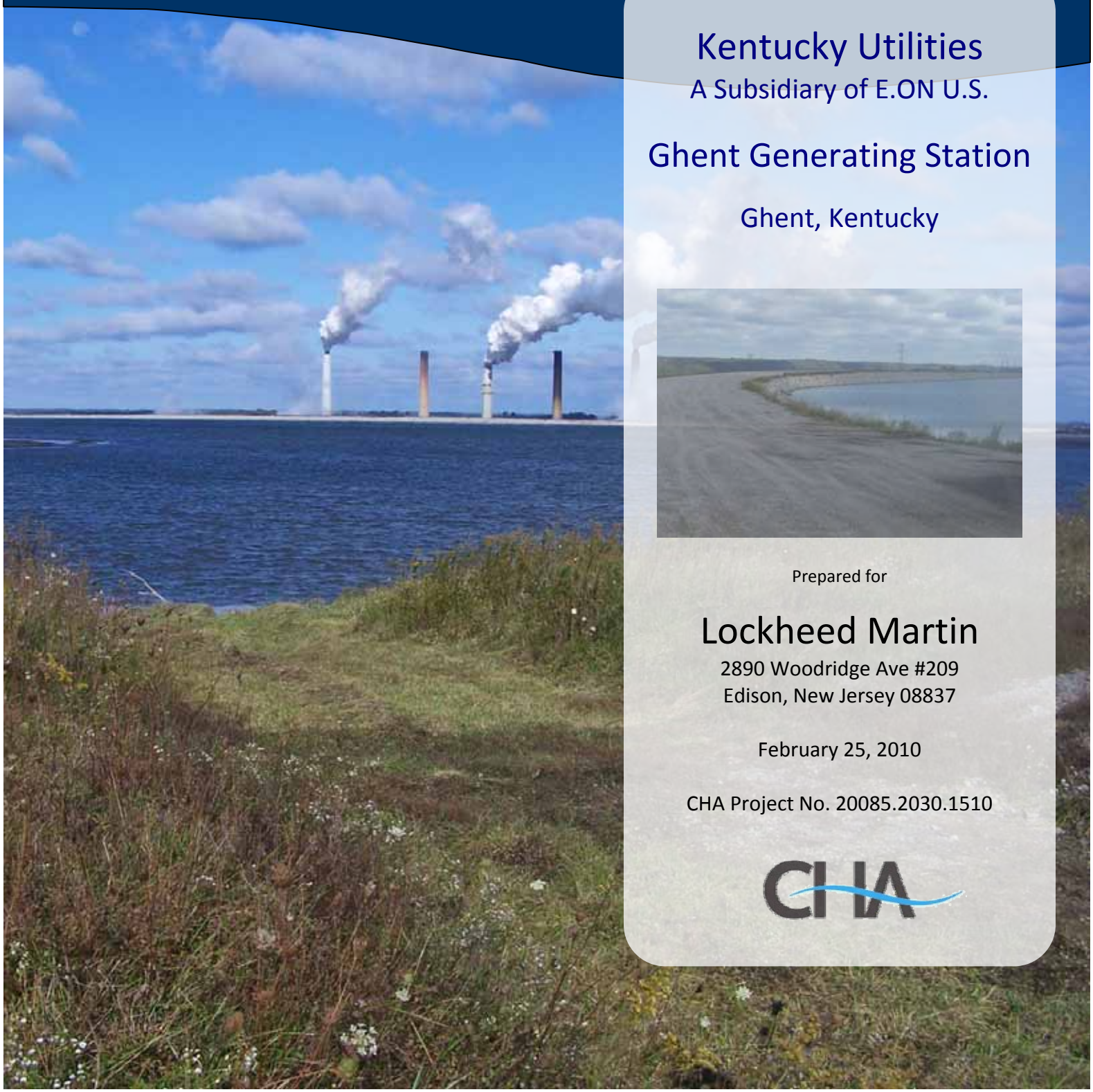
Assessment of Dam Safety
Coal Combustion Surface Impoundments (Task 3)
Final Report



Kentucky Utilities

A Subsidiary of E.ON U.S.

Ghent Generating Station

Ghent, Kentucky

Prepared for

Lockheed Martin

2890 Woodridge Ave #209
Edison, New Jersey 08837

February 25, 2010

CHA Project No. 20085.2030.1510

CHA

I acknowledge that the management units referenced herein:

- Ash Treatment Basin #1
- Ash Treatment Basin #2
- Gypsum Stacking Facility

Have been assessed on October 7, 2009 and October 8, 2009.

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

Signature: _____ 2-25-10
Anthony P. Stellato, P.E.
Senior Geotechnical Engineer
Registered in the State of Kentucky

STATE OF KENTUCKY
ANTHONY P. STELLATO, JR
21671
LICENSED
PROFESSIONAL ENGINEER

Reviewer: _____
Warren A. Harris, P.E.
Geotechnical Operations Manager
Reviewer

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APPENDIX

Appendix A - Completed EPA Coal Combustion Dam Inspection Checklists and Coal Combustion Waste (CCW) Impoundment Inspection Forms

1.0 INTRODUCTION & PROJECT DESCRIPTION

1.1 Introduction

CHA was contracted by Lockheed Martin (a contractor to the United States Environmental Protection Agency) 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 Kentucky Utilities' Ghent Generating Station, which is located in Ghent, Kentucky as shown on Figure 1 – Project Location Map. Kentucky Utilities, a subsidiary of E.ON U.S, is owner and operator of the Ghent Generating Station.

CHA made a site visit on October 7, 2009 and October 8, 2009 to inventory coal combustion surface impoundments at the Ghent facility, to perform visual observations of the containment dikes, and to collect relevant information regarding the site assessment.

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

Company or Organization Name	**Name**
KY DEP – Division of Waste Management	C.B. Dickerson, Environmental Inspector
KY DEP – Division of Water	Scott Phelps, P.E., Dam Safety Supervisor
E.ON U.S.	Michael Winkler, Manager, Environmental Programs
E.ON U.S.	David Millay, P.E., Civil Engineer
Kentucky Utilities	Stephen Nix
Kentucky Utilities	Paul Wright, Manager - Production
Kentucky Utilities	Larry Byrd, Manager - Maintenance
Kentucky Utilities	Timothy Smith, Manager - Commercial

1.2 Project Background

The Ash Treatment Basin (ATB) #1, ATB #2, and Gypsum Stacking Facility at the Ghent Generating Station are under the jurisdiction of the Kentucky Department of Environmental Protection (DEP) – Division of Water. These impoundments are classified by the Kentucky DEP as high hazard based on the potential for loss of life if the impoundments were to fail.

The EPA Coal Combustion Dam Inspection Checklist Forms provided in Appendix A note that CHA concurs with this hazard classification for the Ghent Generating Station facilities.

1.2.1 State Issued Permits

Commonwealth of Kentucky Permit No. KY0002038 has been issued to Kentucky Utilities authorizing discharge under the National Pollutant Discharge Elimination System (NPDES) to the Ohio River in accordance with effluent limitations, monitoring requirements and other conditions set forth in the permit. The permit became effective on July 1, 2002 and was set to expire on June 30, 2007. Kentucky Utilities indicated that they submitted an application for renewal in a timely fashion which is still under review by the Commonwealth. Therefore, the current permit remains in effect until such time as KY DEP makes a ruling on the renewal application.

The Commonwealth of Kentucky - Division of Water issued permits for the construction of ATB #2 and the Gypsum Stacking Facility as follows:

- ATB #2 - Permit #5132 dated February 23, 1993
- Gypsum Stacking Facility - Permit #5131 dated February 23, 1993

1.3 Site Description and Location

Figure 2 – Photo Site Plan shows the three management units constructed for the Ghent Generating Station. ATB #1 and the Gypsum Stacking Facility are located adjacent to one another immediately to the south of the Ghent Generating Station, and ATB #2 is located atop the hill to the south of ATB #1. Kentucky Route 42 separates the management units from the plant, and the Ohio River is north of the plant. Figure 3 shows an enlarged Photo Site Plan of ATB #2.

ATB #1 was commissioned in 1972. Figure 4 shows a typical cross section of the ATB #1 dike creating this impoundment. ATB #1 covers an area of about 120 acres with a maximum height of 52 feet. ATB #1 currently receives decanted water from ATB #2, plant process wastewater, and bottom ash, fly ash and boiler slag if material cannot be sluiced to ATB #2.

ATB #2 was commissioned in 1994 and was raised in 2003. Figure 5 shows a typical cross section of ATB #2. ATB #2 covers an area of about 146 acres and has a maximum height of 227 feet. ATB #2 is currently the primary disposal location for fly ash, bottom ash and pyrites from the Ghent Generating Station.

The Gypsum Stacking Facility was commissioned in 1994 with an earthen starter dike. Under continued raising, dewatered gypsum is used to raise the dike by an upstream berm construction technique into which flue gas emission control residuals are sluiced. Figure 6A shows a typical cross section of the Gypsum Stacking Facility dike. Figure 6B shows a schematic of the construction technique. At the time of CHA's site visit, the gypsum portion of the dike had been raised about 10 feet above the top of starter dike.

An aerial photograph of the region indicating the location of the Ghent Generating Plant facilities and identifying schools, hospitals, or other critical infrastructure located within approximately five miles down gradient of ATB #1, ATB #2 and the Gypsum Stacking Facility is provided as Figure 7.

1.3.1 Other Impoundments

There are two other impoundments potentially containing Coal Combustion byproducts (CCB). Both of these impoundments are incised. One is the Secondary Ash Basin, and the other is the Surge Pond in the Gypsum Stacking area. The Commonwealth of Kentucky also regulates a dam over which the access road to ATB #2 crosses. This dam impounds stormwater runoff from the ATB #2 dam, but reportedly does not contain CCB. These impoundments are labeled on Figure 2.

1.4 Previously Identified Safety Issues

Based on our review of the information provided to CHA and as reported by Kentucky Utilities, there have been no identified safety issues at ATB#1, ATB #2 or the Gypsum Stacking Facility in the last 10 years.

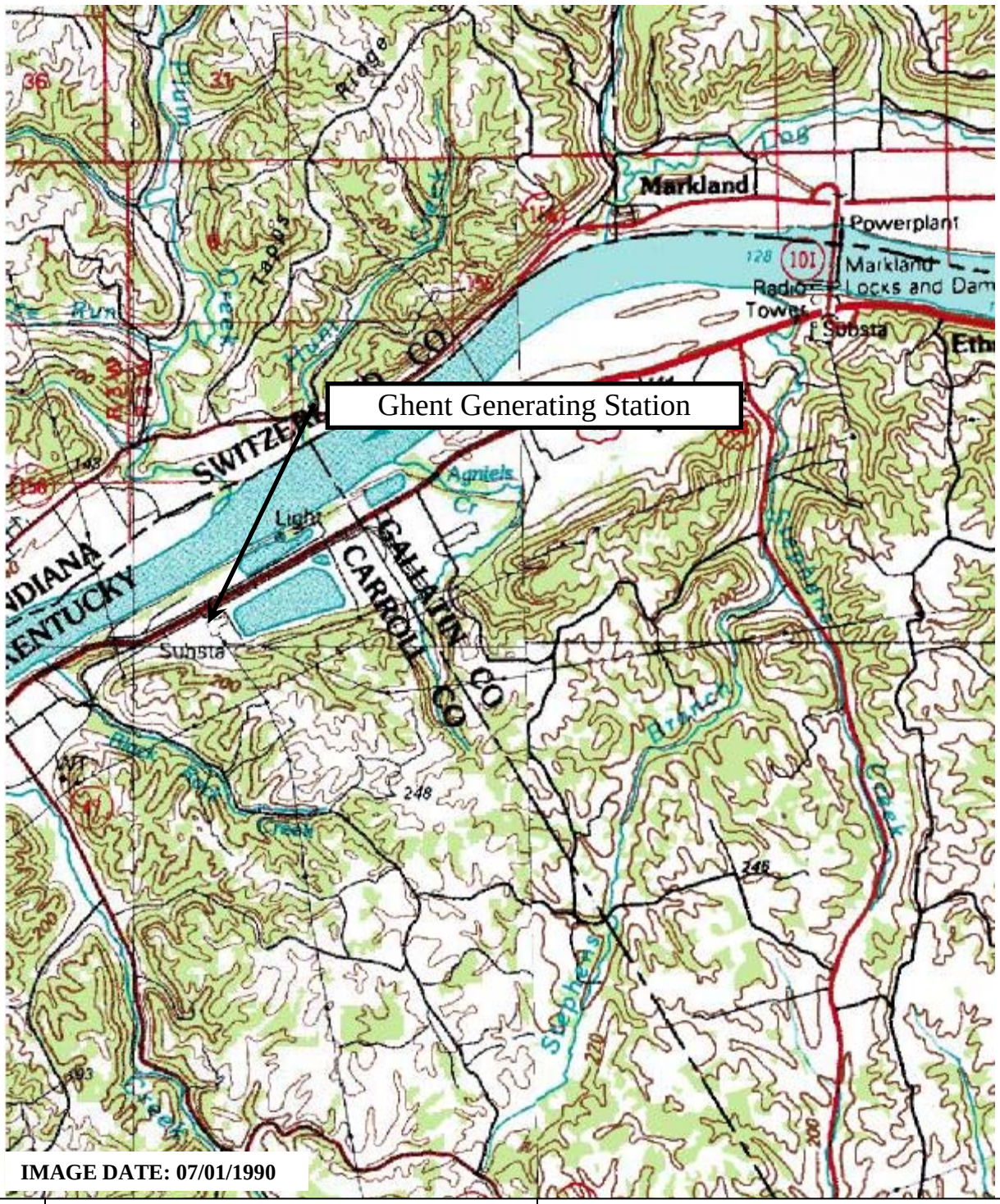
1.5 Site Geology

ATB #2 is located on a hilltop to the south of the Ghent Generating Station where the mapped geology suggests the area is underlain by interbedded limestone and shale. The area of ATB #1 and the Gypsum Stacking Facilities, which are at the base of the hill on which ATB #2 is located, is underlain by glacial outwash consisting of gravels, sand, silt and clay reported to be up to 120 feet thick in the area of the Town of Ghent. *Geologic map of parts of the Vevay South and Vevay North quadrangles, north-central Kentucky* prepared by W.C. Swadley in 1973 for the U.S. Geological Survey (Geologic Quadrangle Map GQ-1123, scale 1:24000) indicates that the south sides of the ATB #1 and the Gypsum Stacking Facility are impounded by the Kope Formation of interbedded limestone and shale formation, which is reported to slump readily when wet. The geology reports reviewed suggested structures built on this formation should be provided with adequate drainage and over-steepened slopes should be avoided. Design documentation suggests that this formation was encountered at foundation elevation at ATB #2 as well. This is further addressed in Section 3.4.2 – Foundation Conditions at ATB #2.

1.6 Bibliography

CHA reviewed the following documents provided by Kentucky Utilities in preparing this report:

- *Ghent Power Plant Engineering Data Compilation for Ash Storage Pond Facility*, March 14, 1980, Sargent & Lundy Engineers
- *Site Development Drawings for Ash Storage Basin*, 1978 with Revisions, Sargent & Lundy Engineers
- *2009 Dam Assessments*, January 2009, ATC Associates, Inc.
- *Engineering Report for Ash Treatment Basin No. 2*, May 1992, Fuller Mossbarger, Scott & May
- *Operating Manual – Ash Treatment Basin No.2*, October, 1995, FMSM Engineers
- *Phase I – Ash Treatment Basin No. 2 Drawings*, October 2, 1992 with Revisions, FMSM Engineers
- *Phase II – Ash Treatment Basin No. 2 Record Drawings*, December 4, 2003, FMSM Engineers
- *Design Report – Ash Treatment Basin No. 2*, February 2002, FMSM Engineers
- *Addendum to Design Report – Ash Treatment Basin No. 2 Phase II*, September 2002, FMSM Engineers
- *Inclinometer, Piezometer, Surface Monument Survey and Field Observations – Ash Treatment Basin No. 2*, June 1, 2009, Stantec
- *Operation Manual – Gypsum Water Recovery and Treatment Facility*, June 1995, FMSM Engineers
- *Gypsum Water Recovery and Treatment Facility Drawings*, November 18, 1992 with Revisions, FMSM Engineers
- *Final Design Report – Gypsum Water Recovery and Treatment Facility*, September 1994, FMSM Engineers



N

CHA

Figure 1
Project Location Map

Scale: 1" = 1 mile

Project No.: 20085.2030.1510

Ghent Generating Station
Kentucky Utilities
Ghent, Kentucky

IMAGE REFERENCE: GOOGLE EARTH, IMAGERY DATED JUNE 20, 2004

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PHOTO SITE MAP

GHENT GENERATING STATION
GHENT, KENTUCKY

PROJECT NO. 20085.2030

DATE: 12/2009

FIGURE 2

File: K:\20085\CADD\ACAD\FIGURES\2030 GHENT GENERATING STATION\2030_2_PHOTO SITE PLAN.DWG Saved: 12/8/2009 10:34:59 AM PLotted: 12/8/2009 10:37:25 AM User: Everleth, Jennifer

IMAGE REFERENCE: GOOGLE EARTH, IMAGERY DATED JUNE 20, 2004

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ATB #2 ENLARGED PHOTO SITE MAP

GHENT GENERATING STATION
GHENT, KENTUCKY

PROJECT NO. 20085.2030

DATE: 12/2009

FIGURE 3

File: K:\20085\CADD\ACAD\FIGURES\2030 GHENT GENERATING STATION\2030_2_PHOTO SITE PLAN.DWG Saved: 12/8/2009 10:34:59 AM PLotted: 12/8/2009 10:38:22 AM User: Everleth, Jennifer

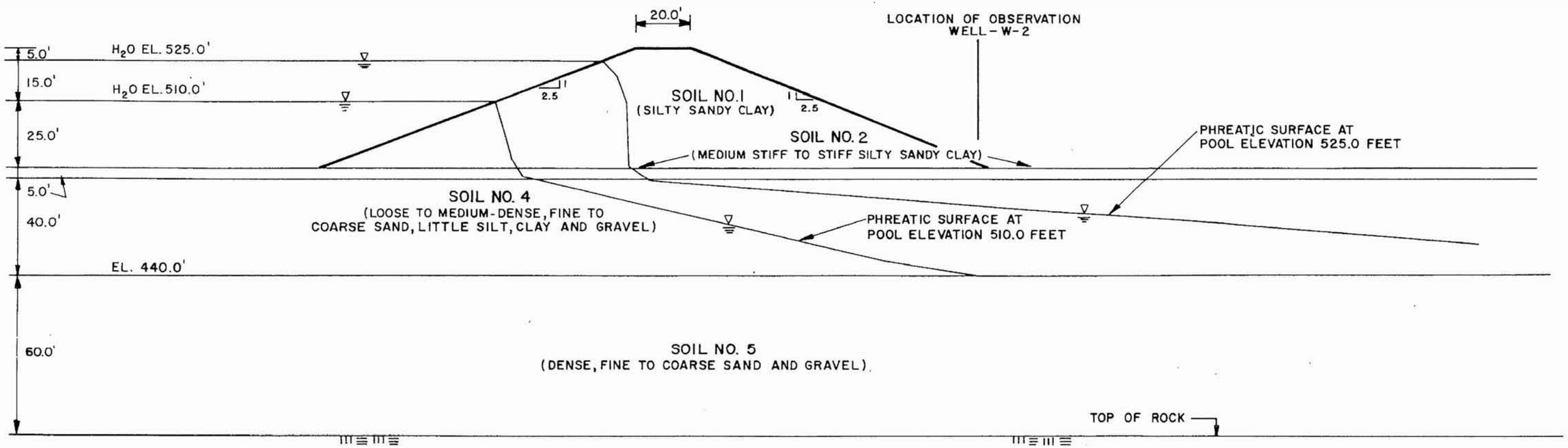

IMAGE REFERENCE: GHENT POWER PLANT ENGINEERING DATA COMPILATION FOR ASH STORAGE POND FACILITY PREPARED BY SARGENT & LUNDY ENGINEERS, MARCH 14, 1980

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ATB #1 TYPICAL CROSS SECTION

GHENT GENERATING STATION
GHENT, KENTUCKY

PROJECT NO. 20085.2030

DATE: 12/2009

FIGURE 4

File: K:\20085\CADD\ACAD\FIGURES\2030 GHENT GENERATING STATION\2030_4_ATB #1_TYPICAL CROSS SECTION.DWG Saved: 12/1/2009 3:49:23 PM Plotted: 12/7/2009 10:11:04 AM User: Gray, Timmolyn

File: K:\20085\CADD\ACAD\FIGURES\2030 GHENT GENERATING STATION\2030_4_ATB #1_TYPICAL CROSS SECTION.DWG Saved: 12/7/2009 11:31:04 AM PLotted: 12/7/2009 11:31:37 AM User: Gray, Timmolyn

LEGEND

ZONE I	CLAY
ZONE II	RANDOM ROCK FILL
ZONE III	CLASS III CHANNEL LINING FOR WAVE PROTECTION
ZONE IV	RANDOM ROCK FILL
ZONE V	ASH OR CCB FROM ATB #1

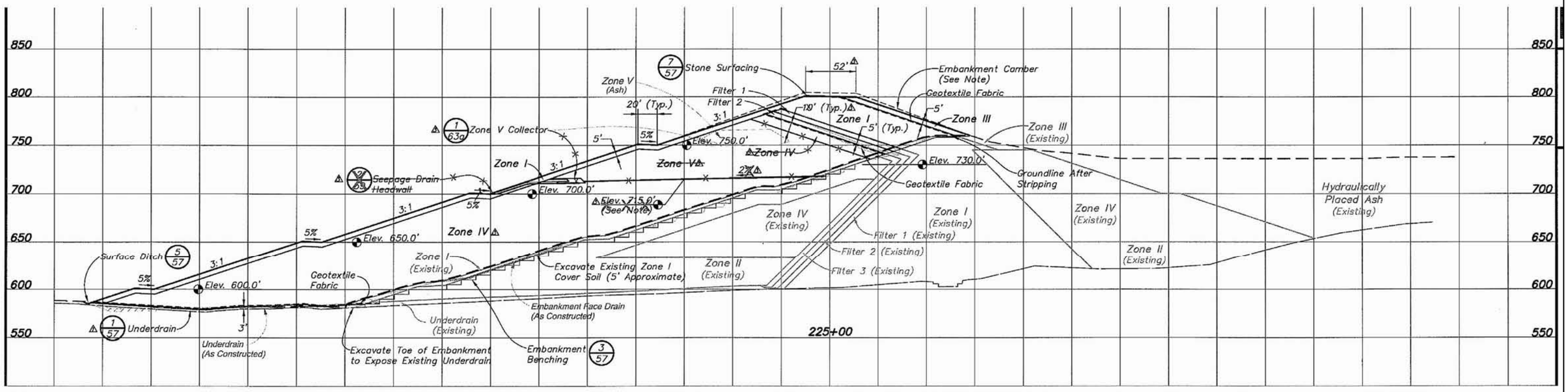

IMAGE REFERENCE: PHASE II – ASH TREATMENT BASIN NO. 2 GHENT GENERATING STATION TYPICAL CROSS SECTIONS – MAIN EMBANKMENT, SHEET 30 OF 74 RECORD DRAWINGS DATED DECEMBER 4, 2003.

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ATB #2 TYPICAL CROSS SECTION

GHENT GENERATING STATION
GHENT, KENTUCKY

PROJECT NO. 20085.2030

DATE: 12/2009

FIGURE 5

LEGEND

SOIL STRATUM SPECIFIED MATERIALS (STABILITY MODEL MATERIAL)	DESCRIPTION
GYPSUM (MATERIAL 1)	
ZONE 1(MATERIAL 2)	PLASTIC CLAY
FILTER NO. 4 (MATERIAL 3)	
SOIL LINER (MATERIAL 4)	FAT CLAY (CH)
ZONE 5 (MATERIAL 5)	GENERAL FILL, INCLUDING EARTH, SOIL LIKE SHALE, SHALE, ETC. FROM BORROW AREAS
CLAY WITH SAND (MATERIAL 6)	EXISTING FOUNDATION SOIL
SILTY SAND/SANDY SILT (MATERIAL 7)	EXISTING FOUNDATION SOIL
SAND WITH SILT AND GRAVEL (MATERIAL 8)	EXISTING FOUNDATION SOIL

LOAD CASE	FACTOR OF SAFETY	FAILURE SURFACE
A	STEADY STATE NO UNDERDRAIN	ROTATIONAL
B	STEADY STATE WITH UNDERDRAIN	ROTATIONAL
C	STEADY STATE NO UNDERDRAIN	WEDGE
D	STAEDY STATE WITH UNDERDRAIN	WEDGE

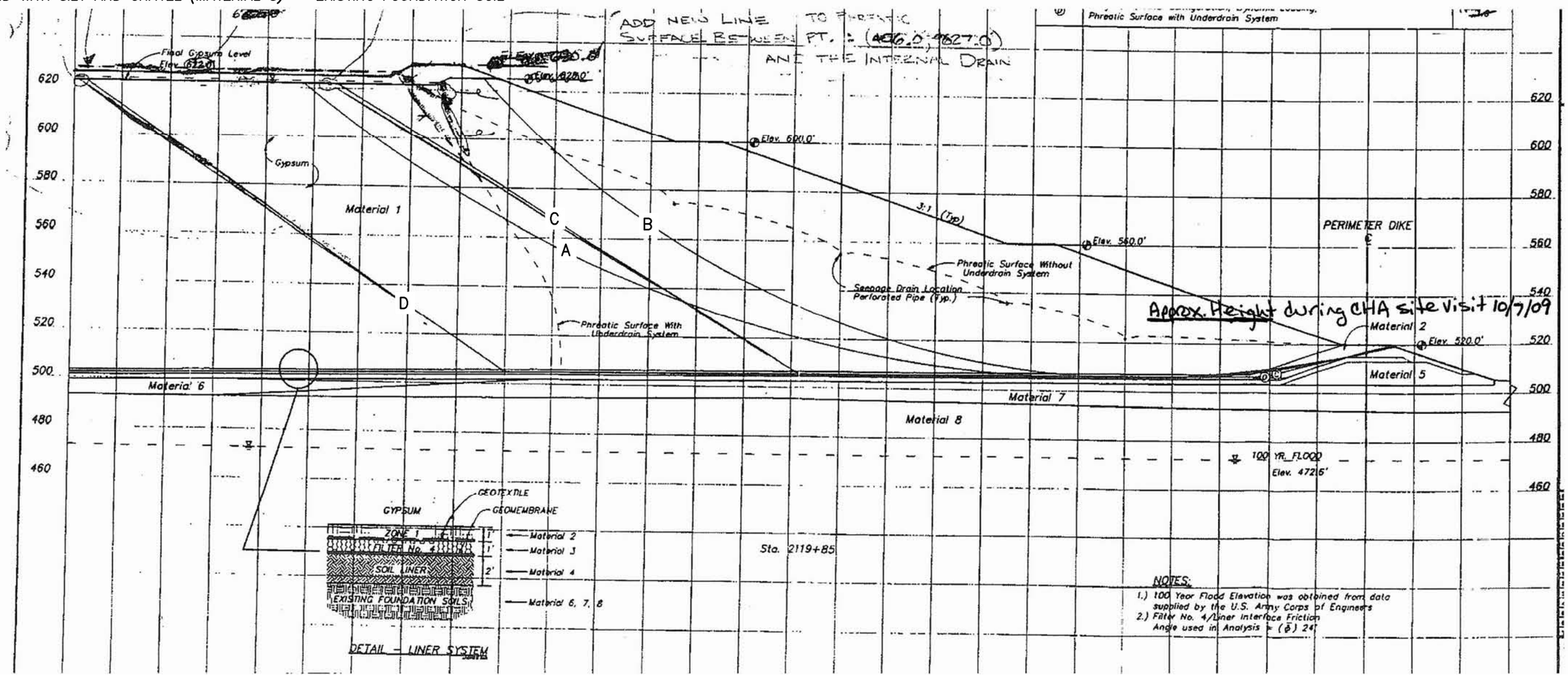

IMAGE REFERENCE: FINAL DESIGN REPORT: GYPSUM WATER RECOVERY AND TREATMENT FACILITY PREPARED BY FMSM ENGINEERS, SPETEMBER 1994.

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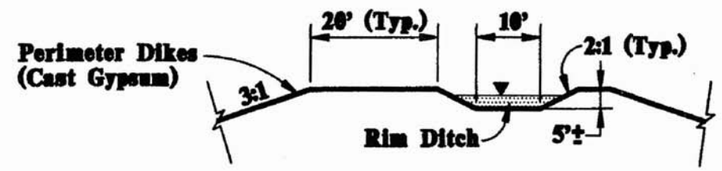
GYPSUM STACKING FACILITY TYPICAL CROSS SECTION AND STABILITY ANALYSIS

GHENT GENERATING STATION
GHENT, KENTUCKY

PROJECT NO. 20085.2030

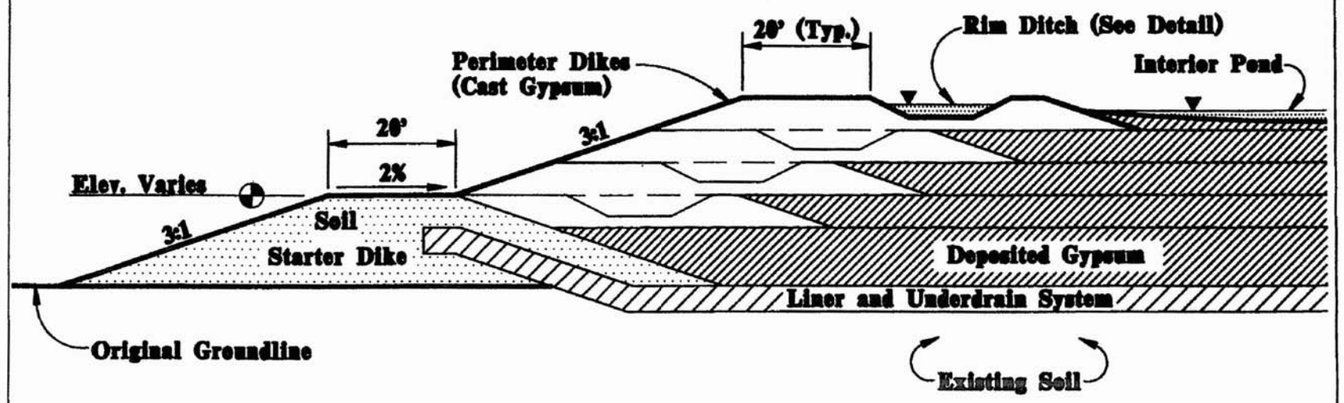
DATE: 12/2009

FIGURE 6A



DETAIL-RIM DITCH

NOTE: Initial rim ditch will be constructed with a 0.5% bottom slope.



TYPICAL GYPSUM STACKING OPERATION

FIGURE 2

IMAGE REFERENCE: OPERATION MANUAL – GYPSUM WATER RECOVERY AND TREATMENT FACILITY PREPARED BY FMSM ENGINEERS, JUNE 1995

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6B TYPICAL GYPSUM STACKING OPERATION

GHENT GENERATING STATION
GHENT, KENTUCKY

PROJECT NO. 20085.2030

DATE: 12/2009

FIGURE 6B

File: K:\20085\CADD\ACAD\FIGURES\2030 GHENT GENERATING STATION\2030_6_GYPSUM STACKING FACILITY TYPICAL CROSS SECTION.DWG Saved: 12/7/2009 2:03:00 PM PLotted: 12/7/2009 2:05:30 PM User: Gray,

IMAGE REFERENCE: GOOGLE EARTH, IMAGERY
DATED JUNE 20, 2004

LEGEND

227 STREET, HIGHWAY	SCHOOL
FIRE DEPARTMENT	CHURCH

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CRITICAL INFRASTRUCTURE LOCATION MAP

GHENT GENERATING STATION
GHENT, KENTUCKY

PROJECT NO. 20085.2030

DATE: 12/2009

FIGURE 7

File: K:\20085\CADD\ACAD\FIGURES\2030 GHENT GENERATING STATION\2030_7_CRITICAL INFRASTRUCTURE LOCATION PLAN.DWG Saved: 2/23/2010 1:56:49 PM Plotted: 2/23/2010 1:57:42 PM User: Gray, Timmolyn

2.0 FIELD ASSESSMENT

2.1 Visual Observations

CHA performed visual observations of the ATB #1, ATB #2 and Gypsum Stacking Facility dikes following the general procedures and considerations contained in Federal Emergency Management Agency's (FEMA's) *Federal Guidelines for Dam Safety* (April 2004), and Federal Energy Regulatory Commission (FERC) Part 12 Subpart D to make observations concerning settlement, movement, erosion, seepage, leakage, cracking, and deterioration. A Coal Combustion Dam Inspection Checklist and Coal Combustion Waste (CCW) Impoundment Inspection Form, prepared by the US Environmental Protection Agency, were completed on-site during the site visit. Copies of the completed forms were submitted via email to a Lockheed Martin representative approximately three days following the site visit to the Ghent Generating Station. Copies of these completed forms are included in Appendix A. A photo log and Site Photo Location Maps (Figures 8A and 8B) are also located at the end of Section 2.5.3.

CHA's visual observations were made on October 7, 2009 and October 8, 2009. The weather was sunny with temperatures between 40 and 60 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 – October 7, 2009 & October 8, 2009		
Day	**Date**	**Precipitation (inches)**
Wednesday	9/30/09	0.00
Thursday	10/1/09	0.00
Friday	10/2/09	0.54
Saturday	10/3/09	0.00
Sunday	10/4/09	0.00
Monday	10/5/09	0.00
Tuesday	10/6/09	0.08
Total	**Week Prior to Site Visit**	**0.62**
Total	**Month of September**	**4.83**

2.2 Visual Observation – ATB #1

CHA performed visual observations of the primary dike, which is about 6,000 feet long and about 52 feet high.

2.2.1 ATB #1 Embankments and Crest

In general, the ATB #1 dike does not show signs of changes in horizontal alignment from the proposed alignment. The up and downstream slopes were reasonably uniformly graded and vegetation had been recently mowed at the time of our site visit. Photos 4, 5, 13, 14, 16, and 20 show the general condition of the downstream embankment, which is covered with appropriate grass vegetation. As noted in Photo 13, some areas at the crest are over steepened, which Kentucky Utilities staff indicated may have occurred during regrading of the crest when work was performed to ensure the top elevation was at the design elevation. No signs of movement were observed in these areas. Photo 14 also shows typical tire rutting from mowers. This is common on earthen embankments, and requires observation to ensure that erosion and sloughing does not occur. Kentucky Utilities indicated that they have reduced their maintenance program to mowing twice a year from three times a year to reduce the impact of mower rutting on the embankments. A few areas of different vegetation were noted along the north slope, which can be an indication of softer soil or seepage. These observed areas, while softer at the surface were firm below a depth of about 6 to 8 inches.

At the northeast corner of the embankment there is a bench about halfway down the slope as shown in Photos 16 and 22. A depression was observed in the bench near the northeast corner as shown in Photo 17. Occasional shallow erosion rills were also noted.

Photo 23 shows the toe drain outlet structure at the northeast corner of ATB #1. There was no appreciable flow from this toe drain. Because the drain headwall structure was wet from splash from the decant discharge, CHA was unable to determine if seepage was occurring.

The general condition of the ATB #1 upstream slope is shown in Photos 3, 6, 9, 10, 12 and 21. The upstream slope is weed covered, but had been trimmed to near the water line. ATB #1 is not a primary disposal site now and primarily receives outflow from ATB #2 and a comparatively small flow of waste water from the plant. This has resulted in ash deposits that are above the water line. Along the west and majority of the north dikes, the ash is within 3 to 5 feet of the top of the dike. As shown in Photo 12, small trees have begun to grow on the exposed ash within the basin. As can be seen in Photo 21, erosion on the upstream slope of the east dike has been filled with rip rap.

The crest is uniformly graded with the exception of rises where pipe utilidors cross beneath the crest access road.

2.2.2 ATB #1 Control Structure and Discharge Channel

The outlet control structure for ATB #1 is located in the northeast corner of the pond. The outlet control structure is a stop log controlled drop inlet, which discharges to the Secondary Ash Treatment Basin, which is an incised pond. Photo 24 shows the control structure, and Photo 26 shows the discharge end into the Secondary Ash Treatment Basin. Photo 25 shows vegetation in the skimmer/debris boom structure. However, flow appears to be passing freely into the tower.

2.3 Visual Observations – ATB #2

CHA performed visual observations of the ATB #2 Dam. The dam containing ATB #2 is about 4,700 feet long and up to 227 feet high.

2.3.1 ATB #2 Embankments and Crest

In general, the dam at ATB #2 does not show signs of changes in horizontal alignment from the proposed alignment. Photos 41, 43, 45 through 53, 55, 57, and 63 show the general condition of the downstream slopes. Minor erosion and rodent holes were observed as shown in Photos 58

and 66. Taller weeds adjacent to drainage swales along the toe and groins along the dam were frequently observed as shown in Photo 61. Standing water was noted on benches as shown in Photos 64 and 72. The soil was firm in these areas indicating that this water is related to poor drainage of stormwater. Photo 70 shows an area of severe erosion on the west side of the main fill of the dam. This area is near the groin swale and was observed during a January 2009 inspection by ATC Associates, Inc. (ATC), and based on a comparison of CHA and ATC photographs appears to have worsened in the subsequent nine months.

Toe drains which were installed to collect seepage from various drains and areas of the zoned embankment daylight at the concrete headwall structures as shown in Photos 56, 60, 62, 65, 67, 68, 71 and 73. Some of these drains have minor amounts of clear flow. One drain on the right side of the secondary fill section had mud in the end of the pipe and it was apparent that erosion of the natural slope in which the drain headwall was constructed may have resulted in at least some of this mud around the pipe. Upon review of ATC's 2009 inspection report, it appears that during the January 2009 inspection, the natural slopes in this area were found to have sloughed and buried the headwall. The sloughed soil had been removed from over the drain, but the drain had not been cleaned. Grass partially obstructed several of these toe drains.

The crest of the ATB #2 dam is uniform and did not show signs of significant settlement or deflection. Photos 35 through 40 show the general condition of the crest.

The upstream slope of the ATB #2 was covered with rip rap, which appeared uniformly placed. Photos 27 through 34 show the general conditions of the upstream slope. Occasional erosion rills, such as that noted in Photo 30 were observed.

2.3.2 ATB #2 Outlet Control Structure and Discharge Structure

The outlet control structure for the ATB #2 is a stop log controlled drop inlet which conveys outflows below the dam near the access road through a 36-inch diameter ductile iron pipe

beneath the dam, which transitions to an HDPE pipe that runs parallel to the access road between ATB #2 and ATB #1. At the southwest corner of ATB #1, the pipe discharges into an impact stilling basin, which then discharges into a gabion lined channel into ATB #1. Photos 75 through 77 show the outlet control structure in ATB #2. Photos 79 and 80 show the discharge of ATB #2 flow at ATB #1.

2.3.3 ATB #2 Emergency Spillway

ATB #2 has an emergency spillway excavated in bedrock at the south end of ATB #2. The emergency spillway is shown in Photos 81 and 82.

2.3.4 ATB #2 Adjacent Hillsides

There is a slump in the natural hillside near the east abutment of the ATB #2 dam which is shown in Photo 54. This slump was also identified in ATC's January 2009 inspection report, and Kentucky Utilities acknowledged that repair of this slump is on a maintenance "to-do" list. At this time it appears the slump is sufficiently far enough away from the toe of the ATB #2 dam such that it is not an immediate threat to the stability of the dam.

2.4 Visual Observation – Gypsum Stacking Facility

CHA performed visual observations of the Gypsum Stacking Facility dike. The starter dike at the Gypsum Stacking Facility is about 4,470 feet long and about 20 feet high. The final height of the Gypsum Stacking Facility will be about 125 feet. At the time of our visit, the top of the gypsum portion of the dike was about 10 feet above the starter dike elevation (about El. 530).

2.4.1 Gypsum Stacking Facility Dike Embankments and Crest

The horizontal alignment of the crest of the starter dike appears unchanged from construction plan layouts. The crest of the starter dike is shown in Photos 88, 89, 95, and 105. The crest is

loose and rutted largely because of ongoing construction activities where gypsum is being placed in the first upstream berm raising of the facility. The starter dike crest will remain as a bench on the final Gypsum Stacking Facility downstream slope. The crest of the placed and compacted gypsum upstream berm is shown in Photos 86 and 103.

The downstream slope of the starter dike is relatively uniformly graded and covered with appropriate grass vegetation. The west starter dike is a shared dike with ATB #1. Photos 85, 90 through 92, 96, 97, 101, and 102 show the general condition of the downstream slope. Photo 102 shows an area where a surficial slough was identified by ATC during the January 2009 inspection. The slough was reportedly about 1.5 feet deep, and was repaired during the summer of 2009. Currently the upstream berm construction of gypsum is underway as can be seen in Photos 87, 88, 89, 97, and 105. Plans call for placement of topsoil and grass seed on the surfaces of stacked gypsum as stacking is completed.

There are several items of note for the downstream slope of the east dike, including the following;

- An area of seepage has been identified near the top of the starter dike at about the mid point of the east dike. This seep is at approximately the elevation of the current water surface within the impoundment. Kentucky Utilities indicated that they are working with Stantec (who acquired FMSM) as the Engineer of Record to resolve this issue.

- Standing water was observed along the toe of the east dike. This water was clear, did not appear to be flowing, and the ground was firm suggesting that this may be undrained surface water runoff. Kentucky Utilities indicated they are working on addressing the drainage in this area with better grading to an in-place stormwater collection system specifically designed to convey storm water runoff from the Gypsum Stacking Facility to the Secondary Ash Treatment Basin outfall structure. Photos 94, 98, and 99 show this standing water.

- Reportedly heavy rains had resulted in erosion of the gypsum/stacked gypsum at the top of the starter dike. This material flowed down the downstream slope and collected around one of the surface drains at the toe on the east side of the facility as can be seen in Photos 100 and 101. These storm drains drain to the Secondary Ash Treatment Basin outlet structure.

The upstream slopes of the Gypsum Stacking Facility can be seen in Photos 84, 86, and 103. The upstream slopes are in a state of change because of the nature of the construction process of the stacking facility which requires sluicing the gypsum into one of two cells (north and south halves of the facility), decanting and dewatering the sluiced gypsum pools, then using that dewatered gypsum for upstream dike construction while raising the level of the pools and dikes.

2.4.2 Gypsum Stacking Facility Decanting System

Photo 103 shows one of the decanting structures in the Gypsum Stacking Facility. The decant system consists of a 24-inch diameter HDPE pipe on both the east and west sides of the impoundment with a network of pipe stubs which will allow for moving of the decant structures as the stacking process occurs, allowing for increasing the elevation of the decant structures as needed based on the height of the upstream berms containing the ponds. These decant pipes discharge to the incised Surge Pond to the north of the Gypsum Stacking Facility.

2.5 Monitoring Instrumentation

There are piezometers installed around ATB #1, and network of piezometers, inclinometers and surface monuments installed on ATB #2, and groundwater sampling wells are installed around the Gypsum Stacking Facility and 11 piezometers and 14 surface monuments are proposed to be installed as the stack is raised. Figures 9A, 9B, 9C show the locations of the monitoring instrumentation plans for the ATB #1, ATB #2 and Gypsum Stacking Facility.

2.5.1 Monitoring Instrumentation – ATB #1

There are some existing piezometers installed on the crest near the northeast corner of ATB #1 and along the toe of the dike on the west and north sides. These piezometers are not currently monitored. CHA took readings on accessible piezometers, and found readings to be at or below historic levels recorded in the 1970s and which were contained in the Engineering Data Compilation Report prepared by Sargent and Lundy Engineers in 1980.

2.5.2 Monitoring Instrumentation – ATB #2

Surface monuments were surveyed by Stantec on April 6, 2009. The following table was taken from Stantec's report:

Table 2 – 2009 Surface Monument Survey Results by Stantec

Monument Number	2009 Northing	2009 Easting	2003 Northing	2003 Easting	2003 Elevation (feet)	2009 Elevation	Change in Elevation (feet)
SMM-9	711.34	-3886.59	711.34	-3886.65	804.89	804.50	-0.39
SMM-10	887.73	-3907.08	N/A	N/A	N/A	744.50	N/A
SMM-11	1057.17	-3935.08	1057.16	-3935.23	694.74	694.73	-0.01
SMM-12	N/A	N/A	742.47	-3687.64	804.99	Not Found	N/A
SMM-13	905.17	-3711.63	N/A	N/A	N/A	749.4	N/A
SMM-14	1075.29	-3754.82	1075.25	-3754.95	700.09	700.01	-0.08
SMM-15	1245.68	-3797.22	1245.74	-3797.21	649.83	649.82	-0.01
SMM-16	1415.18	-3840.12	N/A		N/A	599.53	N/A
SMM-17			N/A		804.69	Monument missing	N/A
SMM-18	951.74	-3522.33	951.79	-3522.35	745.21	745.1	-0.11
SMM-19	1121.72	-3566.02	1121.72	-3566.01	695.61	695.58	-0.03
SMM-20	844.69	-2985.58	844.56	-2985.61	802.12	801.88	-0.24

*SMM-8 was missing for both surveys

SMM-9 is located on the crest of ATB #2 and shows slightly over 4.5 inches of settlement since ATB #2 was raised in 2003. At the first bench down from the crest (El. 750 – crest is at El. 800), settlement was recorded to be about 1.3 inches, and the second bench down from the crest (El. 700) settlement was about 1 inch, and at the third bench down from the crest (El. 650) recorded

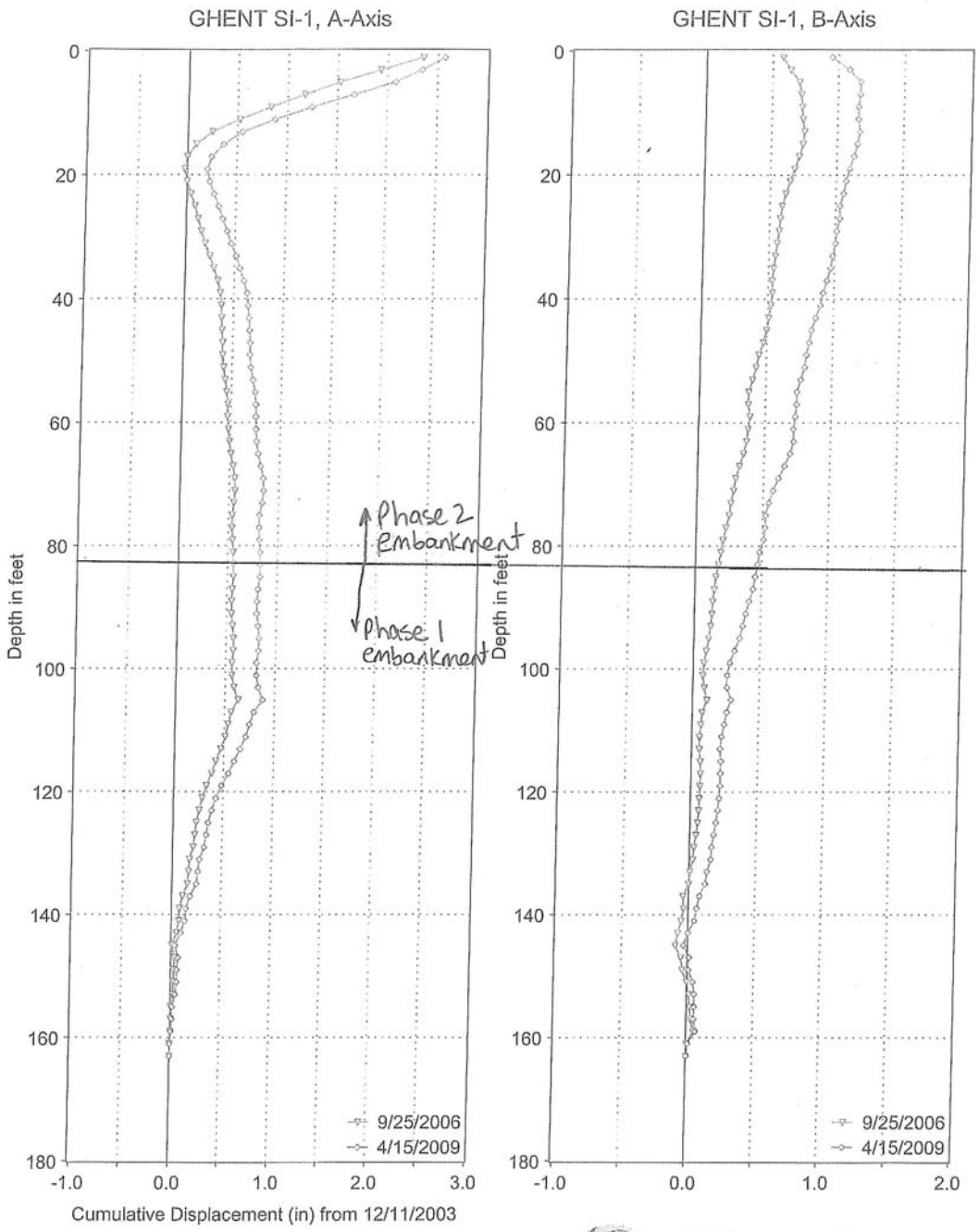
settlement was about 1/8 inch. Stantec reported that the horizontal movements of the monuments were within the margin of error for the survey method used.

Piezometric data collected in 2009 indicates the phreatic surface is at or below the design phreatic surface for the highest portion of the dam. CHA noted that the piezometric elevations towards the groins of the main fill area are within the Zone 4 fill. Zone 4 fill is higher than the designed inclined drains at the full height section. This is further addressed in Section 3.3.2 – ATB #2 Stability Analyses. The following table was taken from Stantec's report:

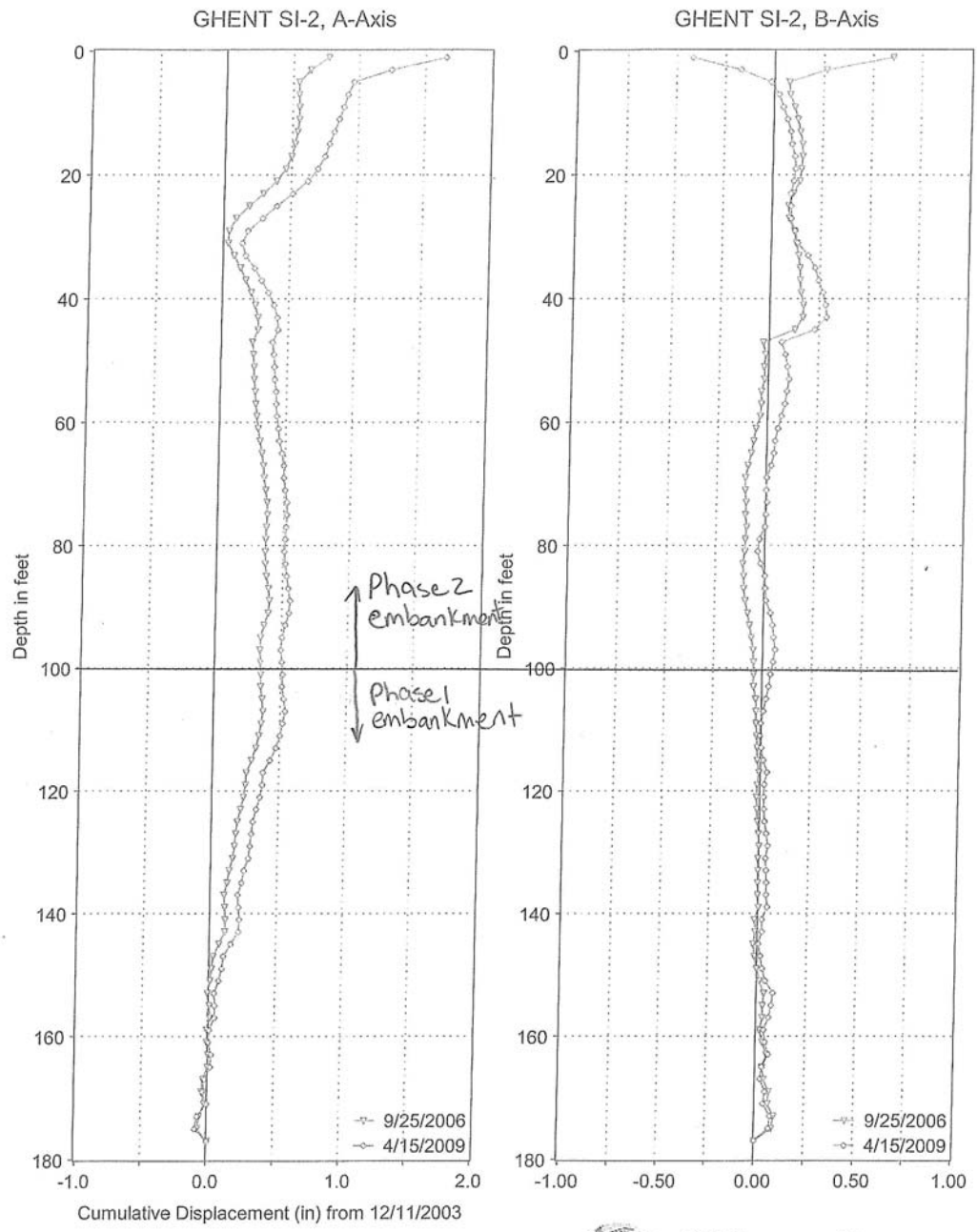
Table 3 – 2009 Piezometer Data from Stantec's Report

Piezometer	Northing	Easting	Piezometer Tip Elevation (feet)	2006 Measured Phreatic Surface Elevation (feet)	2009 Measured Phreatic Surface Elevation (feet)
PZ-9	223+00	25' Rt.	773.2	No water	No water detected
PZ-10	223+00	204' Lt.	647.8	649.1	647.9
PZ-11	225+00	25' Rt.	771.6	No water	No water detected
PZ-12	225+00	186' Lt.	597.0	No water to 601.7	No water to 602.4
PZ-13	227+00	25' Rt.	772.0	No water	772.5
PZ-14	227+00	204' Lt.	658.1	659.1	658.9

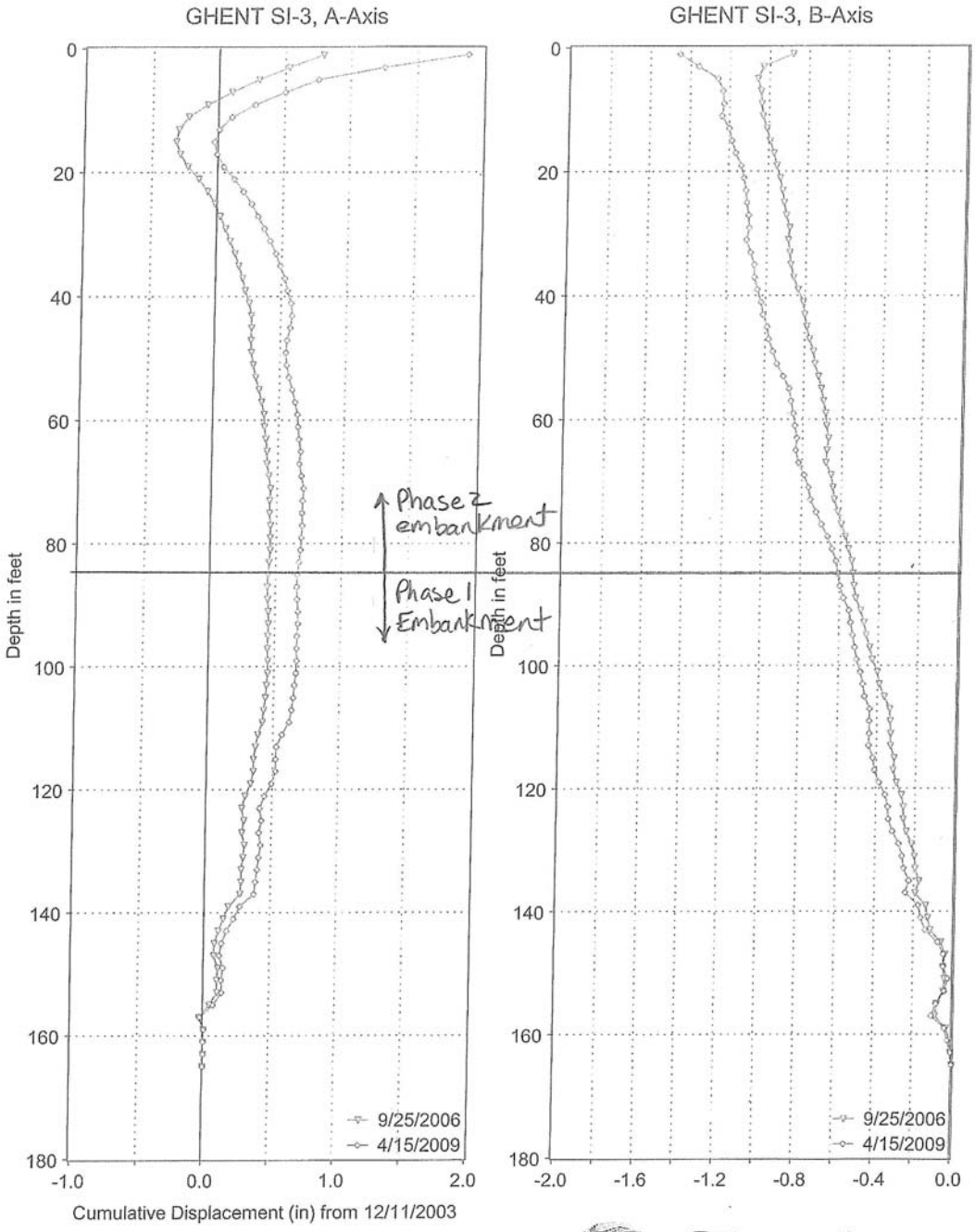
Three inclinometers are located near the crest on the downstream slope of ATB #2 in the area of the main fill. These inclinometers have shown less than 1 inch of movement in the down slope direction since the raising of ATB #2 was completed in 2003. Stantec attributes these movements to settlement within the embankment fill. Movements shown in the upper 20 to 30 feet have been attributed by Stantec to be due to poor compaction around the casing when the inclinometers were extended with the dam raising in 2003. The plots of these inclinometers as presented by Stantec follow on Pages 23, 24 and 25. CHA hand annotated the approximate transition from the original (Phase 1) to raised portions (Phase 2) of the dam based on annotations provided in an FMSM 2006 report.



Ghent Generating Station
Slope Inclinometer
SI-1



Ghent Generating Station
Slope Inclinometer
SI-2



Ghent Generating Station
Slope Inclinometer
SI-3

2.5.3 Monitoring Instrumentation – Gypsum Stacking Facility

There are currently groundwater monitoring wells installed around the Gypsum Stacking Facility. While these have not been monitored by Kentucky Utilities or their consultants to date, CHA took water level measurements in them, in part to evaluate whether standing water at the toe of the east dike was related to a seepage condition or trapped surface water. CHA took readings in GW-9, GW-13, and GW-14. The depth to water was between 82 and 83 feet in these three wells, which corresponds to between elevations of 418 to 423. Based on data from the ATB #1 Engineering Data Compilation Report by Sargent and Lundy, the groundwater table at the Ghent Facility is governed by the Ohio River, which in the 1970s was typically between elevations 420 and 430.

As the height of the Gypsum Stacking Facility rises, five piezometers are planned at El. 560 and another six are scheduled to be installed at El. 600. Fourteen surface monuments for vertical and horizontal displacement monitoring are scheduled to be installed. Surface Movement Monuments (SMM) 5, 8 and 11 are to be on the starter dike crest, SMM 1, 3, 6, 9 and 12 are to be installed on the El. 560 bench, and SMM 2, 4, 7, 10, 13 and 14 are to be installed on the El. 600 bench. The Gypsum Stacking Facility dike is currently at about El. 530.

IMAGE REFERENCE: GOOGLE EARTH, IMAGERY DATED JUNE 20, 2004

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PHOTOGRAPH LOCATION MAP

GHENT GENERATING STATION
GHENT, KENTUCKY

PROJECT NO. 20085.2030

DATE: 12/2009

FIGURE 8A

File: K:\20085\CADD\ACAD\FIGURES\2030 GHENT GENERATING STATION\2030_8_PHOTO LOCATION PLAN.DWG Saved: 12/1/2009 3:51:02 PM PLotted: 12/8/2009 10:44:24 AM User: Everleth, Jennifer

IMAGE REFERENCE: GOOGLE EARTH, IMAGERY DATED JUNE 20, 2004

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PHOTOGRAPH LOCATION MAP

GHENT GENERATING STATION
GHENT, KENTUCKY

PROJECT NO. 20085.2030

DATE: 12/2009

FIGURE 8B

File: K:\20085\CADD\ACAD\FIGURES\2030 GHENT GENERATING STATION\2030_8_PHOTO LOCATION PLAN.DWG Saved: 12/1/2009 3:51:02 PM PLotted: 12/8/2009 10:44:46 AM User: Everleth, Jennifer

1

Crest of west dike ATB #1 looking north, “bumpiness” from buried sluice pipe crossing.

2

West abutment of ATB #1 looking south.

CHA	**KENTUCKY UTILITIES** **GHENT GENERATING STATION** **ATB #1** **GHENT, KY**
CHA Project No.: 20085.2030.1510	October 7, 2009

3

"Upstream" end of ATB #1 at west dike/abutment, looking north.

4

Downstream slope ATB #1 west dike looking north.

CHA	**KENTUCKY UTILITIES** **GHENT GENERATING STATION** **ATB #1** **GHENT, KY**
CHA Project No.: 20085.2030.1510	October 7, 2009

5

Downstream slope ATB #1 west dike looking south.

6

Upstream slope ATB #1 west dike looking north.

CHA	**KENTUCKY UTILITIES** **GHENT GENERATING STATION** **ATB #1** **GHENT, KY**
CHA Project No.: 20085.2030.1510	October 7, 2009

7

Utility corridor at northwest corner of ATB #1.

8

Crest at northwest corner of ATB #1. Station in right of photo is chemical treatment, pad at left is forklift turn around.

9

Upstream slope at northwest corner of ATB #1 looking southwest.

10

Upstream slope at northwest corner of ATB #1 looking northeast.

11

Crest of ATB #1 north dike looking east. Note trees are growing in deposited ash.

12

Upstream slope of ATB #1 north dike pipe racks for gypsum stacking facility. Note trees are growing on ash “not” dike.

13

Downstream slope of ATB #1 north dike. Note over steepening adjacent to crest, looking east.

14

Tire ruts from mower on over steepened area.

15

Area at mid point of ATB #1 north dike toe appeared wet. Area firm when probed, Kentucky Utilities indicated area may be where a water line burst and was repaired.

16

Start of bench around northeast corner of ATB #1 dike.

17

Depression in bench near northeast corner of ATB #1 dike.

18

Secondary Ash Treatment basin (foreground) and gypsum stack surge pond (beyond) are incised ponds.

19

ATB #1 dike crest at northeast corner, looking southeast.

20

Downstream slope at north end of ATB #1 east dike. The east dike is now shared with the gypsum stacking facility.

21

Upstream slope of ATB #1 east dike. Rip rap has been placed to fill areas of erosion.

22

Downstream slope of ATB #1 northeast corner looking northwest.

CHA	**KENTUCKY UTILITIES** **GHENT GENERATING STATION** **ATB #1** **GHENT, KY**
CHA Project No.: 20085.2030.1510	October 7, 2009

23

Toe drain at northeast corner of ATB #1. No apparent flow, concrete is wet from splash from outlet pipe.

24

Outlet structure in ATB #1.

25

Decant structure in ATB #1.

26

Outlet pipe discharge into secondary Ash Treatment Basin.

CHA	**KENTUCKY UTILITIES** **GHENT GENERATING STATION** **ATB #1** **GHENT, KY**
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27

Upstream slope of ATB #2 looking north.

28

Rip rap protection on upstream slope of ATB #2 extends below the normal pool elevation.

CHA	**KENTUCKY UTILITIES** **GHENT GENERATING STATION** **ATB #2** **GHENT, KY**
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29

Upstream slope of ATB #2 looking south at west abutment and boat ramp.

30

Erosion rill on upstream slope.

CHA	**KENTUCKY UTILITIES** **GHENT GENERATING STATION** **ATB #2** **GHENT, KY**
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31

Upstream slope of ATB #2 looking east.

32

Upstream slope of ATB #2 looking east.

CHA	**KENTUCKY UTILITIES** **GHENT GENERATING STATION** **ATB #2** **GHENT, KY**
CHA Project No.: 20085.2030.1510	October 7, 2009

33

Upstream slope of ATB #2 looking east.

34

Upstream slope of ATB #2 looking southeast towards east abutment.

CHA	**KENTUCKY UTILITIES** **GHENT GENERATING STATION** **ATB #2** **GHENT, KY**
CHA Project No.: 20085.2030.1510	October 7, 2009

35

Crest of ATB #2 at west end looking northeast.

36

Crest of ATB #2 from access to decant structure looking east.

37

Crest of ATB #2 looking east.

38

Crest of ATB #2 looking east.

CHA	**KENTUCKY UTILITIES** **GHENT GENERATING STATION** **ATB #2** **GHENT, KY**
CHA Project No.: 20085.2030.1510	October 7, 2009

39

Crest of ATB #2 looking southeast.

40

Crest of ATB #2 looking south toward the east abutment.

41

Downstream slope west end of dike looking north. Taller grass is on natural ground.

42

Maintenance includes removal of woody brush.

43

Western knoll looking east toward access road at downstream slope.

44

East groin at western knoll looking northeast.

45

Downstream slope from access road looking northeast.

46

Downstream slope looking west toward access road.

47

Upper portion of downstream slope of ATB #2 looking northeast. Instrumentation marked with yellow bollards, horizontal benched in main section of Dike at 50 vertical foot increments.

48

Upper portion of downstream slope of ATB #2 looking northeast. Instrumentation marked with yellow bollards, horizontal benched in main section of Dike at 50 vertical foot increments.

49

Downstream slope of ATB #2 at the maximum height section looking north.

50

Downstream slope of ATB #2 at eastern knoll looking northeast.

51

Downstream slope of ATB #2 just east of eastern knoll looking northeast.

52

Downstream slope of ATB #2 looking east.

53

Downstream slope of east end of ATB #2 dike looking northeast.

54

Slump in natural slope near the east abutment of ATB #2.

55

East abutment of ATB #2 looking south.

56

Toe drain on east of ATB #2. Flow clear/immeasurable.

57

Downstream slope of ATB #2 looking west from northeast corner of dike.

58

Small rodent hole on bench in secondary drainage fill section about 18 inches deep.

59

Area around toe drain shown in next photo.

60

Toe drain on east side of secondary drainage fill about ¾ clogged at outlet. Signs of erosion on slopes around outlet so unclear if sediment is from pipe or other causes.

61

Taller weeds along drainage swale at toe.

62

Upper toe drain at east side of main drainage fill (dry).

63

Upper bench on main fill.

64

Close up of standing water on upper bench. Soil firm when probed.

65

Toe drain on east side of main fill between upper bench and next lower bench.

66

Erosion at occasional locations appears related to turning mowers.

67

Toe drain above lowest bench of main fill.

68

Toe drain at base of main fill.

69

Channel below toe of main fill. No discharge, standing water and wetland plants observed likely from seepage/toe drain outlet.

70

Erosion cut gully in west side of main fill about midway up slope from the base. About 2 feet deep.

71

East toe drain at west of main fill.

72

Standing water on west end of upper bench.

73

West toe drain at west of main fill.

74

Utilidor of sluice lines at dam crest. Crest slightly higher at this location.

CHA	**KENTUCKY UTILITIES** **GHENT GENERATING STATION** **ATB #2** **GHENT, KY**
CHA Project No.: 20085.2030.1510	October 7, 2009

75

Outlet structure.

76

Decant over stop logs in outlet structure.

77

Outlet structure equipped with gates to close outlet flow from discharge pipe.

78

Sluice lines through utility corridor to reservoir.

79

Discharge from ATB #2 near ATB #1. Discharges into structure with impact baffle.

80

Sluiceway from ATB #2 discharge into ATB #1.

81

Emergency spillway from south side of ATB #2 looking north.

82

Emergency spillway from south side of ATB #2 looking south.

83

South end of gypsum stacking facility looking southeast.

84

West end of gypsum stacking facility, looking northeast.

CHA	**KENTUCKY UTILITIES** **GHENT GENERATING STATION** **GHENT GYPSUM POND** **GHENT, KY**
CHA Project No.: 20085.2030.1510	October 7, 2009

85

Drainage swale at northwest corner of gypsum stacking facility dike, looking southwest. ATB#1 dike beyond.

86

Crest of west end of gypsum stacking facility dike, looking northeast (under construction from dewatered gypsum).

CHA	**KENTUCKY UTILITIES** **GHENT GENERATING STATION** **GHENT GYPSUM POND** **GHENT, KY**
CHA Project No.: 20085.2030.1510	October 7, 2009

87

Downstream slope of northwest corner of gypsum stacking facility dike
above starter dike (under construction from dewatered gypsum).

88

Crest of starter dike at northwest corner of gypsum stacking facility dike, looking northeast.

89

Crest of starter dike, north side of gypsum stacking facility, looking east.

90

Downstream slope of north side of gypsum stacking facility starter dike (compacted soil), looking east.

CHA	**KENTUCKY UTILITIES** **GHENT GENERATING STATION** **GHENT GYPSUM POND** **GHENT, KY**
CHA Project No.: 20085.2030.1510	October 7, 2009

91

Depressions at toe of north side of starter dike of gypsum stacking facility, looking west.

92

Downstream slope of gypsum stacking facility starter dike at the northeast corner looking west.

93

Pipe rack diverting gypsum to reuse facility on northeast corner of the gypsum stacking facility starter dike.

94

Standing water at toe at northeast corner of gypsum stacking facility starter dike. Appears to be surface drainage water.

95

Crest of starter dike at northeast corner of gypsum stacking facility (under construction).

96

Downstream slope of east side of gypsum stacking facility starter dike, looking north.

97

Over steepening at crest of east side of gypsum stacking facility starter dike, looking south.

98

Standing water at the toe along the east side of the gypsum stacking facility starter dike.
Ground is firm, appears to be surface water drainage.

99

Standing water at the toe along the east side of the gypsum stacking facility starter dike.
Ground is firm, appears to be surface water drainage.

100

Surface drainage system on east side of gypsum stacking facility starter dike.

101

Runoff from gypsum stacking facility east dike under construction.

102

Area of repaired surficial slough on the east side of the gypsum stacking facility starter dike. Slough occurred and was repaired in Spring 2009.

103

Crest of gypsum stacking facility dike east side, looking south.

104

Area of seep near top of gypsum stacking facility east starter dike. Kentucky Utilities is working with Stantec (Engineer of Record) to resolve this issue. Seepage is at approximate elevation of current water surface in the pond.

CHA	**KENTUCKY UTILITIES** **GHENT GENERATING STATION** **GHENT GYPSUM POND** **GHENT, KY**
CHA Project No.: 20085.2030.1510	October 7, 2009

105

East abutment of gypsum starter dike, looking south.

CHA	**KENTUCKY UTILITIES** **GHENT GENERATING STATION** **GHENT GYPSUM POND** **GHENT, KY**
CHA Project No.: 20085.2030.1510	October 7, 2009

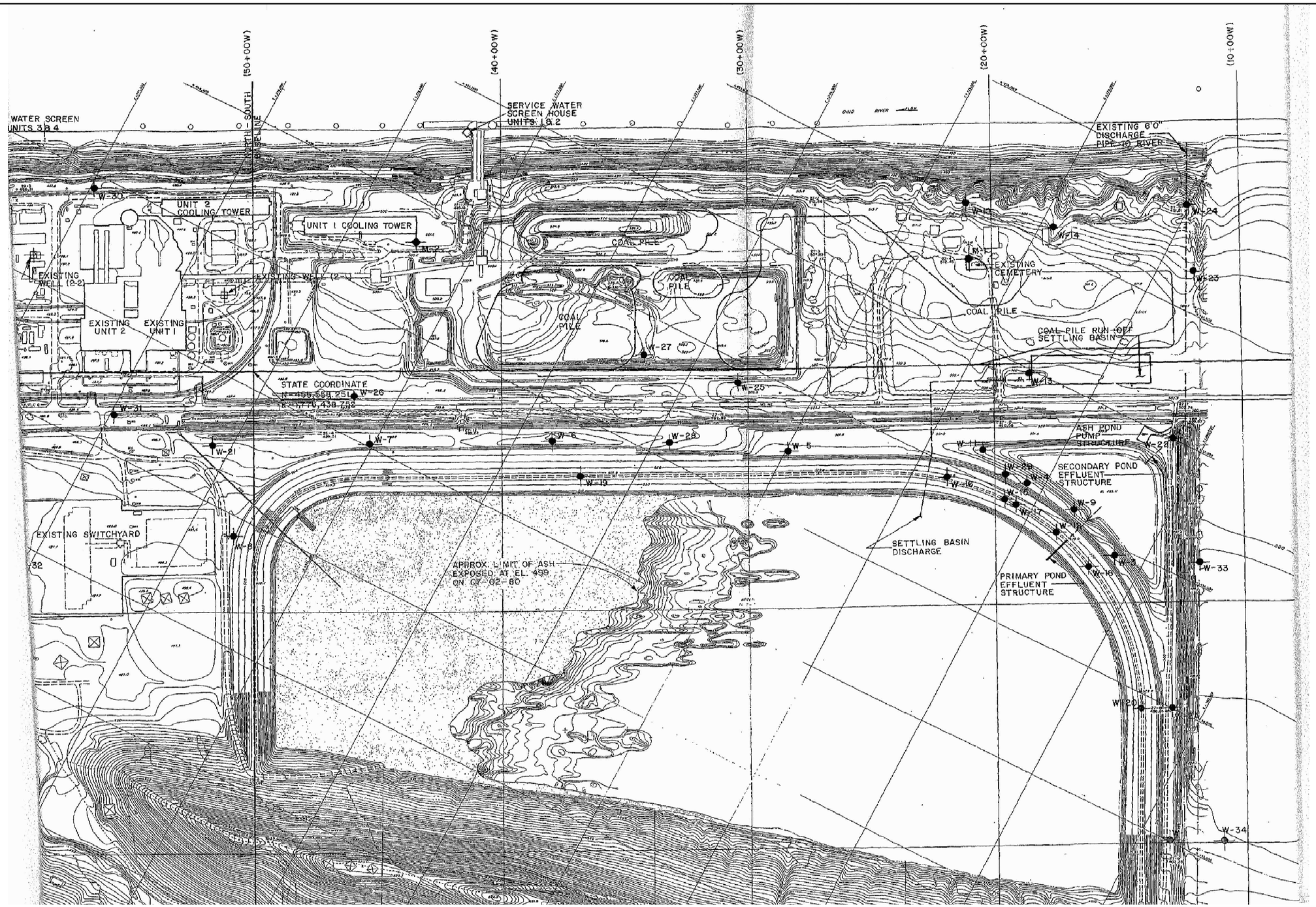

IMAGE REFERENCE: ATB #2 STABILITY ANALYSIS BY CHA, SEISMIC CONDITION– DOWNSTREAM SLOPE.

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ATB #1 MONITORING INSTRUMENTATION PLAN

GHENT GENERATING STATION
GHENT, KENTUCKY

PROJECT NO. 20085.2030

DATE: 12/2009

FIGURE 9A

File: K:\20085\CADD\ACAD\FIGURES\2030 GHENT GENERATING STATION\2030_9_MONITORING INSTRUMENTATION.DWG Saved: 12/7/2009 2:15:04 PM PLotted: 12/8/2009 11:04:39 AM User: Everleth, Jennifer

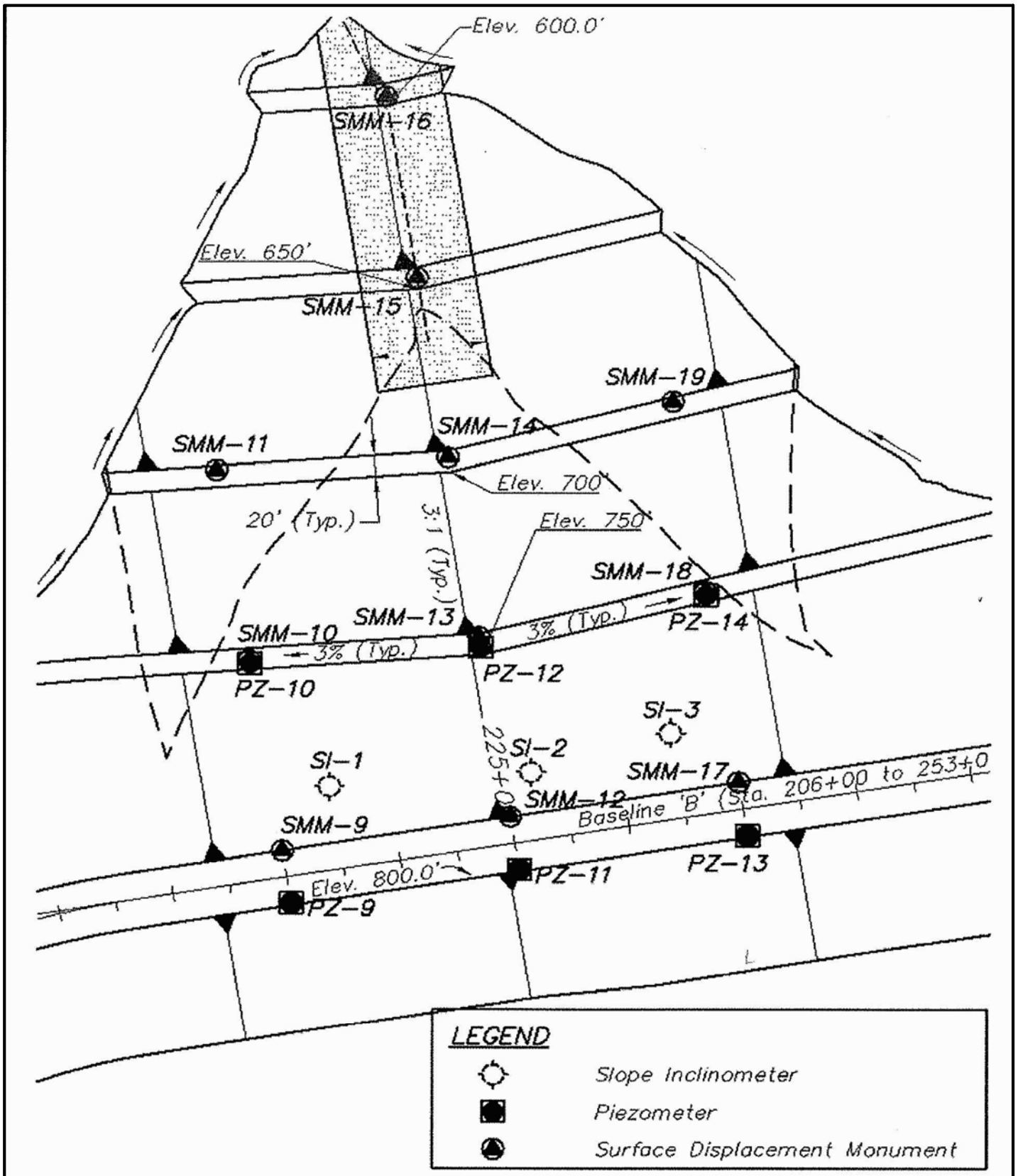

IMAGE REFERENCE: STANTEC, ASH TREATMENT BASIN NO. 2, GHENT GENERATING STATION, CARROLL COUNTY, KENTUCKY, FIG. 1 INCLINOMETER AND PIEZOMETER INSTRUMENT LOCATIONS

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ATB #2 MONITORING INSTRUMENTATION PLAN

GHENT GENERATING STATION
GHENT, KENTUCKY

PROJECT NO. 20085.2030

DATE: 12/2009

FIGURE 9B

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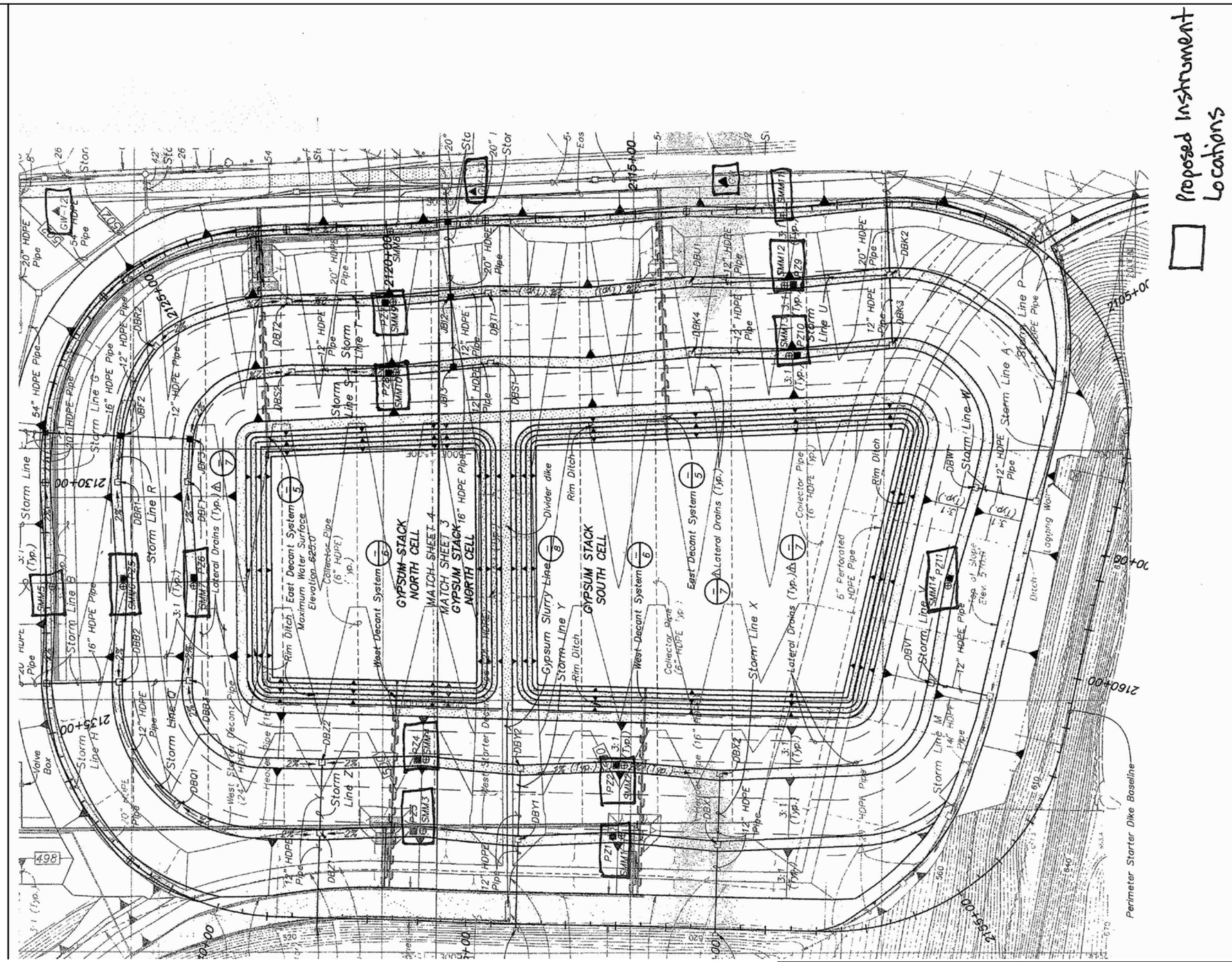

IMAGE REFERENCE: ATB #2 STABILITY ANALYSIS BY CHA, SEISMIC CONDITION– DOWNSTREAM SLOPE.

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GYPSUM STACKING FACILITY MONITORING INSTRUMENTATION PLAN

GHENT GENERATING STATION
GHENT, KENTUCKY

PROJECT NO. 20085.2030

DATE: 12/2009

FIGURE 9C

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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 ATB #1, ATB #2, and Gypsum Stacking Facility ponds and dikes/dams respectively, which were available at the time of our site visits and provided to us by Kentucky Utilities. The design assumptions are listed with the applicable summary of analysis in the following sections.

ATB #1 was designed by Sargent and Lundy Engineers. ATB #2 and the Gypsum Stacking Facility were designed by FMSM Engineers which is now Stantec.

3.2 Hydrologic and Hydraulic Design

All three management units at the Ghent Generating Station are classified as high hazard suggesting that loss of life is probable in the event of a failure. As such, Kentucky regulations (as found in KRS 151.250) require the impoundments to safely store or pass the Probable Maximum Precipitation (PMP). Guidance is provided for the design of an Emergency Spillway as passing a flow equivalent to the 100-year precipitation plus 26 percent of the difference between the PMP and the 100-year precipitation [P100 + 0.26(PMP-P100)]. The Emergency Spillway must be placed such that the full design storm (PMP for high hazard dams) passes without overtopping the dam. At the same time the Emergency Spillway must be set such that it does not flow during a storm smaller than the 100-year storm when vegetated earth, or a storm smaller than the 50-year storm when constructed in bedrock.

The Kentucky guidelines suggest that the principal spillway have the capacity to drain the stored volume of storm flows in 10 days or less. This requirement is considered to be met if 80 percent of the maximum storm storage is drained within 10 days.

For Ghent, Kentucky, the 100-year, 6-hour precipitation is 4.3 inches, and the reported PMP is 27.7 inches, as used by FMSM Engineers. Sargent and Lundy Engineers used 26 inches for the PMP for design of ATB #1. Over the small drainage basin to ATB #1, this difference is not appreciable.

3.2.1 ATB #1 Hydrologic and Hydraulic Analyses

In 1980, design engineers, Sargent & Lundy Engineers, prepared a Engineering Data Compilation summarizing the design criteria, methods of analysis, and design assumptions used for the design of ATB #1, as well as discussion of construction and post construction observations where field adjustments were required.

ATB#1 was designed to originally convey inflows from the plant of 10,000 gallons per minute (gpm), which is about 22 cubic feet per second (cfs) as a routine course, as well as pass flows from the PMP. The drainage area is 175 acres, with 125 acres being the area within the confines of the basin pond associated with the dam crest at El. 530. Normal pool was established to be at El. 526.5 when the stop logs in the decant tower were at their maximum elevation of 525. The 1.5-foot difference is the head required to result in 10,000 gpm outflow through the 48-inch diameter decant discharge pipe. The resulting elevation from the PMP was 529.4 as compared to the top of dike elevation of 530.

In 1994, ATB #2 was put into service. ATB #1 now receives some wastewater flows directly from the plant, but primarily receives the outflow from the ATB #2 decant discharge. As discussed in the following section, ATB #2 was designed for a peak outflow of 44 cfs during the 100-year storm although Kentucky Utilities staff indicated that plant flows continue to be about 22 cfs (10,000 gpm). In our review of design reports for ATB #2, while there is a mention that some material needed to be excavated from ATB #1 to provide adequate retention time for water quality purposes, it does not appear that a storm routing of flows from ATB #2 through ATB #1 has been performed.

CHA performed a simplified comparative analysis of the flows anticipated to be discharged from ATB #2 during the PMP and the impact of the PMP on the water level in ATB #1 with no discharge from the basin. Based on this analysis, we anticipate that with only stormwater inflow to ATB #1 and no outflow from ATB #1, the water elevation would rise from a normal pool at El. 526.5 to El. 529.7, which is approximately 0.3 feet from the top of the ATB #1 dike. Based on a pressure flow analysis for the outlets at ATB #2 and ATB #1, we anticipate that despite the greater head on the 36-inch diameter ATB #2 pipe because of differential elevation changes than the 48-inch ATB #1 pipe, that the ATB #1 pipe will have a greater outflow capacity than can be expected to be conveyed to ATB #1 from ATB #2.

3.2.2 ATB #2 Hydrologic and Hydraulic Analyses

ATB #2 is sited at the top of a hill and therefore, has a relatively small watershed. The watershed is 0.314 square miles, or about 201 acres. The surface area of the impoundment itself is about 146 acres. The Soil Conservation Services (SCS) curve number method was used to evaluate the inflow hydrographs. Because of the geologic conditions in the watershed and the large percentage of water surface, an average Curve Number (CN) of 95 was used (as compared to a CN = 100 for impervious surfaces). This means that the majority of the precipitation will flow to the impoundment as runoff (or directly on the pond) rather than infiltrating the ground.

ATB #2 has been constructed with a 36-inch diameter pipe conveying water from the larger 10-foot by 10-foot square decant tower as the principal spillway, and an Emergency Spillway with a base width of 20 feet at El. 797.5. The dam crest is at El. 800. The following table summarizes the peak inflows and outflows and resulting reservoir elevations for the 100-year, Emergency Spillway, and PMP hydrographs.

Table 4 – ATB #2 – Design Storm Flows and Water Surface Elevation

Storm Hydrograph	Peak Inflow (cfs)	Peak Outflow (cfs)	Reservoir Elev. (ft)
100-year storm	674	44.4	797.8
Emergency Spillway	1,644	82.5	798.0
PMP	4,372	288.6	799.5

3.2.3 Gypsum Stacking Facility Hydrologic and Hydraulic Analyses

At the top of the starter dike, the gypsum stacking facility drainage area encompasses an area of about 59.5 acres. Of this area about 46 acres are the impoundment itself. FMSM evaluated the gypsum stacking facility for the PMP at the top of the starter dike, and at the final pond elevation. The decant system was then designed to convey not only the base flow from the gypsum sluicing operations, but the PMP as well. Excess water from the gypsum stacking facility is decanted into the Surge Pond, an incised pond immediately north of the Gypsum Stacking Facility. The Surge Pond water is recycled for use in plant processes. During times when the prolonged or intense precipitation exceed the need for recycled water within the plant, excess water can be discharged from the Surge Pond to NPDES permitted outfalls. The Operations Plan for the Gypsum Stacking Facility provides a series of elevations within the Surge Pond at which to make adjustments to the amount of process water being recycled, and when to begin discharging to the outfalls.

3.3 Structural Adequacy & Stability

The Kentucky Department for Natural Resources and Environmental Protection (KYDEP) provides guidelines for minimum accepted factors of safety associated with various loading conditions and the reservoir at normal pool level in Table 2 – Factors of Safety of the *Guidelines for the Geotechnical Investigation and Analysis of Existing Earth Dams*. These factors of safety are outlined in Table 2.

Table 5 – Factors of Safety from KY Guidelines

Load Case	Required Minimum Factor of Safety
Rapid Drawdown	1.2
Long-Term Steady State Seepage	1.5
Earthquake Loading	1.0

In addition to the load cases outlined in Table 3 CHA recommends that the maximum surcharge load case as those found in the US Army Corps of Engineers Engineering Manual (EM) 1110-2-

1902 be modeled and analyzed. .This load case and associated minimum recommended safety factor is outlined in Table 3.

Table 6- Minimum Safety Factor Recommended by US Army Corps of Engineers

Load Case	Required Minimum Factor of Safety
Maximum Surcharge Pool (Flood) Condition	1.4

Ghent, Kentucky falls into Seismic Zone 1, which for deterministic based evaluation of seismic acceleration results in a typical acceleration value of 0.05g for seismic analysis. Based on more recent probabilistic hazard analyses performed by the United States Geological Society (USGS) accelerations of about 0.038g and 0.09g are representative of seismic accelerations with a 10 and 2 percent probability of exceedance in 50 years, respectively (about 500-year and 2,500-year events, respectively).

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 ATB #1, ATB #2, and the Gypsum Stacking Facility, respectively.

3.3.1 ATB #1 Stability Analyses

CHA reviewed the stability analyses performed by Sargent & Lundy Engineers who were the designers for ATB #1. They performed stability analyses for the typical embankment section, as well as for the east portion of the dike, which overlies an old stream bed where a soft layer of clay was encountered. Table 6 below summarizes the soil properties used for these analyses.

Table 7 - Soil Strength Properties as Determined by Sargent & Lundy Engineers

Soil Stratum	Unit Weight (pcf)	Friction Angle (φ)	Cohesion (psf)	Description
Soil No. 1	128	32	400	Embankment Fill
Soil No. 2	126	30	300	Sandy Clay
Soil No. 3	126	25	150	Soft Silty Clay
Soil No. 4	115	35	0	Silty Sand
Soil No. 5	125	38	0	Sand and Gravel

For the typical sections of the embankment (west and north sides of the impoundment) the Sargent & Lundy analyses resulted in the factors of safety summarized in Table 7. Figures 10a, 10b, and 10c show the stability analysis cross sections.

Table 8 – Summary of Safety Factors for ATB #1 Typical Section

Load Case	Required Minimum Factor of Safety	Calculated Minimum Factor of Safety
Steady State Condition Downstream Slope, Water El. 525	1.5	2.0
Rapid Drawdown from El. 525 for Upstream Slope	1.2	1.4
Seismic with Water at 525, a = 0.05g	1.0	1.7

During construction, the east embankment experienced lateral spreading and slope stability issues because of the soft clay layer within the limits of the former stream bed. Sargent & Lundy revised the cross section in this area to include berms buttressing the toe on both the upstream and downstream sides of the dike. With these berms, the factors of safety summarized in Table 8 were determined.

Table 9 – Summary of Safety Factors for ATB #1 East Dike Section

Load Case	Required Minimum Factor of Safety	Calculated Minimum Factor of Safety
Steady State Condition Downstream Slope, Water El. 525	1.5	1.8
Rapid Drawdown from El. 525 for Upstream Slope	1.2	1.8
Seismic with Water at 525, a = 0.05g	1.0	1.4

The east dike is now a shared dike between ATB #1 and the Gypsum Stacking Facility.

As discussed in Section 2.5.1, CHA took measurements in piezometers at the northeast corner crest and along the north dike toe, and found water levels to be at, or lower than those used in the stability analyses.

3.3.2 ATB #2 Stability Analyses

CHA was provided with the Engineering Design Report for the raising of ATB #2 as well as record drawings showing the actual placement of zoned material in the embankment. Figure 11 was taken from the record drawings and shows the stability analyses and zones of materials used for the embankment construction. Table 9 summarizes the soil properties used for steady state conditions in analyzing the embankment. Descriptions of the soils represented by zone numbers were taken from technical specs provided in the Engineering Design Report.

Table 10 - Soil Strength Properties as Determined by FMSM Engineers for ATB #2

Soil Stratum	Unit Weight (pcf)	Friction Angle (φ)	Cohesion (psf)	Description
Zone 1	**120**	**27**	**0**	**Clay Core**
Zone 2	**120**	**30**	**0**	**Random Rock Fill (18" minus)**
Zone 3	**115**	**32**	**0**	**Class III Channel Lining for Wave Protection**
Zone 4	**120**	**30**	**0**	**Random Rock Fill (18" minus)**
Zone 5	**90**	**28.7**	**0**	**Ash or CCB from ATB #1**
Filter Material	**115**	**32**	**0**	**Concrete Sand, No. 57 Crushed Stone, and No.**
Hydraulically Placed Ash	**75**	**28.7**	**0**	**Material in ATB #2**
Soil Foundation Material	**120**	**25**	**0**	

The seismic analyses were performed using a pseudo static analysis with a horizontal seismic coefficient of 0.108g. The report reviewed by CHA also included stability analyses with the Kope Formation soils, which as discussed in Section 1.5 – Site Geology, are weaker and can be problematic for foundation support. Based on the results of those analyses, FMSM made the decision to excavate soils from the Kope Formation from beneath the ATB #2 dam to found it on

the underlying bedrock. The resulting computed factors of safety from FMSM's record drawing analyses are reported in Table 10.

Table 11 – ATB #2 – Summary of Stability Analyses

Load Case	Required Minimum Factor of Safety	Calculated Minimum Factor of Safety
Steady State Conditions at Present Pool • Downstream Slope • Upstream Slope	1.5	1.6 4.5
Seismic Loading • Downstream Slope • Upstream Slope	1.0	1.2 1.2

CHA recreated the maximum height cross section used in FMSM's analyses using the computer program Slide™ and the soil properties from Table 9 to confirm these results. CHA performed these analyses to verify the calculated minimum factors of safety because the record drawings showed very shallow surfaces representative of a surface slough rather than a deep seated failure as the worst case scenario, whereas FMSM had reported deep seated failure conditions in the design report. These shallow surfaces are sometimes an anomaly of the computer programs used for the analysis and verification of factors of safety against deep seated slip surfaces is warranted.

In addition to confirming factors of safety against deep seated slip surface, CHA evaluated the upstream embankment assuming no strength in the hydraulically deposited ash to confirm that the dam is stable without this buttress, and with a phreatic surface as defined by piezometer measurements taken in 2006 and 2009 which suggest that towards the sides of the main drainage fill, but where the embankment is still 150 feet tall, the phreatic surface is within the random rock fill on the downstream slope, rather than fully lowered by the filter drain layer.

Based on these conditions, CHA computed the minimum factors of safety for the maximum height of ATB #2 summarized in Table 11. Results of CHA's stability analyses are shown in Figures 12A through 12E.

Table 12 – CHA Computed Stability Factors of Safety

Load Case	Required Minimum Factor of Safety	Calculated Minimum Factor of Safety
Steady State Conditions at Present Pool with No Strength Ash		
• Downstream Slope w/design phreatic surface	1.5	1.8
• Downstream Slope (150-foot height) w/higher phreatic surface		2.2
• Upstream Slope		2.9
Seismic Loading		
• Downstream Slope	1.0	1.4
• Upstream Slope		1.6

FMSM has not performed rapid drawdown analyses for the ATB #2 embankment.

FMSM performed a liquefaction analysis on the CCB materials to be used within the dam (Zone V material). They determined that for confining conditions of 10 to 50 feet deep within the embankment, minimum factors of safety against liquefaction were 1.8 to 2.3, respectively.

3.3.3 Gypsum Stacking Facility

The gypsum stacking facility is under construction. The starter dike was constructed in 1995 when the first scrubber unit was installed. Until the early part of 2009 when remaining scrubber units were completed, the area within the starter dike in combination with gypsum transferred to a local wallboard manufacturer provided sufficient capacity to handle generated gypsum from the plant. At the time of our site visit, the first upstream berm of the gypsum dike had been

constructed to approximately El. 530. The final proposed elevation of the gypsum stacking facility is El. 630.

FMSM designed the gypsum stacking facility and used the soil properties summarized in Table 12 below for the analyses.

Table 13 – Soil Strength Properties as Determined by FMSM Engineers

Soil Stratum Specified Materials (Stability Model Material)	Unit Weight (pcf)	Friction Angle (φ)	Cohesion (psf)	Description
Gypsum (Material 1)	**110**	**35**	**0**	
Zone 1 (Material 2)	**120**	**26**	**0**	**Plastic Clay**
Filter No. 4 (Material 3)	**110**	**24**	**0**	
Soil Liner (Material 4)	**120**	**28**	**0**	**Fat Clay (CH)**
Zone 5 (Material 5)	**100**	**28**	**0**	**General Fill, including earth, soil like shale, shale, etc. from borrow areas.**
Clay with Sand (Material 6)	**120**	**24**	**0**	**Existing Foundation Soil**
Silty Sand/Sandy Silt (Material 7)	**100**	**30**	**0**	**Existing Foundation Soil**
Sand with Silt and Gravel (Material 8)	**120**	**35**	**0**	**Existing Foundation Soil**

FMSM reported that control of the phreatic surface within the stacked gypsum is critical to the stability of the facility. Therefore, not only is there an underdrain system in the bottom of the pond, but periodic seepage drains are scheduled to be installed at various elevations as the gypsum is stacked. In addition, a supplemental drainage layer has been designed and is being added. These seepage drains are intended to act as a backup in case the underdrain system and supplemental drain fails. Figure 6 (in Section 1) shows the stability analysis results and

anticipated phreatic surfaces based on the underdrain or backup seepage drains. The results of these analyses are summarized in Table 13.

Table 14 - Summary of Safety Factors from FMSM Analyses – Gypsum Stacking Facility

Load Case	Required Minimum Factor of Safety	Calculated Minimum Factor of Safety
Final Configuration – Steady State • Rotational failure, without underdrain • Rotational failure, with underdrain • Translational failure, without underdrain • Translational failure, with underdrain	1.5	1.7 2.5 1.5 2.3
Final Configuration – Seismic • Rotational failure, without underdrain • Rotational failure, with underdrain • Translational failure, without underdrain • Translational failure, with underdrain	1.0	1.2 1.8 1.0 1.5

Because of the critical impact of properly functioning underdrains and/or seepage drains within the stacked gypsum on the overall stability of the stack, the installation and monitoring of piezometers to confirm the phreatic surface is part of the Operation Manual prepared by FMSM for the Gypsum Stacking Facility. The first of the piezometers will be installed when the stack reaches El. 560. At the time of CHA site visit, the stack was only constructed to about El. 530.

In addition to piezometers, surface movement monuments will be installed to monitor horizontal and vertical movement and groundwater monitoring wells have been installed to evaluate the competency of the liner system.

3.4 Foundation Conditions

3.4.1 Foundation Conditions at ATB #1

Based on reports by Sargent & Lundy Engineers, ATB #1 is founded on native, glaciofluvial and glacial outwash deposits. These foundation soils were analyzed for strength parameters for the design of ATB #1. During construction, soft clays within a former stream bed along the east dike proved problematic causing cracking and lateral spreading of the east dike. These conditions were addressed before the completion of construction by excavating and replacing the cracked region of the dike, and installing berms on both the upstream and downstream slopes to buttress the east dike against further lateral displacement.

Although a liquefaction analysis of the foundation soils was not performed during the design of ATB #1, CHA has reviewed boring logs, and conclusions for the Gypsum Stacking Facility foundation soils which are similar to those at ATB #1 and does not expect liquefaction to be a concern at the design earthquake magnitude.

3.4.2 Foundation Conditions at ATB #2

Based on reports by FMSM, ATB #2 is founded on bedrock. During design, it was identified that within portions of the proposed footprint of the dam, the Kope Formation was present at foundation elevation. This geologic formation is comprised of interbedded limestone and shale, which is subject to slaking (disintegration to soil when wetted). FMSM evaluated leaving this material in place under the dam, and based on stability results opted to remove the Kope Formation materials to an underlying, more competent bedrock.

3.4.3 Foundation Conditions at the Gypsum Stacking Facility

The Gypsum Stacking Facility is founded on similar materials as the ATB #1 dike. In areas where looser foundation soils were encountered during the geotechnical explorations, a pad of

alternating layers of crushed stone and geogrid were proposed for use to reinforce the foundation and reduce the potential for localized differential settlement.

FMSM performed a liquefaction analysis for both stacked gypsum and the foundation soils and concluded that liquefaction is not expected to occur under loading from the design earthquake.

3.5 Operations & Maintenance

Ghent Generating Station staff perform security type observations once per shift of ATB #1, ATB #2 and the Gypsum Stacking Facility. In addition to maintenance items noticed during these observations, the vegetated portions of the dikes are mowed twice a year. Formerly, mowing was performed three times a year, but this has been reduced to try to reduce rutting from the mowers on the steep banks of the dikes. Kentucky Utilities hired a consultant to perform a visual inspection of the three facilities in January 2009, and will have the same consultant perform a follow-up inspection in November 2009 per their recommendations based on conditions observed in January. A survey of instrumentation at ATB #2 was performed in April 2009. Previous instrumentation surveys had been performed in 2004 and 2006.

Kentucky DEP performs dam safety inspections every two years based on the high hazard rating for these facilities.

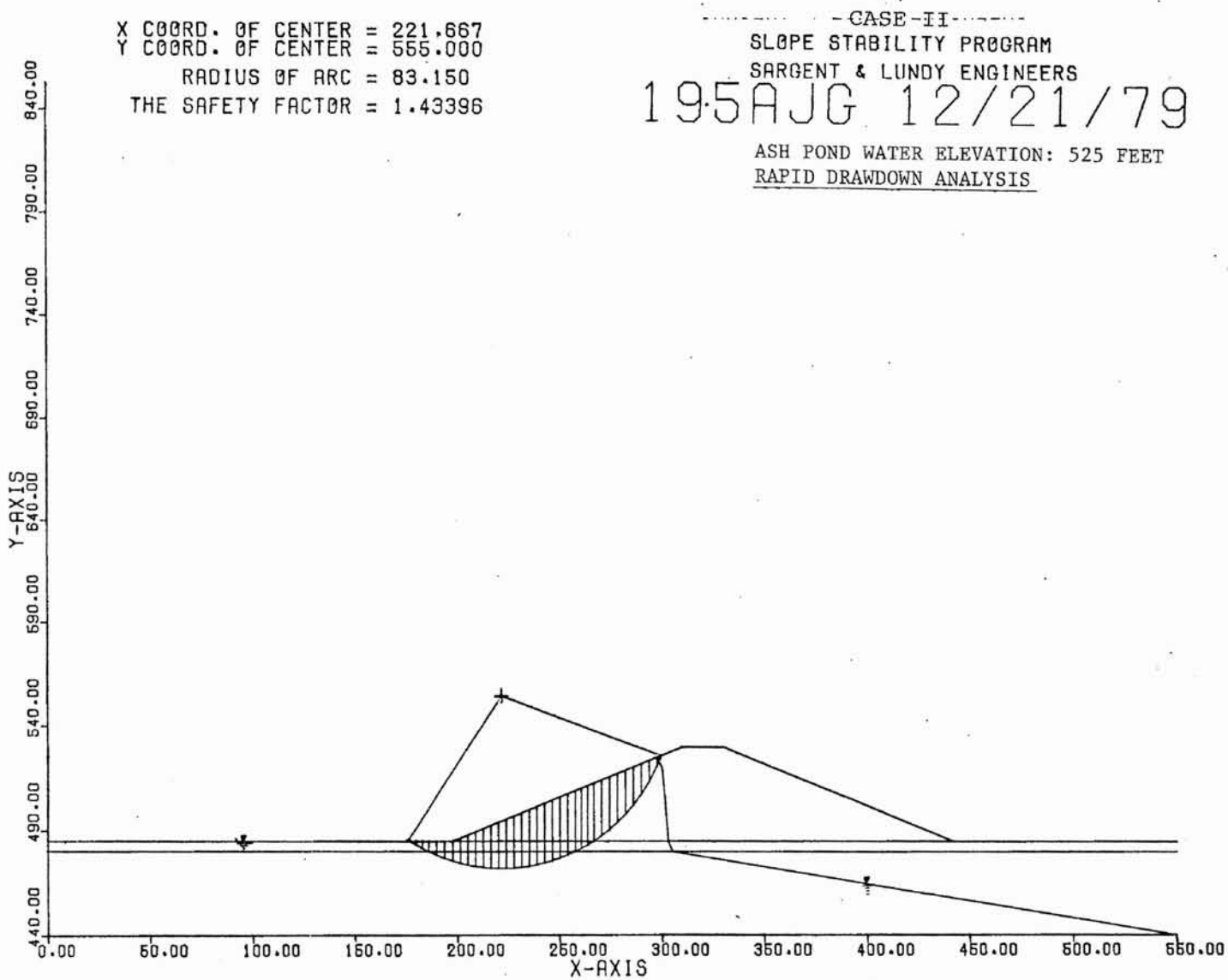

IMAGE REFERENCE: ENGINEERING DATA COMPILATION FOR ASH STORAGE POND FACILITY, PREPARED BY SARGENT & LUNDY ENGINEERS, MARCH 14, 1980.

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RAPID DRAWDOWN ANALYSIS

GHENT GENERATING STATION
GHENT, KENTUCKY

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DATE: 12/2009

FIGURE 10A

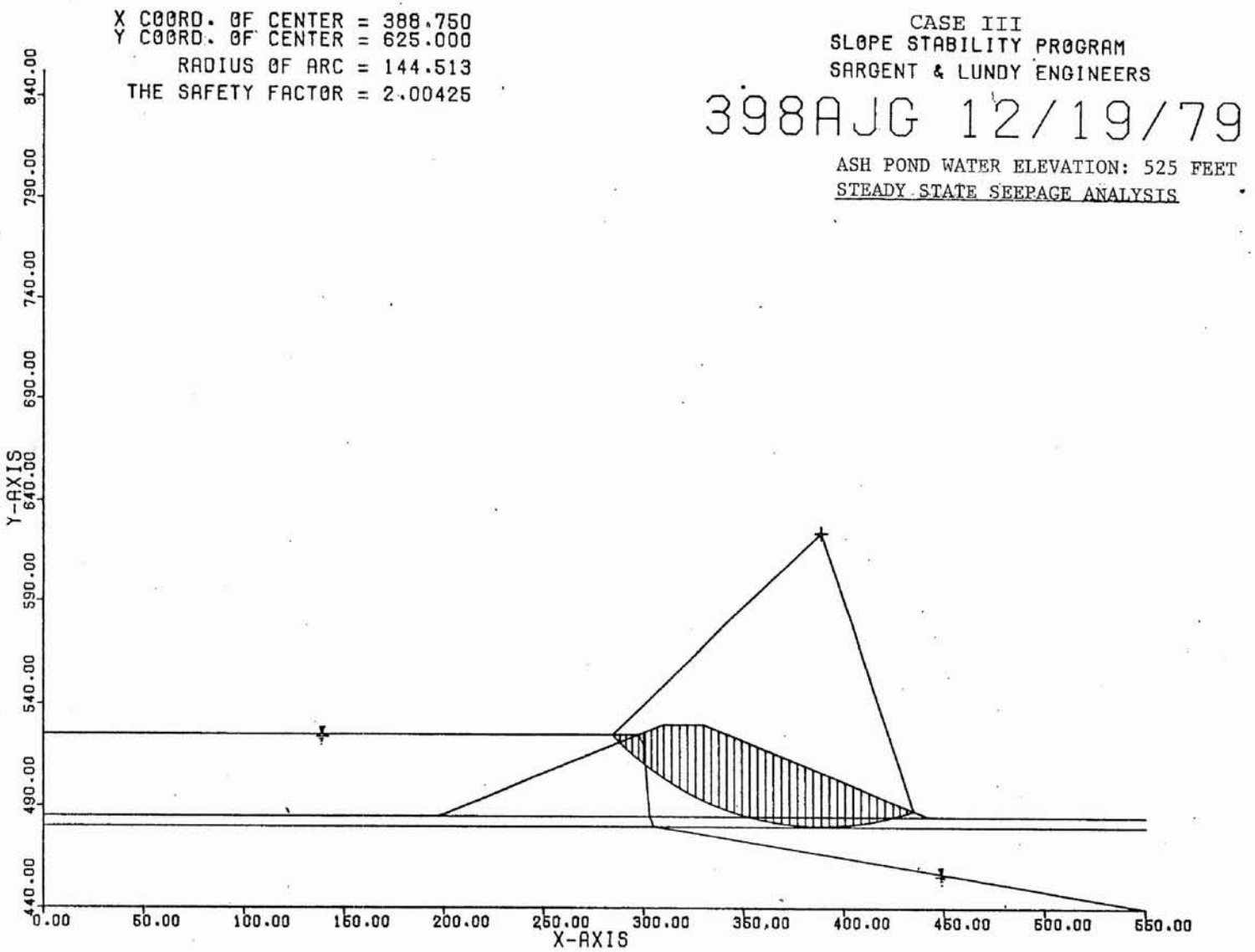

IMAGE REFERENCE: ENGINEERING DATA COMPILATION FOR ASH STORAGE POND FACILITY, PREPARED BY SARGENT & LUNDY ENGINEERS, MARCH 14, 1980.

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STEADY STATE SEEPAGE ANALYSIS

GHENT GENERATING STATION
GHENT, KENTUCKY

PROJECT NO. 20085.2030

DATE: 12/2009

FIGURE 10B

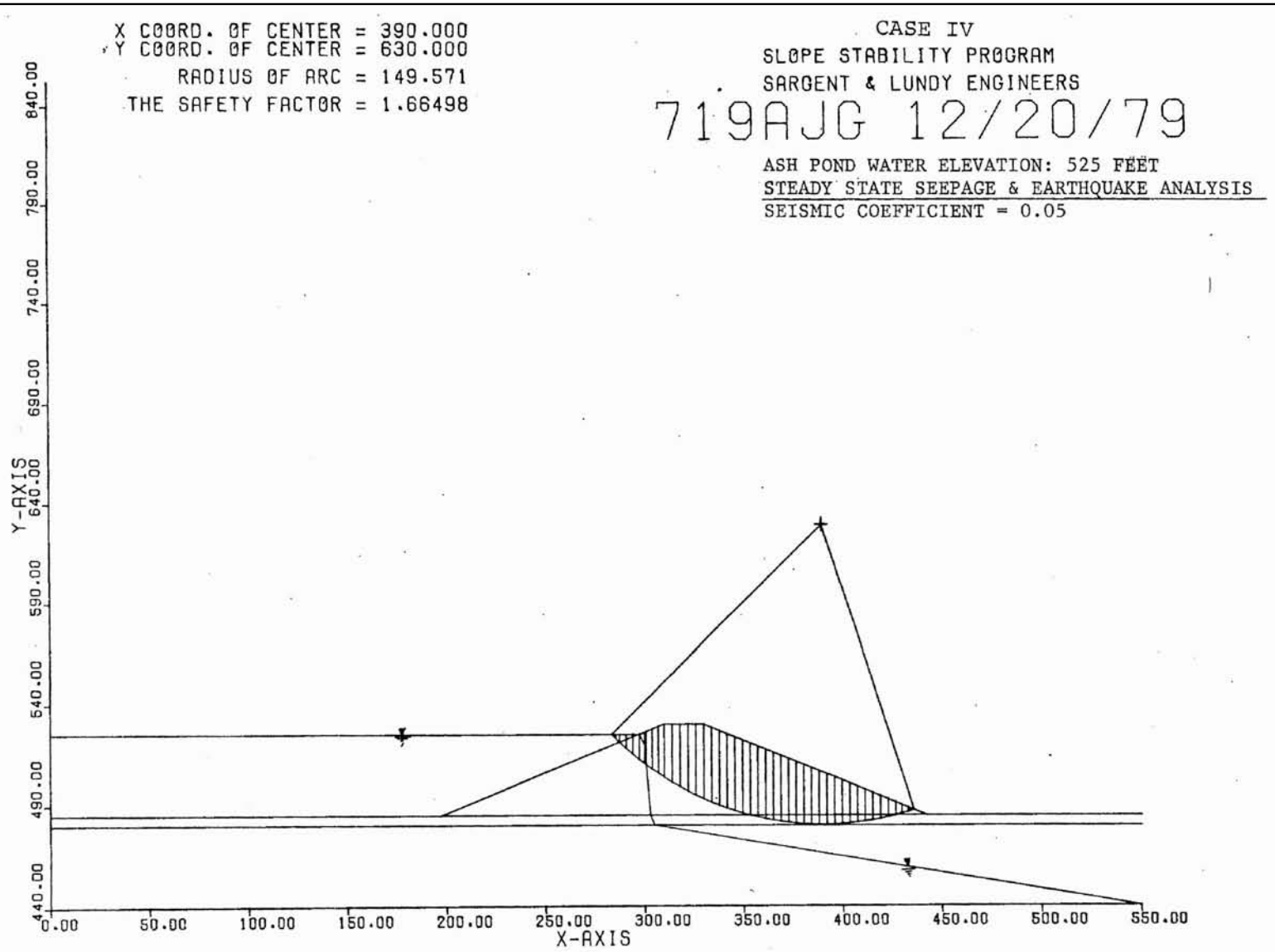

IMAGE REFERENCE: ENGINEERING DATA COMPILATION FOR ASH STORAGE POND FACILITY, PREPARED BY SARGENT & LUNDY ENGINEERS, MARCH 14, 1980.

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STEADY STATE SEEPAGE AND EARTHQUAKE ANALYSIS

GHENT GENERATING STATION
GHENT, KENTUCKY

PROJECT NO. 20085.2030

DATE: 12/2009

FIGURE 10C

LEGEND

ZONE I CLAY
ZONE II RANDOM ROCK FILL
ZONE III CLASS III CHANNEL LINING FOR WAVE PROTECTION
ZONE IV RANDOM ROCK FILL
ZONE V ASH OR CCB FROM ATB #1

SUMMARY OF SHEAR STRENGTH PROPERTIES

Description	Total Stress			Effective Stress		
	$\phi°$	c(p.s.f.)	γ(p.c.f.)	$\bar{\phi}°$	$\bar{c}$(p.s.f.)	γ(p.c.f.)
Zone I	0	1800	120	27	0	120
Zone II	30	0	120	30	0	120
Zone III	32	0	115	32	0	115
Zone IV	30	0	120	30	0	120
Zone V	28.7	0	90	28.7	0	90
Filter Material	32	0	115	32	0	115
Hydraulically Placed Ash	28.7	0	75	28.7	0	75
Soil Foundation Material	0	1700	120	25	0	120

SUMMARY OF STABILITY ANALYSIS

Circle	Loading Condition	X (Feet)	Y (Feet)	R (Feet)	Factor of Safety
A 4	Downstream Slope – Short Term – Static Loading Crest Elev. 800.0' – Pool Elev. 752.0'	-715 ~~-525~~	1495 ~~1228~~	912 ~~646~~	2.1 ~~1.8~~
B 4	Downstream Slope – Long Term – Static Loading Crest Elev. 800.0' – Pool Elev. 796.9'	-650 ~~-427~~	1280 ~~1198~~	642 ~~503~~	1.6 ~~1.5~~
C 4	Downstream Slope – Long Term – Dynamic Loading Crest Elev. 800.0' – Pool Elev. 796.9'	-650 ~~-527~~	1280 ~~1540~~	642 ~~859~~	1.2 ~~1.2~~
D	Upstream Slope – Short Term – Static Loading Crest Elev. 800.0' – Pool Elev. 752.0'	206	915	266	2.0
E	Upstream Slope – Long Term – Static Loading Crest Elev. 800.0' – Pool Elev. 796.9'	313	990	351	4.5
F	Upstream Slope – Long Term – Dynamic Loading Crest Elev. 800.0' – Pool Elev. 796.9'	223	1475	707	1.2

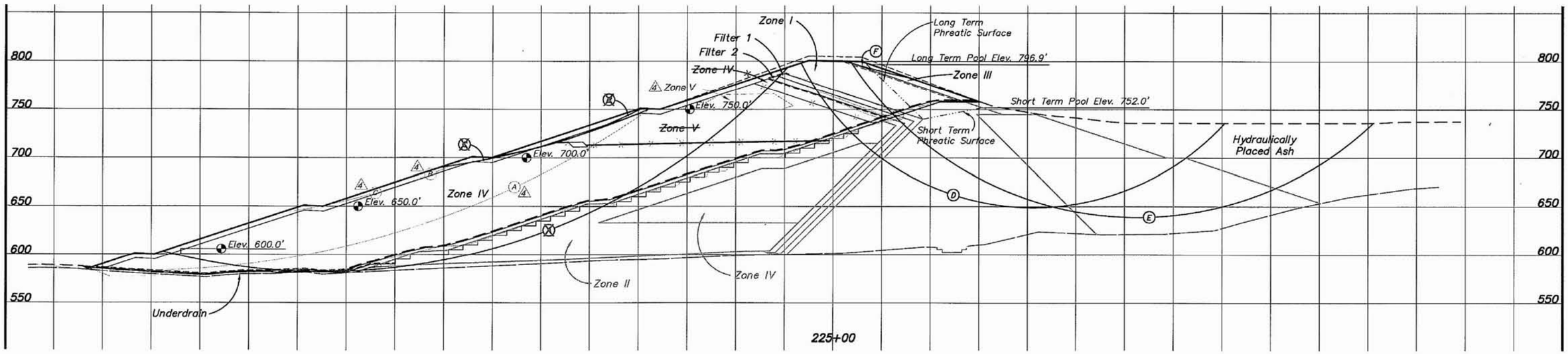

IMAGE REFERENCE: PHASE II ASH TREATMENT BASIN NO. 2, GHENT GENERATING STATION, STABILITY ANALYSES, SHEET 74 OF 74 RECORD DRAWINGS DATED DECEMBER 4, 2003.

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STABILITY OF ATB #2

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FIGURE 11

File: K:\20085\CADD\ACAD\FIGURES\2030 GHENT GENERATING STATION\2030_11_STABILITY OF ATB #2.DWG Saved: 12/7/2009 11:29:57 AM PLotted: 12/7/2009 11:30:36 AM User: Gray, Timmolyn

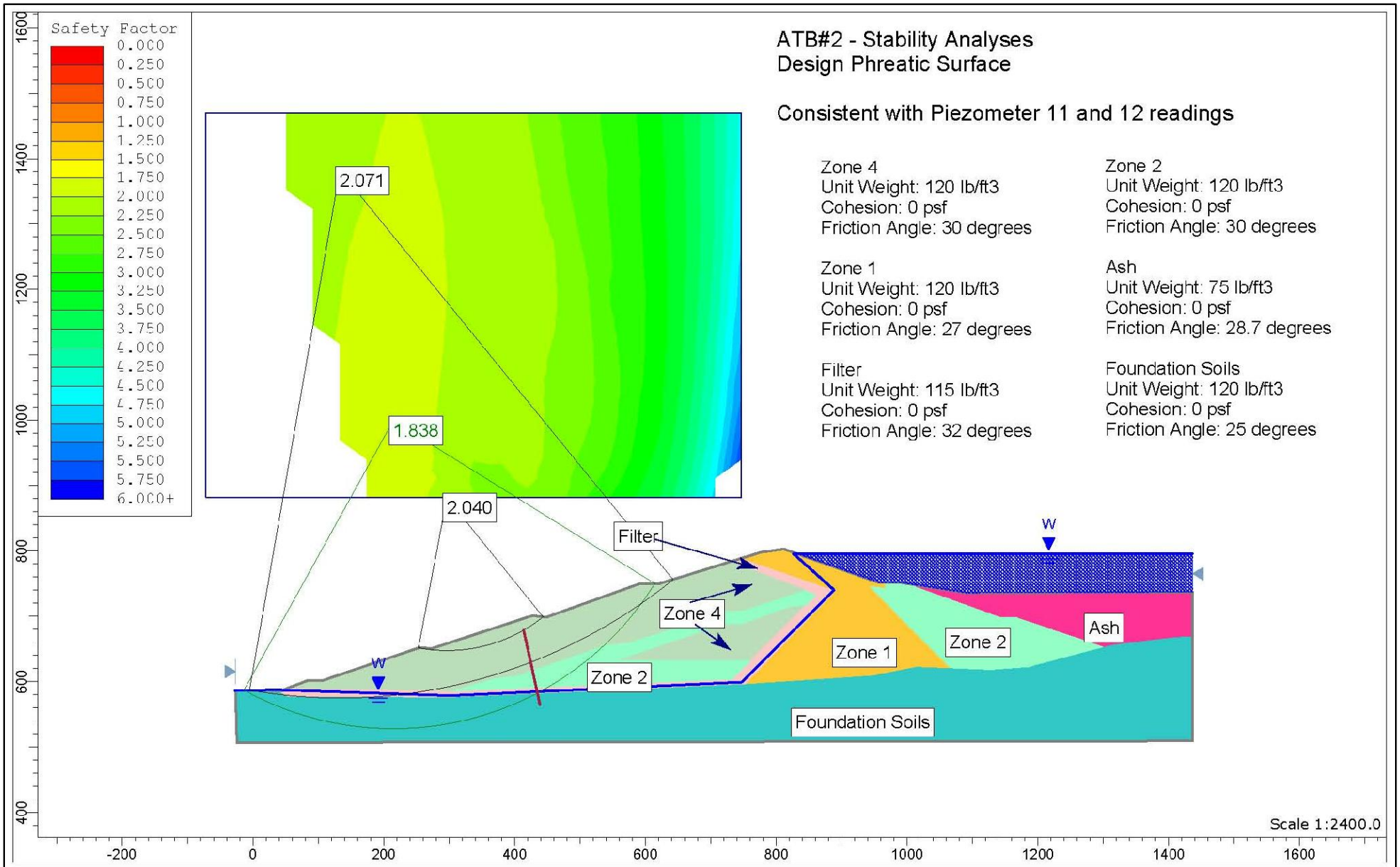

IMAGE REFERENCE: ATB #2 STABILITY ANALYSIS BY CHA, STEADY STATE CONDITION WITH DESIGN PHREATIC SURFACE – DOWNSTREAM SLOPE.

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ATB #2 STABILITY ANALYSIS STATIC DESIGN WATER TABLE

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DATE: 12/2009

FIGURE 12A

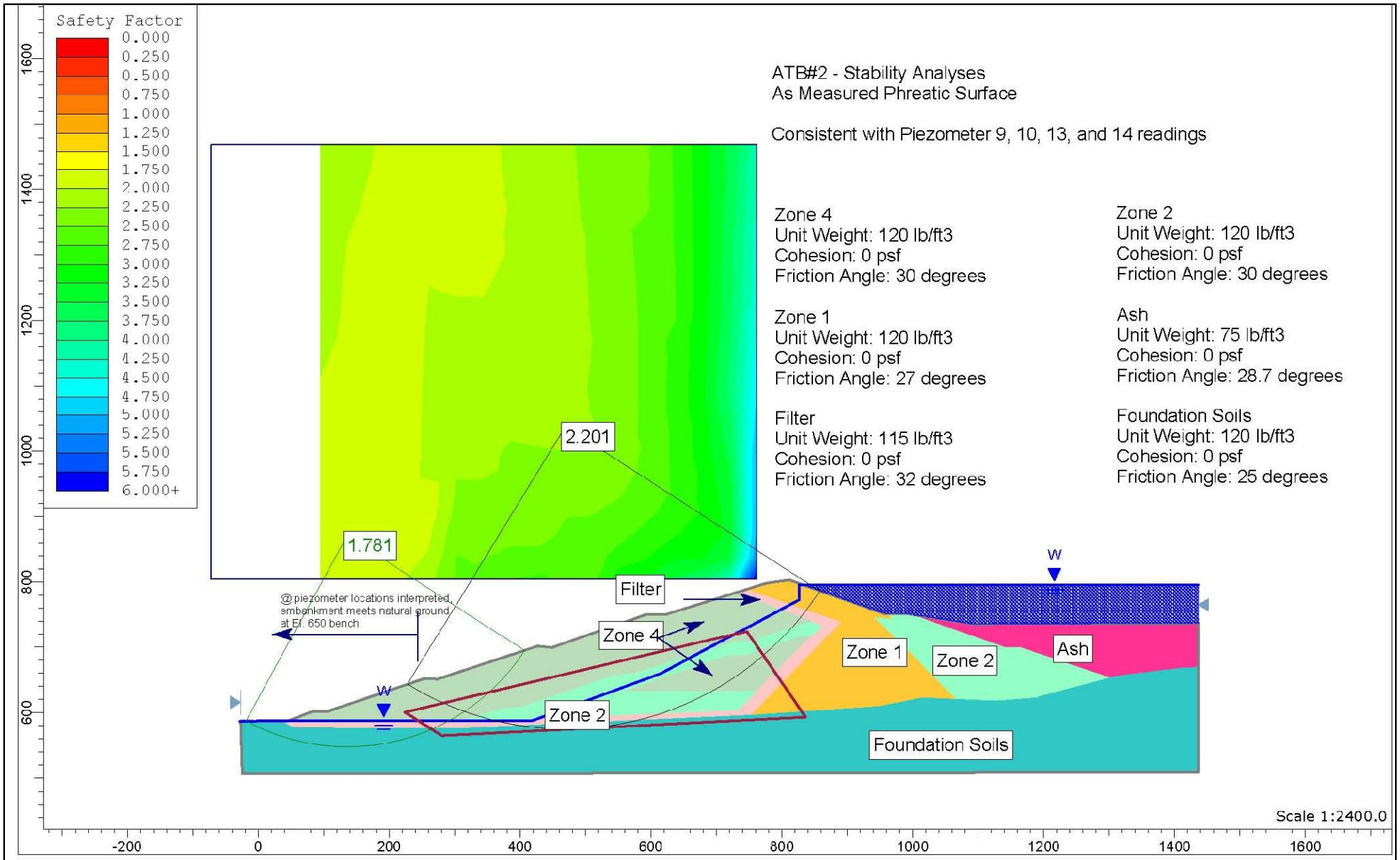

IMAGE REFERENCE: ATB #2 STABILITY ANALYSIS BY CHA, STEADY STATE CONDITION WITH AS MEASURED PHREATIC SURFACE – DOWNSTREAM SLOPE.

Drawing Copyright © 2009

CHA
III Winners Circle, PO Box 5269 · Albany, NY 12205-0269
Main: (518) 453-4500 · www.chacompanies.com

ATB #2 STABILITY ANALYSIS STATIC ADJUSTED WATER

GHENT GENERATING STATION
GHENT, KENTUCKY

PROJECT NO. 20085.2030

DATE: 12/2009

FIGURE 12B

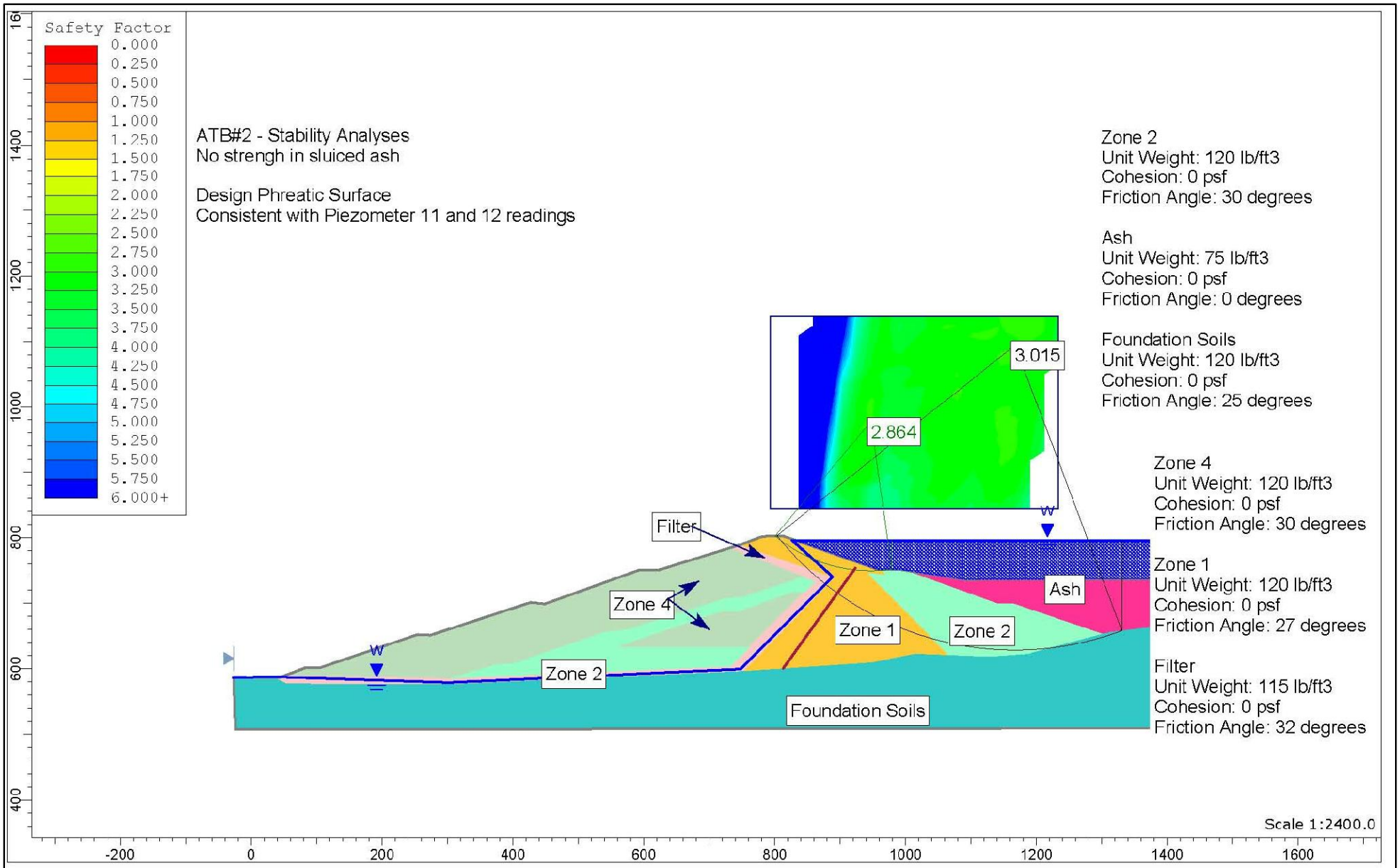

IMAGE REFERENCE: ATB #2 STABILITY ANALYSIS BY CHA, STEADY STATE CONDITION WITH NO STRENGTH IN SLUICED ASH – UPSTREAM SLOPE.

Drawing Copyright © 2009

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Main: (518) 453-4500 · www.chacompanies.com

ATB #2 STABILITY ANALYSIS STATIC UPSTREAM NO ASH STRENGTH

GHENT GENERATING STATION
GHENT, KENTUCKY

PROJECT NO. 20085.2030

DATE: 12/2009

FIGURE 12C

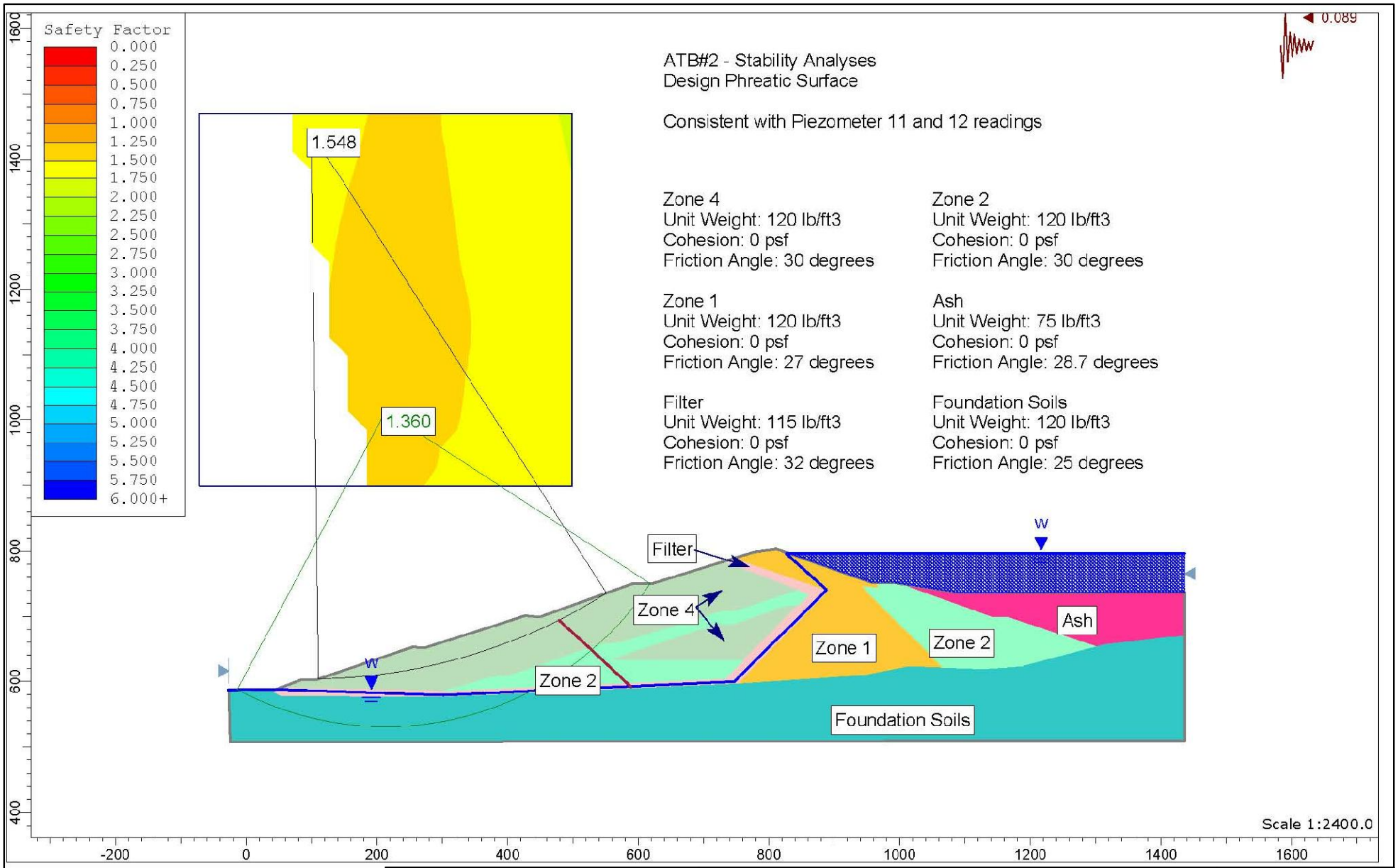

IMAGE REFERENCE: ATB #2 STABILITY ANALYSIS BY CHA, SEISMIC CONDITION– DOWNSTREAM SLOPE.

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Main: (518) 453-4500 · www.chacompanies.com

ATB #2 STABILITY ANALYSIS DOWNSTREAM DYNAMIC

GHENT GENERATING STATION
GHENT, KENTUCKY

PROJECT NO. 20085.2030

DATE: 12/2009

FIGURE 12D

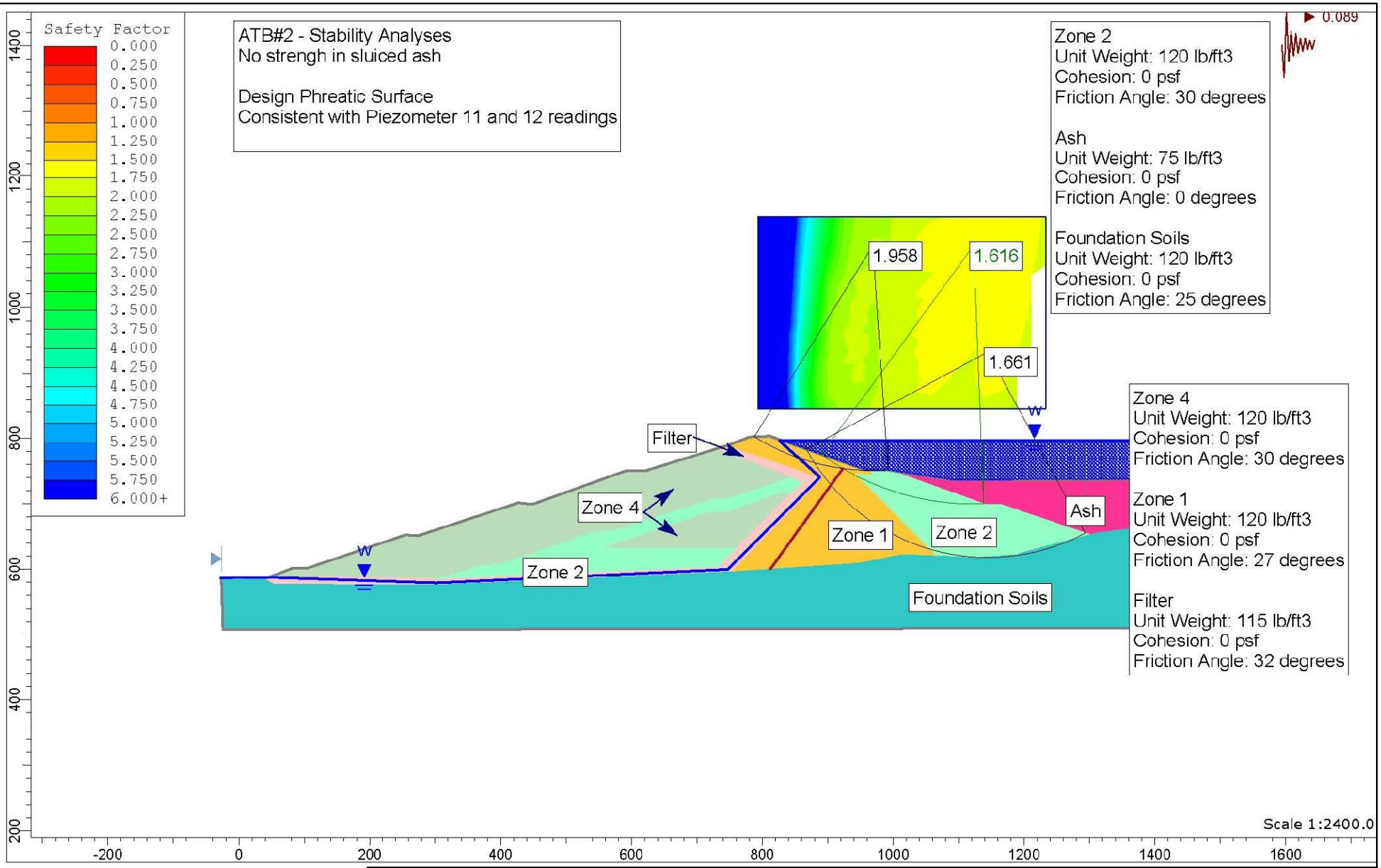

IMAGE REFERENCE: ATB #2 STABILITY ANALYSIS BY CHA, SEISMIC CONDITION– UPSTREAM SLOPE.

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Main: (518) 453-4500 · www.chacompanies.com

ATB #2 STABILITY ANALYSIS DYNAMIC UPSTREAM NO ASH STRENGTH

GHENT GENERATING STATION
GHENT, KENTUCKY

PROJECT NO. 20085.2030

DATE: 12/2009

FIGURE 12E

4.0 CONCLUSIONS/RECOMMENDATIONS

4.1 Acknowledgement of Management Unit Condition

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

A management unit found to be in satisfactory condition is defined as one in which no existing or potential management unit safety deficiencies are recognized. Acceptable performance is expected under all applicable loading conditions in accordance with the applicable criteria. Minor maintenance items may be required.

CHA's assessment of the ATB #1, ATB #2, and Gypsum Stacking Facility dikes indicate that they are in satisfactory condition. Kentucky Utilities provided CHA with descriptions of a proactive maintenance and monitoring program at these facilities. These efforts should be continued.

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

4.2 ATB #1 General Condition Monitoring and Maintenance

The downstream slope of ATB #1 was found to be in satisfactory condition. A few areas were observed that warrant monitoring on a routine basis to confirm that changes are not occurring or periodic maintenance. These areas are as follows:

- Steep areas near the top of the downstream slope where grading of the dam crest resulted in over steepened slopes should be monitored to ensure that slope movements do not develop in these steep areas.

- Tire ruts from mowing operations should be monitored to ensure they are not worsening or resulting in localized surficial sloughing or erosion. Periodic maintenance may be warranted.
- Fill the depression and shallow erosion rills on the bench at the northeast corner of the impoundment. These areas should be identified after filling for further monitoring to ensure that this depression is not a continuing condition indicative of embankment stability concerns.
- Remove debris and vegetation from the ATB #1 skimmer at the decant structure to discourage further vegetation growth.

4.3 ATB #2 General Condition Monitoring and Maintenance

The downstream slope of ATB #2 was found to be in satisfactory condition. A few areas were observed that warrant monitoring on a routine basis to confirm that changes are not occurring or periodic maintenance. These areas are as follows:

- Continue to be vigilant in watching for rodent holes. A few small rodent holes were observed.
- Monitor, and improve drainage where possible on the benches to prevent stormwater from ponding.
- Cut larger brush from the embankment/groin swale contacts where mowers cannot get close enough to the swale rip rap for effective mowing.
- Keep toe drains free of vegetation and debris**.**
- Monitor the crest for potholes and erosion rills that may require refilling.

4.4 Erosion Repair at ATB #2

On the west side of the main fill of the dam, there is an erosion rill about 2 feet deep. This erosion feature needs to be filled and the adjacent drainage swale regraded as necessary to prevent this type of erosion from occurring in this area.

4.5 Toe Drain Cleaning

One of the toe drains on the east side of the secondary fill has mud partially clogging the end of the drain pipe. It appeared from our observations and a review of ATC's January 2009 inspection that a natural slope slough in the area of this headwall had buried the pipe. While the drain pipe had been re-exposed, mud from the slough still partially clogged the pipe. This pipe needs to be cleaned out, and monitored to confirm that seepage is clear and that the surrounding natural slopes are stable.

4.6 Gypsum Stacking Facility Standing Water

Standing water was observed along the east side of the Gypsum Stacking Facility. Indications were that this standing water was related to poor drainage of stormwater. However, long term standing water can contribute to softening of the embankment toe and foundation soils, and prevent inspectors from differentiating seepage from ponded stormwater. CHA recommends improving the drainage in this area to provide positive drainage of stormwater in this area.

4.7 Seepage at the Gypsum Stacking Facility

Kentucky Utilities is working with Stantec to evaluate and resolve a seep observed about 2 feet below the crest of the starter dike on the east embankment. Corrective action of this seep would appear critical prior to raising the pool elevation within the stacking facility.

4.8 Rapid Drawdown Stability Analysis at ATB #2

A rapid drawdown analysis has not been performed for ATB #2. Although the potential for this type of loading condition is low, it is standard dam safety practice to evaluate the condition for full understanding of the behavior of the upstream embankment should water need to be evacuated from the reservoir rapidly. There have also been documented case histories where other types of failure (such as a gate failure) have resulted in rapid drawdown conditions developing which have led to a domino effect and made the situation worse. CHA recommends that a rapid drawdown analysis be performed for ATB #2, particularly since the clay (low permeability) core is located on the upstream slope of the raised portion of the dam.

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 Ghent Generating 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.

APPENDIX A

Completed EPA Coal Combustion Dam Inspection Checklist Forms

&

Completed EPA Coal Combustion Waste (CCW) Impoundment Inspection Forms

Coal Combustion Dam Inspection Checklist Form

US Environmental Protection Agency

Site Name:	Ghent Power Generating Station	Date:	10-07-09
Unit Name:	Ash Treatment Basin #1	Operator's Name:	Kentucky Utilities
Unit I.D.:	ATB #1	Hazard Potential Classification:	High Significant Low
Inspector's Name:	Katherine Adnams & Anthony Stellato, P.E.		

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?	See Note		18. Sloughing or bulging on slopes?		X
2. Pool elevation (operator records)?	523		19. Major erosion or slope deterioration?		X
3. Decant inlet elevation (operator records)?	523		20. Decant Pipes:		
4. Open channel spillway elevation (operator records)?	Not Applicable		Is water entering inlet, but not exiting outlet?		X
5. Lowest dam crest elevation (operator records)?	530		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?	See	Note
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)?	NA		From underdrain?	NA	
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?	See	Note
15. Are spillway or ditch linings deteriorated?	NA		22. Surface movements in valley bottom or on hillside?		X
16. Are outlets of decant or underdrains blocked?	NA		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

1. Daily observations are made by plant personnel. State of Kentucky Dam Safety program makes inspections about every two years.

In January 2009 an independent consultant performed a visual inspection of ATB #1.

20., 21. The discharge end of the outlet pipe was inaccessible due to flow through the pipe.

NA = Not Applicable

U. S. Environmental Protection Agency

Coal Combustion Waste (CCW)
Impoundment Inspection

Impoundment NPDES Permit # KY0002038 INSPECTOR Adnams/Stellato
Date October 7, 2009

Impoundment Name Ash Treatment Basin #1
Impoundment Company Kentucky Utilities
EPA Region 4
State Agency (Field Office) Addresss 300 Fair Oaks Lane
Frankfort, KY 40601
Name of Impoundment ATB #1
(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: Primarily receives decant discharge from ATB #2

Nearest Downstream Town : Name Ghent, KY/Vevay, IN
Distance from the impoundment Approx. 1.2 miles
Impoundment
Location: Longitude 85 Degrees 01 Minutes 38 Seconds
Latitude 38 Degrees 44 Minutes 55 Seconds
State KY County Carroll

Does a state agency regulate this impoundment? YES X NO _____

If So Which State Agency? KY Department of Environmental Protection, Division of Water

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.

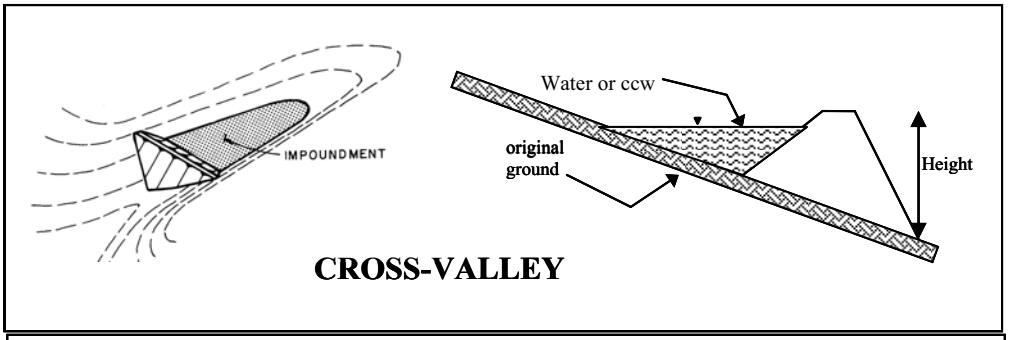
_____ **SIGNIFICANT HAZARD POTENTIAL:** Dams assigned the significant hazard potential classification are those dams where failure or misoperation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or can impact other concerns. 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.

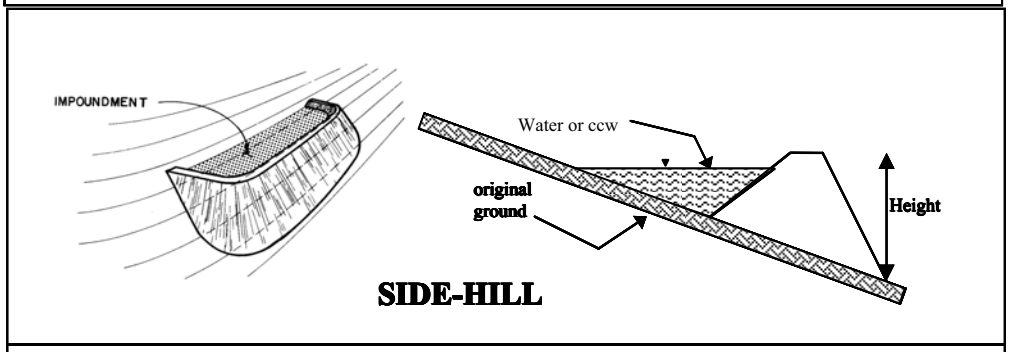
X_____ **HIGH HAZARD POTENTIAL:** Dams assigned the high hazard potential classification are those where failure or misoperation will probably cause loss of human life.

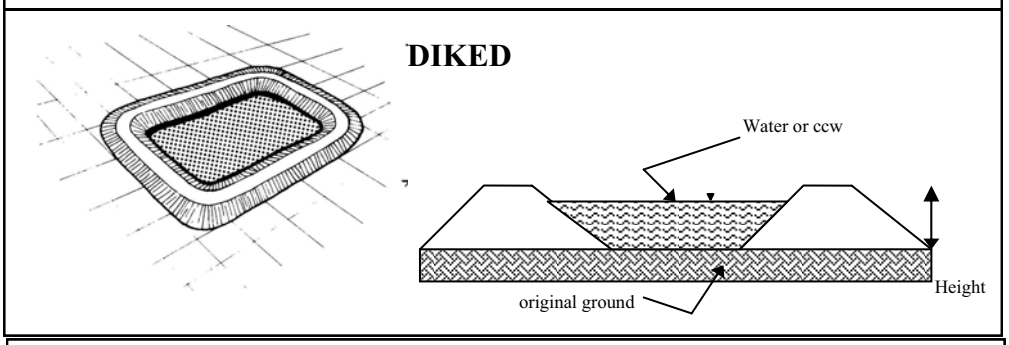
DESCRIBE REASONING FOR HAZARD RATING CHOSEN:

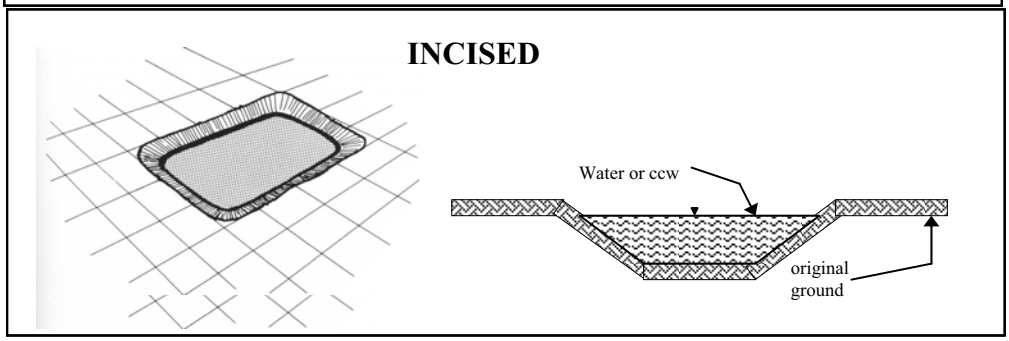
Power generating station is immediately downstream from the impoundment and is staffed 24/7.

CONFIGURATION:









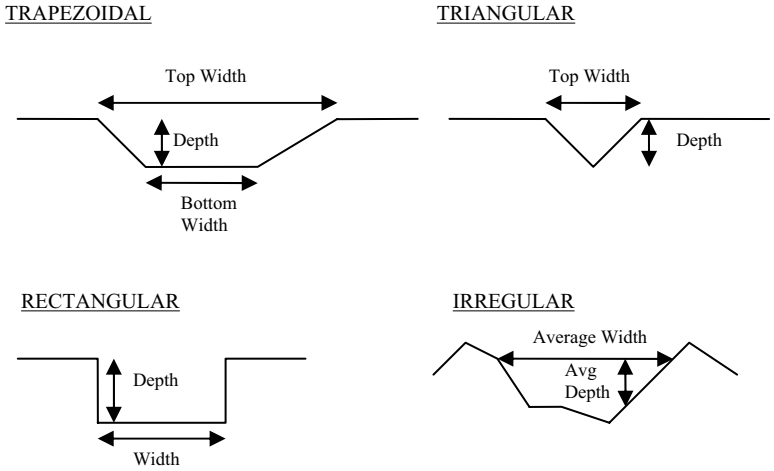
_____ Cross-Valley
__X__ Side-Hill
_____ Diked
_____ Incised (form completion optional)
_____ Combination Incised/Diked

Embankment Height ___52___ feet Embankment Material ___Compacted clay___
Pool Area ___120___ acres Liner ___NA___
Current Freeboard ___7___ feet Liner Permeability ___NA___

TYPE OF OUTLET (Mark all that apply)

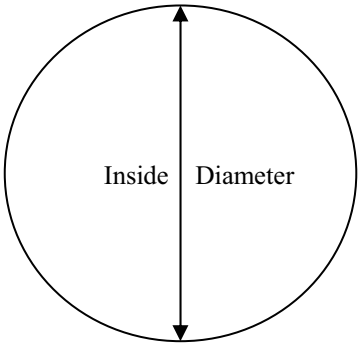
_____ **Open Channel Spillway**
_____ Trapezoidal
_____ Triangular
_____ Rectangular
_____ Irregular

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



__X__ **Outlet**

48-in. inside diameter



Material
_____ corrugated metal
_____ welded steel
X_____ concrete
_____ plastic (hdpe, pvc, etc.)
_____ other (specify) _____

_____

Is water flowing through the outlet? YES __X__ NO _____

_____ **No Outlet**

_____

_____ **Other Type of Outlet** (specify) _____

The Impoundment was Designed By Sargent & Lundy Engineers
_____

Has there ever been a failure at this site? YES _____ NO X_____

If So When? _____

If So Please Describe : _____

Has there ever been significant seepages at this site? YES X NO _____

If So When? 1980

IF So Please Describe:

During a rise in the operating pool elevation, the water level ATB 1 dropped about 6 feet. It was determined that seepage was occuring between ATB 1 and the Ohio River based on a rise in piezometer levels. Stabilizing work was performed and there have not been reported problems since.

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

If so, which method (e.g., piezometers, gw pumping,...)? 1980

If so Please Describe : The outcome of the 1980 seepage issue will be reviewed as part of the document review for this site. Exact details are not available at this time.

Coal Combustion Dam Inspection Checklist Form

US Environmental Protection Agency

Site Name:	Ghent Power Generating Station	Date:	10-07-09
Unit Name:	Ash Treatment Basin #2	Operator's Name:	Kentucky Utilities
Unit I.D.:	ATB #2	Hazard Potential Classification:	High Significant Low
Inspector's Name:	Katherine Adnams & Anthony Stellato, P.E.		

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?	See Note		18. Sloughing or bulging on slopes?		X
2. Pool elevation (operator records)?	794		19. Major erosion or slope deterioration?		X
3. Decant inlet elevation (operator records)?	794		20. Decant Pipes:		
4. Open channel spillway elevation (operator records)?	Not Applicable		Is water entering inlet, but not exiting outlet?		X
5. Lowest dam crest elevation (operator records)?	800		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)?	NA		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?	See	Note
15. Are spillway or ditch linings deteriorated?		X	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

1. Daily observations are made by plant personnel. State of Kentucky Dam Safety program makes inspections about every two years. In January 2009 an independent consultant performed a visual inspection of ATB #2.

21. The decant pipe extends below grade (under the access road) about 3,200 feet to a stilling basin. When flowing, discharge end of pipe is inaccessible. Underdrains daylight at several locations, some had minor seepage, some were dry.

22. Natural slope movements have occurred near, the east abutment, but have not intercepted the embankment

NA = Not Applicable

U. S. Environmental Protection Agency

Coal Combustion Waste (CCW)
Impoundment Inspection

Impoundment NPDES Permit # KY0002038 INSPECTOR Adnams/Stellato
Date October 7, 2009

Impoundment Name Ash Treatment Basin #2
Impoundment Company Kentucky Utilities
EPA Region 4
State Agency (Field Office) Addresss 300 Fair Oaks Lane
Frankfort, KY 40601
Name of Impoundment ATB #2
(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: Primarily receives fly ash and bottom ash.

Nearest Downstream Town : Name Ghent, KY/Vevay, IN
Distance from the impoundment Approx. 2 miles
Impoundment
Location: Longitude 85 Degrees 01 Minutes 23 Seconds
Latitude 38 Degrees 44 Minutes 23 Seconds
State KY County Carroll

Does a state agency regulate this impoundment? YES X NO _____

If So Which State Agency? KY Department of Environmental Protection, Division of Water

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.

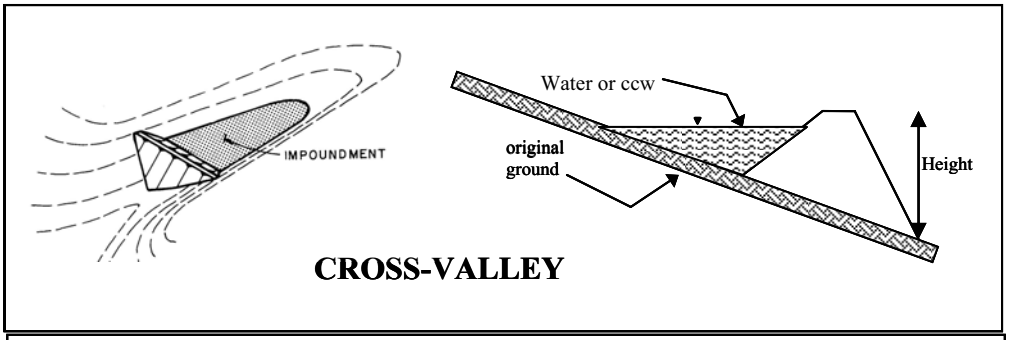
_____ **SIGNIFICANT HAZARD POTENTIAL:** Dams assigned the significant hazard potential classification are those dams where failure or misoperation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or can impact other concerns. 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.

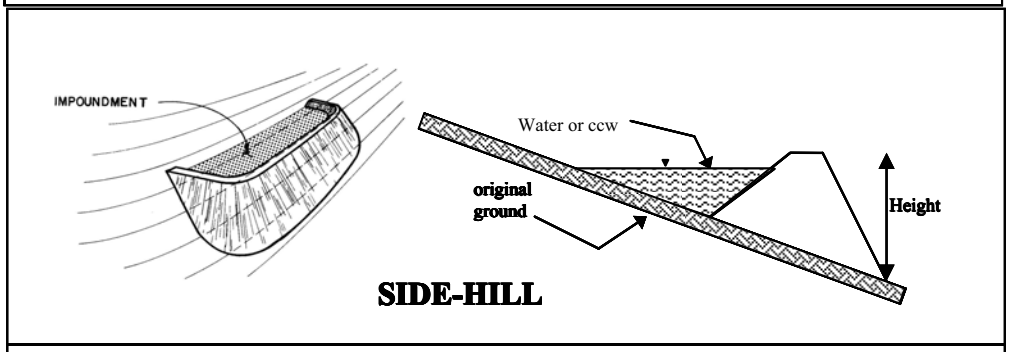
X_____ **HIGH HAZARD POTENTIAL:** Dams assigned the high hazard potential classification are those where failure or misoperation will probably cause loss of human life.

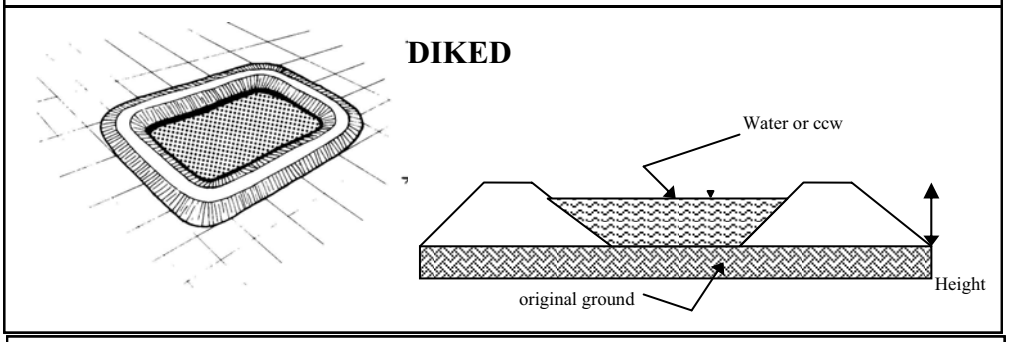
DESCRIBE REASONING FOR HAZARD RATING CHOSEN:

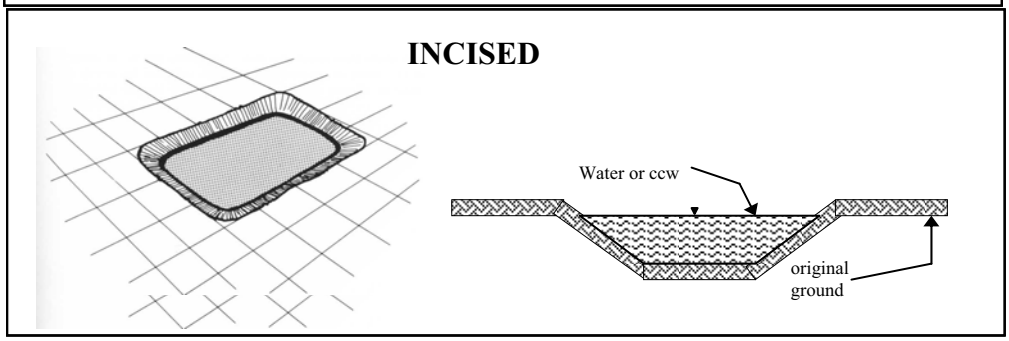
Power generating station is immediately downstream from the impoundment and is staffed 24/7.

CONFIGURATION:









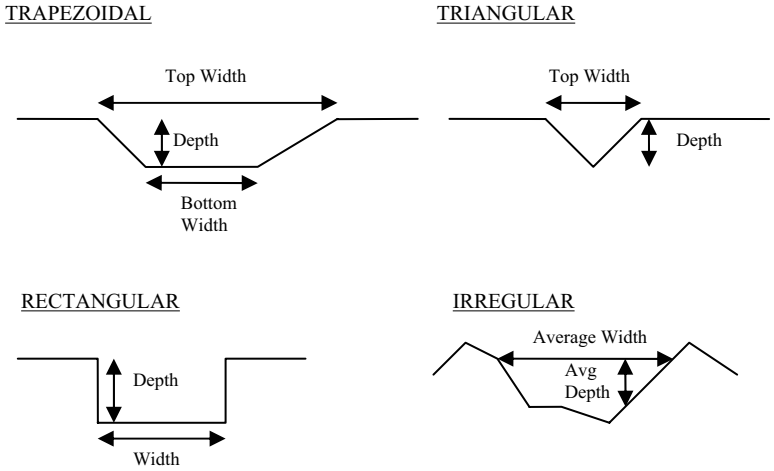
__X__ Cross-Valley
_____ Side-Hill
_____ Diked
_____ Incised (form completion optional)
_____ Combination Incised/Diked

Embankment Height ___227___ feet Embankment Material ___Zoned Fill___
Pool Area ___146___ acres Liner ___NA___
Current Freeboard ___6___ feet Liner Permeability ___NA___

TYPE OF OUTLET (Mark all that apply)

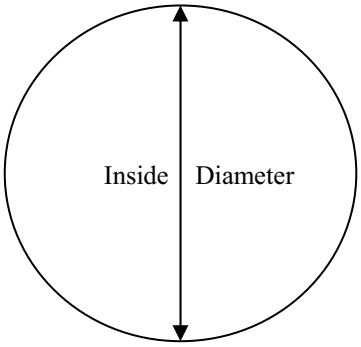
_____ **Open Channel Spillway**
_____ Trapezoidal
_____ Triangular
_____ Rectangular
_____ Irregular

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



__X__ **Outlet**

36-in. inside diameter



Material
_____ corrugated metal
_____ welded steel
_____ concrete
_____ plastic (hdpe, pvc, etc.)
X_____ other (specify) Ductile Iron beneath embankment HPDE along access road

_____

Is water flowing through the outlet? YES __X__ NO _____

_____ **No Outlet**

_____

_____ **Other Type of Outlet** (specify) _____

The Impoundment was Designed By FMSM Engineers (Fuller Mossbarger Scott & May)
_____

Has there ever been a failure at this site? YES _____ NO ___X_____

If So When? _____

If So Please Describe : _____

Has there ever been significant seepages at this site? YES _____ NO ___X___

If So When? _____

IF So Please Describe: _____

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,...)? _____

If so Please Describe : _____

Coal Combustion Dam Inspection Checklist Form

US Environmental Protection Agency

Site Name:	Ghent Power Generating Station	Date:	10-07-09
Unit Name:	Gypsum Stacking Facility	Operator's Name:	Kentucky Utilities
Unit I.D.:	Gypsum Stacking Facility	Hazard Potential Classification:	High Significant Low
Inspector's Name:	Katherine Adnams & Anthony Stellato, P.E.		

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?	See Note		18. Sloughing or bulging on slopes?		X
2. Pool elevation (operator records)?	518		19. Major erosion or slope deterioration?		X
3. Decant inlet elevation (operator records)?	See Note		20. Decant Pipes:		
4. Open channel spillway elevation (operator records)?	Not Applicable		Is water entering inlet, but not exiting outlet?		X
5. Lowest dam crest elevation (operator records)?	520, 530		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?	See Note	
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)?	NA		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?	See Note		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?	See	Note
15. Are spillway or ditch linings deteriorated?		X	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

1. Daily observations are made by plant personnel. State of Kentucky Dam Safety program makes inspections about every two years. In January 2009 an independent consultant performed a visual inspection of the Gypsum Stacking Facility

21. The decant outlet discharges into an incised reclaim pond an was therefore, not accessible. Seepage was observed on the east slope in an area about 30 to 50 feet wide near the top of the starter dike. Kentucky Utilities indicated that they are working with the engineer of record on this issue.

3., 5. Decant structures being adjusted based on current construction, top of starter dike El. 520, Current top of Gypsum Dike El. 530

NA = Not Applicable

U. S. Environmental Protection Agency

Coal Combustion Waste (CCW)
Impoundment Inspection

Impoundment NPDES Permit # KY0002038 INSPECTOR Adnams/Stellato

Date October 7, 2009

Impoundment Name Gypsum Stacking Facility

Impoundment Company Kentucky Utilities

EPA Region 4

State Agency (Field Office) Addresss 300 Fair Oaks Lane
Frankfort, KY 40601

Name of Impoundment Gypsum Stacking Facility

(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: Receives gypsum

Nearest Downstream Town : Name Ghent, KY/Vevay, IN

Distance from the impoundment Approx. 2.4 miles

Impoundment Location:

Longitude 85 Degrees 01 Minutes 40 Seconds

Latitude 38 Degrees 45 Minutes 06 Seconds

State KY County Carroll

Does a state agency regulate this impoundment? YES X NO _____

If So Which State Agency? KY Department of Environmental Protection, Division of Water

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.

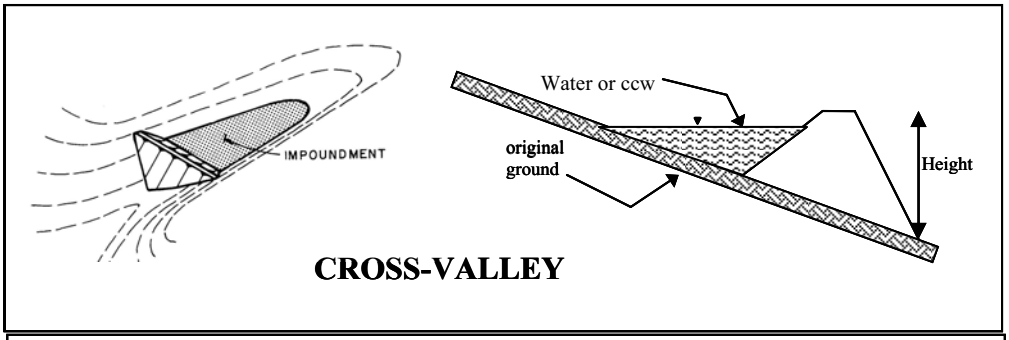
_____ **SIGNIFICANT HAZARD POTENTIAL:** Dams assigned the significant hazard potential classification are those dams where failure or misoperation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or can impact other concerns. 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.

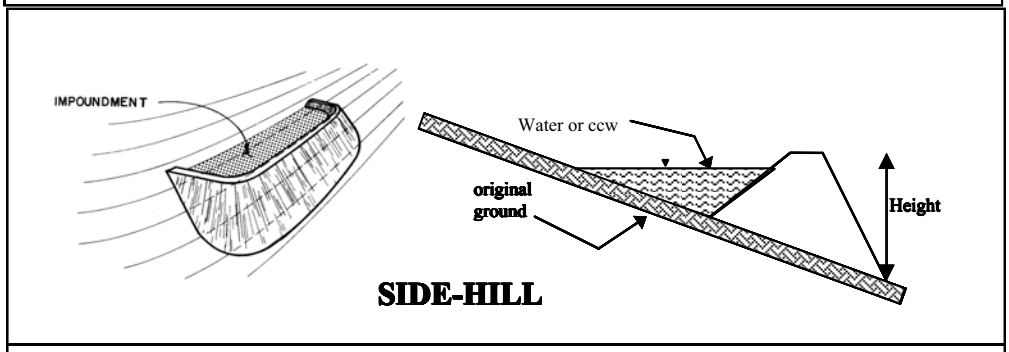
X_____ **HIGH HAZARD POTENTIAL:** Dams assigned the high hazard potential classification are those where failure or misoperation will probably cause loss of human life.

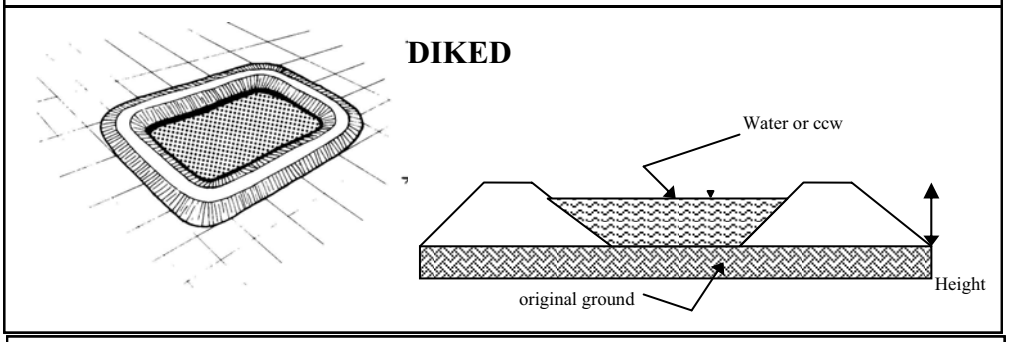
DESCRIBE REASONING FOR HAZARD RATING CHOSEN:

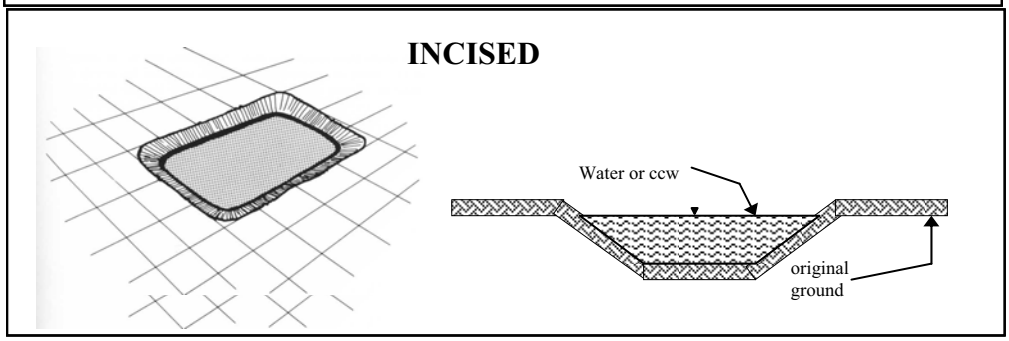
Power generating station is immediately downstream from the impoundment and is staffed 24/7.

CONFIGURATION:









_____ Cross-Valley
_X_____ Side-Hill
_____ Diked
_____ Incised (form completion optional)
_____ Combination Incised/Diked

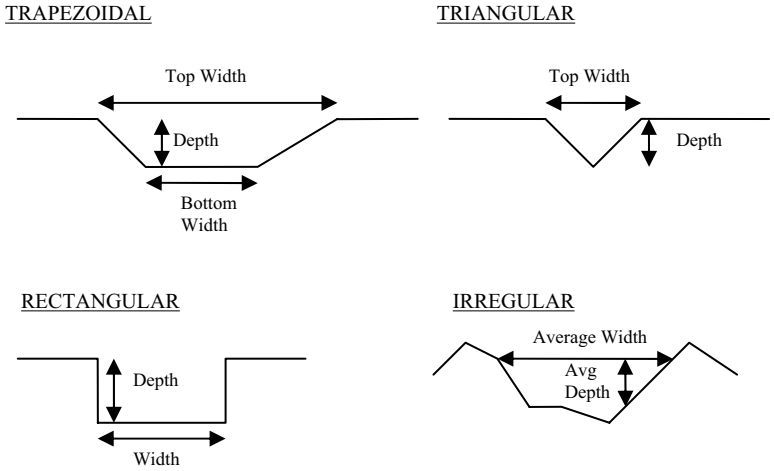
Embankment Height ____30_____ feet
Pool Area ___46_____ acres
Current Freeboard 12_____ feet

Embankment Material__Compacted Clay to 520, compacted gypsum above.
Liner NA_____
Liner Permeability NA_____

TYPE OF OUTLET (Mark all that apply)

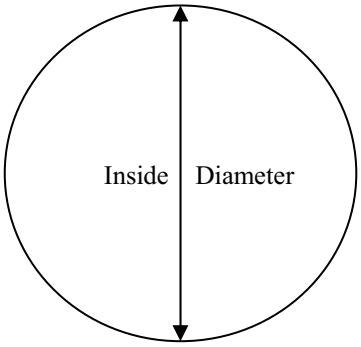
_____ **Open Channel Spillway**
_____ Trapezoidal
_____ Triangular
_____ Rectangular
_____ Irregular

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



__X__ **Outlet**

_____ inside diameter



Material
_____ corrugated metal
_____ welded steel
_____ concrete
X_____ plastic (hdpe, pvc, etc.)
_____ other (specify) _____

2 @ 24-in

Is water flowing through the outlet? YES __X__ NO _____

_____ **No Outlet**

_____

_____ **Other Type of Outlet** (specify) _____

The Impoundment was Designed By FMSM Engineers (Fuller Mossbarger Scott & May) acquired by Stantec.

Has there ever been a failure at this site? YES _____ NO __X_____

If So When? _____

If So Please Describe : _____

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

If So When? Current

IF So Please Describe:

Until 2009 when additional FGD units came on line at the Ghent Power Station, the Starter Dike and beneficial reuse agreements contained all generated gypsum. Now, additional capacity is required so the original plan to enlarge the gypsum stacking facility is underway. The dike has been raised in 2009 by 10 feet. A seep has developed in a localized area of the east dike. Kentucky Utilities is working with the engineer of record (Stantec) to address this area of seepage.

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,...)? _____

If so Please Describe : _____