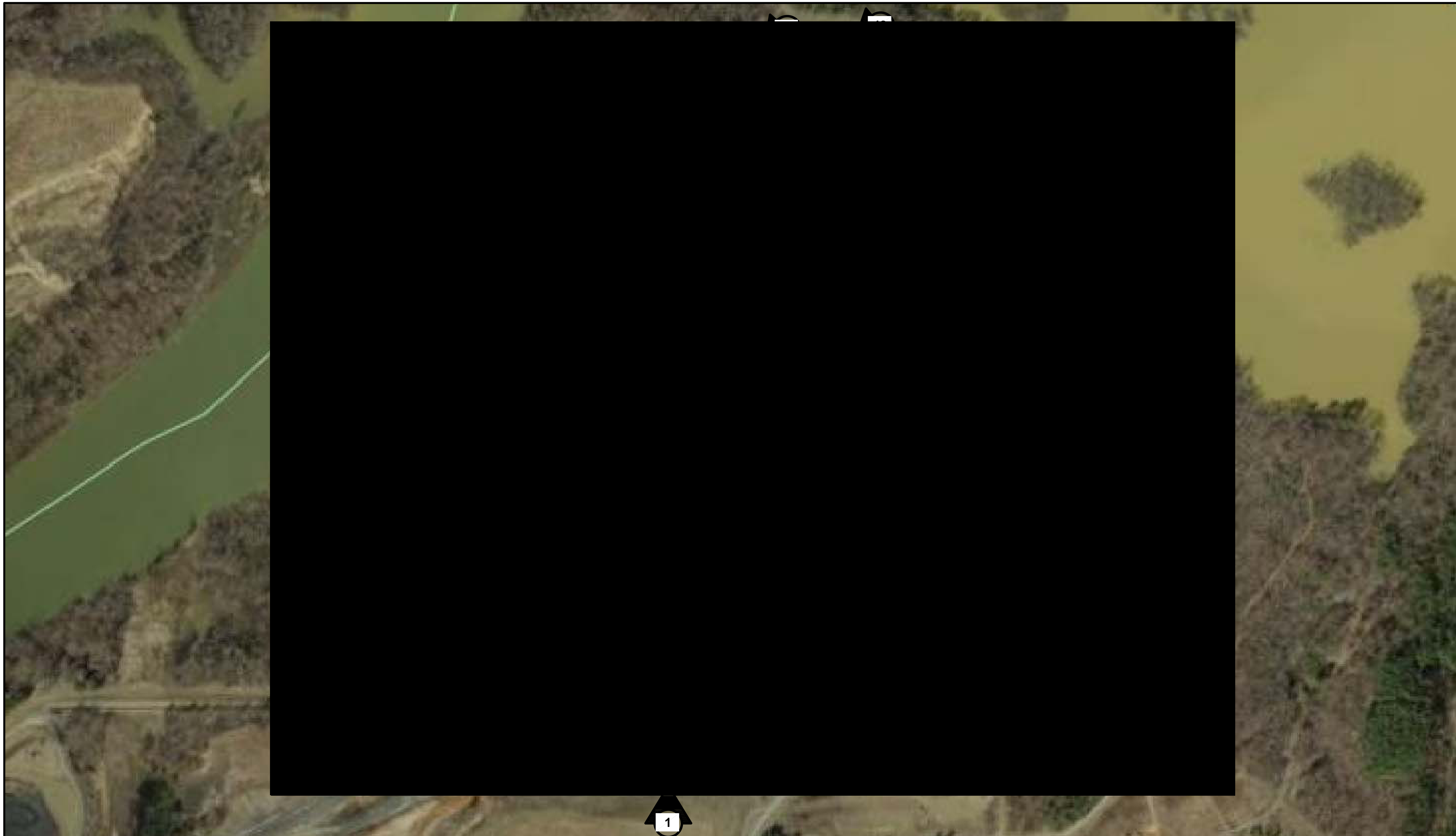

IMAGE REFERENCE: GOOGLE EARTH

N

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CHA

PHOTO LOCATION PLAN
RIVERBEND STEAM PLANT
DUKE ENERGY
MT. HOLLY, NORTH CAROLINA

PROJECT NO. 20085

DATE: JULY 2009

FIGURE 7

File: K:\20085\CADD\ACAD\FIGURES\GEO\2000 RIVERBEND\2000 RB PLANS-MAPS.DWG Saved: 7/6/2009 7:11:26 PM Plotted: 7/7/2009 11:22:47 AM User: Filkins, Rebecca

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1 redacted

Primary ash pond, looking north from the dredged ash fill.

2

Ash and yard sump sluice area at the southwest corner of the primary ash pond.

CHA	**DUKE ENERGY** **RIVERBEND STEAM PLANT** **PRIMARY ASH DISPOSAL POND** **MOUNT HOLLY, NC**
CHA Project No.: 20085.2000.1510	June 4, 2009

redacted

3

Primary dike crest alignment, looking south.

redacted

4

Primary dike right (north) abutment, looking north.

DUKE ENERGY
RIVERBEND STEAM PLANT
PRIMARY ASH DISPOSAL POND
MOUNT HOLLY, NC

CHA Project No.: 20085.2000.1510

June 4, 2009

US EPA ARCHIVE DOCUMENT

redacted

5

Primary dike left (south) abutment, looking south.

redacted

6

Dike downstream slope left (south) of sluice pipes.

DUKE ENERGY
RIVERBEND STEAM PLANT
PRIMARY ASH DISPOSAL POND
MOUNT HOLLY, NC

CHA Project No.: 20085.2000.1510	June 4, 2009

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7

Close-up of slope at left (south) abutment with sparse vegetation.

redacted

8

Sluice Pipes traversing downstream slope of the primary dike.

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redacted

9

Primary dike downstream slope at left (south) groin drainage swale/upper bench drainage swale intersection.

redacted

10

Primary dike downstream slope, drainage swale at toe. Access road runs across bottom bench.

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redacted

11

Primary dike downstream slope above lower bench, looking north.

redacted

12

Primary dike downstream slope lower bench and toe of dam, looking north.

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redacted

13

Primary dike downstream slope above lower bench, looking south.

redacted

14

Primary dike upper bench, looking south. Note sparse grass on upstream slope.

CHA	**DUKE ENERGY** **RIVERBEND STEAM PLANT** **PRIMARY ASH DISPOSAL POND** **MOUNT HOLLY, NC**
CHA Project No.: 20085.2000.1510	June 4, 2009

US EPA ARCHIVE DOCUMENT

redacted

15

Primary dike downstream slope north of benches, looking north.

redacted

16

Right end of primary dike downstream slope. Erosion area in right of photo appears to be in natural ground and is reportedly unchanged in many years.

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redacted

17

Primary dike upstream slope, looking south.

redacted

18

Primary dike upstream slope and crest, looking north.
Note: Van is at right abutment/intersection with intermediate dike.

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redacted

19

Right end (north) upstream slope of primary dike at intermediate dike.

20

Primary pond outlet tower at north corner of the pond.

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21

Open weir in primary cell outlet tower.

22

Concrete stop logs used to regulate water level in the primary pond.

redacted

23

Discharge of outlet pipe from primary cell into secondary pond. Outlet pipe is beneath the intermediate dike.

24

Outlet channel into secondary pond. Vegetated area on right side of channel is accumulated ash in secondary pond.

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redacted

25

Northeast corner of the primary pond.
Note: Ash diverter dike inboard of upstream slopes is used to dewater the pond during dredge operations.

redacted

26

Upstream slope intermediate dike, looking west. Inboard ash diverter dike is used for dewatering the pond during dredge operations.

DUKE ENERGY
RIVERBEND STEAM PLANT
INTERMEDIATE DIKE
MOUNT HOLLY, NC

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redacted

27

Upstream slope intermediate dike, looking west.

28

Slope intermediate dike beach erosion.

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29

Upstream slope intermediate dike approaching outlet tower and primary dike for primary pond.

redacted

30

Downstream slope intermediate dike, looking west.

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redacted

31

Breach in ash diverter dike filled during dredging operations to isolate primary pond from water draining to outlet tower.

redacted

32

Intermediate dike downstream slope/right (east) abutment contact. Note water at the toe is partially from storm water runoff and partly a shallow portion of the secondary pond.

CHA	**DUKE ENERGY RIVERBEND STEAM PLANT INTERMEDIATE DIKE MOUNT HOLLY, NC**
CHA Project No.: 20085.2000.1510	June 4, 2009

US EPA ARCHIVE DOCUMENT

redacted

33

Downstream slope intermediate dike, looking East.

redacted

34

Downstream slope intermediate dike, looking west.

DUKE ENERGY
RIVERBEND STEAM PLANT
INTERMEDIATE DIKE
MOUNT HOLLY, NC

CHA Project No.: 20085.2000.1510

June 4, 2009

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redacted

35

Downstream slope of intermediate dike beach erosion, looking east.

36

Downstream slope of intermediate dike near west abutment. Tree growth in right of photo is on deposited ash in secondary pond.

CHA	**DUKE ENERGY** **RIVERBEND STEAM PLANT** **INTERMEDIATE DIKE** **MOUNT HOLLY, NC**
CHA Project No.: 20085.2000.1510	June 4, 2009

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redacted

37

Secondary pond from east abutment, looking west.

38

Catawba River from secondary dike.

CHA	**DUKE ENERGY** **RIVERBEND STEAM PLANT** **SECONDARY DIKE** **MOUNT HOLLY, NC**
CHA Project No.: 20085.2000.1510	June 4, 2009

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redacted

39

East abutment of secondary dike.

redacted

40

East end of upstream slope and crest of secondary dike, looking northwest.

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redacted

41

Upstream slope and intake tower at secondary dike, looking northwest.

redacted

42

Upstream slope of secondary dike taken from the intake tower, looking west.

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redacted

43

West end of secondary dike crest, looking northeast.

redacted

44

West end of secondary dike downstream slope, looking east.

CHA	**DUKE ENERGY** **RIVERBEND STEAM PLANT** **SECONDARY DIKE** **MOUNT HOLLY, NC**
CHA Project No.: 20085.2000.1510	June 4, 2009

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redacted

45

West end of secondary dike downstream slope, looking east. Note sparse grass cover.

redacted

46

Root growth from trees beyond toe. West end of secondary dike.

CHA	**DUKE ENERGY** **RIVERBEND STEAM PLANT** **SECONDARY DIKE** **MOUNT HOLLY, NC**
CHA Project No.: 20085.2000.1510	June 4, 2009

47

Close up of root growth.

redacted

48

Downstream slope of secondary dike at northern point, looking south.

CHA	**DUKE ENERGY** **RIVERBEND STEAM PLANT** **SECONDARY DIKE** **MOUNT HOLLY, NC**
CHA Project No.: 20085.2000.1510	June 4, 2009

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redacted

49

Downstream slope and toe drain of secondary dike, looking east.

redacted

50

Downstream slope of secondary dike, looking west.

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redacted

51

Downstream slope of secondary dike at mid-slope bench, looking east.

redacted

52

Downstream slope of secondary dike drainage swale on bench ties into drainage swale at toe of dike, looking west.

DUKE ENERGY
RIVERBEND STEAM PLANT
SECONDARY DIKE
MOUNT HOLLY, NC

CHA Project No.: 20085.2000.1510

June 4, 2009

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redacted

53

Toe drain of secondary dike. Duke Power controls vegetation growth in the rip rap with herbicides.

54

Reeds growing in area of seepage at the toe.

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55

Seepage at the toe of the secondary dike about 300 feet from piezometer row. Water is clear.

56

Rip rap placed in a wet area at the toe of the secondary dike. Based on field observations it appears the wet area was the result of surface drainage from the bench swale discharge and shallow groundwater levels in this area.

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redacted

57

Bench and toe area of secondary dike, looking northwest.

redacted

58

Downstream slope and bench of secondary dike, looking west. Note steeper area of drainage swale to left of bench in photo is the location of a culvert draining to the downstream area of the dike.

CHA	**DUKE ENERGY RIVERBEND STEAM PLANT SECONDARY DIKE MOUNT HOLLY, NC**
CHA Project No.: 20085.2000.1510	June 4, 2009

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redacted

59

Downstream slope near east end of secondary dike, looking northwest.

60

Intake tower in secondary pond.

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61

Intake tower in secondary pond.

62

Intake tower in secondary pond.

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63

Outlet structure at toe of secondary dike, looking upstream.

64

Outlet channel of secondary dike, looking downstream.

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3.0 DATA EVALUATION

3.1 Design Assumptions

CHA has reviewed the design assumptions related to the design and analysis of the stability and hydraulic adequacy of the primary and secondary ash ponds and dikes, respectively, which were available at the time of our site visits and provided to us by Duke Energy. The design assumptions are listed with the applicable summary of analysis in the following sections.

3.2 Hydrologic and Hydraulic Design

The primary and secondary ash ponds at the Riverbend Steam Station were originally constructed as one basin. In the 1970's the primary dike was raised and the intermediate dike was constructed to provide additional decanting ability prior to discharging effluent to the Catawba River. The drainage area appears to primarily flow into the primary pond.

These dikes have been classified as High Hazard by NCUC in accordance with North Carolina Dam Safety Regulations. As such, based on the height of the primary and secondary dikes and their hazard classification, these facilities are required to safely pass or store the inflows resulting from ¾ of the Probable Maximum Precipitation (PMP).

A 1989 report by Trigon Engineering Consultants indicated that the primary pond would not be attenuated the PMP inflow and it would overflow into the secondary pond. The secondary pond would safely store the inflow from the ¾ PMP. The calculations supporting this conclusion were not provided to CHA. CHA recommends Duke Energy revisit these calculations for a couple reasons as listed below.

- The dredge pond that was formerly located to the south of the primary pond is now filled with a capped dry ash stack from the most recent dredging operation. This change in the drainage area topography and ground cover may have an impact on the runoff (and therefore inflows) which could impact the conclusions of previous calculations.

- The storage capacity of the primary pond continually changes between dredging operations as sluiced ash fills the pond. The calculations should be evaluated for the minimum available storage capacity.

- The reported inflow from the drainage area was about redacted cfs, while CHA estimates that the outlet pipe discharging water from the primary pond to the secondary pond only has a capacity of between redacted cfs suggesting that significant storage capacity is needed in the primary pond to safely pass the ¾ PMP.

3.3 Structural Adequacy & Stability

The North Carolina Department of Environmental and Natural Resources, Land Quality Section, Dam Safety Program regulations require "a minimum factor of safety of 1.5 for slope stability for normal loading conditions, and 1.25 for quick drawdown conditions and for construction conditions, shall be required unless the design engineer provides a thoroughly documented basis for using other safety factors."

Table 2 - Minimum Safety Factors Required by NCDENR

Load Case	Required Minimum Factor of Safety
Steady State Conditions at Present Pool or Flood Elevation	1.5
Rapid Draw-Down Conditions from Present Pool Elevation	1.25

NCDENR also requires "Foundation bearing capacity and sliding base analyses should be considered for all dams and may be required for class B and C dams. Where bearing capacity or sliding base analyses are required, documentation of assumptions, computations, and safety factors shall be included in the final design report. A minimum factor of safety against bearing

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capacity and sliding wedge failure of 2.0 shall be required unless the design engineer provides a thoroughly documented basis for using other safety factors."

Additional industry guidelines such as those published in the US Army Corps of Engineers EM 1110-2-1902, Table 3-1 suggest the following guidance values for minimum factors of safety as shown in Table 3 below.

Table 3 - Additional Minimum Safety Factors Recommended by US Army Corps of Engineers

Load Case	Required Minimum Factor of Safety
Maximum Surcharge Pool (Flood) Condition	1.4
Seismic Conditions from Present Pool Elevation	1.0

In Sections 3.3.1, 3.3.2, and 3.3.3 we discuss our review of the effects of overtopping, stability analyses, and performance of the primary dike, secondary dike, and intermediate dike, respectively.

3.3.1 Liquefaction Analysis

In 2003, Duke Energy contracted an outside consultant to perform a liquefaction study on the alluvial soil deposits underlying the primary and secondary dikes. These analyses concluded that the soils at this site are not subject to liquefaction.

3.3.2 Primary Dike

CHA was provided with past independent consultant reports that summarized the results of various stability analyses performed throughout the past 50 years. Most recently, Duke Energy performed stability analyses of the primary dike in 1979 and again in 1984 using different soil strength parameters for each stability analysis as summarized below in Table 4.

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Table 4 - Soil Strength Properties as Determined by Duke Energy

Soil Stratum	Unit Weight (pcf)	Friction Angle (φ)	Cohesion (psf)	Description
Original Embankment Fill ▪ 1979 Analysis ▪ 1984 Analysis	 NR 120	redacted	 800 0	1957 Embankment Materials
Additional Embankment Fill ▪ 1979 Analysis ▪ 1984 Analysis	 NR 105	redacted	 200 0	1979 Embankment Raising
Foundation Soils ▪ 1979 Analysis ▪ 1984 Analysis	 NR 115	redacted	 NR 200	Natural Subgrade

NR – Not Recorded in documentation provided to CHA

The 1979 shear strength and unit weight values used for Duke Energy's slope stability analyses were reportedly based on triaxial shear test results on remolded borrow soils and undisturbed samples obtained from borings through the original embankment. A theoretical phreatic surface was assumed for a homogeneous fill on impermeable foundation. The 1984 analysis used a phreatic surface developed from actual piezometer readings on instruments installed as part of the 1979 dam raising.

The resulting computed factors of safety from Duke Energy's analyses are reported in Table 5 below.

Table 5 - Summary of Safety Factors from Duke Energy Analyses – Primary Dike

Load Case	Required Minimum Factor of Safety	Calculated Minimum Factor of Safety
Steady State Conditions at Present Pool or Flood Elevation (Downstream Slope) ▪ 1979 Analysis ▪ 1984 Analysis	1.5	 1.5 (deep failure) 1.5 (deep), 1.4 (shallow)

CHA recreated the cross sections used in the Duke Energy Analyses using the computer program Slide™ and the 1984 soil properties to flood and seismic loading conditions. The outputs from

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our recreated analyses are labeled as Figures 10A through 10C. The seismic analyses were performed using a pseudo static analysis with a horizontal seismic coefficient of 0.108g This coefficient was determined from the 2008 USGS National Seismic Hazard Maps for the Peak Acceleration (%g) with 2% Probability of Exceedance in 50 Years. CHA did not perform a rapid drawdown analysis because the clayey soils that comprise the primary dike require rigorous analyses to understand the changing stress within the soil mass resulting from slow drainage and adequate laboratory shear strength data. While some shear strength data was performed in 1979 for the raising of the primary dike, strength tests under current conditions would be justified. The results of CHA's analyses are summarized below in Table 6.

Table 6 - Summary of Safety Factors from CHA Analyses – Primary Dike

Load Case	Required Minimum Factor of Safety	Calculated Minimum Factor of Safety
Steady State Conditions at Present Pool – Figure 10A	1.5	1.8
Rapid Draw-Down Conditions from Present Pool Elevation	1.25	NP
Maximum Surcharge Pool (Flood) Condition – Figure 10B	1.4	1.7
Seismic Conditions from Present Pool Elevation – Figure 10C	1.0	1.2

NP = Not performed

As part of our review of these stability analyses, CHA reviewed the piezometer data provided by Duke Energy and found that current piezometric levels are slightly lower than those used in the analyses. It is unclear why CHA's analyses resulted in a steady state condition factor of safety of 1.8 compared to Duke Energy's 1984 analysis, which suggested a factor of safety of 1.5.

3.3.3 Secondary Dike

Duke Energy did not provide stability analyses for the secondary dike. CHA created stability analyses for this dike using similar soil properties as were used in the 1984 analyses for the primary dike. The outputs from our analyses are labeled as Figures 11A through 11C. The phreatic surface was developed based on a review of piezometer data from this dike provided by Duke Energy. CHA did not perform a rapid drawdown analysis because the clayey soils that comprise the secondary dike require rigorous analyses to understand the changing stress within the soil mass resulting from slow drainage and laboratory shear strength data for the secondary dike was not provided by Duke Energy. The results of these analyses are summarized in Table 7 below.

Table 7 - Summary of Safety Factors from CHA Analyses – Secondary Dike

Load Case	Required Minimum Factor of Safety	Calculated Minimum Factor of Safety
Steady State Conditions at Present Pool or Flood Elevation (Downstream Slope) - Figure 11A	1.5	1.4
Rapid Draw-Down Conditions from Present Pool Elevation	1.25	NP
Maximum Surcharge Pool (Flood) Condition - Figure 11B	1.4	1.4
Seismic Conditions from Present Pool Elevation – Figure 11C	1.0	1.0

NP = Not performed

3.4 Operations & Maintenance

Riverbend Steam Station staff make monthly inspections and piezometer readings at the primary and secondary ash ponds. On an annual basis, Duke Energy has a visual inspection of the dike conditions performed by an outside consultant. And, in accordance with NCUC requirements, an

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independent third party inspection is made every 5 years. The next 5 year inspection is due in 2009. Normal maintenance operations include mowing the grass on the dikes twice a year.

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redacted

IMAGE REFERENCE: DUKE ENERGY, RIVERBEND STEAM STATION, 2008 DIKE INSPECTION, LAYOUT OF CELLS AND DIKES, FIGURE 2

N

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CHA

PIEZOMETER LOCATION PLAN

RIVERBEND STEAM PLANT
DUKE ENERGY
MT. HOLLY, NORTH CAROLINA

PROJECT NO. 20085

DATE: JULY 2009

FIGURE 8

US EPA ARCHIVE DOCUMENT

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File: K:\20085\CADD\ACAD\FIGURES\GEO\2000 RIVERBEND\2000 RB DATA.DWG Saved: 7/6/2009 2:31:57 PM PLotted: 7/7/2009 2:42:59 PM User: Filkins, Rebecca

redacted

NOTE: THE "DREDGE POND" NO LONGER EXISTS.

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PIEZOMETER READINGS RIVERBEND STEAM PLANT DUKE ENERGY MT. HOLLY, NORTH CAROLINA	PROJECT NO. 20085.2000	
	DATE: JULY 2009	
	FIGURE 9A	

redacted

NOTE: THE "DREDGE POND" NO LONGER EXISTS.

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PIEZOMETER READINGS
RIVERBEND POWER PLANT
DUKE ENERGY
MT. HOLLY, NORTH CAROLINA

PROJECT NO. 20085.2000	
DATE: JULY 2009	
FIGURE 9B	

File: K:\20085\CADD\ACAD\FIGURES\GEO\2000 RIVERBEND\2000 RB DATA.DWG Saved: 7/6/2009 2:31:57 PM PLotted: 7/7/2009 2:44:25 PM User: Filkins, Rebecca

US EPA ARCHIVE DOCUMENT

redacted

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CROSS SECTION OF PRIMARY DIKE
STABILITY ANALYSIS
RIVERBEND STEAM PLANT
DUKE ENERGY
MT. HOLLY, NORTH CAROLINA

PROJECT NO.
20085.2000

DATE: JULY 2009

FIGURE 10A

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CROSS SECTION OF PRIMARY DIKE STABILITY ANALYSIS
RIVERBEND STEAM PLANT
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PROJECT NO. 20085.2000

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FIGURE 10B

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FIGURE 10C	

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FIGURE 11A

File: K:\20085\CADD\ACAD\FIGURES\GEO\2000 RIVERBEND\2000 RB XSECTIONS.DWG Saved: 7/7/2009 2:37:42 PM Plotted: 7/7/2009 3:15:04 PM User: Filkins, Rebecca

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FIGURE 11B

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FIGURE 11C

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4.0 CONCLUSIONS/RECOMMENDATIONS

4.1 Acknowledgement of Management Unit Condition

I acknowledge that the management unit reference herein was personally inspected by me and was found to be in the following condition: **Satisfactory.**

CHA's assessment of the primary, secondary and intermediate dikes indicate that they are in satisfactory condition. Duke Energy provided CHA with descriptions of a proactive maintenance and monitoring program at these facilities. These efforts should be continued.

CHA presents recommendations for maintenance and updating of analyses for more complete record keeping.

4.2 Maintaining Vegetation Growth

Appropriate grass vegetated the dikes. However, there were areas of sparse vegetation where reseeding maintenance should be performed. There are also some areas where the grass cover appeared to be removed by sliding mower wheels. Duke Energy should perform reseeding as required yearly to maintain a good grass cover on the dikes. If mower damage routinely occurs in the same areas each time grass is re-established, consideration should be given to using alternative methods (such as weed-whacking) of cutting the grass in these areas.

4.3 Drainage Swale Maintenance

Sediment was evident in rip rap drainage swales. The sediment observed appeared to be related to surface runoff and tended to be accumulated at the toe of the swales. Duke Energy should monitor the condition of these drainage swales and if the sediment appears to be clogging the rip rap and impeding surface runoff from being adequately conveyed away from the earthen embankments, the rip rap should be cleaned of sediment.

4.4 Tree and Root Removal

Tree roots were observed at the slope surface near the northwest end of the secondary dike. These tree roots appear to be from trees growing beyond the toe of the dam. CHA recommends that Duke Energy, under the direction of a professional engineer, remove trees from beyond the toe of the dam, and remove large root masses in the embankment toe.

Similarly, trees have established themselves in ash sediment adjacent to or over the toe of the intermediate dike at the west end. CHA recommends these trees be removed under the direction of a professional engineer.

4.5 Exposed Soil Beyond Primary Dike Toe

CHA recommends filling and re-vegetating an area of exposed soil beyond the toe of the north end of the primary dike. Although not directly related to the embankment stability, this area is undergoing erosion from storm water runoff. By re-grading and re-vegetating this area will minimize erosion and future changes if any will be more easily observed.

4.6 Outlet Pipe Inspections

During our site visit the outlet pipe from the primary pond to the secondary pond was submerged. This concrete pipe was constructed beneath the intermediate dike on top of sluiced ash. We recommend a condition survey be performed on this pipe to check for condition degradation, leaking joints, joint settlement, etc. that could impact the performance of the overlying intermediate dike.

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The secondary pond outlet pipe was inspected in 2008 via video survey. This pipe is a corrugated metal pipe that was installed in 1958. Corrugated metal pipes are subject to corrosion and, although commonly used in the era when this dam was constructed, current industry practice recommends against using this type of pipe. CHA recommends Duke Energy considers replacing or slip-lining this pipe with a less corrosive material, or at a minimum, performs periodic video inspection of the pipe to observe for changes that will indicate when the pipe has reached the end of its useful life.

4.7 Seepage Monitoring

As discussed in Section 2.3.1, flowing seepage was observed at the toe of the secondary dike. Duke Energy was aware of this seepage and makes observations of this area during their routine inspections. CHA recommends a collection trench or pipe and monitoring weir be installed in this area to facilitate quantifiable volume measurements and sample collection. Quantifiable measurements will allow Duke Energy and outside consultants to see changes if they occur which would need to be addressed, and allow for a sampling point so a sample can be observed for sediment transport on a routine basis, again to simplify observations of change in the condition.

4.8 Artesian Monitoring Wells

Two of twelve recently installed groundwater monitoring wells beyond the toes of the dikes show artesian conditions. This condition has been noted in MW-1S and MW-6D. CHA recommends that Duke Energy include these monitoring locations in monthly piezometer readings. Accurate measurements of head can be performed at these locations either by extending the well casings, or by fitting each well with a low pressure gage.

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4.9 Hydrologic and Hydraulic Evaluation Update

As discussed in Section 3.2, CHA recommends the hydrologic and hydraulic analysis be updated to confirm that the primary and secondary ponds can safely store or pass the design storm, which is the inflow from the ¾ PMP. Changes in topography to the south of the primary pond with the filling of the former dredge pond along with an apparent lack of routing analysis of inflows through the primary pond outlet pipe warrant this updated analysis. Consideration to available storage volume in the primary pond based on anticipated ash volumes should be included in this analysis.

4.9 Stability Analyses

CHA was not provided with stability analyses for the secondary dike. We recommend Duke Energy perform stability analyses for this embankment including steady state, flood surcharge, rapid drawdown, and seismic loading conditions. CHA performed preliminary analyses for each of these cases except for the rapid drawdown using similar parameters as used by Duke Energy for the primary dike. These soil properties need to be confirmed for the secondary dike. Stability analyses should also be performed for the intermediate dike.

A rapid drawdown analysis should be performed for the primary dike as well.

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5.0 CLOSING

The information presented in this report is based on visual field observations, review of reports by others and this limited knowledge of the history of the Riverbend Steam Station surface impoundments. The recommendations presented are based, in part, on project information available at the time of this report. No other warranty, expressed or implied is made. Should additional information or changes in field conditions occur the conclusions and recommendations provided in this report should be re-evaluated by an experienced engineer.

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