Report of Dam Safety Assessment of Coal Combustion Surface Impoundments
Interstate Power and Light Company
Sutherland Generating Station
Marshalltown, IA

AMEC Project No. 3-2106-0191

Prepared By:

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Prepared For:

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PROFESSIONAL ENGINEER
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12/10/12

October 2012

amec

I certify that the management units referenced herein:

Interstate Power and Light Company's Sutherland Power Station North and South Primary Settling Ponds (Primaries) and Main (Secondary and Polishing) Ash Settling Ponds were assessed on June 14, 2011. I further certify that this report was prepared under my direct personal supervision.

Signature Don W Dotson

Don W. Dotson, PE
Senior Geotechnical Engineer

List of AMEC Participants who have participated in the assessment of the management units and in preparation of the report:

- Chris Eger
  CADD Technician
- Daniel Conn
  GIS Specialist
- Mary Sawitzki, PE
  Civil/Environmental Engineer
- James Black, PE
  Civil Engineer

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1.0 INTRODUCTION AND PROJECT DESCRIPTION

1.1 Introduction

AMEC was contracted by the United States Environmental Protection Agency (EPA) contract BPA EP09W001702, to perform assessments of selected coal combustion byproducts surface impoundments. AMEC was directed by EPA, through the provided scope of work and verbal communications, to utilize the following resources and guidelines to conduct a site assessment and produce a written assessment report for the coal combustion waste facilities and impoundments.

- Coal Combustion Waste (CCW) Impoundment Inspection forms (hazard rating, found in Report Appendix A)
- Coal Combustion Dam Inspection Checklist (found in Report Appendix A)
- Impoundment Design Guidelines of the Mining Safety and Health Administration (MSHA) Coal Mine Impoundment Inspection and Plan Review Handbook (hydrologic, hydraulic, and stability conditions)
- National Dam Safety Review Board Condition Assessment Definitions (condition rating)

As part of this contract with EPA, AMEC was assigned to perform an assessment of Interstate Power and Light Company's (IPL) Sutherland Generating Station (Sutherland), which is located in Marshalltown, Iowa as shown on Figure 1, the Site Location and Vicinity Map. (This figure is presented on the next page and in the figures section of this report.)

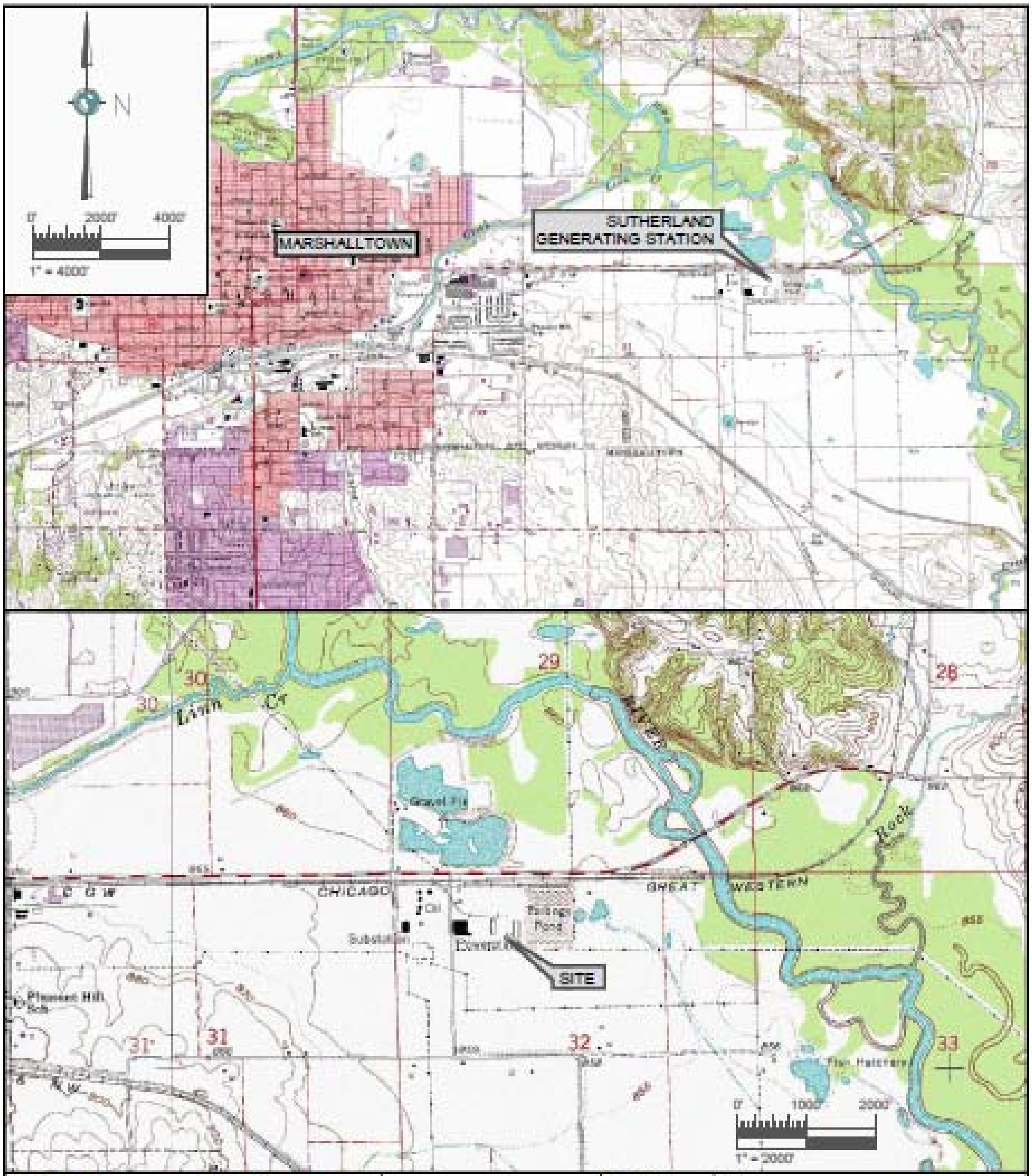
A site visit to Sutherland was made by AMEC on June 14, 2011. The purpose of the visit was to perform visual observations, to inventory coal combustion waste (CCW) surface impoundments, assess the containment dikes, and to collect relevant historical impoundment documentation.

AMEC engineers, Don Dotson, PE and James Black, PE, were accompanied during the site visit by the individuals listed on Table 1.

Table 1. Site Visit Attendees

Company or Organization	Name and Title
Interstate Power and Light Company	Nichol Toomire, Plant Manager
Interstate Power and Light Company	George Kueny, Environmental and Safety Specialist
Alliant Energy Corporate Services, Inc.	Tony Morse, Environmental Specialist II
Alliant Energy Corporate Services, Inc.	William Skalitzky, Senior Environmental Specialist

AMEC submitted a draft of this report in July 2011. AMEC received comments from EPA and Alliant Energy in September 2012 Alliant Energy comments included a response to the draft report by Aether, dbs dated July 2012 (see Appendix E). Minor corrections and descriptive edits have been made within this report. Technical comments are addressed in Section 4, Comments and Recommendations section of this report. Between July 2011 and September 2012 (after AMEC's site visit), the units at the Sutherland Plant were switched from coal fired to natural gas (but still capable of burning coal). Coal combustion waste is not presently being discharged to the ponds and the water levels have dropped significantly. As a result, the descriptions of water levels within this report may not represent current conditions.



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PROTECTION AGENCY

PROJECT
ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS

TITLE
INTERSTATE POWER AND LIGHT COMPANY
SUTHERLAND GENERATING STATION, MARSHALLTOWN, IA
SITE LOCATION & VICINITY MAP

DWN BY: CAE
DATUM:
DATE: 7/13/11
CHK'D BY: JHB
REV. NO.:
PROJECT NO: 3-2106-0191.0001.****
PROJECTION:
SCALE: AS SHOWN
FIGURE No. 1

1.2 Project Background

Coal fired power plants, like IPL's Sutherland Generating Station, produce CCW as a result of the power production process. At Sutherland, impoundments (dams) were designed and constructed to provide storage and disposal for the CCW that is produced. CCW impoundment areas at the Sutherland facility are referred to as the North Primary Settling Pond (Unit 1 & 2 Initial Settling Pond), South Primary Settling Pond (Unit 3 Initial Settling Pond) and Main Ash Pond (Main Pond). Based on historic drawings, these ponds are located within the footprint of the original "ash pond" for the facility. At some time, the original ash pond was modified to include the primary ponds (North and South Primary Settling Ponds) to aid in the separation and removal of ash. This and other improvements, including the latest in 2006, have transformed the original "ash pond" to the current configuration to improve the detention time in the Main Pond by construction of fingers to increase the flow length and creating divisions within the basin, Polishing and Discharge (Bubbler) Ponds, to provide secondary and tertiary settlement areas. The original ash pond, current North Primary Settling Pond and Main Pond, was commissioned with Generating Units 1 and 2 at the plant in 1955. The current South Primary Settling Pond was commissioned with Generating Unit 3 in 1961.

The National Inventory of Dams (NID), administered by the U.S. Army Corps of Engineers (USACE), provides a hazard rating for many dams within the United States. The Ash Settling Ponds at Sutherland are not included in the NID.

1.2.1 Coal Combustion Dam Inspection and Checklist Forms

As part of the observations and evaluations performed at Sutherland, AMEC completed EPA's Coal Combustion Dam Inspection Checklists and CCW Impoundment Inspection Forms. Inspection forms for each pond are presented in Appendix A. The Impoundment Inspection Forms include a section that assigns a "Hazard Potential" that is used to indicate what would occur following failure of an impoundment. "Hazard Potential" choices include "Less than Low," "Low," "Significant," and "High." As defined on the Inspection Form, dams assigned a "Significant Hazard Potential" 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." "Low Hazard Potential" classification definition is reserved for dams 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." "Less than Low Hazard Potential" classification is reserved for dams where "failure or misoperation results in no probable loss of human life and no economic or environmental losses."

Based on the site visit evaluation of the impoundments, AMEC engineers assigned a "Low Hazard" potential to the Main Pond. A breach of the Main Pond would be confined to the owner's property. Based on the site visit and subsequent evaluation, the North and South Ponds are considered incised within the ash management area. Incised ponds are not given hazard or condition ratings. IPL provided information on these ponds and AMEC included them in the site visit. Information within this report for the North and South Ponds are provided for reference only.

1.2.2 State Issued Permits

The Iowa Department of Natural Resources (IDNR) issued an Iowa National Pollution Discharge Elimination System (NPDES) Permit to IPL. The current permit identification number is Iowa 6469103. This NPDES Permit authorizes IPL to discharge decant from the Main Ash Pond through Outfall 001 to an unnamed tributary to the Iowa River. The effective date of the permit is November 13, 2006. The permit date of expiration is November 12, 2011. The required date to file for renewal of the permit was May 16, 2011. IPL reports they submitted the renewal application through IDNR's WWPIE web-based system on May 15, 2011. Based on this information, the renewal application is still under review.

1.3 Site Description and Location

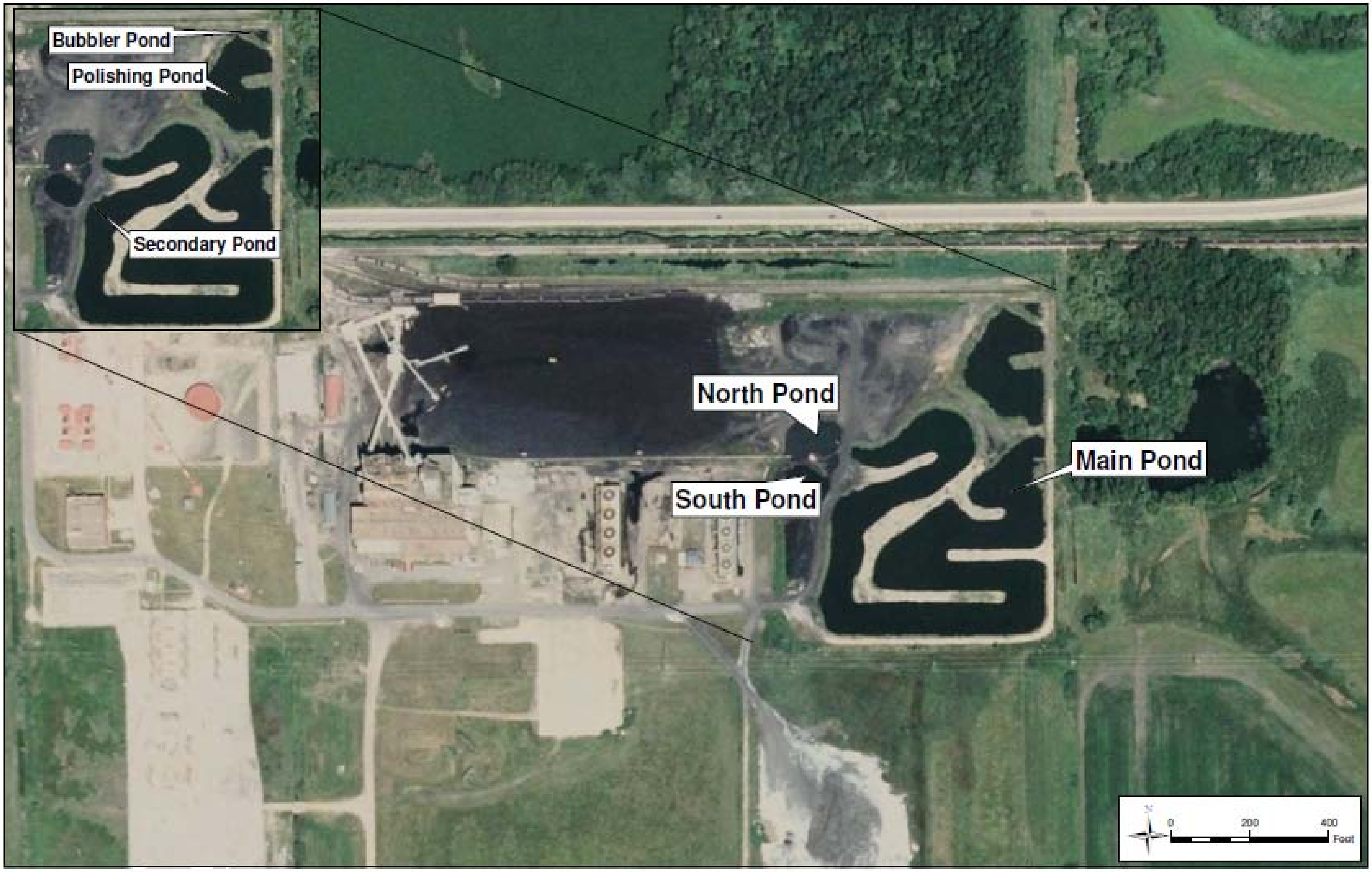
The Sutherland Generating Station is located in the city of Marshalltown, Marshall County, Iowa. The station is located on the east side of the city, adjacent and south of Main Street Road (County Highway E35) in a rural setting. Sutherland is atypical from other plants as water to cool the boilers is not obtained from an adjacent river, but from on-site wells. The ash pond area is located at the east end of the station. The Iowa River is located approximately one-half mile to the east of the site.

Figure 3, the Critical Infrastructure Map, provides an aerial view of the region and indicates the location of the Sutherland ash ponds in relation to schools, hospitals, and other critical infrastructure that is located within approximately 5 miles down gradient of the impoundments. A table that provides names and coordinate data for the infrastructure is included on the map. A Topographic Site Map is included in Figure 1. The Aerial Site Plan, shown on the next page and included in the figures section as Figure 2, provides a view of the pond areas.

1.4 Ash Ponds

The Sutherland Station originally consisted of three coal-fired steam generating units rated at 170 MW. Units 1 &2 were started in 1955 and Unit 3 started in 1962. With the retirement of Unit 2 in 2010 and the conversion of the remaining units to natural gas (but still capable of burning coal), the rated capacity for Units 1 and 3 is approximately 133 MWs.

The ash pond discharge has an NPDES permit for ash sluice water, cooling tower blowdown, boiler blowdown, low volume source leachate from a closed ash landfill, metal cleaning waste, coal pile runoff, and storm water associated with industrial activity. Bottom ash from the steam units is sluiced to the ash pond. Fly ash captured in the electrostatic precipitators is conveyed dry and stored in the fly ash silos. When the fly ash cannot be trucked offsite for beneficial uses, it is trucked to an on-site storage area where it is hydrated to form a beneficially reusable product called C-Stone. If the dry conveying system malfunctions, there is an emergency by-pass system that uses water to convey fly ash to the ash pond. Cooling water for the generating units is provided by several water wells on the site, and two cooling towers provide cooling for the circulating water system. A blowdown waste stream for the towers is used in the ash handling system and eventually ends up in the ash pond. Storm water in the coal handling and storage area drains through and underground tiling system, and is pumped to the ash pond. Other low-volume waste water streams in the plant are directed to the ash pond through a ground-floor sump pump.



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DWN BY: DJC
CKD BY: MS
Datum: NAD 83
Projection: UTM 15
Scale: As Shown

ASSESSMENT OF DAM SAFETY OF
COAL COMBUSTION SURFACE IMPOUNDMENTS

INTERSTATE POWER AND LIGHT COMPANY
SUTHERLAND GENERATING STATION,
MARSHALLTOWN, IA
SITE MAP

REV. No.: A
Date: 9-15-10
Project No: 3-2106-0191
Figure No: 2

All of the waste water, except for sluicing of Slag from Unit 3, enters the North Primary Settling Pond at the same location. Unit 3 is a cyclone boiler and its bottom ash produces a hard glass-like material called slag. The slag from Unit 3 is sluiced to the South Primary Settling Pond where the slag can be recovered and beneficially reused. The primary ponds are dredged out two to three times a week with a long-reach back hoe. The material is scooped out of the dipping ponds, allowed to dewater, and then moved with an end-loader to a temporary storage pile. During dredging operations of the North and South Primary Ponds, valves can be turned to direct the waste water to the pond that is not currently being dredged. The small dipping ponds remove the majority of the ash material and decant water from these ponds flow through a pipe to the Main Ash Pond. In this way, the larger Main Ash Pond is reserved for settling out the fine-grained suspended solids in the water streams. The Main Ash Pond consists of a Secondary Pond, Polishing Pond and small Discharge (Bubbler) Pond with decant water conveyed through the system by gravity. The outlet of the main ash pond is monitored with a parshall flume for flow quantity and other NPDES permit parameters. From this outlet, the water flows westward for several hundred yards through an open grassy ditch between the rail-road tracks. At the end of the ditch, an underground culvert directs the stream under the rail-road tracks towards the north and into the un-named drainage ditch, NPDES outfall 001, parallel to Main Street Road (County Highway E35), eventually emptying towards the east at the Iowa River. The ash handling summary detailed above was based on review of provided documentation as well as communication with Alliant Energy personnel who are knowledgeable concerning the facility's operational processes.

A May 18, 2009 document, written by Alliant Energy in response to EPA's Request for Information under Section 104(e) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S.C 9604(e), provided the following general background for the ash ponds.

- Both Primary and Main Ash Settling Ponds temporarily or permanently contain fly ash, bottom ash, slag, and other materials including slag and/or ash transport water, boiler water wash, air heater wash (fly ash), steam grade water water production wastewaters, cooling tower blowdown, boiler blowdown, coal pile runoff, plant floor drains, and site storm water runoff.
- Based on its review of readily available records, IPL was unable to determine whether the Primary Ash Ponds were initially designed by and constructed under the supervision of a professional Engineer. The Main Ash Ponds was designed by and constructed under the supervision of a professional engineer. Modifications made in 2006 were designed by and constructed under the supervision of a professional engineer.
- The Primary and Main Ash Ponds are not presently inspected or monitored by a professional engineer.

IPL's March 18, 2009 response to EPA's Request for Information and other provided documentation, as well as recent communications with Alliant Energy personnel, provided the following additional information that is specific to each ash pond. Current descriptive information resulting from the site visit, as well as photographic references, are provided in Section 2 of this Assessment Report.

As previously stated, the CCW impoundment areas at the Sutherland facility are referred to as the North Primary Settling Pond, South Primary Settling Pond and Main Ash Pond. Based on historic drawings (1959 and 1961), these ponds are located within the footprint of the original "ash pond" for the facility. The provided drawings only show the location of the "ash pond" and no other original details are known. It is presumed the original was one large ash pond. At some time, the original ash pond was modified to include the primary ponds (North and South Primary Settling Ponds). This and other improvements, including the latest in 2006, have transformed the original "ash pond" to the current configuration and include improvements to the Main Pond by construction of fingers to increase the flow length and creating divisions within the basin to provide secondary and tertiary settlement areas. The North Primary Settling Pond and Main Pond are presumed to be commissioned with generating Units 1 and 2 at the plant in 1955. The South Primary Settling Pond is presumed as commissioned with generating Unit 3 in 1961.

1.4.1 North Primary Settling Pond

The North Primary Settling Pond is located between the coal pile and Main Ash Pond. It is our understanding the actual construction date is unknown and there are no formal plans or details for the basin. The pond is presumed to be commissioned with the startup of generating Units 1 and 2 in 1955. CCW, other plant wastewaters and surface runoff water from the facility is sluiced or pumped into the North Pond. Bottom ash settles in the pond while the finer particles pass through to the Secondary Pond. The bottom ash material is regularly cleaned from the pond and stockpiled to the north to allow for dewatering and possible sale for beneficial reuse or transport to an off-site landfill. Decant from the North Pond flows by gravity through a pipe to the Main Ash Secondary Settling Pond. Table 2 provides a summary of surface area, height, storage capacity, and stored material volumes for this pond.

1.4.2 South Primary Settling Pond

The South Primary Settling Pond is located south of the North Pond and west of the Main Ash Pond. It is our understanding the actual construction date is unknown and there are no formal plans or details for the basin. The pond is presumed to be commissioned with the startup of generating Unit 3 in 1961. CCW from Unit 3 of the facility consisting of bottom ash, or "slag" can be sluiced to the South Pond by pipe. The slag is regularly cleaned from the pond and stockpiled to allow for dewatering and possible sale for beneficial reuse. Decant from the South Pond flows by gravity through a pipe to the Main Ash Secondary Settling Pond. Table 2 provides a summary of surface area, height, storage capacity, and stored material volumes for this pond.

1.4.3 Main Ash Pond

The Main Ash Settling Pond is located at the east end of the plant facilities and east of the two primary ponds. The area was commissioned in 1955 at startup of the plant (Units 1 and 2). The Main Ash Pond receives CCW decant from the North and South Primary Ponds and local surface runoff. The Main Ash Pond represents the major portion of the original ash pond for the facility. There are no original construction drawings for the main ash pond.

In 2005, the Main Ash Pond consisted of one large pond with a finger on the west side directing flow to the southwest corner then into the large Secondary Pond. The Secondary Settling Pond contained an overflow through a metering flume to the discharge structure in the Discharge Pond. In 2006, dredging, the stabilization of fingers, addition of fingers and formation of a polishing pond were constructed to allow access to the entire pond area, increase the detention path, and provide a tertiary settling area. Decant from the primary ponds to the Main Ash Pond is conveyed by gravity through pipes to the Secondary Settling Pond. Flow from the Secondary Ash Pond to the Polishing Pond is conveyed by a flume constructed with a mixing channel to allow chemical addition to reduce algae. Flow from the Polishing Pond to the Discharge (Bubbler) Pond is conveyed by the previously mentioned metering flume. Flow is released from the Discharge Pond through a discharge manhole and 24-inch pipe. Table 2 provides a summary of surface area, height, storage capacity, and stored material volumes for these ponds.

Table 2. Ash Settling Pond Size and Storage Data

Area	Surface Area (acre)	Maximum Height of Management Unit (feet)	Storage Capacity (cubic yards)	Store Material Volume (cubic yards)
Primary Ash Settling Ponds				
North	0.30	7	2,440[1]	490[1]
South	0.13	7	1,050[1]	210[1]
Main Ash Settling Pond				
Secondary, Polishing and Discharge Settling Ponds	5.75	13[2]	83,500[1]	4,640[1]

Measurements, unless otherwise noted, are reported from the 2009 IPL response letter to EPA.

[1] Measured in April 2009.

[2] Although reported as 7 feet in response letter to EPA, the 2011 *Ash Pond Slope Stability and Hydraulic Analysis* report by Aether dbs states "the specified height of the dike for the idealized cross-section is 13 feet based on the maximum depth to native soils reported in the 2006 field investigation" (by Hard Hat Services).

1.5 Previously Identified Safety Issues

Discussions with plant personnel and review of provided documentation indicate that there are no current or previously identified safety issues from the previous 5 years at the Sutherland Generating Station.

1.6 Site Geology

Based on research on the internet, the Sutherland Generating Station is located within the Kinderhook geologic formation. The 2011 *Ash Pond Slope Stability and Hydraulic Analysis* report by Aether, dbs reports the "surface soil in the ash management area is Zook Clay (low plasticity clay with 5-7% organic content) USCS Marshall County Soil Survey." The 2011 stability and hydraulic report also reports the depth to bedrock in the area to be over 250 feet as referenced by a provided well record for Well 6A.

1.7 Inventory of Provided Materials

IPL provided documents to AMEC that pertained to the design and operation of the Sutherland Generating Station. These documents were used in the preparation of this report and are listed in Appendix C, Inventory of Provided Materials.

2.0 FIELD ASSESSMENT

2.1 Visual Observations

AMEC performed visual assessments of Sutherland's Ash Ponds, including the North Primary Settling Pond, South Primary Settling Pond and Main Ash Pond, on June 14, 2011. Assessment of the ash ponds was completed in general accordance with FEMA's *Federal Guidelines for Dam Safety, Hazard Potential Classification System for Dams,* April 2004. The EPA Coal Combustion Dam Inspection Checklist and Coal Combustion Waste (CCW) Impoundment Inspection Form were completed for each ash pond during the site visit and provided to EPA via email within five business days following the site visit. Appendix A contains copies of the completed checklist forms. A Photo Location Map (B-1), as well as descriptive photos, can be found in Appendix B. Rainfall data for the Marshalltown, Iowa area was collected for thirty days prior to the site visit. Table 3, below, summarizes the rainfall data for the days and month immediately preceding AMEC's site visit.

Table 3. Sutherland Rainfall Data

Rainfall Prior to Site Visit	
Date	**Rainfall (in.)**
June 5, 2011	0.01
June 6, 2011	0.00
June 7, 2011	0.00
June 8, 2011	0.28
June 9, 2011	1.54
June 10, 2011	0.60
June 11, 2011	0.00
June 12, 2011	0.06
June 13, 2011	0.05
Total (9 days prior to visit)	2.54
June Rainfall (13 days prior to visit)	2.55
Total (30 days prior to visit)	5.54

2.2 Visual Observations - North Primary Settling Pond

The North Primary Settling Pond is located within the ash management area at the east end of fenced facility building area. The North Pond is situated near the center of the west edge of the ash management area. Features surrounding the pond include the ash sediment storage area to the north, coal pile storage area to the northwest, plant cooling towers and buildings to the southwest, South Primary Settling Pond to the south and the Main Ash Pond to the east. The slope of the adjacent area to the North Pond is either to the pond itself or to the east and southeast toward the Main Pond. CCW and other plant wastewaters enter the North Pond from pipes on its west boundary (Photo NP-1). The outlet pipe of the North Pond leaves on its east dike (Photo NP-2) and enters the Main Pond on its west dike (Photo NP-3).

2.2.1 North Primary Settling Pond - Embankments and Crest

The North Pond is separated from the South Pond by a common dike with an approximate width of 5 feet, or less. The North Pond is separated from the Main Ash Pond with a dividing dike that serves as a road with an approximate width of 25 feet. The North Pond is generally incised within ash of the ash management area (Photo NP-2). Drawings indicate the land surface elevation at the top of the north and east embankment of the North Pond is 870 feet. Drawings show the water elevation in the pond at 862.9 feet, presumed to coincide with the approximate elevation of the inlet of the outlet pipe. Settled ash is removed regularly and placed in the stockpile area to the north. Being incised within ash and regularly dredged, the upstream slopes and crest area surrounding the pond are ash and generally void of any vegetative cover (Photos NP-1 and NP-2). The lowest freeboard appears to be at the inlet of the sluice pipes. Photo NP-1 indicates a couple of feet of freeboard in this location. Any overflow back to the plant would collect to the surface water sump to be returned to the pond.

2.2.2 North Primary Settling Pond - Outlet Control Structures

The North Primary Pond discharges flow from its east dike to the Main Ash Pond (Secondary Pond) by gravity through a CMP culvert pipe located in the internal divider dike (Photos NP-2 and NP-3). The inlet and outlet elevations of the pipe are reported to be 862.6 and 861.6 feet, respectively.

2.3 Visual Observations - South Primary Settling Pond

The South Primary Settling Pond is located within the ash management area at the east end of facility building area. The South Pond is situated immediately adjacent to the North Primary Settling Pond therefore its location, surrounding features and slope of adjacent area are similar to the North Pond. CCW bottom ash or slag from generating Unit 3 enters the South Pond on its north boundary (Photo SP-1). The outlet pipe from the South Pond is located on its east dike (Photo SP-2) and the discharge enters the Main Pond on the West Dike (Photo SECP-2).

2.3.1 South Primary Settling Pond - Embankments and Crest

The South Pond is separated from the North Pond by a common dike with an approximate width of 5 feet, or less. The South Pond is separated from the Main Ash Pond with a dividing dike that serves as a road with an approximate width of 20 feet (See Figure B-1 and SECP-12). The South Pond is generally incised within ash of the ash management area. Drawings indicate the land surface elevation of the immediate area surrounding the South Pond is about 869 to 867 feet. Drawings show the water elevation in the pond at 862.6 feet, presumed to coincide with the approximate elevation of the inlet of the outlet pipe. Settled slag is removed regularly and placed in the stockpile area to the south. Being incised within ash and regularly dredged, the upstream slopes and crest area surrounding the pond are ash and void of any vegetative cover (Photos SP-1 and SP-2).

2.3.2 South Primary Settling Pond - Outlet Control Structures

The South Primary Pond discharges flow from its east dike to the Main Ash Pond (Secondary Pond) by gravity through a CMP culvert pipe located in the internal divider dike (Photos SP-2, SECP-12 and SECP-2). The inlet and outlet elevations of the pipe are 862.6 and 861.8 feet, respectively.

2.4 Visual Observations - Main Ash Pond (Secondary and Polishing Ponds and Discharge Pond)

The Main Ash Settling Pond area is located at the east end of the plant facility. The pond area includes a Secondary Pond, Polishing Pond and Discharge Pond. The Main Pond is bordered by a open grass field to the south, the North and South Primary Ponds and plant cooling towers and buildings to the west, the ash storage area to the northwest, a roadside ditch and Main Street Road to the north, and a wooded with open grass field area (south) to the east.

The existing three pond series system in the Main Ash Settling Pond area was originally constructed as a single settling pond. The original ash management area is shown on historic drawing as a rectangular area encompassing all of the ponds and the ash storage area. The exact configuration of the original pond is unknown. Prior to 2006, the Main Ash Pond area consisted of two ponds consisting of a Secondary Settling Pond and a Discharge Pond. In 2006, improvements were constructed primarily to lower solids leaving the ash pond area. The improvements included dredging of the existing pond, excavation and strengthening of existing fingers and construction of new fingers within the Secondary Pond to lengthen the flow path and allow equipment access to all areas of the pond. A Polishing Pond was constructed from the northeast end of the Secondary Pond to provide an additional settlement area. Figure 2, the Aerial Site Plan, illustrates the extent of the current three pond configuration.

The North and South Primary Ponds are used to settle and remove ash on a regular basis. The Main Ash Pond is used to settle the finer ash and finer materials in other plant wastewaters or surface runoff that flow through the primary ponds. CCW and plant overflow from the North and South Primary Ponds enter through separate pipes at the west end of the Secondary Pond. Flow is directed south to the southwest corner, then east to the southeast corner, around a half loop to the west then back to the east edge, then north to the northeast corner of the pond to the divider dike and the Polishing Pond. At the Polishing Pond, flow is directed north around a small half loop to the west then back to the east to the northeast corner to the discharge flume to the small (0.04 acre) Discharge Pond. The flow exits the Discharge Pond to a ditch. The open to piped ditch travels west along the north edge of the property approximately 1300 feet then turns north through an embankment to the Main Street Road roadside ditch. This ditch travels back to the east about 4000 feet to the Iowa River.

2.4.1 Main Ash Pond (Secondary and Polishing Ponds and Discharge Pond) - Embankments and Crest

Secondary Settling Pond

It is presumed all or a good portion of the area of the ash stockpile to the northwest, the remaining west side of the Main Ash Pond and old interior fingers consist of ash from the original ash pond (Photos SECP-1 through SECP-8, NP-1 through NP-3, and SP-1 through SP-3). The interior embankments were generally in good to fair shape with steep and exposed slopes observed at isolated locations and in reaches. Notable reaches include the following locations:

- Area beginning at the inlet from the North Pond extending northeast along the embankment below the ash stockpile area. See photo below presented as SECP-1 in Appendix B.

- Area in the vicinity of the inlet from the South Pond and to the north. See Photo SECP-2, below, and Photo SECP-3 presented in Appendix B.

- Local area located to the north of the southwest corner. See Photo below presented as Photo SECP-4 in Appendix B.

Stabilized and new fingers are primarily constructed of shot rock and/or recycled aggregate materials. Surface cover on the other areas of the interior embankments was generally good consisting of rip-rap and or grasses (Photos SECP-9 through SECP-11). Minor small woody vegetation was observed in isolated locations. Except for the areas at the North and South Primary Ponds, extensive at-grade areas exist behind the upstream embankment slopes and therefore there are no downstream slopes on the northwest and west portions of the pond (Photos SECP-1 and SECP-12). The road/crest separating the primary from the secondary pond is 20 to 25 feet wide. Any collapse of the embankments would only join the smaller primary pond to the much larger secondary pond (See Figure B-1 and SECP-12).

The south and east embankments of the Secondary Pond appear to be the original embankments. Tall grass covered the upstream slopes on these embankments which prevented observations of the surface of the slopes. Based on our observations under these restrictions, the east upstream slope appeared generally to be in fair condition (Photo SECP-13). The south upstream slope was generally in fair condition, but isolated locations of surface slough failures were observed (Photo SECP-4 and SECP-14). The number of locations seemed to increase from east to west. The downstream slopes of the east and south embankment had tall grass which prevented viewing the surface of the slopes (Photos SECP-15 through SECP-18). Based on our observations under these restrictions, the downstream slopes generally appeared to be in fair condition with one exception. The exception consisted of ponded water in an area against the downstream toe on the east embankment. See the following photo presented as Photo SECP-16 in appendix B.

Ponded water was also present to the east of this location (Photo SECP-19). The open field area to the east of the east embankment included wet area vegetation and further east a pond (Photo SECP-20).

Since the southwest and northwest embankments are situated well inside the original embankment, the crests consisted of ash. The area at the crest/entrance road near the southwest corner of the secondary pond appeared to be low and sloped to the west and away from the ash management area (Photo SECP-4). The crests of the east and south dikes were covered with gravel and appeared to be in good condition (Photos SECP-15, SECP-21, and SECP-18). Observations and survey information indicate the east and south crest heights maintain or exceed the idealized design elevation of 865 feet. The northwest and west crest generally exceeds this height and grade to the southeast toward the ponds (Photos SECP-1 and SECP-12).

Polishing Pond

The Polishing Pond was constructed in 2006 from the northeast end of the Secondary Pond. Other than the dividing structure to make a separate pond, the only change to the embankments consisted of placing fill at the northwest corner. The west slopes were observed to be the highest and appeared very steep. Isolated areas of surface sloughing on the south, west and internal finger upstream embankment slopes of the Polishing Pond exposed ash and indicate they were formed from cuts within the original ash pond (Photos PP-1 through PP-4). Tall grasses and some brushy vegetation on these slopes prevented observation of the surface of these slopes. Based on our observations under these restricted conditions and exceptions noted above, the upstream slopes generally appeared to be in fair condition. There are at-grade conditions for some distance behind these slopes and therefore no downstream slopes. More moderate upstream slopes covered with rip-rap were observed on the south half of the east embankment. This indicates a recent repair and the slopes are in good condition (Photo PP-4). The upstream slopes on the north half of the east embankment were covered with tall grass which prevented observation of the surface of the slopes. Although restricted by these conditions, the upstream slopes viewed from across the pond appeared to be steep and in fair condition (Photo PP-5). The downstream slopes on the east embankment were covered with tall grass which prevented observations of the surface of the slopes. Although restricted by these conditions, no evidence of surface sloughing or other failures were observed on the downstream slopes (Photos SECP-15 and SECP-21).

Discharge Pond

The area at the discharge pond was covered in tall grasses which prevented viewing of the upstream and downstream slopes (Photos DP-1 and PP-4). Although restricted by these conditions, no evidence of surface sloughing or other failures were observed on the slopes.

2.4.2 Main Ash Pond (Secondary and Polishing ponds and Discharge Pond) - Outlet Control Structures

Secondary Settling Pond

Flow is discharged from the northeast corner of the Secondary Pond into the southeast corner of the Polishing Pond. The two ponds are separated by a lower elevation dike with a static mixing channel/flume. The Secondary Settling Pond overflows at elevation 862.4 feet. During an extreme hydrological event, the small dike separating the two ponds will overtop and the two ponds will work as a single pond with an approximate surface area of 6 acres (Photos SECP-13 and PP-6). At the time of our field visit, there was flow through the flume.

Polishing Pond

Flow is discharged from the northeast corner of the Polishing Pond into the southeast corner of the Small Discharge Pond through a flow monitoring flume. The flume is equipped with a solar recorder. The Polishing Pond overflows at elevation 861.6 feet. During a severe storm, the water may overtop the internal weir and flow to the Discharge Pond (Photos PP-1 and DP-1). At the time of field visit, there was flow through the flume.

Discharge Pond

Flow is discharged from the northeast corner of the Discharge Pond into a ditch at the north end of the property. Improvements were made to this outlet in 2006. The outlet consists of a inverted 24-inch diameter pipe. The pipe is "J" shaped. At the time of our field assessment, the pipe was flowing. The outlet to the ditch was submerged and could not be seen (Photos DP-1, DP-3 and DP-4). Flow travels west along the north edge of the property in an open ditch and pipe system (Photos OP-1 and OP-2) approximately 1300 feet then turns north through an embankment to the Main Street Road roadside ditch at NPDES Outfall 001 (Photo OP-3). Flow in the roadside ditch travels back to the east (Photo OP-4) about 4000 feet to discharge into the Iowa River.

2.5 Monitoring Instrumentation

A partial flume at the outlet of the Polishing Pond monitors flow and other NPDES permit parameters (Photo DP-2). There is no geotechnical or groundwater monitoring instrumentation located at the Sutherland Power Station.

3.0 DATA EVALUATION

3.1 Design Assumptions

AMEC has reviewed provided documentation related to design assumptions regarding both hydraulic adequacy and dike stability.

3.2 Hydrologic and Hydraulic Design

3.2.1 Long Term Hydrologic Design Criteria

The Mine Safety and Health Administration provides minimum hydrologic criteria relevant to CCW impoundments in Impoundment Design Guidelines of the Mining Safety and Health Administration (MSHA) Coal Mine Impoundment Inspection and Plan Review Handbook (Number PH07-01) published by the U.S. Department of Labor, Mine Safety and Health Administration, Coal Mine Safety and Health, October 2007.

When detailing impoundment design storm criteria, MSHA states that dams need “to be able to safely accommodate the inflow from a storm event that is appropriate for the size of the impoundment and the hazard potential in the event of failure of the dam.” Additionally, MSHA notes that sufficient freeboard, adequate factors of safety for embankment stability, and the prevention of significant erosion to discharge facilities, are all design elements that are required for dam structures under their review. Additional impoundment and design storm criteria are as shown in Table 4, MSHA Minimum Long Term Hydrologic Design Criteria.

Table 4. MSHA* Minimum Long Term Hydrologic Design Criteria

Hazard Potential	**Impoundment Size**	
	< 1000 acre-feet **< 40 feet deep**	**≥ 1000 acre-feet** **≥ 40 feet deep**
Low - Impoundments located where failure of the dam would result in no probable loss of human life and low economic and/or environmental losses.	100 - year rainfall**	½ PMF
Significant/Moderate - Impoundments located where failure of the dam would result in no probably loss of human life but can cause economic loss, environmental damage, or disruption of lifeline facilities.	½ PMF	PMF
High - Facilities located where failure of the dam will probably cause loss of human life.	PMF	PMF

*Mining Safety and Health Administration (MSHA) Coal Mine Impoundment Inspection and Plan Review Handbook (Number PH07-01) published by the U.S. Department of Labor, Mine Safety and Health Administration, Coal Mine Safety and Health, October 2007

**Per MSHA, the 24-hour duration shall be used with the 100-year frequency rainfall.

Probable maximum flood (PMF) is, per MSHA, “the maximum runoff condition resulting from the most severe combination of hydrologic and meteorological conditions that are considered reasonably possible for the drainage area.” Additionally, MSHA notes the designer should consider several components of the PMF that are site specific. These components are said to include: “antecedent storm; principal storm; subsequent storm; time and spatial distribution of the rainfall and snowmelt; and runoff conditions.” Basic agreement, it was noted, exists between dam safety authorities regarding “combinations of conditions and events that comprise the PMF;” however, there are “differences in the individual components that are used.” MSHA provided the following as a “reasonable set of conditions for the PMF:

- Antecedent Storm: 100-year frequency, 24 hour duration, with antecedent moisture condition II (AMC II), occurring 5 days prior to the principal storm.

- Principal Storm: Probable maximum precipitation (PMP), with AMC III. The principal storm rainfall must be distributed spatially and temporally to produce the most sever conditions with respect to impoundment freeboard and spillway discharge.

- Subsequent Storm: A subsequent storm is considered to be handled by meeting the “storm inflow drawdown criteria,” as described subsequently in the document.

With regard to storm influent drawdown criteria, MSHA Impoundment Design Guidelines noted that:

> *Impoundments must be capable of handling the design storms that occur in close succession. To accomplish this, the discharge facilities must be able to discharge, within 10 days, at least 90 percent of the volume of water stored during the design storm above the allowable normal operating water level. The 10-day drawdown criterion begins at the time the water surface reaches the maximum elevation attainable for the design storm. Alternatively, plans can provide for sufficient reservoir capacity to store the runoff from two design storms, while specifying means to evacuate the storage from both storms in a reasonable period of time - generally taken to be at a discharge rate that removes at least 90% of the second storm inflow volume within 30 days………When storms are stored, the potential for an elevated saturation level to affect the stability of the embankment needs to be taken into account.*

In, Mineral Resources, Department of Labor, Mine Safety and Health Administration, Title *30 CFR § 77.216-2 Water, sediment, or slurry impoundments and impounding structures; minimum plan requirements; changes or modifications, certification*, information relevant to the duration of the probable maximum precipitation is given. Sub-section *(10)* of *77.216-2* states that a “statement of the runoff attributable to the probable maximum precipitation of 6-hour duration and the calculations used in determining such runoff” shall be provided at minimum in submitted plans for water, sediment or slurry impoundments and impounding structures.

The definition of design freeboard, according to the MSHA Guidelines, is “the vertical distance between the lowest point on the crest of the embankment and the maximum water surface elevation resulting from the design storm.” Additionally, the Handbook states that “Sufficient documentation should be provided in impoundment plans to verify the adequacy of the freeboard.” Recommended items to consider when determining freeboard include “potential wave run-up on the upstream slope, ability of the embankment to resist erosion, and potential for embankment foundation settlement.” Lastly, the Handbook states, “Without documentation, and absent unusual conditions, a minimum freeboard of 3 feet is generally accepted for impoundments with a fetch of less than 1 mile.”

The CCW impoundments at the Sutherland Power Station fall within the smallest storm event designation category on Table 4. Using MSHA long term hydrologic criteria, design for the 100-year, 24-hour rainfall event would be recommended.

3.2.2 Hydrologic Design Criteria - Primary Ash Settling Ponds

Hydrologic and Hydraulic information was not specifically provided for the Primary Ash Settling Ponds, however, the pond area and inflow from the plant was included in the Main pond analysis.

3.2.3 Hydrologic Design Criteria - Main Ash Settling Ponds

AMEC was provided with an *Ash Pond Slope Stability and Hydraulic Analysis*, completed by aether dbs and dated June 17, 2011. The Analysis stated that, with respect to stormwater runoff, the "total area contributing to the ponds is 57 acres." Areas noted as routed to the ash ponds include "the plant area, the ash management area and coal pile stormwater." These areas are shown on Figure 4. Additionally, the Analysis noted that a small dike with a static mixing channel exists between the secondary ash and polishing ponds and that "during an extreme hydrological event, the small dike…….will overtop and the two ponds will work together as a single pond with an approximate surface area of 6 acres." Outer dike heights were reported as 865 feet for the Secondary Settling Pond and 864 feet for the Polishing Pond. Further, "the secondary ash settling pond overflows at elevation 862.4 feet" and "the polishing pond overflows at elevation 861.6 feet." The discharge structure for the Discharge Pond is a 24-inch diameter vertical riser pipe.

Other provided design input included:

- A current topographical map file, dated April 19, 2006, of the Primary and Main Ash Settling Pond areas, showing the Main Settling Pond reconfiguration;

- A 100-year, SCS Type 2, 24-hour storm event rainfall for Marshall County, Iowa of 6.6 inches was used in the runoff calculations. The chosen rainfall amount was based on the United States Department of Commerce, Rainfall Frequency Analysis of the United States;

- Hydraflow by Intelisolve (2002) was used to generate and route the storm hydrograph through the Main Ash Ponds (secondary settling, polishing, and small discharge ponds). A hydrograph report was included as part of the Analysis (Attachment B);

Design assumptions included:

- Starting pond elevation for the secondary ash pond was specified at the normal water surface elevation of 862.4 feet;

- Starting pond elevation for the polishing pond was specified at the normal water surface elevation of 861.6 feet;

The hydrograph routing output, as presented in the Analysis, indicates that the 100-year 24-hour rainfall event (6.6 inches) will result in a water surface elevation in the Secondary Settling Pond of 864.4 feet, "leaving a freeboard or slightly more than 6-inches." The Discharge Pond was noted to reach “a storm elevation of 862.5 feet which is 1.5 feet below the outer dike height of 864 feet.”

The 2011 report notes a report from plant personnel that “the site received four inches of rainfall on November 4, 2003 and the water level in the secondary ash pond rose only 6 to 7 inches above the normal operating elevation. The historical event indicates that the analysis is conservative.” The 2006 improvements to the pond have changed conditions since 2003, therefore this event in effect cannot be used to prove conservatism.

3.3 Structural Adequacy & Stability

EPA policy for conventional minimum recommended factors of safety for different loading conditions are shown in Table 5 below.

Table 5. Minimum Stability Factors of Safety

Loading Condition	Minimum Factor of Safety
Rapid Drawdown	1.3
Long-Term Steady Seepage	1.5
Earthquake Loading (pseudo-static method)	1.0

To consider the structural adequacy and stability of the ash ponds at the Sutherland Generating Station, AMEC reviewed stability analysis material provided by IPL.

AMEC reviewed the June 17, 2011 report entitled *Ash Pond Slope Stability and Hydraulic Analyses* prepared by Aether, dbs, for the Sutherland Generating Station prepared for Interstate Power and Light (Alliant Energy). The recently completed stability analyses are summarized in Section 3.3.1. The Aether analysis included a study of a section of the south embankment of the Secondary Settling Pond dike, which is within the original ash management dike. The report presented a summary of the data that was reviewed including a previous geotechnical exploration that was performed in 2006 by Hard Hat Services entitled *Field Investigation Report, Sutherland Generating Station, Bottom ash Settling Pond*, as well as the results of the structural stability analyses performed for one cross-section.

Aether evaluated the overall stability of the dam by reviewing previously collected drilling data for their study. The report states:

> *Field characterizations of the clay unconfined compressive strength made with a pocket penetrometer are shown on the five boring logs from the outer dike of the ash pond. The cohesive strength of the clay (unconfined compressive strength divided by 2) is charted versus depth in Attachment C. All five borings produced similar strength results showing a strong crust (very stiff to hard clay above a depth of 4 feet) with stiff to firm clay underneath*.

The study notes the section analyzed is a “conservative idealized section” that corresponds best with the outer dike along the south edge of the active fly ash management area”. The report states the south dike is a little narrower and presumed higher because natural topography of the area slopes slightly to the south. Two to one side slopes were used for both the upstream and downstream slopes due to specifications for reconstruction of the upstream slopes and topographic information for the downstream slopes. The embankment height of 13 feet was based on the maximum depth to native soils reported in the geotechnical investigation. With a crest elevation of 865 feet the toe of both slopes were placed at 862 feet. The study noted the bottom of pond elevations adjacent to the southernmost dike ranges between 851 to 855 feet. The top width of 13 feet was the narrowest width measured on the Settling Pond Reconfiguration Drawing for the 2006 improvements. The location of the section selected for analysis is shown on Figure 4 and a graphical representation of the section is shown on Figure 5. The analysis assumed the clay cohesion in the dike was the lowest strength measured above a depth of 14 feet, 1,250 psf, and the cohesion below the dike was the lowest measured below a depth of 13 feet, 1,000 psf. The report noted:

> *Fine to medium sand with silt is present below the clay in the five nearest deep borings at elevations ranging from 848 feet to 852 feet, Attachment E and F. The search for failure surfaces in the Zook Clay was limited to a depth of 9 feet below the toe of the dike to avoid the stronger sand below that depth. The sand is relatively dense and will not liquefy in a low intensity earthquake.*

The report substantiated the depth to bedrock in the area was over 250 feet by providing a copy of a well record. The slope stability analyses were performed using STABL5M (1966) from Purdue University. The report states "Because the dike foundation soils are considered weaker than the dike, the most critical surface mode is a sliding block failure…."

Aether stated in their report:

> *Only two loading cases / failure scenarios were analyzed because in the case of a clay dike, the rapid drawdown case on the inside of the pond is essentially the same as the stability of the outside of the dike. (Clay soils cannot drain quickly; hence short term seepage forces are not a concern.)*
>
>> *1.) Ash pond water elevation at the normal elevation (862.6 feet) with a steady state seepage face emerging above the toe of the slope. Because a cohesion only strength is considered using undrained clay strength, the location of the seepage face does not influence the Factor of Safety calculation. However, water pressure on the inside of the dike can contribute to instability and it was included in the model.*
>>
>> *2.) The small ponds at Sutherland Station do not pose a significant risk and contain minimum volumes of coal combustion residue. The procedures of FEMA suggest that the structures rate as low risk dams. For low risk structures, a probability of 10% in 50 years (return period of 475 years) is an acceptable standard. Consequently, a pseudostatic earthquake analysis was completed using the effective peak ground acceleration for a 475 year return period. With dense soil under the site, a Site Class "D" was selected for soil amplification giving a probable maximum horizontal earthquake acceleration of 0.019g for the ash ponds. The vertical earthquake force is specified as 2/3 of the horizontal earthquake force."*

Table 6 provides a summary of the soil properties utilized in Aether's report.

Table 6. Soil Properties for Stability Analysis

Material	Unit Weight γ (lb/ft^3)	Friction Angle, σ’ (Degrees)	Cohesion, c’ (lb/ft^2)
Dike Fill (Cohesive)	130	0	1,250
Clay (Original)	126	0	1,000

3.3.1 Primary Ash Settling Ponds - Structural Adequacy & Stability

Since the North and South Primary Ponds are incised, static and seismic analyses are not required.

3.3.2 Main Ash Pond (Secondary Pond) - Structural Adequacy & Stability

Static and Seismic Analysis

A June 2011 report by Aether, dbs, titled *Ash Pond Slope Stability and Hydraulic Analysis,* for the Sutherland Generating Station presents stability analyses for Main Ash Pond. One cross section was analyzed for short term and short term seismic conditions. The location of the cross section was selected to represent the “most critical” area on the south dike. The static and seismic analyses performed by Aether contain method and procedure errors that rendered their results invalid.

In comments to the draft report Alliant Energy provided a report by Aether, dbs dated July 2012 (see Appendix E) with revised stability analyses for the Main Pond. Data used for the analyses included recent survey for four sections, and a review and adjustment to more conservative values for strength parameters for the embankment and underlying soils. The resubmission of analysis using total stress parameters are for short term conditions and are still not valid. Aether did perform a new analysis representing long term conditions using the revised data. The results of this analysis indicate a factor of safety of 1.6 for the embankment. The method of analysis appears valid and the result exceeds the required minimum factor of safety. A seismic analysis under effective stress conditions was not provided.

3.4 Foundation Conditions

Attachments to the June 17, 2011 report entitled *Ash Pond Slope Stability and Hydraulic Analyses* prepared by Aether, dbs, for the Sutherland Generating Station prepared for Interstate Power and Light (Alliant Energy) provides the most information concerning the foundation conditions at the site. The attachments include a geotechnical report dated March 2006 by Hard Hat Services (Attachment A) with borings performed by Cabeno, selected deep soil borings performed by Black & Veatch (Attachment E) and Team (Attachment F), and a deep well record/log for Well 6A performed in 1994 by Layne-Western.

The March 2006 geotechnical report by Hard Hat Services includes borings performed to a depth of 15 feet within the ash management area. The borings primarily characterize the embankment soils, but do penetrate the top of the foundation soils for a few feet. The borings indicate the top layer of the foundation soils consist of clay. The selected deep borings confirm a clay foundation to a depth of about 8 feet in the plant area. It appears Shelby Tubes were obtained in some of the borings, but testing results are not listed. Pocket Penetrometer tests results included two at 1500 and one at 2500 lbs per square foot. The borings show fine to coarse grained, generally loose to medium dense sands underlying the clay. The water table was noted to be at or slightly above the start of the sand layer. Very stiff clay/glacial till was encountered at depths of about 45 to 50 feet. The deep well record for Well 6A indicates the depth to bedrock in the plant area is about 250 feet. Based on the limited provided information for the foundation soils, there is no evidence the exterior embankments of the Main Pond are built over wet ash, slag or other unsuitable materials.

3.5 Operations and Maintenance

3.5.1 Safety Assessments

IPL reported daily inspections of the plant grounds, including the ash management area, are performed daily but not documented. Documented inspections were reported to be performed bi-annually by plant environmental personnel. Based on provided documents, IPL personnel performed and recorded visual inspections of the ash ponds in November 2010 and April 2011. Each inspection report includes a title page with inspection details (site, date, weather, etc.) and a description section where a summary of recent plant operation and inspection causes/results in sentence form. Following the title page is a one page checklist to guide the site inspection to evaluate dike integrity, specifically the presence of animal activity, seepage, erosion, trees/vegetation, ponding, leakage from valving or piping, or damage due to heavy equipment use. Outfall structures are also inspected for the presence of many of the same issues. The dike walls and discharge structures are also checked for the presence of any settled ash. The final page of the report is a cumulative work items list which tracks issues; what has been, and is scheduled to be performed; and completion dates.

The visual inspection performed in November 2010 noted a tree had re-grown on the berm of the Main (Secondary) Ash Pond and fill needed on the west wall of the Unit 1 & 2 (North Primary) Pond due to recent work on the piping rack. The provided recommendations were to re-cut the tree and replace the material on the west wall. No issues were reported for the Unit 3 (South Primary) Pond.

Visual inspections performed in April 2011 noted a contractor had cut down several brush trees located outside and near the fence line of the pond (prior to the inspection). Issues observed during the inspection included animal activity on the east dike wall and the inside of the east dike wall had a small area that had sloughed off above the water level. Recommendations included setting traps for the animal problem and to repair the slough area. The attached work items page noted tree removal work completed on the outside of the east and south walls, traps set and two muskrats caught, and a due date of 6/1 for the east wall repair with no completion date listed. During AMEC's site visit, we observed a repair to the upstream slope of the east dike of the Polishing Pond.

No other plant or subcontractor inspection documentation was provided.

3.5.2 Instrumentation

There is no geotechnical or groundwater monitoring instrumentation located at the Sutherland Power Station.

3.5.3 State or Federal Inspections

No State or Federal inspections regarding the condition of the ponds have taken place at the Sutherland Power Station. A wastewater inspection was performed by Field Office #5 for the

State of Iowa Department of Natural resources in September, 2010. This inspection specifically addressed NPDES effluent/monitoring details and did not address the condition of the embankments. The report did note the solar powered 4210 Ultrasonic Flow Meter had not been calibrated in quite some time and recommended calibration at least annually if not semi-annually.

4.0 COMMENTS AND RECOMMENDATIONS

Condition assessment definitions, as accepted by the National Dam Safety Review Board, are as follows:

SATISFACTORY

No existing or potential dam safety deficiencies are recognized. Acceptable performance is expected under all loading conditions (static, hydrologic, seismic) in accordance with the applicable regulatory criteria or tolerable risk guidelines.

FAIR

No existing dam safety deficiencies are recognized for normal loading conditions. Rare or extreme hydrologic and/or seismic events may result in a dam safety deficiency. Risk may be in the range to take further action.

POOR

A dam safety deficiency is recognized for loading conditions which may realistically occur. Remedial action is necessary. POOR may also be used when uncertainties exist as to critical analysis parameters which identify a potential dam safety deficiency. Further investigations and studies are necessary.

UNSATISFACTORY

A dam safety deficiency is recognized that requires immediate or emergency remedial action for problem resolution.

NOT RATED

The dam has not been inspected, is not under state jurisdiction, or has been inspected but, for whatever reason, has not been rated.

4.1 Acknowledgement of Management Unit Conditions

I certify that the management units referenced hereinafter were personally assessed by me and was found to be in the following condition:

Main Ash Settling Pond (Secondary, Polishing and Discharge Ponds): Fair

4.2 Recommendations

(The north and south primary settling ponds are incised within the ash management area. Incised ponds are not given condition ratings.)

The Fair rating for the Main Ash Pond reflects the fact that rare or extreme hydrologic and/or seismic events may result in a dam safety deficiency. Uncertainties exist as to critical analysis parameters which identify a potential dam safety deficiency. Further investigations and studies are necessary. In addition, vegetation on the embankments was too high to inspect the embankments closely.

4.2.1 Hydrologic and Hydraulic

Main Ash Settling Ponds

Although the small discharge pond was reported to maintain a freeboard of 1.5 feet while passing the 100-year 24-hour design storm (condition rating of Fair), the other two components of the Main Ash Settling Ponds (the Secondary Settling and Polishing Ponds) were inundated and operated as a single pond during the 100-year 24-hour storm event. Additionally, the resulting freeboard of their combined condition, indicated by the storm routing, was just over 6 inches.

In comments to the draft report Alliant Energy states that the conversion to natural gas and resulting lower water level "can clearly handle a 100 year 24 hour storm. AMEC agrees that with the lower static water level from the conversion the Main Pond would be capable of handling the storm. However, with the ability to burn coal and return the ponds to the original condition there is only 6 inches of freeboard during the design storm event. AMEC recommends an evaluation of the ponds to determine if the freeboard can be increased if the plant returns to burning coal.

4.2.2 Geotechnical and Stability Recommendations

Conventional minimum factor of safety criteria are 1.5 for static long-term stability and 1.0 for earthquake stability (by pseudo-static method). Likewise, if the dam does not meet the above seismic factor of safety, then the stability of the embankment should be analyzed and the amount of embankment deformation or settlement that may occur should be evaluated to assure that sufficient section of the crest will remain intact to prevent a release from the impoundment.

A June 2011 report by Aether, dbs, titled *Ash Pond Slope Stability and Hydraulic Analysis,* for the Sutherland Generating Station presents stability analyses for Main Ash Pond. One cross section was analyzed for short term and short term seismic conditions. The location of the cross section was selected to represent the "most critical" area on the south dike.

In comments to the draft report Alliant Energy provided a report by Aether, dbs dated July 2012 (see Appendix E) with revised stability analyses for the Main Pond. Data used for the analyses included recent survey for four sections, and a review and adjustment to more conservative values for strength parameters for the embankment and underlying soils. The resubmission of analysis using total stress parameters are for short term conditions and are still not valid. Aether did perform a new analysis representing long term conditions using the revised data. The results of this analysis indicate a factor of safety of 1.6 for the embankment. The method of analysis appears valid and the result exceeds the required minimum factor of safety. A seismic analysis under effective stress conditions was not provided. AMEC recommends a seismic analysis using effective stress parameters be performed to meet the stability analysis requirements for the Main Pond.

The vegetation on the embankment slopes of the Main Ash Pond was too tall to inspect the embankment closely. No visible signs of major slope failures were observed. AMEC recommends IPL periodically mow the area to allow inspection of the embankments. One of the formal plant inspections could be performed in the winter/early spring months when the vegetation is low and the embankments are more visible. Mowing may be needed at the time of the other inspection and/or inspection by an engineer as recommended below, ideally preceding or following the normal season of heavier rainfall. Mowing should extend at least to the fence on the downstream embankments. Mowing beyond the fence may need to be coordinated with or approved by a regulatory agency as adjacent areas could be classified as wetlands. Maintenance issues such as steep and exposed slopes, and water against the toe of the slope as described in Section 2.4.1 and other issues discovered after mowing should be promptly addressed to maintain the structural integrity of the embankments.

4.2.3 Inspection Recommendations

Inspection procedures at the Sutherland station include daily, undocumented inspection of the grounds by plant personnel and bi-annual, documented inspections by plant environmental staff.

AMEC recommends that Alliant Energy, IPL, revise the bi-annual inspection to reflect the changes in 2006 by completing forms for each impoundment of the Main Pond. AMEC suggests a map be included to maintain a record of the approximate locations of any identified problems. A map could also be used to maintain a record of work performed cumulatively or since the last inspection. AMEC recommends annual visual inspections of each management unit should be performed by a Professional Engineer, either by a consultant or by internal, off-site personnel. Inspection reports are and should be maintained by the facility. Additionally, routine inspections (daily or weekly) performed by facility O&M personnel could be supported by an inspection checklist to serve as documentation of the inspection.

Vegetation on the impoundments should continue to be aggressively managed. We further recommend that vegetation be managed based on guidance in (a) Corps of Engineers EM 1110-2-301, *Guidelines for Landscape Planting and Vegetation Management at Floodwalls, Levees, and Embankment Dams* and (b) FEMA 534, *Technical Manual for Dam Owners: Impacts of Plants on Earthen Dams*. Additionally, animal impact should be mitigated based on guidance in FEMA 473, *Technical Manual for Dam Owners: Impacts of Animals on Earthen Dams*.

The paragraphs above in this section were provided in the draft report. Comments to the draft report by Alliant Energy states that subsequent to the ash pond assessments by EPA,

"Alliant Energy has prepared a "Corporate Operations and Maintenance Plan" (Corporate Plan) that outlines the proper operations and maintenance of coal combustion ash ponds based on the guidance documents readily available from the Corps of Engineers; FEMA; and OSHA. In addition to the Corporate Plan, each generating station has a "Site Specific Operations and Maintenance Plan" (Site Plan) that defines the roles; responsibilities; and actions required by the generating station to ensure our ponds are maintained and operated in a safe manner now and in the future. As part of the Site Plan, a 3rd Party PE will inspect the site on an annual basis to evaluate the current conditions; evaluate maintenance activities; and provide additional guidance to improve the overall safety of the ponds. The inspection sheet has been revised accordingly to include monthly and more detailed quarterly inspection. We anticipate having this plan, including training; operational at the Sutherland Generating Station by December 31, 2012.

AMEC commends Alliant Energy's Corporate and Site Plan initiatives. Provided the maintenance issues described herein are addressed, the proposed inspections and subsequent maintenance will provide a means to monitor and maintain the overall condition of the ponds.

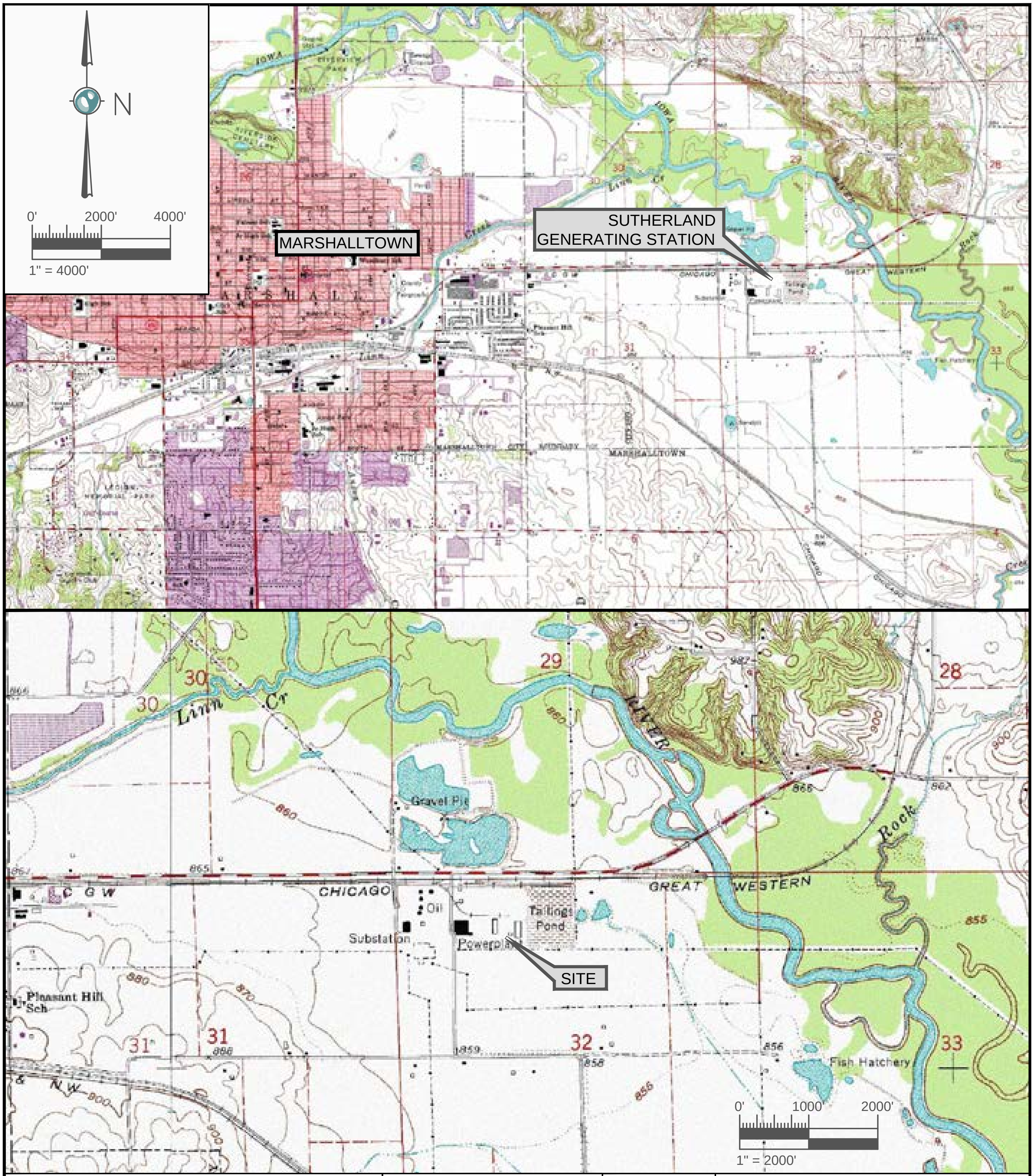
5.0 CLOSING

This report is prepared for the exclusive use of the Environmental Protection Agency for the site and criteria stipulated herein. This report does not address regulatory issues associated with storm water runoff, the identification and modification of regulated wetlands, or ground water recharge areas. Further, this report does not include review or analysis of environmental or regional geo-hydrologic aspects of the site, except as noted herein. Questions or interpretation regarding any portion of the report should be addressed directly by the geotechnical engineer.

Any use, reliance on, or decisions to be made based on this report by a third party are the responsibility of such third parties. AMEC accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

The conclusions and recommendations given in this report are based on visual observations, our partial knowledge of the history of Sutherland's impoundments, and information provided to us by others. This report has been prepared in accordance with normally accepted geotechnical engineering practices. No other warranty is expressed or implied.

FIGURES



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UNITED STATES
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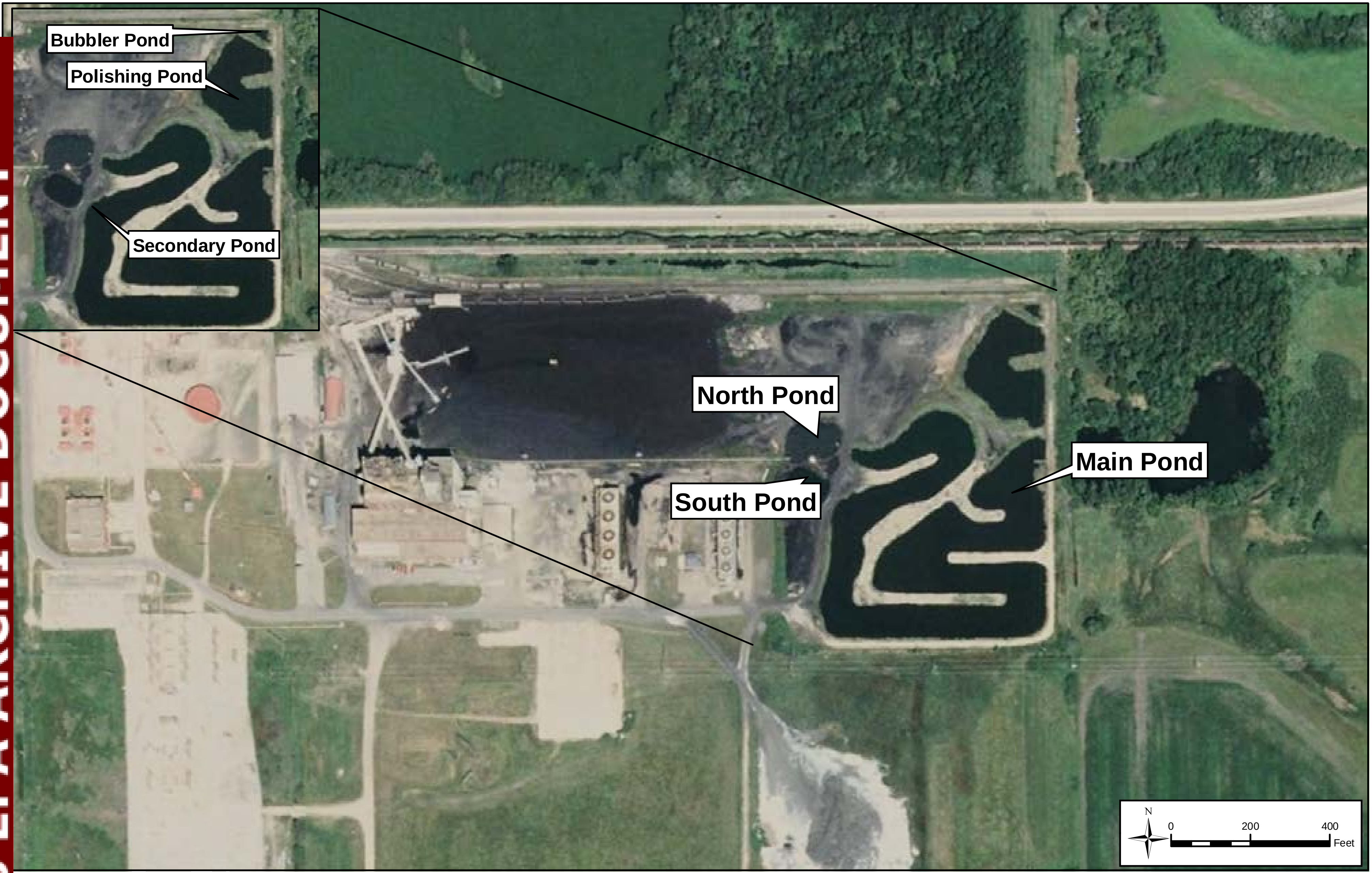
PROJECT
ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS

TITLE
INTERSTATE POWER AND LIGHT COMPANY
SUTHERLAND GENERATING STATION, MARSHALLTOWN, IA
SITE LOCATION & VICINITY MAP

DWN BY: CAE
DATUM:
DATE: 7/13/11
CHK'D BY: JHB
REV. NO.:
PROJECT NO: 3-2106-0191.0001.****
PROJECTION:
SCALE: AS SHOWN
FIGURE No. 1

S:\Geosciences\Proposals\EPA Coal Impoundment Inspection\April 2011 Round 10\Alliant Sutherland\CAD\marshalltownfig1.dwg — Layout1 — Jul. 13, 2011 10:52am — chris.eger



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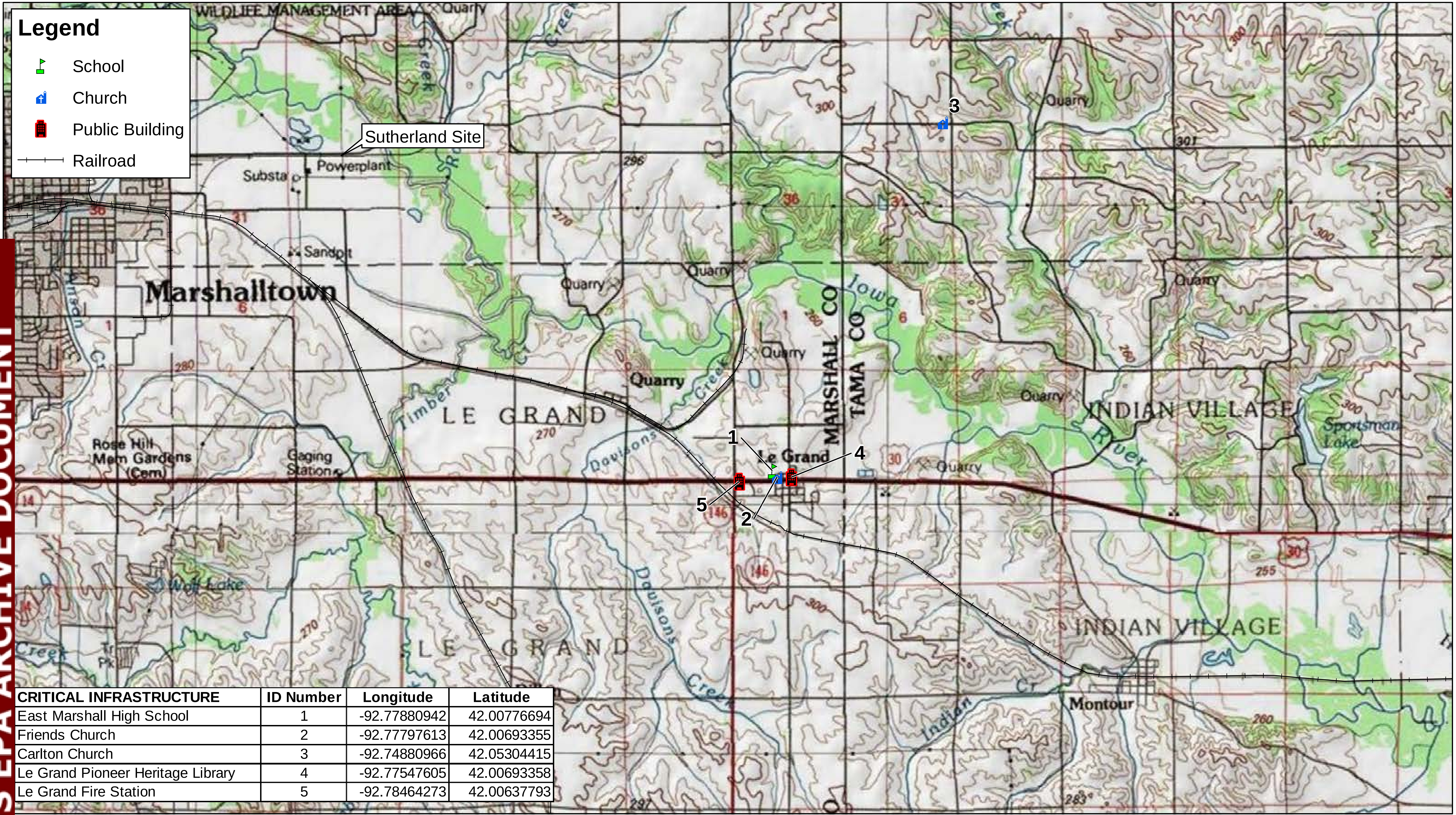
DWN BY: DJC
CKD BY: MS
Datum: NAD 83
Projection: UTM 15
Scale: As Shown

ASSESSMENT OF DAM SAFETY OF
COAL COMBUSTION SURFACE IMPOUNDMENTS

INTERSTATE POWER AND LIGHT COMPANY
SUTHERLAND GENERATING STATION,
MARSHALLTOWN, IA
SITE MAP

REV. No.: A
Date: 9-15-10
Project No: 3-2106-0191
Figure No: 2



CRITICAL INFRASTRUCTURE	ID Number	Longitude	Latitude
East Marshall High School	1	-92.77880942	42.00776694
Friends Church	2	-92.77797613	42.00693355
Carlton Church	3	-92.74880966	42.05304415
Le Grand Pioneer Heritage Library	4	-92.77547605	42.00693358
Le Grand Fire Station	5	-92.78464273	42.00637793

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DATUM: NAD83
PROJECTION: Albers
SCALE: AS SHOWN
DATE: 7/14/2011

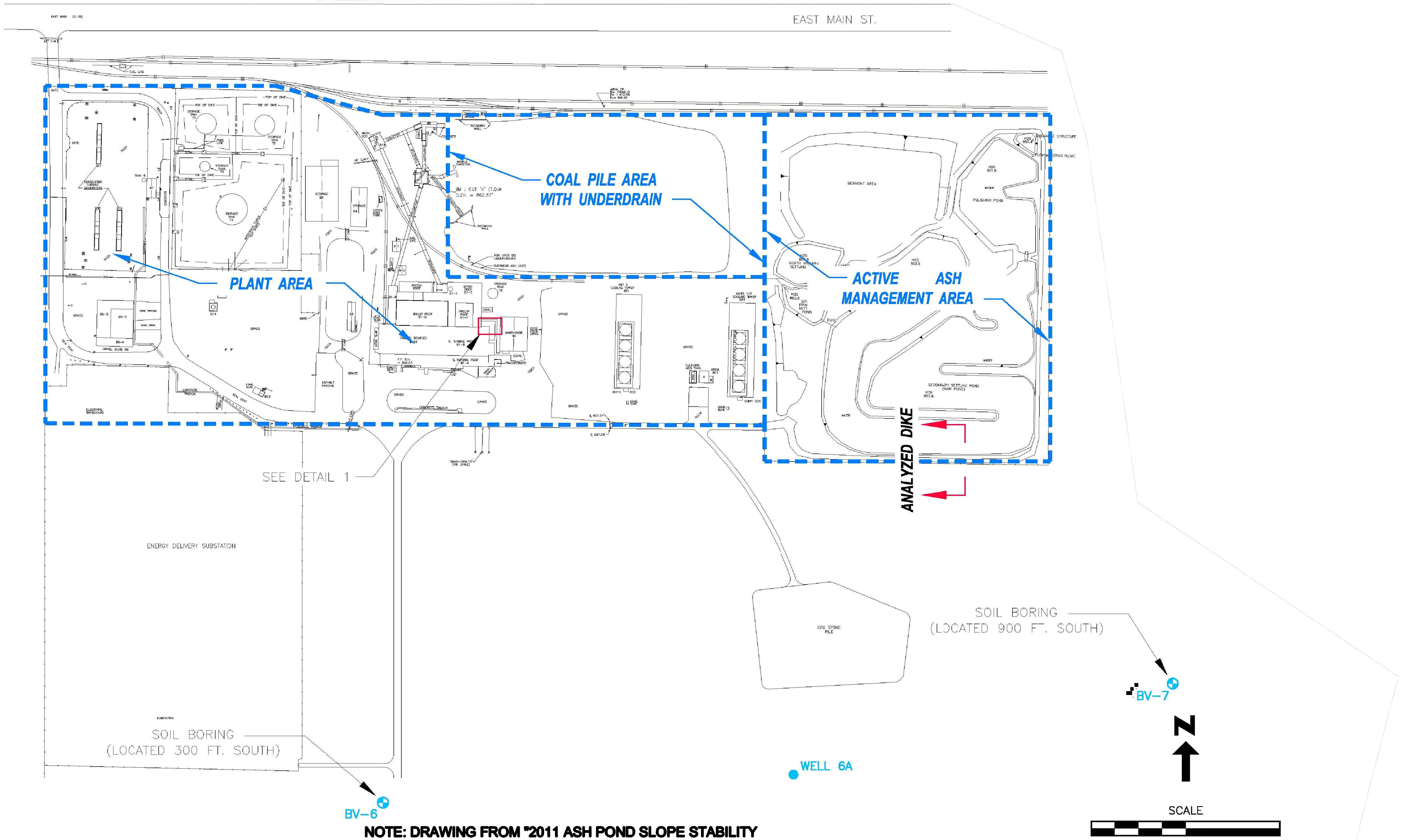
ASSESSMENT OF DAM SAFETY OF
COAL COMBUSTION SURFACE IMPOUNDMENTS

INTERSTATE POWER AND LIGHT COMPANY
SUTHERLAND GENERATING STATION, MARSHALLTOWN, IA
CRITICAL INFRASTRUCTURE

N
0 1 Miles
0 1 Kilometers

Notes: Critical infrastructure data provided by ESRI

FIGURE
3



NOTE: DRAWING FROM "2011 ASH POND SLOPE STABILITY AND HYDRAULIC ANALYSIS" REPORT BY AETHER DBS

NOTE: THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE AMEC EARTH & ENVIRONMENTAL REPORT

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DWN BY: DNP
CHK'D BY: MOS
DATUM:
PROJECTION:
SCALE: AS SHOWN

PROJECT: ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS

TITLE: INTERSTATE POWER AND LIGHT COMPANY SUTHERLAND GENERATING STATION, MARSHALLTOWN, IA DRAINAGE AREA TO PONDS AND LOCATION OF ANALYZED STABILITY SECTION

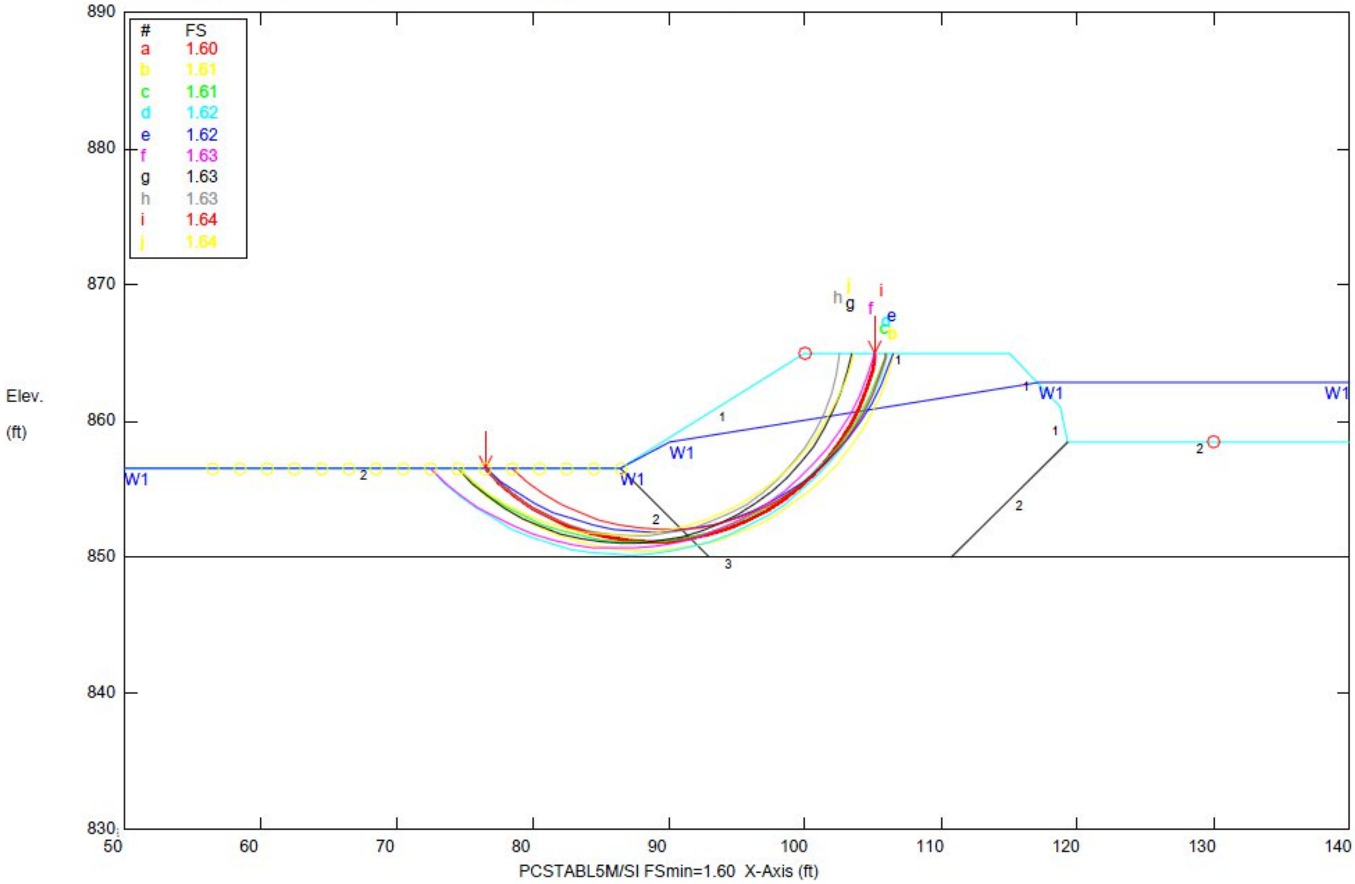
DATE: 7/15/11
PROJECT NO: 3-2106-0191
REV. NO.:
FIGURE No. 4

S:\Geosciences\Proposals\EPA Coal Impoundment Inspection\April 2011 Round 10\Alliant Sutherland\CAD\pondstabilityfig4.dwg – Layout1 – Jul. 15, 2011 4:10pm – chris.eger

CONFIDENTIAL BUSINESS INFORMATION

Alliant Energy - Marshalltown, Iowa Static Case - Effective Stress

Ten Most Critical. C:MARSH31.PLT By: TCW 06-25-12 10:07am



Soil Type No.	Label	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	Dike	120	120	240	19	0	0	W1
2	NC Clay	100	110	0	24	0	0	W1
3	Sand	120	120	0	28	0	0	W1

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ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS

DWN BY: CAE

DATUM:

DATE: 7/13/11

TITLE
INTERSTATE POWER AND LIGHT COMPANY
SUTHERLAND GENERATING STATION, MARSHALLTOWN, IA
CRITICAL CROSS-SECTION SECONDARY POND

CHK'D BY: JHB

REV. NO.:

PROJECT NO: 3-2106-0191.0001.****

PROJECTION:

SCALE:

FIGURE NO. 5

APPENDIX A

EPA COAL COMBUSTION DAM INSPECTION CHECKLISTS AND COAL COMBUSTION WASTE IMPOUNDMENT INSPECTION FORMS DATA - JUNE 2010

Coal Combustion Dam Inspection Checklist Form

US Environmental
Protection Agency

Site Name: Sutherland

Date: 6/14/2011

Unit Name: Main Ash Pond *

Operator's Name: Alliant Energy (IPL)

Unit I.D.:

Hazard Potential Classification: High Significant [✓ Low]

Inspector's Name: Don Dotson/James Black, PE

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.

*** Includes Secondary, Polishing and Discharge Pond.**

	Yes	No		Yes	No
1. Frequency of Company's Dam Inspections?	See Comment		18. Sloughing or bulging on slopes?	See Comment	
2. Pool elevation (operator records)?	852.6		19. Major erosion or slope deterioration?	See Comment	
3. Decant inlet elevation (operator records)?	859.6				
4. Open channel spillway elevation (operator records)?	N/A		Is water entering inlet, but not exiting outlet?		X
5. Lowest dam crest elevation (operator records)?	865		Is water exiting outlet, but not entering inlet?		X
6. If instrumentation is present, are readings recorded (operator records)?	N/A		Is water exiting outlet flowing clear?	X	
7. Is the embankment currently under construction?		X	21. Seepage (specify location, if seepage carries fines, and approximate seepage rate below):		
8. Foundation preparation (remove vegetation, stumps, topsoil in area where embankment fill will be placed)?	N/A		From underdrain?		X
9. Trees growing on embankment? (If so, indicate largest diameter below)		X	At isolated points on embankment slopes?		X
10. Cracks or scarps on crest?		X	At natural hillside in the embankment area?		X
11. Is there significant settlement along the crest?		X	Over widespread areas?		X
12. Are decant trash racks clear and in place?	N/A		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?		X
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?	See Comment		23. Water against downstream toe?	X	X
17. Cracks or scarps on slopes?	see Comment		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. Bi-annual documented inspection of pond system by on-site Environmental and Safety Specialist; plant personnel perform daily inspection - not documented.

2. Secondary pond pool elevation (highest) listed.

3. Pipe in discharge pond listed.

9, 17 & 18. Vegetation too tall to inspect embankment closely.

23. Locations on East Dike of Secondary Pond.

EPA FORM -XXXX

U. S. Environmental Protection Agency

Coal Combustion Waste (CCW)
Impoundment Inspection

Impoundment NPDES Permit # 64-69-1-03 INSPECTOR Dotson/Black

Date 06/14/2011

Impoundment Name Main ash pond (Secondary, Polishing & Discharge Ponds)

Impoundment Company Interstate Power & Light - Sutherland Generating Station

EPA Region VII

State Agency (Field Office) Address

Name of Impoundment

(Report each impoundment on a separate form under the same Impoundment NPDES Permit number)

New X Update

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

IMPOUNDMENT FUNCTION: Secondary & Tertiary Settling of CCW, surface runoff and other plant waste streams.

Nearest Downstream Town : Name La Grand

Distance from the impoundment 5 miles

Impoundment

Location:

Longitude -92 Degrees 51 Minutes 18.13 Seconds

Latitude 42 Degrees 02 Minutes 50.83 Seconds

State IA County Marshall

Does a state agency regulate this impoundment? YES NO X

If So Which State Agency? N/A

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.

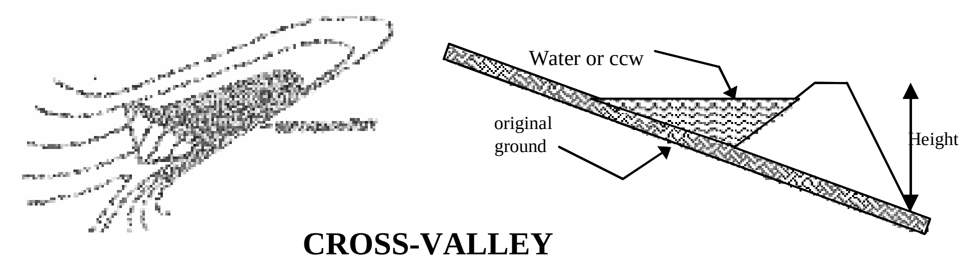
__X__**LOW HAZARD POTENTIAL:** Dams assigned the low hazard potential classification are those where failure or misoperation results in no probable loss of human life and low economic and/or environmental losses. Losses are principally limited to the owner's property.

______**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.

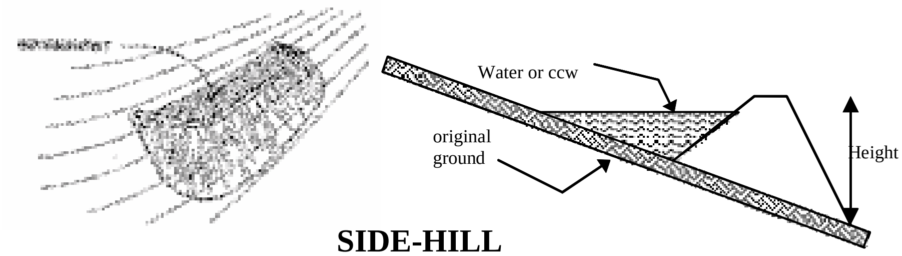
______**HIGH HAZARD POTENTIAL:** Dams assigned the high hazard potential classification are those where failure or misoperation will probably cause loss of human life.

DESCRIBE REASONING FOR HAZARD RATING CHOSEN:
Release would stay within plant (IPL) property. (No adjacent major river or stream, operation water obtained from wells.)

CONFIGURATION:

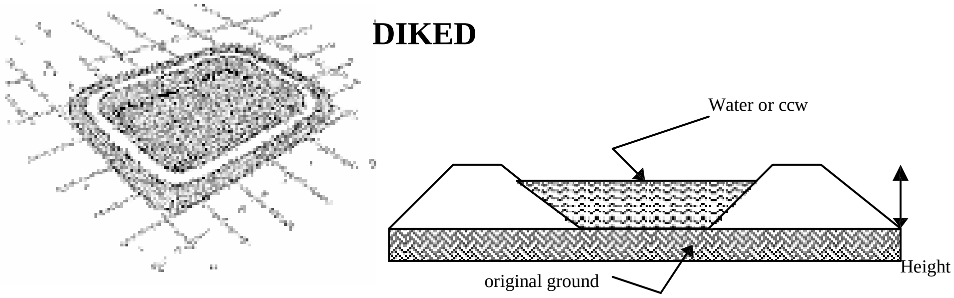


CROSS-VALLEY

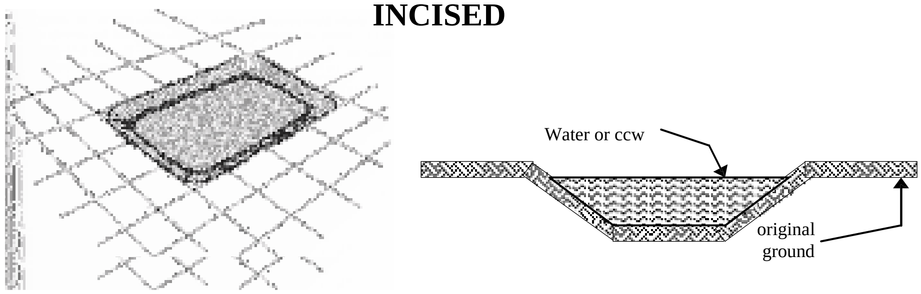


SIDE-HILL

DIKED



INCISED



______Cross-Valley
______Side-Hill
__X__Diked (Construction within former ash management area)
______Incised (form completion optional)
______Combination Incised/Diked

Embankment Height ___7_____feet Embankment Material___Clay________
Pool Area _____6.18 acres____ acres Liner N/A__________________
Current Freeboard _3.4_______ feet Liner Permeability _N/A__________

TYPE OF OUTLET (Mark all that apply)

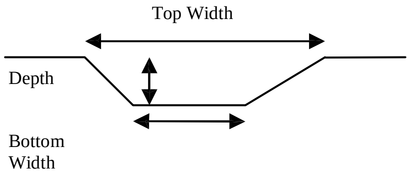
______**Open Channel Spillway**
__X__Trapezoidal
______Triangular
______Rectangular
______Irregular

Partial Flume from Secondary and Polishing Pond

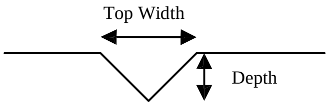
______depth
______bottom (or average) width
______top width

__X__ Drop inlet pipe from Discharge pond

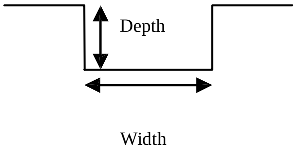
TRAPEZOIDAL



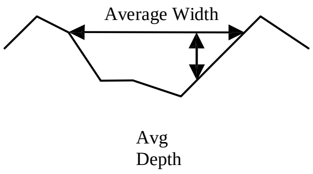
TRIANGULAR



RECTANGULAR

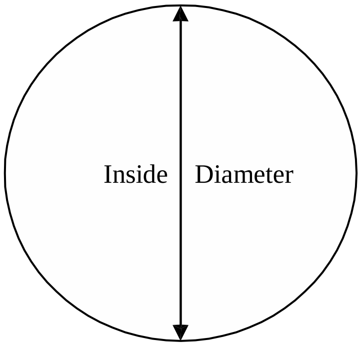


IRREGULAR



______**Outlet**

24"___ inside diameter



Material
______corrugated metal
______welded steel
__X__concrete* * w/metal cap
______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 Hard Hat Services, Inc.______________

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: ____

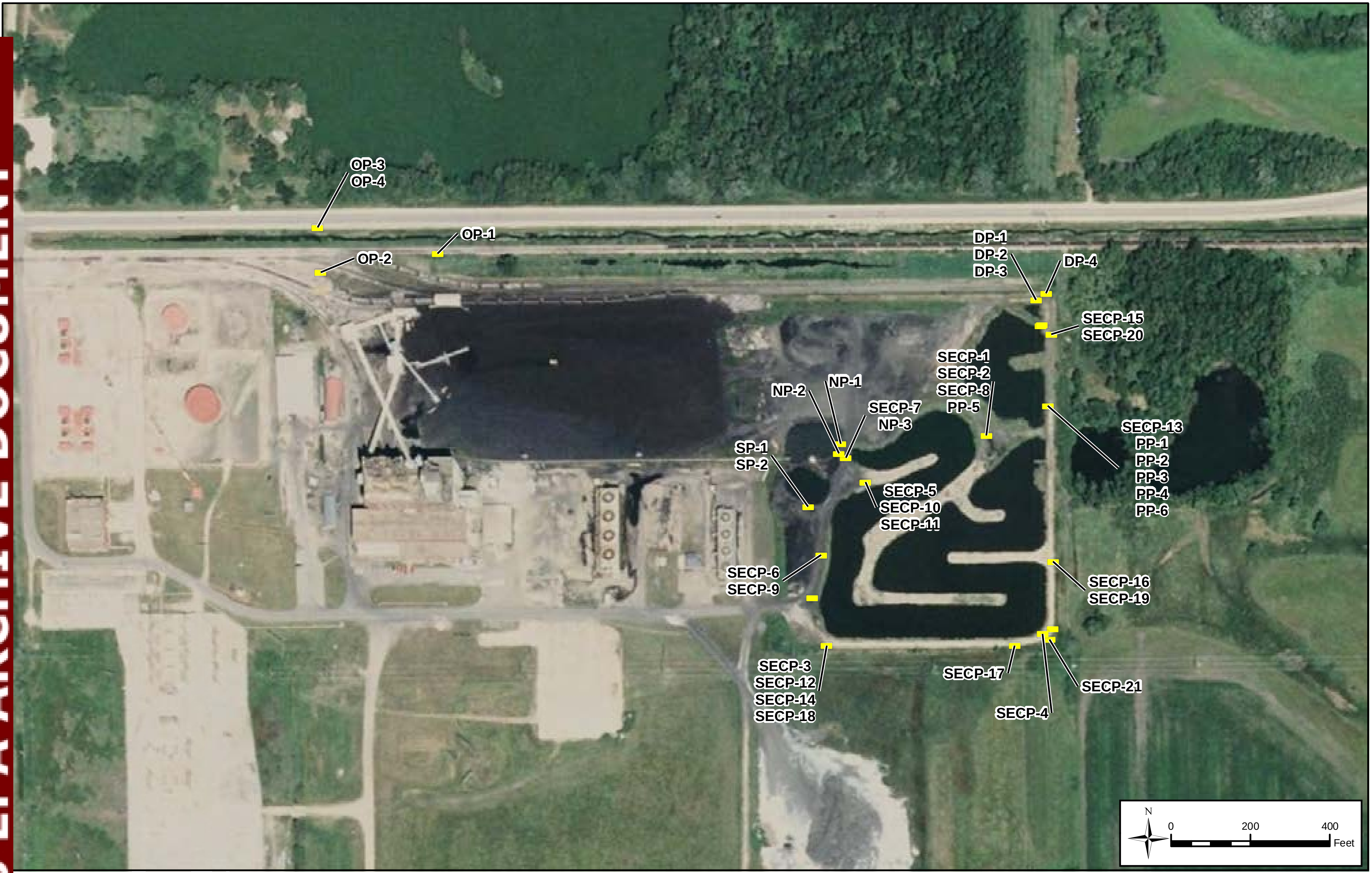
Has there ever been any measures undertaken to monitor/lower
Phreatic water table levels based on past seepages or breaches
at this site? YES _________ NO ___X____

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

If so Please Describe :

APPENDIX B

SITE PHOTO LOG MAP AND SITE PHOTOS



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DWN BY: DJC
CKD BY: MS
Datum: NAD 83
Projection: UTM 15
Scale: As Shown

ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS

INTERSTATE POWER AND LIGHT COMPANY
SUTHERLAND GENERATING STATION,
MARSHALLTOWN, IA
SITE MAP

REV. No.: A
Date: 7-14-11
Project No: 3-2106-0191
Figure No: B-1

NP-1
LOOKING WEST AT CCW AND OTHER
WASTESTREAM INLET PIPES FROM PLANT

NP-2
LOOKING NORTH AT INLET OF OUTLET PIPE

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ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS

TITLE
INTERSTATE POWER AND LIGHT COMPANY
SUTHERLAND GENERATING STATION, MARSHALLTOWN, IA
NORTH POND SITE PHOTOS

DWN BY: CAE
DATUM:
DATE: 7/13/11
CHK'D BY: JHB
REV. NO.:
PROJECT NO: 3-2106-0191
PROJECTION:
SCALE:
PAGE NO.. B-2

NP-3
LOOKING EAST AND DOWN AT OUTLET OF PIPE
FROM NORTH POND TO SECONDARY POND

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ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS

DWN BY: CAE
DATUM:
DATE: 7/13/11

TITLE
INTERSTATE POWER AND LIGHT COMPANY
SUTHERLAND GENERATING STATION, MARSHALLTOWN, IA
NORTH POND SITE PHOTOS

CHK'D BY: JHB
REV. NO.:
PROJECT NO: 3-2106-0191
PROJECTION:
SCALE:
PAGE NO.. B-3

SP-1
LOOKING NORTH AT CCW INLET PIPE TO SOUTH POND.
NORTH POND ABOVE AND TO THE RIGHT

SP-2
FROM SOUTH CREST LOOKING EAST AT
INLET OF OUTLET PIPE FROM SOUTH POND

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ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS

TITLE
INTERSTATE POWER AND LIGHT COMPANY
SUTHERLAND GENERATING STATION, MARSHALLTOWN, IA
SOUTH POND SITE PHOTOS

DWN BY: CAE
CHK'D BY: JHB
PROJECTION:
DATUM:
REV. NO.:
SCALE:
DATE: 7/13/11
PROJECT NO: 3-2106-0191
PAGE NO.. B-4

SECP-1
LOOKING WEST AT START OF SECONDARY POND. STEEP/BARE SLOPES ON NORTH INTERIOR EMBANKMENT. NOTE GRADE (TRUCK) TO NORTH

SECP-2
LOOKING SOUTHWEST AT INTERIOR OF SECONDARY POND. STEEP AND BARE SLOPE AREA AT SOUTH POND INLET IN BACKGROUND

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ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS

DWN BY: CAE

DATUM:

DATE: 7/13/11

TITLE
INTERSTATE POWER AND LIGHT COMPANY
SUTHERLAND GENERATING STATION, MARSHALLTOWN, IA
SECONDARY POND SITE PHOTOS

CHK'D BY: JHB

REV. NO.:

PROJECT NO: 3-2106-0191

PROJECTION:

SCALE:

PAGE NO.. B-5

SECP-3
LOOKING NORTH AT INTERIOR AND WEST DIKE US SLOPES OF SECONDARY POND, STEEP/BARE AREA AT INLET FROM SOUTH POND (TOP LEFT)

SECP-4
LOOKING WEST AT US SLOPES OF SOUTH DIKE OF SECONDARY POND. TALL VEGETATION, SLOUGHS OBSERVED ON US SLOPE

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ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS

TITLE
INTERSTATE POWER AND LIGHT COMPANY
SUTHERLAND GENERATING STATION, MARSHALLTOWN, IA
SECONDARY POND SITE PHOTOS

DWN BY: CAE
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REV. NO.:
PROJECT NO: 3-2106-0191
PROJECTION:
SCALE:
PAGE NO.. B-6

SECP-5
LOOKING SOUTH AT INTERIOR AND WEST EMBANKMENT OF SECONDARY POND

SECP-6
LOOKING NORTHEAST AT WEST UPPER SECTION OF SECONDARY POND. ROCK AT TOE OF INTERIOR SLOPES

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PROJECT ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS	DWN BY: CAE	DATUM:	DATE: 7/13/11
TITLE INTERSTATE POWER AND LIGHT COMPANY SUTHERLAND GENERATING STATION, MARSHALLTOWN, IA SECONDARY POND SITE PHOTOS	CHK'D BY: JHB	REV. NO.:	PROJECT NO: 3-2106-0191
	PROJECTION:	SCALE:	PAGE NO.. B-7

SECP-7
LOOKING NORTHEAST AT INTERIOR OF START OF SECONDARY POND. STEEP SLOPES AND TALL GRASSES ON NORTH BANK

SECP-8
LOOKING SOUTHEAST AT INTERIOR OF SECONDARY POND

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PROJECT ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS	DWN BY: CAE	DATUM:	DATE: 7/13/11
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	PROJECTION:	SCALE:	PAGE NO.. B-8

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SECP-9
LOOKING EAST AT SOUTH INTERIOR OF SECONDARY POND.
INTERIOR FINGERS COMPLETED IN 2006 IN BACKGROUND

SECP-10
LOOKING EAST-SOUTHEAST AT INTERIOR OF SECONDARY POND.
WEST (START) IN FOREGROUND, EAST (END) IN BACKGROUND

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PROJECT
ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS

TITLE
INTERSTATE POWER AND LIGHT COMPANY
SUTHERLAND GENERATING STATION, MARSHALLTOWN, IA
SECONDARY POND SITE PHOTOS

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PROJECT NO: 3-2106-0191
PROJECTION:
SCALE:
PAGE NO.. B-9

SECP-11
FROM START OF FINGER ACROSS FROM SOUTH POND
LOOKING EAST AT INTERIOR OF POND

SECP-12
LOOKING NORTH AT US SLOPES OF WEST DIKE OF SECONDARY POND,
TALL VEGETATION, STEEP/BARE AREA AT INLET FROM SOUTH POND

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PROJECT ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS	DWN BY: CAE	DATUM:	DATE: 7/13/11
TITLE INTERSTATE POWER AND LIGHT COMPANY SUTHERLAND GENERATING STATION, MARSHALLTOWN, IA SECONDARY POND SITE PHOTOS	CHK'D BY: JHB	REV. NO.:	PROJECT NO: 3-2106-0191
	PROJECTION:	SCALE:	PAGE NO.. B-10

SECP-13
LOOKING SOUTH AT US SLOPES OF EAST DIKE, INTERIOR, AND OVERFLOW DIKE BETWEEN SECONDARY AND POLISHING PONDS, TALL VEGETATION

SECP-14
LOOKING EAST AT US SLOPES OF SECONDARY POND, TALL VEGETATION AND ISOLATED ERODED AREAS

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TITLE INTERSTATE POWER AND LIGHT COMPANY SUTHERLAND GENERATING STATION, MARSHALLTOWN, IA SECONDARY POND SITE PHOTOS	CHK'D BY: JHB	REV. NO.:	PROJECT NO: 3-2106-0191
	PROJECTION:	SCALE:	PAGE NO.. B-11

SECP-15
LOOKING SOUTH AT EAST DIKE CREST AND DOWNSTREAM EMBANKMENT

SECP-16
LOOKING SOUTH AT CREST AND DS SLOPE OF EAST DIKE OF SECONDARY POND, WATER AT TOE OF DOWNSTREAM SLOPE

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CLIENT LOGO	CLIENT UNITED STATES ENVIRONMENTAL PROTECTION AGENCY		
PROJECT ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS	DWN BY: CAE	DATUM:	DATE: 7/13/11
TITLE INTERSTATE POWER AND LIGHT COMPANY SUTHERLAND GENERATING STATION, MARSHALLTOWN, IA SECONDARY POND SITE PHOTOS	CHK'D BY: JHB	REV. NO.:	PROJECT NO: 3-2106-0191
	PROJECTION:	SCALE:	PAGE NO.. B-12

SECP-17
LOOKING WEST AT DS SLOPES AND CREST OF SOUTH DIKE OF SECONDARY POND, TALL VEGETATION

SECP-18
LOOKING EAST AT CREST OF SOUTH DIKE OF SECONDARY POND, TALL VEGETATION ON US AND DS SLOPES

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CLIENT LOGO	CLIENT UNITED STATES ENVIRONMENTAL PROTECTION AGENCY		
PROJECT ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS	DWN BY: CAE	DATUM:	DATE: 7/13/11
TITLE INTERSTATE POWER AND LIGHT COMPANY SUTHERLAND GENERATING STATION, MARSHALLTOWN, IA SECONDARY POND SITE PHOTOS	CHK'D BY: JHB	REV. NO.:	PROJECT NO: 3-2106-0191
	PROJECTION:	SCALE:	PAGE NO.. B-13

SECP-19
LOOKING SOUTHEAST FROM SECONDARY POND, WATER AT AND BEYOND TOE OF DS SLOPE

SECP-20
LOOKING SOUTHEAST AT POND TO EAST OF EAST DIKE

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

PROJECT
ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS

DWN BY: CAE
DATUM:
DATE: 7/13/11

TITLE
INTERSTATE POWER AND LIGHT COMPANY
SUTHERLAND GENERATING STATION, MARSHALLTOWN, IA
SECONDARY POND SITE PHOTOS

CHK'D BY: JHB
REV. NO.:
PROJECT NO: 3-2106-0191
PROJECTION:
SCALE:
PAGE NO.. B-14

SECP-21
LOOKING NORTH AT CREST AND SLOPES OF SECONDARY AND POLISHING PONDS, TALL VEGETATION ON SLOPES

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ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS

DWN BY: CAE	DATUM:	DATE: 7/13/11
CHK'D BY: JHB	REV. NO.:	PROJECT NO: 3-2106-0191
PROJECTION:	SCALE:	PAGE NO.. B-15

TITLE
INTERSTATE POWER AND LIGHT COMPANY
SUTHERLAND GENERATING STATION, MARSHALLTOWN, IA
SECONDARY POND SITE PHOTOS

PP-1
LOOKING SOUTHWEST AT INTERIOR AND WEST DIKE OF POLISHING POND.
STEEP SLOPES, SLOUGH AREAS, AND TALL VEGETATION

PP-2
LOOKING NORTHWEST ACROSS POLISHING POND,
STEEP SLOPES, TALL AND SOME BRUSHY VEGETATION

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PROJECT
ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS

DWN BY: CAE
DATUM:
DATE: 7/13/11

TITLE
INTERSTATE POWER AND LIGHT COMPANY
SUTHERLAND GENERATING STATION, MARSHALLTOWN, IA
POLISHING POND SITE PHOTOS

CHK'D BY: JHB
REV. NO.:
PROJECT NO: 3-2106-0191

PROJECTION:
SCALE:
PAGE NO.. B-16

PP-3

LOOKING NORTHWEST ACROSS POLISHING POND, STEEP/BARE INTERIOR SLOPES, RECENT REPAIR (RIP-RAP) ON EAST DIKE

PP-4

LOOKING NORTH AT CREST AND US SLOPE OF EAST DIKE OF POLISHING POND, RECENT REPAIR (RIP-RAP) ON EAST DIKE

AMEC Earth & Environmental 690 Commonwealth Center 11003 Bluegrass Parkway Louisville, Ky 40299 (502) 267-0700	amec	CLIENT LOGO	CLIENT UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
PROJECT ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS	DWN BY: CAE	DATUM:	DATE: 7/13/11
TITLE INTERSTATE POWER AND LIGHT COMPANY SUTHERLAND GENERATING STATION, MARSHALLTOWN, IA POLISHING POND SITE PHOTOS	CHK'D BY: JHB	REV. NO.:	PROJECT NO: 3-2106-0191
	PROJECTION:	SCALE:	PAGE NO.. B-17

PP-5
LOOKING NORTHEAST AT TOP END OF POLISHING POND.
BRUSHY VEGETATION ON INTERIOR SLOPES

PP-6
LOOKING SOUTHWEST AT WEIR AND OVERFLOW AREA
BETWEEN SECONDARY AND POLISHING POND

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PROJECT
ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS

TITLE
INTERSTATE POWER AND LIGHT COMPANY
SUTHERLAND GENERATING STATION, MARSHALLTOWN, IA
POLISHING POND SITE PHOTOS

DWN BY: CAE
DATUM:
DATE: 7/13/11
CHK'D BY: JHB
REV. NO.:
PROJECT NO: 3-2106-0191
PROJECTION:
SCALE:
PAGE NO.. B-18

DP-1
DISCHARGE POND OUTLET STRUCTURE AND EMERGENCY OVERFLOW INLET

DP-2
LOOKING SOUTH AT DISCHARGE POND PARTIAL FLUME INLET WITH SOLAR POWERED FLOW METER

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CLIENT LOGO	CLIENT UNITED STATES ENVIRONMENTAL PROTECTION AGENCY		
PROJECT ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS	DWN BY: CAE	DATUM:	DATE: 7/13/11
TITLE INTERSTATE POWER AND LIGHT COMPANY SUTHERLAND GENERATING STATION, MARSHALLTOWN, IA DISCHARGE POND SITE PHOTOS	CHK'D BY: JHB	REV. NO.:	PROJECT NO: 3-2106-0191
	PROJECTION:	SCALE:	PAGE NO.. B-19

DP-3
DISCHARGE POND OUTLET STRUCTURE

DP-4
BUBBLER POOL/OUTLET DITCH

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Louisville, Ky 40299
(502) 267-0700

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UNITED STATES
ENVIRONMENTAL
PROTECTION AGENCY

PROJECT ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS	DWN BY: CAE	DATUM:	DATE: 7/13/11
TITLE INTERSTATE POWER AND LIGHT COMPANY SUTHERLAND GENERATING STATION, MARSHALLTOWN, IA DISCHARGE POND SITE PHOTOS	CHK'D BY: JHB	REV. NO.:	PROJECT NO: 3-2106-0191
	PROJECTION:	SCALE:	PAGE NO.. B-20

OP-1
TREE MARKS LOCATION OF INLET OF OUTLET DITCH PIPE FROM PROPERTY

OP-2
SURFACE DRAINAGE CATCH BASIN AND MANHOLE FOR POND OUTLET DITCH ON WEST SIDE OF PLANT PROPERTY

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UNITED STATES
ENVIRONMENTAL
PROTECTION AGENCY

PROJECT
ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS

TITLE
INTERSTATE POWER AND LIGHT COMPANY
SUTHERLAND GENERATING STATION, MARSHALLTOWN, IA
OUTLET PIPE/DITCH SITE PHOTOS

DWN BY: CAE
DATUM:
DATE: 7/13/11
CHK'D BY: JHB
REV. NO.:
PROJECT NO: 3-2106-0191
PROJECTION:
SCALE:
PAGE NO.. B-21

OP-3

LOOKING SOUTH AT OUTLET PIPE TO ROADSIDE DITCH, CORRODED CMP PIPE

OP-4

LOOKING EAST AND DOWNSTREAM OF ROADSIDE DITCH

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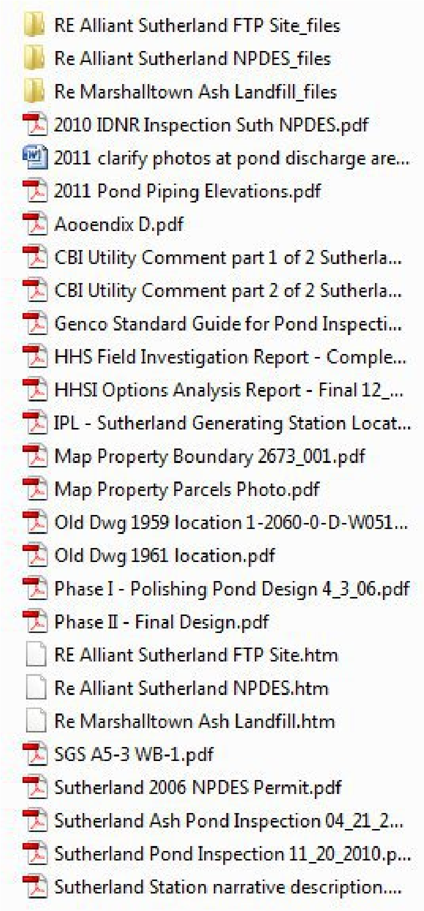
CLIENT LOGO	CLIENT UNITED STATES ENVIRONMENTAL PROTECTION AGENCY		
PROJECT ASSESSMENT OF DAM SAFETY OF COAL COMBUSTION SURFACE IMPOUNDMENTS	DWN BY: CAE	DATUM:	DATE: 7/13/11
TITLE INTERSTATE POWER AND LIGHT COMPANY SUTHERLAND GENERATING STATION, MARSHALLTOWN, IA OUTLET PIPE/DITCH SITE PHOTOS	CHK'D BY: JHB	REV. NO.:	PROJECT NO: 3-2106-0191
	PROJECTION:	SCALE:	PAGE NO.. B-22

APPENDIX C

INVENTORY OF PROVIDED MATERIALS

INVENTORY OF PROVIDED MATERIALS



RE Alliant Sutherland FTP Site_files
Re Alliant Sutherland NPDES_files
Re Marshalltown Ash Landfill_files
2010 IDNR Inspection Suth NPDES.pdf
2011 clarify photos at pond discharge are...
2011 Pond Piping Elevations.pdf
Aooendix D.pdf
CBI Utility Comment part 1 of 2 Sutherla...
CBI Utility Comment part 2 of 2 Sutherla...
Genco Standard Guide for Pond Inspecti...
HHS Field Investigation Report - Comple...
HHSI Options Analysis Report - Final 12_...
IPL - Sutherland Generating Station Locat...
Map Property Boundary 2673_001.pdf
Map Property Parcels Photo.pdf
Old Dwg 1959 location 1-2060-0-D-W051...
Old Dwg 1961 location.pdf
Phase I - Polishing Pond Design 4_3_06.pdf
Phase II - Final Design.pdf
RE Alliant Sutherland FTP Site.htm
Re Alliant Sutherland NPDES.htm
Re Marshalltown Ash Landfill.htm
SGS A5-3 WB-1.pdf
Sutherland 2006 NPDES Permit.pdf
Sutherland Ash Pond Inspection 04_21_2...
Sutherland Pond Inspection 11_20_2010.p...
Sutherland Station narrative description....

APPENDIX D

SLOPE STABILITY AND HYDRAULIC ANALYSIS

CONFIDENTIAL BUSINESS INFORMATION

aether dbs

elemental design build solutions

June 17, 2011

Mr. William Skalitzky
Alliant Energy
4902 N. Biltmore Lane
Madison, WI 53718

154.006.005

Re: Ash Pond Slope Stability and Hydraulic Analysis
Sutherland Generating Station – Marshalltown, IA

Mr. Skalitzky;

Aether dbs, reports our findings from the Ash Pond Slope Stability and Hydraulic Analysis performed for the Sutherland Generating Station. The purpose of the study is evaluation of the stability of the bottom ash settling ponds under 100-year storm flow and for both seismic and rapid drawdown induced loadings. The analysis is based on existing data on the generating station subsurface conditions, ash pond dike conditions, and surface drainage arrangements. The data pertinent to the evaluation is provided in the attachments.

The ash ponds are capable of routing a SCS Type II, 24-hour, 100 year storm without overtopping. The outer dikes of the ash pond have a factor of safety greater than the standard acceptable factor of safety of 1.5 for static stability and 1.0 for earthquake stability. The exterior dikes are constructed of clay and there is no rapid drawdown stability issue.

Background

The Sutherland Generating Station is a fossil-fueled electric generating plant consisting of three steam electric generators, three combustion turbine units, and two diesel oil generators. Coal is the primary fuel and each unit has the capability to use natural gas as a secondary fuel. The power plant's three units have a total rated capacity of 146 megawatts. The generating station including the coal stockpile and ash management facility are shown on Figure 1.

Bottom ash and fly ash from the coal fired boilers are sluiced to settling ponds east of the power plant at a flow rate of 700 gallons per minute. In addition, smaller quantities of cooling tower blow down, air compressor cooling water, and boiler blow down flow to the ash ponds. Bottom ash and fly ash settle in the ponds and are removed for beneficial reuse or disposal. The water from the ponds discharges through a 24-inch diameter circular overflow weir in the Northeast corner of the ash management area.

During storm events the pond also receives storm water runoff from the generating station and the coal storage pile.

In 2006, the secondary ash settling pond was reconfigured with the addition of a polishing pond at the Northeast corner and internal dikes were added within the main pond to lengthen the travel path and facilitate fly ash removal, Attachment A. The primary settling ponds are used to settle and remove ash on a regular basis. The secondary pond is used to settle the finer ash with less frequent removals. Discharge is through an NPDES permitted outfall.

Drainage

The coal pile has underground drain tiles which direct infiltration to the ash settling ponds. Storm water runoff from the powerhouse and the surrounding area is also directed to the ash ponds. For assessment of the storm water inflow to the ash pond, the plant area, the ash management area and the coal pile storm water is routed to the ash ponds. The storage lag that occurs in the coal pile underdrain system is not modeled and some areas of the plant that may not discharge directly to the ash ponds are included in the inflow to the ponds. The total area contributing to the ponds is 57 acres, Figure 1.

Hydrology and Hydraulics

The secondary ash settling pond overflows at elevation 862.4 feet. The polishing pond overflows at elevation 861.6 feet. The two ponds are separated by a lower elevation dike with a static mixing channel, Attachment A. During an extreme hydrological event, the small dike separating the secondary ash settling pond from the polishing pond will overtop and the two ponds will work together as a single pond with an approximate surface area of 6 acres.

After the polishing pond, water discharges through a flow monitoring flume to a small discharge pond with a circular overflow weir at elevation 860.4 feet. During a severe storm the water may overtop the internal weir of the small discharge pond to reach the overflow weir.

A 100-year, SCS Type 2, 24-hour storm for Marshall County, Iowa is 6.6 inches of precipitation[1]. A runoff Curve Number of 89 was used in the storm hydrograph calculation. The curve number is based on weighting the relative percentages of ash, coal, grass, and industrial uses at the generating station. A hydraulic length of 1920 feet was used for the longest flow path to the ponds, Attachment B.

Hydraflow by Intelisolve[2] was used to generate and route the storm hydrograph through the secondary settling pond, the polishing pond and finally the small discharge pond. The starting pond elevation was specified as the normal water elevation of 862.4 feet in the secondary ash pond and 861.6 feet in the polishing pond. The reservoir routing model predicts a maximum rise to water elevation 864.4 feet during the storm leaving a freeboard of slightly more than 6-inches, Attachment B. The discharge pond reaches a storm elevation of 862.5 feet which is 1.5 feet below the outer dike height of 864 feet.

---

[1] United States Department of Commerce, Rainfall Frequency Analysis of the United States,

[2] Intelisolve. Pond Routing Software Hydraflow, 2002

Sutherland Generating Station Personnel[3] report that the site received four inches of rainfall on November 4, 2003 and the water level in the secondary ash pond rose only 6 to 7 inches above the normal operating elevation. The historical event indicates that the analysis is conservative.

Ash Pond Dike Stability

Surface soil in the ash management area is Zook Clay (low plasticity clay with 5-7% organic content) USCS Marshall County Soil Survey[4]. During an investigation of the ash pond dikes in 2006 by Hard Hat Services the dikes were found to be constructed of the Zook Clay, Attachment A. Field characterizations of the clay unconfined compressive strength made with a pocket penetrometer are shown on the five boring logs from the outer dike of the ash pond. The cohesive strength of the clay (unconfined compressive strength divided by 2) is charted versus depth in Attachment C. All five borings produced similar strength results showing a strong crust (very stiff to hard clay above a depth of 4 feet) with stiff to firm clay underneath.

Two dimensional limit equilibrium slope stability analyses were performed on a conservative idealized cross-section that corresponds best with the outer dike along the southern edge of the active fly ash management area, Figure 1. The southern dike is a little narrower than the eastern outer dike and presumed higher, because the natural topography slopes slightly to the south, Attachment D. Two to one side slopes were specified for the reconstruction of the inside of the secondary ash pond and the available topographic information indicates that the outside dike slopes were also built at a two horizontal to one vertical slope.

The specified height of the dike in the idealized cross-section is 13 feet based on the maximum depth to native soils reported in the 2006 field investigation. The crest of the dike is at 865 feet and the toe is at 852 feet for a 13 foot height. The bottom of the ash pond adjacent to the southernmost dike is within the range of 851 feet to 855 feet. The 13 foot top width of the idealized dike is the narrowest width measured on the Settling Pond Reconfiguration Drawing, Attachment A.

The slope stability analysis assumes that the clay cohesion in the dike is the lowest strength measured above a depth of 14 feet, 1,250 pounds per square foot (psf), and the cohesion below the dike is the lowest strength measured below a depth of 13 feet, 1,000 psf, Attachment C.

Fine to medium sand with silt is present below the clay in the five nearest deep borings at elevations ranging from 848 feet to 852 feet, Attachment E and F. The search for failure surfaces in the Zook Clay was limited to a depth of 9 feet below the toe of the dike to avoid the stronger sand below that depth. The sand is relatively dense and will not liquefy in a low intensity earthquake.

---

[3] Correspondence with Mr. George Kueny of Sutherland Generating Station sent February 13, 2006.

[4] Soil Survey, Marshall County, Iowa, United States Soil Conservation Service

The depth to rock is over 250 feet as shown by the Well Record for Well Number 6A, Attachment G. Well Number 6A is located on Figure 1.

Program STABL5M (1996) from Purdue University[5] was used to analyze hundreds of potential slip surfaces for each loading case. The program calculates a factor of safety based on the ratio of the driving forces to the resisting forces along each potential slip surface. A calculated factor of safety greater than one indicates stability along the surface analyzed. Because the dike foundation soils are considered weaker than the dike, the most critical surface mode is a sliding block failure as shown in Attachment H.

Only two loading cases / failure scenarios were analyzed because in the case of a clay dike, the rapid drawdown case on the inside of the pond is essentially the same as the stability of the outside of the dike. (Clay soils cannot drain quickly; hence short term seepage forces are not a concern.)

1.) Ash pond water elevation at the normal elevation (862.6 feet) with a steady state seepage face emerging above the toe of the slope. Because a cohesion only strength is considered using undrained clay strength, the location of the seepage face does not influence the Factor of Safety calculation. However, water pressure on the inside of the dike can contribute to instability and it was included in the model.

2.) The small ponds at Sutherland Station do not pose a significant risk and contain minimum volumes of coal combustion residue. The procedures of FEMA[6] suggest that the structures rate as low risk dams. For low risk structures, a probability of 10% in 50 years (return period of 475 years) is an acceptable standard. Consequently, a pseudo-static earthquake analysis was completed using the effective peak ground acceleration for a 475 year return period[7]. With dense soil under the site, a Site Class “D” was selected for soil amplification giving a probable maximum horizontal earthquake acceleration of 0.019g for the ash ponds. The vertical earthquake force is specified as $^2/_3$ of the horizontal earthquake force[8].

The ten most critical potential failure surfaces for each loading case are shown in Attachment H. The lowest Factor of Safety for each case is:

---

[5] STABL User Manual, By Ronald A. Siegel, Purdue University, June 4, 1975 and STABL5 …The SPENCER Method of Slices: Final Report, By J.R.Carpenter, Purdue University, August 28, 1985

[6] Federal Emergency Management Agency, “Federal Guidelines for Dam Safety”, May 2005

[7] U.S. Army Engineer Research and Development Center, Vicksburg, MS., “DEQAS-R: Standard response spectra and effective peak ground accelerations for seismic design and evaluation” Yule, D. E. Kala, R., and Matheu, E. E. (2005),

[8] N.M.Newmark and W.J.Hall, “Procedures and Criteria for Earthquake Resistant Design”, Building Science Series No. 46, National Bureau of Standards, U.S. Dept. of Commerce, Washington, D.C., 1973

Dike Stability Loading Case	Minimum Factor of Safety
Static Conditions with Seepage Face	**3.4**
Earthquake with Seepage Face	**3.2**
Rapid Draw Down	**NA**

Conclusion

The secondary ash pond working in conjunction with the polishing pond can pass a 100-year 24-hour storm without overtopping.

The stability of the outer dike on the ponds is greater than the acceptable Factor of Safety standard of 1.5 for static conditions[9]. The outer dike also shows a Factor of Safety greater than the normally acceptable standard for Earthquake conditions (factor of safety greater than 1.0).

Respectfully Submitted,

Thomas C. Wells, P.E.

Timothy J. Harrington, P.E.

---

[9] USACE,"Engineering Design Slope Stability, EM 1110-2-1902", Table 3-1

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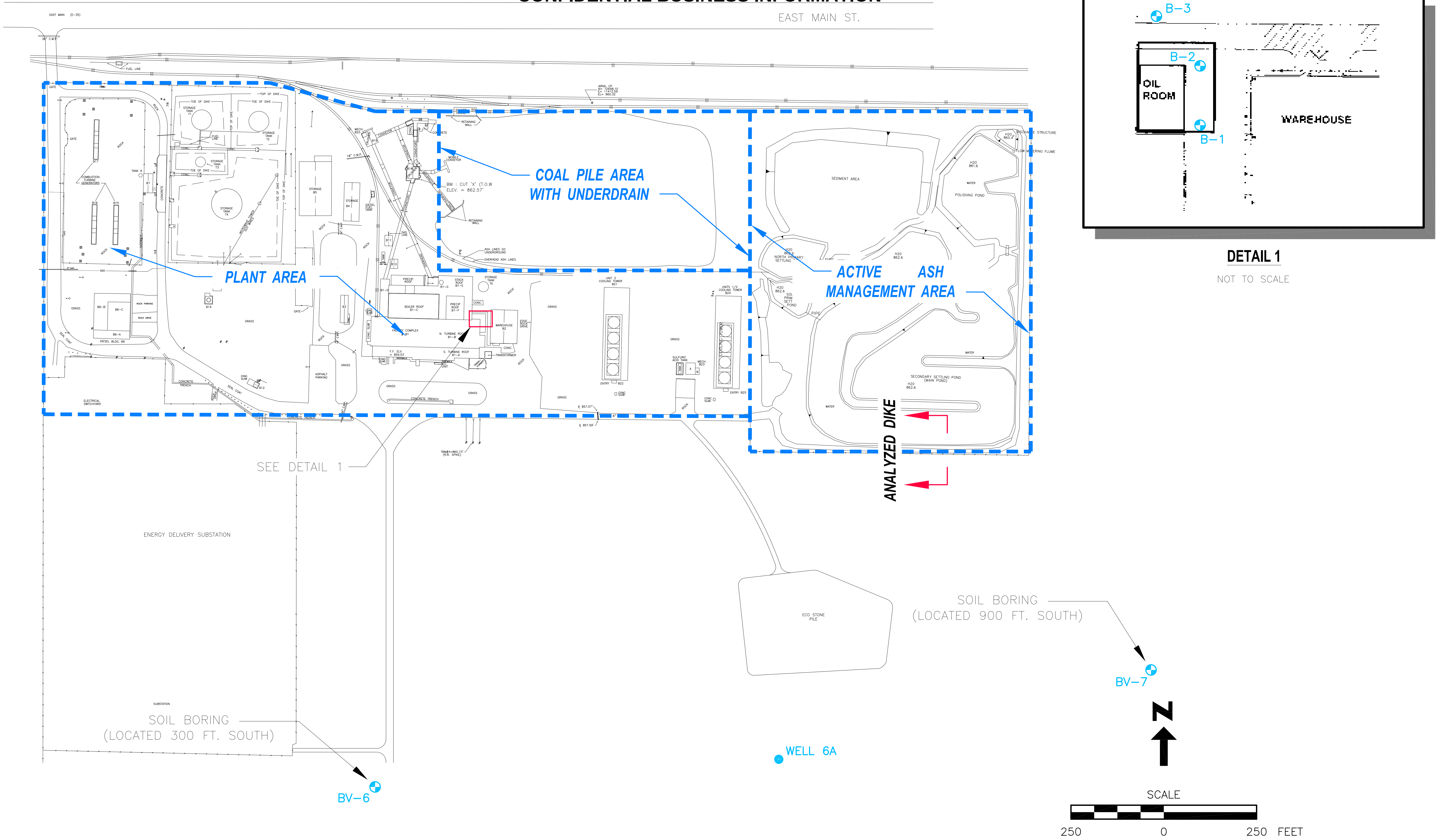

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REV	DATE	BY	DESCRIPTION
5			
4			
3			
2			
1			

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www.aetherdbs.com

SCALE: AS SHOWN
DATE: 12-29-2010
DRAWN BY: MM
CHKD. BY: TCW
APPROVED: 12-29-2010

CLIENT / LOCATION
ALLIANT ENERGY
SUTHERLAND GENERATING STATION
MARSHALLTOWN, IOWA

DRAWING DESCRIPTION
SITE PLAN

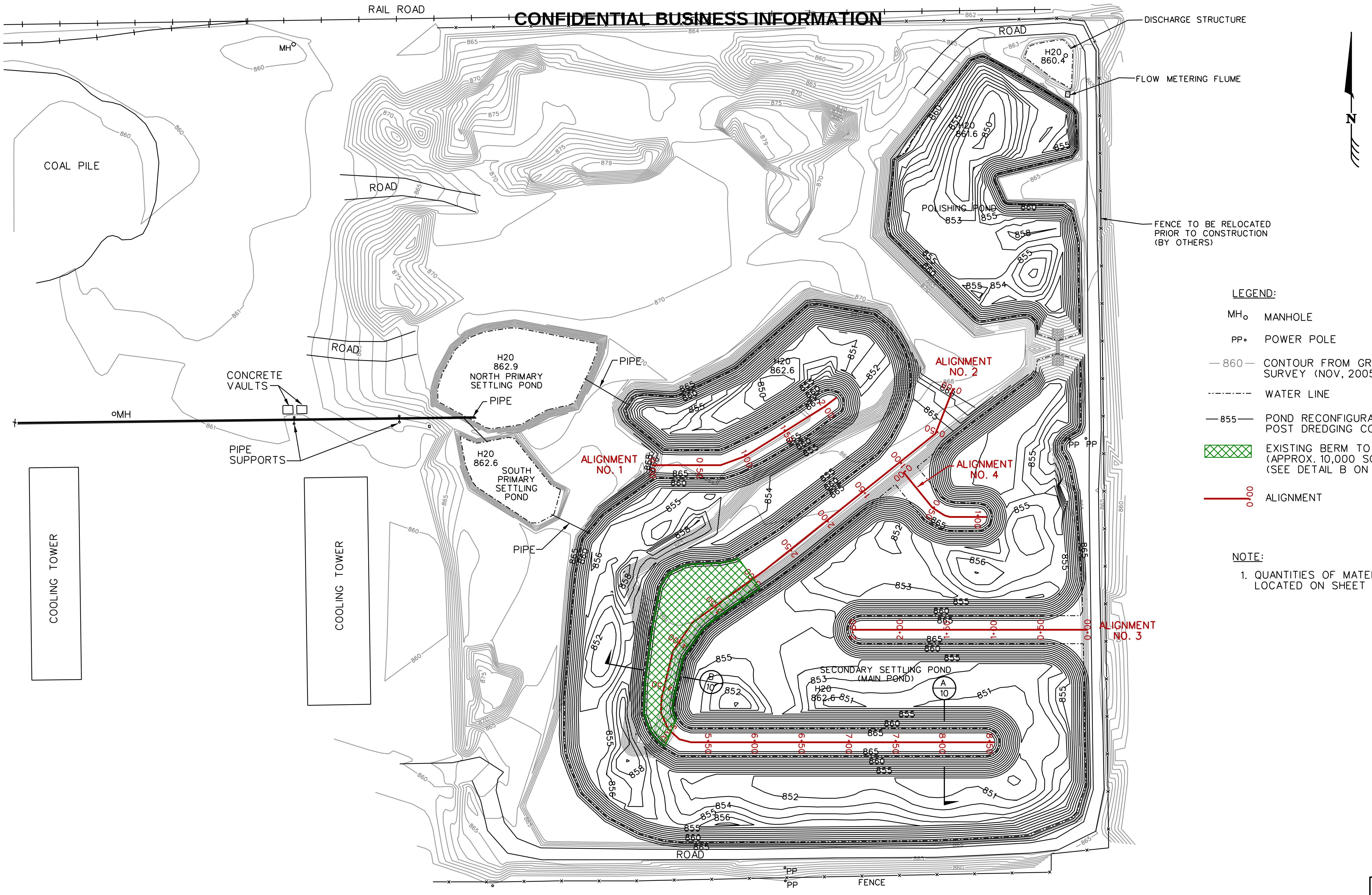
JOB 154
SHT. 1
DWG. SITE PLAN

Attachment A

Field Investigation Report
Sutherland Generating Station
Bottom Ash Settling Pond

Source:
Hard Hat Services, March 31, 2006

CONFIDENTIAL BUSINESS INFORMATION



LEGEND:

MH∘	MANHOLE
PP∘	POWER POLE
— 860 —	CONTOUR FROM GROUND SURVEY (NOV, 2005)
—·—·—	WATER LINE
— 855 —	POND RECONFIGURATION AND POST DREDGING CONTOURS
▨	EXISTING BERM TO BE STABILIZED (APPROX. 10,000 SQ FT) (SEE DETAIL B ON SHEET 10)
— 0+00	ALIGNMENT

NOTE:

1. QUANTITIES OF MATERIALS ARE LOCATED ON SHEET 12.

DRAWING NUMBER:
1-2060-0-D-C5001-003

REV	DATE	BY	DESCRIPTION

SCALE:
0 50 100
SCALE IN FEET

DESIGNED: M. Loerop
DRAWN: HHSI
CHECKED: T. Blair

HARD HAT SERVICES ™
Engineering, Construction and Management Solutions

940 E. Diehl Rd, Suite 150
Naperville, IL 60563
(630) 637-9470

CLIENT:
INTERSTATE POWER & LIGHT
SUTHERLAND GENERATING STATION

TITLE:
PHASE 2
SETTLING POND RECONFIGURATION

SHEET
3

...\reconfiguration.dgn

4/19/2006

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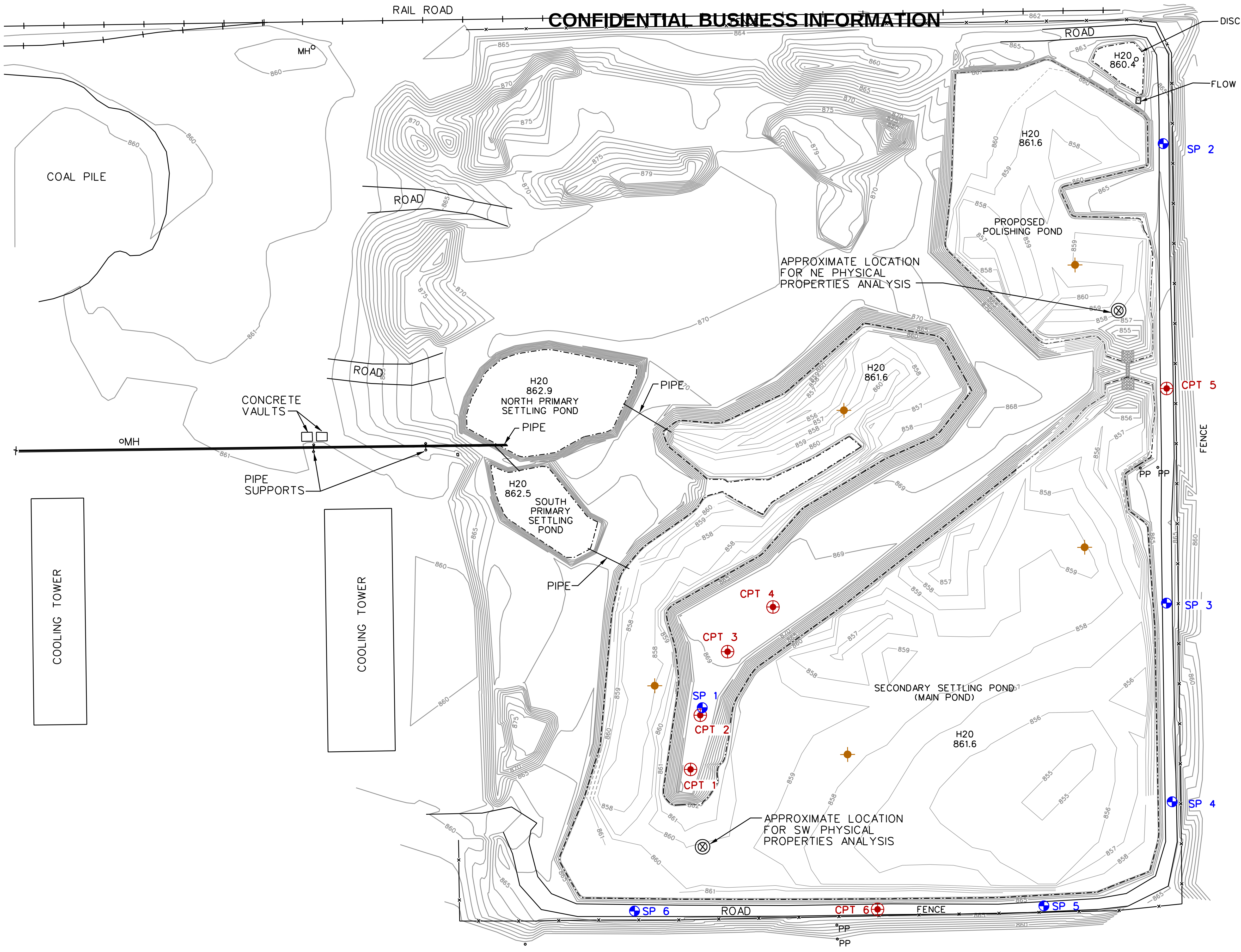

N

0 100
SCALE IN FEET

LEGEND:

🔵	SOIL PROBE LOCATION
🔴	CONE PENETRATION TEST LOCATION
✦	COMPOSITE SAMPLE LOCATION
MH∘	MANHOLE
PP∘	POWER POLE
— 860 —	CONTOUR FROM GROUND SURVEY (NOV, 2005)
-·-·-·-	WATER LINE

NOTES:

1. CONE PREPARATION TESTS WERE CONDUCTED TO A DEPTH OF 15' OR UNTIL REFUSAL.
2. SOIL PROBES WERE COMPLETED WITH A SPLIT SPOON SAMPLER TO A DEPTH OF 15' OR UNTIL REFUSAL.
3. SAMPLING ACTIVITIES WERE CONDUCTED ON 3-14-06.
4. ALL FIVE COMPOSITE SAMPLE LOCATIONS WERE PLACED IN A FIVE GALLON BUCKET. IT WAS MIXED FOR 15 MINUTES, SAMPLED, AND SENT TO THE LABORATORY FOR TOTAL METALS AND SFLP ANALYSIS.

DRAWING NUMBER:

$FILEABBREVS

$DATES

REV	DATE	BY	DESCRIPTION

SCALE:
0 50 100
SCALE IN FEET

DESIGNED: M. Loerop
DRAWN: HHSI
CHECKED: T. Blair

HARD HAT SERVICES™
Engineering, Construction and Management Solutions

940 E. Diehl Rd, Suite 150
Naperville, IL 60563
(630) 637-9470

CLIENT:
INTERSTATE POWER & LIGHT
SUTHERLAND GENERATING STATION

TITLE:
GEOTECHNICAL AND SEDIMENT SAMPLE
TEST LOCATIONS

FIGURE
1

CONFIDENTIAL BUSINESS INFORMATION

CABENO

Environmental Field Services, LLC

BORING LOG

CLIENT: Hard Hat

PROJECT: Alliant Energy

COORDINATES: N NOT SURVEYED
E NOT SURVEYED

BORING NO.: *SP2*

page 1 of 2

LOGGED BY: John Noves
EDITED BY: John Noves
CHECKED BY: Mark Lorep
DATE BEGAN: 3-14-06
DATE FINISHED: 3-14-06
GROUND SURFACE ELEVATION: NOT MEASURED

DEPTH TO WATER WHILE DRILLING	SAMPLE NO AND TYPE	SAMPLE RECOVERY	SAMPLE INFORMATION	POCKET PENETROMETER READINGS	DEPTH IN FEET
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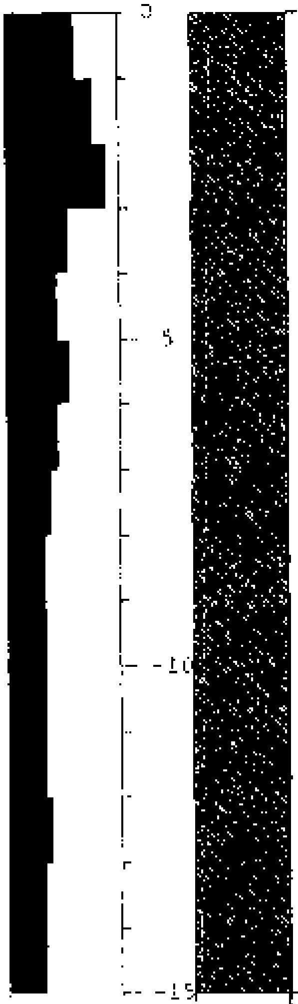
				2.75	
				3.5	
	GP 1	5/5'			
				4.0	
				2.5	
					5
				2.0	
				1.5	
	GP 2	2/5'			
				1.5	
					10
				1.5	
				1.75	
	GP 3	5/5'			
				1.5	
					15
				1.5	
					20



DESCRIPTION

CLAY; brown, low to high plasticity; moist; trace sand and gravel.

Bottom of boring @ 15'

Boring advanced w/ Geoprobe Model [illegible] using 5' Macro-core sampling system.

CABENO

Environmental Field Services, LLC

BORING LOG

CLIENT: Hard Hat

PROJECT: Alliant Energy

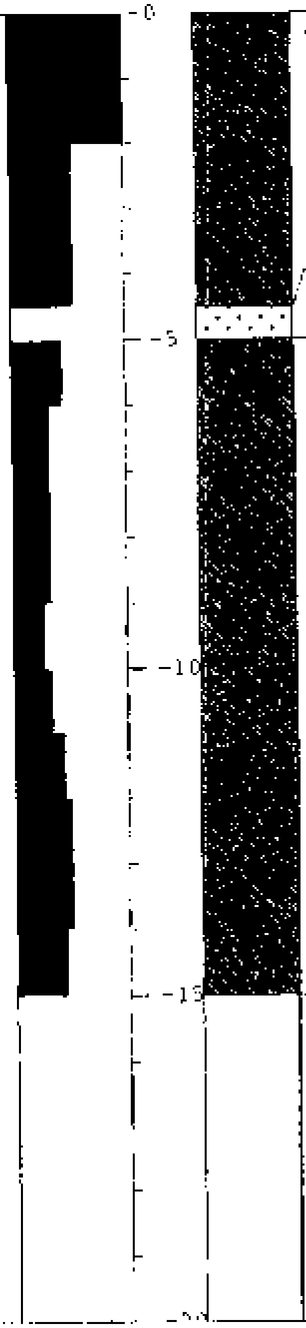
COORDINATES: N NOT SURVEYED
E NOT SURVEYED

BORING NO.: SP3

page 1 of 2

LOGGED BY: John Noyes
EDITED BY: John Noyes
CHECKED BY: Mark Lorep
DATE BEGAN: 3-14-06
DATE FINISHED: 3-14-06
GROUND SURFACE ELEVATION: NOT MEASURED

DEPTH TO WATER WHILE DRILLING	SAMPLE NO. AND TYPE	SAMPLE RECOVERY	SAMPLE INFORMATION	POCKET PENETROMETER READINGS	DEPTH IN FEET	DESCRIPTION
				0	0	CLAY; yellowish brown to olive; med. plastic to low plasticity; moist; trace ash, sand and gravel
				4.5		
	GP 1	5/5'		4.5		
				2.5		SAND; olive; poorly graded; medium grained; moist
					5	CLAY; olive; low plasticity; moist, some sand.
				2.0		
	GP 2	2/5'		1.5		8.4' grades into organic matter
				1.5		
				1.25	10	
				1.5		11' [illegible]
	GP 3	5/5'		2.0		
				2.25		13' grades to olive
				2.25		
				2.0	15	Bottom of boring @ 15.0'.
						Boring advanced w/ Geoprobe Model 6610 using 60" Macrocore sampling system.
					20	



CONFIDENTIAL BUSINESS INFORMATION

CABENO

Environmental Field Services, LLC

BORING LOG

CLIENT: Hard Hat

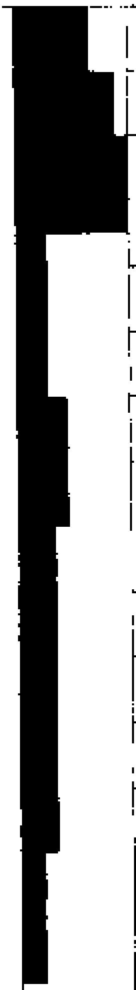
PROJECT: Alliant Energy

COORDINATES: X NOT SURVEYED
E NOT SURVEYED

BORING NO.: SP4

page 1 of 2

LOGGED BY: John Noyes
EDITED BY: John Noyes
CHECKED BY: Mark Loerop
DATE BEGAN: 3-14-06
DATE FINISHED: 3-14-06
GROUND SURFACE ELEVATION: NOT MEASURED



DEPTH TO WATER WHILE DRILLING	SAMPLE NO. AND TYPE	SAMPLE RECOVERY	SAMPLE INFROMATION	POCKET PENETROMETER READINGS	DEPTH IN FEET	DESCRIPTION
				0	0	[illegible] wet [illegible] brown to black, non-plastic to low plastic silty [illegible] with sand and gravel.
				3.0		
				4.0		
	GP 1	5/5'				
				4.5		
				1.25	5	CLAY: olive, low plasticity, moist, some sand
				1.25		
				1.0		
	GP 2	2/5'				@ 8' grades dark gray and olive
				2.0		
				1.5	10	
						With organic matter, wood, [illegible]
				1.5		
	GP 3	5/5'				@ 13' grades olive
				1.5		
				1.0		
				1.0	15	Bottom of boring @ 15.0'.
						Boring advanced w/ Geoprobe Model 6610 using 60" Macrocore sampling system.
					20	

CONFIDENTIAL BUSINESS INFORMATION

CABENO

Environmental Field Services, LLC

BORING LOG

CLIENT: Hard Hat

PROJECT: Alliant Energy

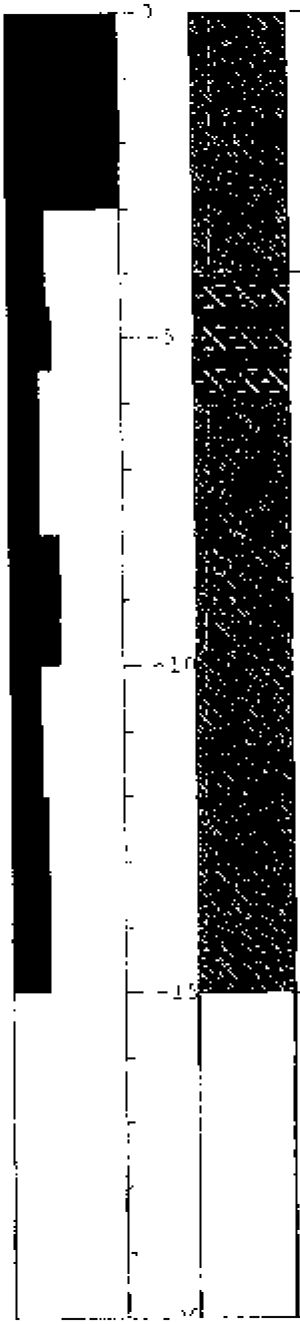
COORDINATES: N NOT SURVEYED
E NOT SURVEYED

BORING NO.: SP5

page 1 of 2

LOGGED BY: John Noyes
EDITED BY: John Noyes
CHECKED BY: Mark Lorep
DATE BEGAN: 3-14-06
DATE FINISHED: 3-14-06
GROUND SURFACE ELEVATION: NOT MEASURED

DEPTH TO WATER WHILE DRILLING	SAMPLE NO. AND TYPE	SAMPLE RECOVERY	SAMPLE INFORMATION	POCKET PENETROMETER READINGS	DEPTH IN FEET	DESCRIPTION
				0	0	CLAY; brown; low plasticity; moist; trace sand and gravel.
				>4.5		
	GP 1	5'/5'		>4.5		
				>4.5		
				1.5		CLAY & ASH; black; nonplastic to low plasticity; moist.
					5	
				1.75		CLAY; olive; low plasticity; moist; trace sand and gravel
				1.25		
	GP 2	2'/5'		1.25		
						@ 9' grades yellow
				2.0	10	
						@11' grades olive
				1.25		
	GP 3	5'/5'		1.5		
				1.5		
				1.5	15	
						Bottom of Boring @ 15 ft.
						Boring advanced w/ Geoprobe Model 6610 using 5' Macrocore sampling system.
					20	



CONFIDENTIAL BUSINESS INFORMATION

CABENO

Environmental Field Services, LLC

BORING LOG

CLIENT: Hard Hat

PROJECT: Alliant Energy

COORDINATES: *N NOT SURVEYED*
E NOT SURVEYED

BORING NO.: *SP6*

page 1 of 2

LOGGED BY: *John Noves*
EDITED BY: *John Noves*
CHECKED BY: *Mark Lureq*
DATE BEGAN: *3-14-06*
DATE FINISHED: *3-14-06*
GROUND SURFACE ELEVATION: *NOT MEASURED*

DEPTH TO WATER WHILE DRILLING	SAMPLE NO. AND TYPE	SAMPLE RECOVERY	SAMPLE INFROMATION	POCKET PENETROMETER READINGS	DEPTH IN FEET	PROFILE	DESCRIPTION
				0	0	▨	CLAY, brown, low [illegible] silty, [illegible] [illegible] sand and gravel.
				> 4.5		▨	
				> 4.5		▨	
	GP 1	5/5'				▨	
				> 4.5		▨	
				2.5	5	▨	
				2.5		▨	
				1.75		▨	
	GP 2	2/5'				▨	
				2.5		▨	
						▨	@ 9' grades some organic material
					10	▨	
				2.25		▨	
						▨	@11' organic [illegible] [illegible] grades out
				1.75		▨	
	GP 3	5/5'				▨	
				2.5		▨	
				2.25		▨	
					15		
				2.0			
							Bottom of boring @ 15.0'.
							Boring advanced w/ Geoprobe Model 66.DT using 60" Macrocore sampling system.
					20		

CONFIDENTIAL BUSINESS INFORMATION

Attachment B

Hydrological and Hydraulics Study

Aether dbs, December 31, 2010

Hydrograph Summary Report

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (acft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (acft)	Hydrograph description
1	SCS Runoff	92.95	10	790	24.867	----	------	------	Sutherland Station
2	Reservoir	65.48	10	840	24.862	1	864.39	9.532	Through Secondary Pond
3	Reservoir	64.12	10	860	24.858	2	864.39	3.343	Polishing Pond
4	Reservoir	64.14	10	850	24.858	3	862.51	0.061	Discharge Pond

Proj. file: Marshalltown2.gpw

Return Period: 100 yr

Run date: 12-31-2010

Hydrograph Report

Hyd. No. 1

Sutherland Station

Hydrograph type = SCS Runoff
Storm frequency = 100 yrs
Drainage area = 57.00 ac
Basin Slope = 0.1 %
Tc method = LAG
Total precip. = 6.60 in
Storm duration = 24 hrs

Peak discharge = 92.95 cfs
Time interval = 10 min
Curve number = 89
Hydraulic length = 1920 ft
Time of conc. (Tc) = 130.6 min
Distribution = Type II
Shape factor = 484

Hydrograph Volume = 24.867 acft

Hydrograph Discharge Table

Time --	**Outflow**	**Time --**	**Outflow**	**Time --**	**Outflow**	**Time --**	**Outflow**
(hrs	**cfs)**	**(hrs**	**cfs)**	**(hrs**	**cfs)**	**(hrs**	**cfs)**
6.00	0.95	11.67	14.06	17.33	9.12	23.00	4.45
6.17	1.08	11.83	19.20	17.50	8.83	23.17	4.42
6.33	1.21	12.00	28.89	17.67	8.56	23.33	4.39
6.50	1.35	12.17	39.07	17.83	8.31	23.50	4.36
6.67	1.50	12.33	49.53	18.00	8.08	23.67	4.33
6.83	1.64	12.50	60.09	18.17	7.87	23.83	4.30
7.00	1.79	12.67	70.50	18.33	7.67	24.00	4.27
7.17	1.94	12.83	80.64	18.50	7.49	24.17	4.20
7.33	2.10	13.00	89.18	18.67	7.32	24.33	4.07
7.50	2.25	13.17	92.95 <<	18.83	7.15	24.50	3.90
7.67	2.41	13.33	89.25	19.00	6.99	24.67	3.68
7.83	2.57	13.50	84.60	19.17	6.84	24.83	3.42
8.00	2.73	13.67	79.23	19.33	6.69	25.00	3.11
8.17	2.89	13.83	73.40	19.50	6.54	25.17	2.76
8.33	3.06	14.00	67.27	19.67	6.39	25.33	2.36
8.50	3.24	14.17	60.89	19.83	6.24	25.50	1.99
8.67	3.44	14.33	54.35	20.00	6.09	25.67	1.65
8.83	3.65	14.50	47.68	20.17	5.94	25.83	1.35
9.00	3.88	14.67	40.94	20.33	5.79	26.00	1.08
9.17	4.14	14.83	34.21	20.50	5.65		
9.33	4.42	15.00	27.53	20.67	5.51		
9.50	4.71	15.17	21.43	20.83	5.38	*...End*	
9.67	5.03	15.33	17.12	21.00	5.26		
9.83	5.37	15.50	15.63	21.17	5.14		
10.00	5.73	15.67	14.48	21.33	5.04		
10.17	6.11	15.83	13.58	21.50	4.94		
10.33	6.53	16.00	12.82	21.67	4.86		
10.50	6.99	16.17	12.16	21.83	4.79		
10.67	7.51	16.33	11.58	22.00	4.72		
10.83	8.11	16.50	11.06	22.17	4.66		
11.00	8.82	16.67	10.60	22.33	4.61		
11.17	9.63	16.83	10.17	22.50	4.57		
11.33	10.63	17.00	9.79	22.67	4.52		
11.50	11.85	17.17	9.44	22.83	4.49		

Reservoir No. 1 - Secondary

Pond Data

Pond storage is based on known values

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (acft)	Total storage (acft)
0.00	862.40	00	0.000	0.000
1.00	863.40	00	4.800	4.800
2.00	864.40	00	4.800	9.600
3.00	865.40	00	4.800	14.400

Culvert / Orifice Structures

	[A]	[B]	[C]	[D]
Rise in	= 0.0	0.0	0.0	0.0
Span in	= 0.0	0.0	0.0	0.0
No. Barrels	= 0	0	0	0
Invert El. ft	= 0.00	0.00	0.00	0.00
Length ft	= 0.0	0.0	0.0	0.0
Slope %	= 0.00	0.00	0.00	0.00
N-Value	= .000	.000	.000	.000
Orif. Coeff.	= 0.00	0.00	0.00	0.00
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len ft	= 2.00	20.00	0.00	0.00
Crest El. ft	= 862.40	863.40	0.00	0.00
Weir Coeff.	= 2.60	2.60	0.00	0.00
Weir Type	= Broad	Broad	---	---
Multi-Stage	= No	No	No	No

Exfiltration Rate = 0.00 in/hr/sqft Tailwater Elev. = 0.00 ft

Note: All outflows have been analyzed under inlet and outlet control.

Stage / Storage / Discharge Table

Stage ft	Storage acft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	Clv D cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	Total cfs
0.00	0.000	862.40	---	---	---	---	0.00	0.00	---	---	---	0.00
0.10	0.480	862.50	---	---	---	---	0.16	0.00	---	---	---	0.16
0.20	0.960	862.60	---	---	---	---	0.46	0.00	---	---	---	0.46
0.30	1.440	862.70	---	---	---	---	0.85	0.00	---	---	---	0.85
0.40	1.920	862.80	---	---	---	---	1.32	0.00	---	---	---	1.32
0.50	2.400	862.90	---	---	---	---	1.84	0.00	---	---	---	1.84
0.60	2.880	863.00	---	---	---	---	2.42	0.00	---	---	---	2.42
0.70	3.360	863.10	---	---	---	---	3.04	0.00	---	---	---	3.04
0.80	3.840	863.20	---	---	---	---	3.72	0.00	---	---	---	3.72
0.90	4.320	863.30	---	---	---	---	4.44	0.00	---	---	---	4.44
1.00	4.800	863.40	---	---	---	---	5.20	0.00	---	---	---	5.20
1.10	5.280	863.50	---	---	---	---	6.00	1.64	---	---	---	7.64
1.20	5.760	863.60	---	---	---	---	6.84	4.65	---	---	---	11.48
1.30	6.240	863.70	---	---	---	---	7.71	8.54	---	---	---	16.25
1.40	6.720	863.80	---	---	---	---	8.61	13.15	---	---	---	21.76
1.50	7.200	863.90	---	---	---	---	9.55	18.38	---	---	---	27.93
1.60	7.680	864.00	---	---	---	---	10.52	24.16	---	---	---	34.68
1.70	8.160	864.10	---	---	---	---	11.52	30.44	---	---	---	41.97
1.80	8.640	864.20	---	---	---	---	12.56	37.19	---	---	---	49.75
1.90	9.120	864.30	---	---	---	---	13.62	44.38	---	---	---	58.00
2.00	9.600	864.40	---	---	---	---	14.71	52.00	---	---	---	66.71
2.10	10.080	864.50	---	---	---	---	15.82	59.99	---	---	---	75.81
2.20	10.560	864.60	---	---	---	---	16.97	68.35	---	---	---	85.32
2.30	11.040	864.70	---	---	---	---	18.14	77.07	---	---	---	95.21
2.40	11.520	864.80	---	---	---	---	19.33	86.13	---	---	---	105.46
2.50	12.000	864.90	---	---	---	---	20.55	95.52	---	---	---	116.07
2.60	12.480	865.00	---	---	---	---	21.80	105.23	---	---	---	127.02
2.70	12.960	865.10	---	---	---	---	23.07	115.24	---	---	---	138.31
2.80	13.440	865.20	---	---	---	---	24.36	125.56	---	---	---	149.92
2.90	13.920	865.30	---	---	---	---	25.68	136.16	---	---	---	161.84
3.00	14.400	865.40	---	---	---	---	27.02	147.08	---	---	---	174.10

Reservoir No. 2 - Polishing

Pond Data

Pond storage is based on known values

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (acft)	Total storage (acft)
0.00	861.60	00	0.000	0.000
1.00	862.60	00	1.200	1.200
2.00	863.60	00	1.200	2.400
3.00	864.60	00	1.200	3.600

Culvert / Orifice Structures

	[A]	[B]	[C]	[D]
Rise in	= 0.0	0.0	0.0	0.0
Span in	= 0.0	0.0	0.0	0.0
No. Barrels	= 0	0	0	0
Invert El. ft	= 0.00	0.00	0.00	0.00
Length ft	= 0.0	0.0	0.0	0.0
Slope %	= 0.00	0.00	0.00	0.00
N-Value	= .000	.000	.000	.000
Orif. Coeff.	= 0.00	0.00	0.00	0.00
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len ft	= 1.00	24.00	0.00	0.00
Crest El. ft	= 861.60	863.50	0.00	0.00
Weir Coeff.	= 2.60	2.60	0.00	0.00
Weir Type	= Broad	Broad	---	---
Multi-Stage	= No	No	No	No

Exfiltration Rate = 0.00 in/hr/sqft Tailwater Elev. = 0.00 ft

Note: All outflows have been analyzed under inlet and outlet control.

Stage / Storage / Discharge Table

Stage ft	Storage acft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	Clv D cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	Total cfs
0.00	0.000	861.60	---	---	---	---	0.00	0.00	---	---	---	0.00
0.10	0.120	861.70	---	---	---	---	0.08	0.00	---	---	---	0.08
0.20	0.240	861.80	---	---	---	---	0.23	0.00	---	---	---	0.23
0.30	0.360	861.90	---	---	---	---	0.43	0.00	---	---	---	0.43
0.40	0.480	862.00	---	---	---	---	0.66	0.00	---	---	---	0.66
0.50	0.600	862.10	---	---	---	---	0.92	0.00	---	---	---	0.92
0.60	0.720	862.20	---	---	---	---	1.21	0.00	---	---	---	1.21
0.70	0.840	862.30	---	---	---	---	1.52	0.00	---	---	---	1.52
0.80	0.960	862.40	---	---	---	---	1.86	0.00	---	---	---	1.86
0.90	1.080	862.50	---	---	---	---	2.22	0.00	---	---	---	2.22
1.00	1.200	862.60	---	---	---	---	2.60	0.00	---	---	---	2.60
1.10	1.320	862.70	---	---	---	---	3.00	0.00	---	---	---	3.00
1.20	1.440	862.80	---	---	---	---	3.42	0.00	---	---	---	3.42
1.30	1.560	862.90	---	---	---	---	3.85	0.00	---	---	---	3.85
1.40	1.680	863.00	---	---	---	---	4.31	0.00	---	---	---	4.31
1.50	1.800	863.10	---	---	---	---	4.78	0.00	---	---	---	4.78
1.60	1.920	863.20	---	---	---	---	5.26	0.00	---	---	---	5.26
1.70	2.040	863.30	---	---	---	---	5.76	0.00	---	---	---	5.76
1.80	2.160	863.40	---	---	---	---	6.28	0.00	---	---	---	6.28
1.90	2.280	863.50	---	---	---	---	6.81	0.00	---	---	---	6.81
2.00	2.400	863.60	---	---	---	---	7.35	1.97	---	---	---	9.33
2.10	2.520	863.70	---	---	---	---	7.91	5.58	---	---	---	13.49
2.20	2.640	863.80	---	---	---	---	8.48	10.25	---	---	---	18.73
2.30	2.760	863.90	---	---	---	---	9.07	15.78	---	---	---	24.85
2.40	2.880	864.00	---	---	---	---	9.67	22.05	---	---	---	31.72
2.50	3.000	864.10	---	---	---	---	10.28	28.99	---	---	---	39.27
2.60	3.120	864.20	---	---	---	---	10.90	36.53	---	---	---	47.43
2.70	3.240	864.30	---	---	---	---	11.53	44.63	---	---	---	56.17
2.80	3.360	864.40	---	---	---	---	12.18	53.26	---	---	---	65.44
2.90	3.480	864.50	---	---	---	---	12.84	62.38	---	---	---	75.22
3.00	3.600	864.60	---	---	---	---	13.51	71.99	---	---	---	85.50

Reservoir No. 3 - Discharge Pond

Pond Data

Pond storage is based on known values

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (acft)	Total storage (acft)
0.00	860.40	00	0.000	0.000
1.00	861.40	00	0.029	0.029
2.00	862.40	00	0.029	0.058
3.00	863.40	00	0.029	0.087
4.00	864.40	00	0.029	0.116

Culvert / Orifice Structures

	[A]	[B]	[C]	[D]
Rise in	= 0.0	0.0	0.0	0.0
Span in	= 0.0	0.0	0.0	0.0
No. Barrels	= 0	0	0	0
Invert El. ft	= 0.00	0.00	0.00	0.00
Length ft	= 0.0	0.0	0.0	0.0
Slope %	= 0.00	0.00	0.00	0.00
N-Value	= .000	.000	.000	.000
Orif. Coeff.	= 0.00	0.00	0.00	0.00
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len ft	= 6.30	0.00	0.00	0.00
Crest El. ft	= 860.40	0.00	0.00	0.00
Weir Coeff.	= 3.33	0.00	0.00	0.00
Weir Type	= Riser	---	---	---
Multi-Stage	= No	No	No	No

Exfiltration Rate = 0.00 in/hr/sqft Tailwater Elev. = 0.00 ft

Note: All outflows have been analyzed under inlet and outlet control.

Stage / Storage / Discharge Table

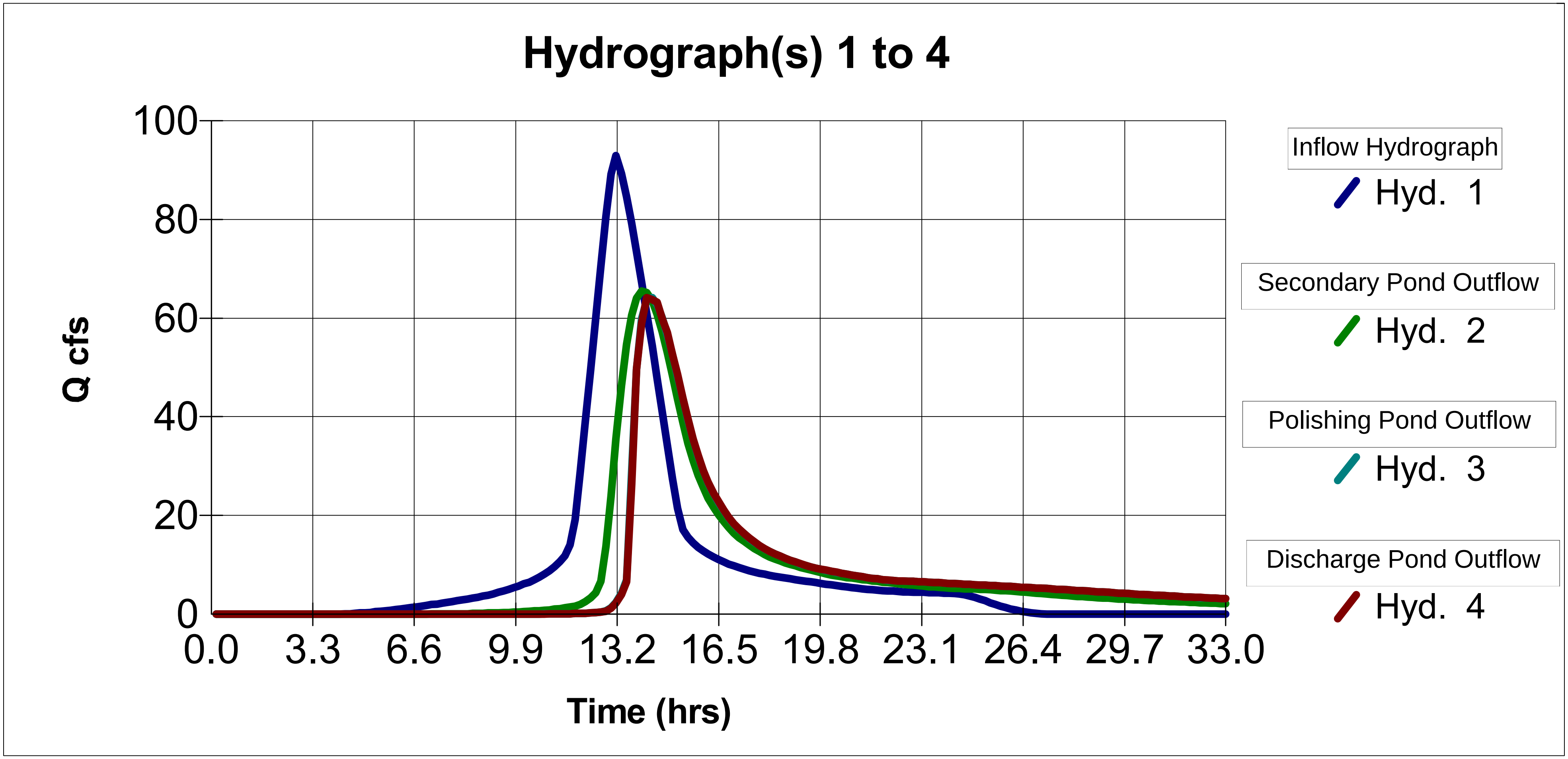
Stage ft	Storage acft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	Clv D cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	Total cfs
0.00	0.000	860.40	---	---	---	---	0.00	---	---	---	---	0.00
0.10	0.003	860.50	---	---	---	---	0.66	---	---	---	---	0.66
0.20	0.006	860.60	---	---	---	---	1.88	---	---	---	---	1.88
0.30	0.009	860.70	---	---	---	---	3.45	---	---	---	---	3.45
0.40	0.012	860.80	---	---	---	---	5.31	---	---	---	---	5.31
0.50	0.015	860.90	---	---	---	---	7.41	---	---	---	---	7.41
0.60	0.017	861.00	---	---	---	---	9.75	---	---	---	---	9.75
0.70	0.020	861.10	---	---	---	---	12.28	---	---	---	---	12.28
0.80	0.023	861.20	---	---	---	---	15.01	---	---	---	---	15.01
0.90	0.026	861.30	---	---	---	---	17.91	---	---	---	---	17.91
1.00	0.029	861.40	---	---	---	---	20.98	---	---	---	---	20.98
1.10	0.032	861.50	---	---	---	---	24.20	---	---	---	---	24.20
1.20	0.035	861.60	---	---	---	---	27.58	---	---	---	---	27.58
1.30	0.038	861.70	---	---	---	---	31.09	---	---	---	---	31.09
1.40	0.041	861.80	---	---	---	---	34.75	---	---	---	---	34.75
1.50	0.044	861.90	---	---	---	---	38.54	---	---	---	---	38.54
1.60	0.046	862.00	---	---	---	---	42.45	---	---	---	---	42.45
1.70	0.049	862.10	---	---	---	---	46.49	---	---	---	---	46.49
1.80	0.052	862.20	---	---	---	---	50.66	---	---	---	---	50.66
1.90	0.055	862.30	---	---	---	---	54.93	---	---	---	---	54.93
2.00	0.058	862.40	---	---	---	---	59.34	---	---	---	---	59.34
2.10	0.061	862.50	---	---	---	---	63.84	---	---	---	---	63.84
2.20	0.064	862.60	---	---	---	---	68.45	---	---	---	---	68.45
2.30	0.067	862.70	---	---	---	---	73.17	---	---	---	---	73.17
2.40	0.070	862.80	---	---	---	---	78.00	---	---	---	---	78.00
2.50	0.073	862.90	---	---	---	---	82.92	---	---	---	---	82.92
2.60	0.075	863.00	---	---	---	---	87.94	---	---	---	---	87.94
2.70	0.078	863.10	---	---	---	---	93.07	---	---	---	---	93.07
2.80	0.081	863.20	---	---	---	---	98.28	---	---	---	---	98.28
2.90	0.084	863.30	---	---	---	---	103.59	---	---	---	---	103.59
3.00	0.087	863.40	---	---	---	---	109.01	---	---	---	---	109.01
3.10	0.090	863.50	---	---	---	---	114.50	---	---	---	---	114.50
3.20	0.093	863.60	---	---	---	---	120.09	---	---	---	---	120.09

Continues on next page...

Stage / Storage / Discharge Table

Stage ft	Storage acft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	Clv D cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	Total cfs
3.30	0.096	863.70	---	---	---	---	125.76	---	---	---	---	125.76
3.40	0.099	863.80	---	---	---	---	131.52	---	---	---	---	131.52
3.50	0.102	863.90	---	---	---	---	137.36	---	---	---	---	137.36
3.60	0.104	864.00	---	---	---	---	143.29	---	---	---	---	143.29
3.70	0.107	864.10	---	---	---	---	149.30	---	---	---	---	149.30
3.80	0.110	864.20	---	---	---	---	155.39	---	---	---	---	155.39
3.90	0.113	864.30	---	---	---	---	161.56	---	---	---	---	161.56
4.00	0.116	864.40	---	---	---	---	167.83	---	---	---	---	167.83

...End



Note: Hydrographs 3 & 4 are almost identical.

Alliant Energy near Marshalltown - Sutherland Station

Ash Pond Analysis 154.006.005

Curve Number (CN) Calculation

Group D soils assumed (clay soils)

Plant Drainage Area => approximates a rectangle (see working drawing)

Total Drainage Area = 10.8" * 240'/" * 4" * 240'/" * acres / 43,560 SF = 57 acres (Conservative)

	X	Y	SF	Acres	CN
Total	10.8	4	2488320	57.1	89

Different Areas have different Curve Numbers => areas approximated as rectangles

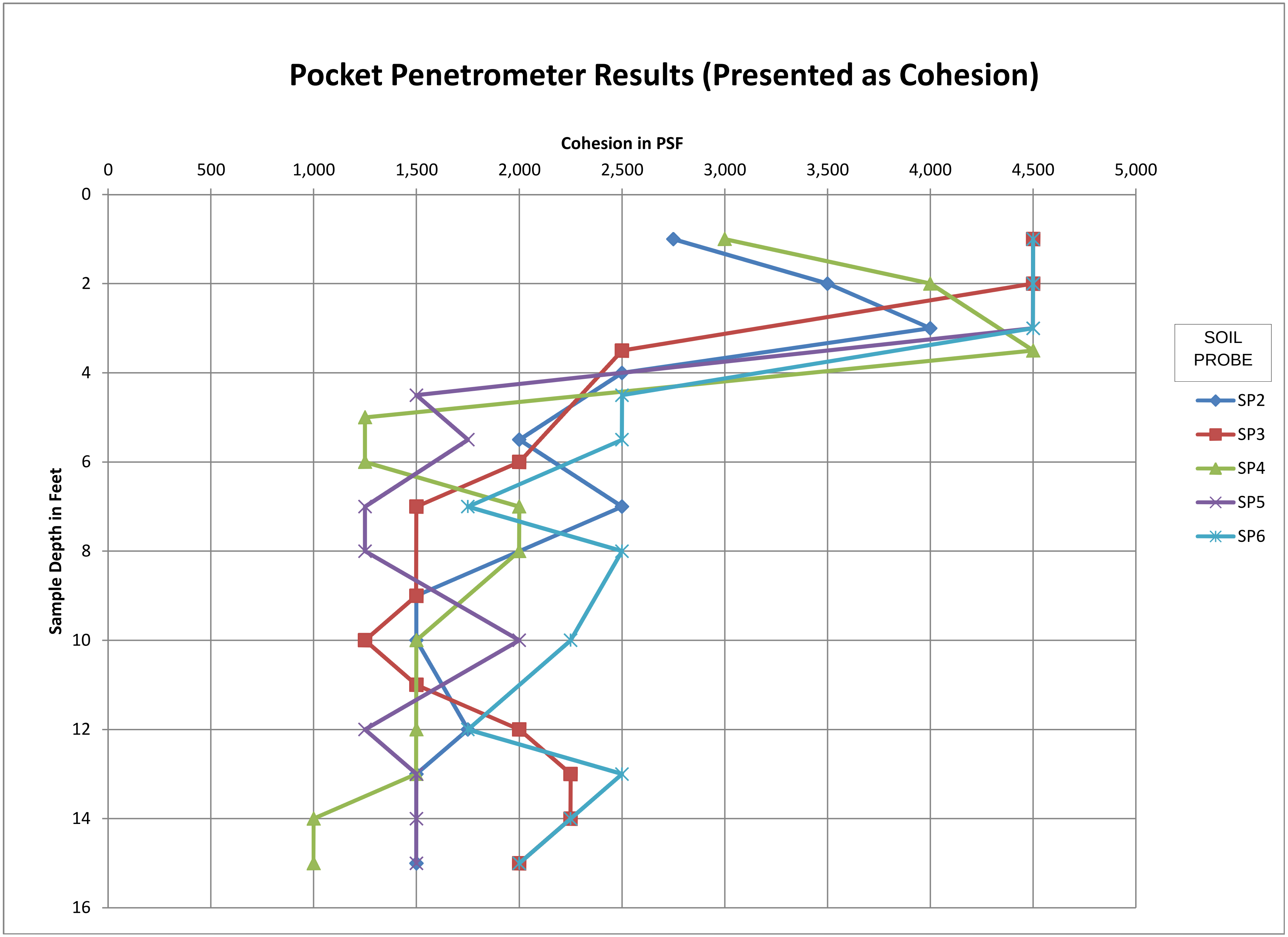
Ash	3	4	691200	15.9	91	Gravel Road
Coal	3.1	1.6	285696	6.6	91	Gravel Road
Grass	2.4	1.9	262656	6.0	80	grass cover > 75%
Grass	1.6	1.5	138240	3.2	80	grass cover > 75%
Difference (Rock, concrete, asphalt, plant, etc				25.5	91	Industrial CN

CONFIDENTIAL BUSINESS INFORMATION

Attachment C

CABENO Environmental Field Services, LLC
2006 Pocket Penetrometer Results

Strength data presented in Appendix A charted by Aether dbs, December 30th, 2010



Pocket Penetrometer Results (Presented as Cohesion)

CONFIDENTIAL BUSINESS INFORMATION

Attachment D

Area Plan
Marshalltown Steam Power Station

Source:
Iowa Light & Power Company 1957 Drawing

NOTES:

C.I.P.M.J. - CAST IRON PIPE MECHANICAL JOINT
R.C.P. - REINFORCED CONCRETE PIPE
V.S.P. - VITRIFIED SOIL PIPE
SEE DRAWING 1-2060-0-V- FOR LOCATION & ELEVATION OF 4" SANITARY LINE FROM WAREHOUSE.

THIS DRWG. BASED ON ORIGINAL DRWG. NO. R1189
WITH CORRECTIONS AND ADDITIONS TO FEB 1957

REV. PER MARK UP. 4-15-94 R.M.

16	COOLING TOWER REVISION 7-24-95 MAH	8	6-30-60 FM ADDED ELEVATIONS OF DUCT BETWEEN MANHOLE & CHLORINATOR HOUSE
15	UP-DATED PER MARK-UPS 8-3-93 REB	7	JUNE 20, 60 12" C.I.P.M.J. TO WELLS 5, 6 ADDED DIM. OF TRACKS ADDED D.G.
14	ADDED SEPTIC TANK #2 & DISPOSAL FIELD 9-1-52 REB	6	3-21-60 REV. DG
13	ADDED WAREHOUSE 11-20-91 MAH	5	12-21-59 REVISED 1¼" GAS LINE, ADDED 12" GAS LINE DEG
12	10-31-61 ACID TANK ADDED BOILER CONN. HEATING ADDED	4	8-7-59 REVISED DEG
11	10-9-61 TRACK HOPPER LOCATION MOVED TO NEW HOPPER DG	3	5-15-59 CONDUIT LINES ADDED D.E.G.
10	4-19-61 WELL WATER LINE TO CONDUITS TO NEW UNIT 3 ADDED DG	2	3-27-59 WELLS 5 AND 6 ADDED DEG.
9	1-12-61 ADDED LOCATIONS OF WELLS DIM. CORRECTED DG	1	2-26-59 8 CELL COOLING TOWER ADDED DG

IOWA ELECTRIC LIGHT & POWER CO.
ENGINEERING DEPT. CEDAR RAPIDS IOWA

MARSHALLTOWN STEAM POWER STATION

AREA PLAN

DATE 3-19-57
SCALE 1" = 50'
DWG. BY DEG
APPROVED

IMPR. REQD NO.
DRWG NO R-1189A

CONFIDENTIAL BUSINESS INFORMATION

Attachment E

Selected Deep Soil Borings
Sutherland Generating Station

Source:
Preliminary Subsurface Investigation
Black & Veatch, May 14, 2007

BLACK & VEATCH

CONFIDENTIAL BUSINESS INFORMATION

BORING LOG

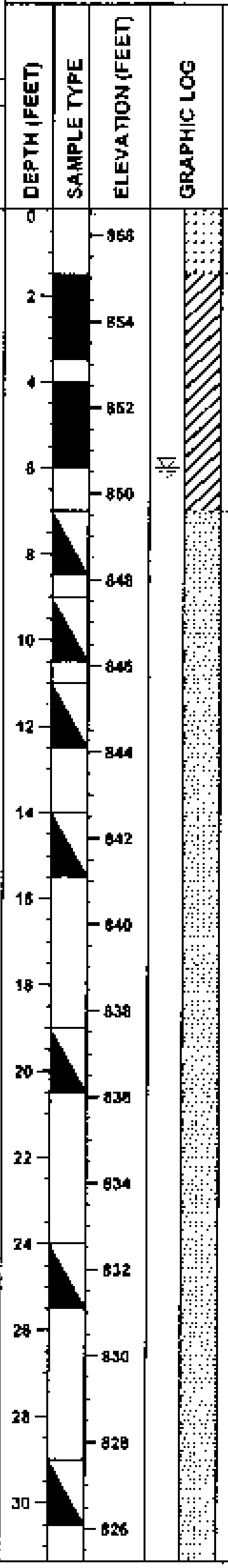
BORING NO. BV-6
SHEET 1 OF 3

CLIENT Interstate Power & Light	**PROJECT** Sutherland Station	**PROJECT NO.** 145491

PROJECT LOCATION Marshalltown, Iowa	**COORDINATES** N 3479395.0' E 5095039.0'	**GROUND ELEVATION (DATUM)** 856.6 ft (MSL)	**TOTAL DEPTH** 80.5 (feet)
SURFACE CONDITIONS Flat, grassy marsh, standing water, offset 28' south	**COORDINATE SYSTEM** State Plane	**DATE START** 04/13/07	**DATE FINISHED** 04/14/07

LOGGED BY R. S. Edwards vs SE	**CHECKED BY** V. Bhadriraju vs	**APPROVED BY** E. Meyer

SOIL SAMPLING: SAMPLE TYPE	SAMPLE NUMBER	SET 6 INCHES	2ND 6 INCHES	3RD 6 INCHES	N VALUE	SAMPLE RECOVERY
ROCK CORING: CORE SIZE	**RUN NUMBER**	**RUN LENGTH**	**RUN RECOVERY**	**RQD RECOVERY**	**PERCENT RECOVERY**	**RQD**
TW	1	-	-	-	-	1.6
TW	2	-	-	-	-	1.5
SPT	3	3	3	5	8	1.5
SPT	4	3	5	7	12	0.7
SPT	5	5	7	8	15	0
SPT	6	6	4	4	8	0
SPT	7	9	7	7	14	0
SPT	8	5	4	3	7	0 7
SPT	9	9	10	15	25	0.8



CLASSIFICATION OF MATERIALS

Silty CLAY; dark gray; moist; low plasticity; (TOPSOIL)

1.5

CLAY; yellow-brown; moist, high plasticity

grading gray w/some brown mottling

7.0

SAND; brownish-yellow; loose; wet; medium to coarse grained; well graded; rounded

grading medium dense

grading loose

grading medium dense

grading loose

grading medium dense; medium to fine grained; rounded to subrounded; w/rounded cobbles

REMARKS

Boring advanced w/4-1/4" ID hollow stem auger. SPT performed w/ automatic hammer.

Water encountered @ 6' during drilling.

Below 11.5' continued w/ 2-15/16" tricone roller bit using bentonite mud as drilling fluid

Driller reports cobbles.

5/11/2007 1:04 PM IP&L - Sutherland Station

BLACK & VEATCH

CONFIDENTIAL BUSINESS INFORMATION
BORING LOG

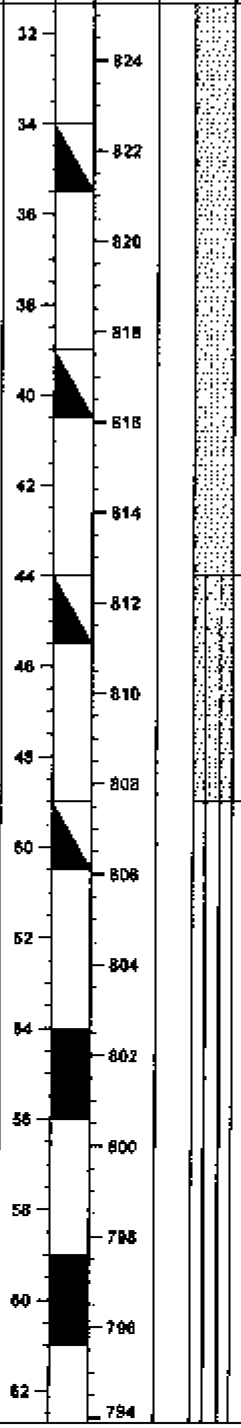
BORING NO. BV-6
SHEET 2 OF 3

CLIENT Interstate Power & Light	PROJECT Sutherland Station	PROJECT NO. 145491

PROJECT LOCATION Marshalltown, Iowa	COORDINATES N 3479395.0' E 5095039.0'	GROUND ELEVATION (DATUM) 856.6 ft (MSL)	TOTAL DEPTH 80.5 (feet)
SURFACE CONDITIONS Flat, grassy marsh, standing water, offset 28' south	COORDINATE SYSTEM State Plane	DATE START 04/13/07	DATE FINISHED 04/14/07
LOGGED BY R. S. Edwards	CHECKED BY V. Bhadriraju VB	APPROVED BY E. Meyer	

SOIL SAMPLING / ROCK CORING

SAMPLE TYPE / CORE SIZE	SAMPLE NUMBER / RUN NUMBER	1ST 6 INCHES / RUN LENGTH	2ND 6 INCHES / RUN RECOVERY	3RD 6 INCHES / RQD RECOVERY	N VALUE / PERCENT RECOVERY	SAMPLE RECOVERY / RQD
SPT	10	8	11	11	22	0.5
SPT	11	6	6	5	11	0.8
SPT	12	3	6	7	13	0.8
SPT	13	6	13	12	25	1.4
TW	14	-	-	-	-	0
TW	15	-	-	-	-	0



CLASSIFICATION OF MATERIALS

grading fine to coarse grained; fine to coarse, angular gravel

36.7' to 37.3' gravel lense

44.0

Silty SAND; dark gray; medium dense; wet; fine grained; poorly graded

49.0

SILT; dark gray; very stiff; moist; low plasticity; w/trace sand (Glacial Till)

REMARKS

Graval lense based on drilling resistance.

TW 14 recovered w/split spoon.
PP = 1.5 tsf

BLACK & VEATCH

CONFIDENTIAL BUSINESS INFORMATION

BORING LOG

BORING NO. BV-6
SHEET 3 OF 3

CLIENT Interstate Power & Light	PROJECT Sutherland Station	PROJECT NO. 145491
PROJECT LOCATION Marshalltown, Iowa	COORDINATES N 3479395.0' E 5095039.0'	GROUND ELEVATION (DATUM) 856.6 ft (MSL)
TOTAL DEPTH 80.5 (feet)	SURFACE CONDITIONS Flat, grassy marsh, standing water, offset 28' south	COORDINATE SYSTEM State Plane
DATE START 04/13/07	DATE FINISHED 04/14/07	LOGGED BY R. S. Edwards
CHECKED BY V. Bhadriraju	APPROVED BY E. Meyer	

SOIL SAMPLING / ROCK CORING

SAMPLE TYPE	SAMPLE NUMBER	1ST 6 INCHES	2ND 6 INCHES	3RD 6 INCHES	N VALUE	SAMPLE RECOVERY	DEPTH (FEET)	SAMPLE TYPE	CLASSIFICATION OF MATERIALS	REMARKS
SPT	18	6	8	8	16	1.4	64–65.5	◣		PP = 1.5 to 2.0 tsf
TW	18A	-	-	-	-	0	69–71	■	grading stiff	TW 18A recovered w/split spoon. PP = 1.75 tsf
SPT	19	7	9	10	19	1.4	74–75.5	◣	grading very stiff	PP = 2.25 tsf
										PP = 3.0 tsf
TW	20	-	-	-	-	1.0	77–79	■		
SPT	21	8	9	9	18	1.0	79–80.5	◣		PP = 2.5 tsf
										Bottom of boring @ 80.5'. Water level not recorded. Boring backfilled w/ cement bentonite grout on 04/14/07.

CORE SIZE | RUN NUMBER | RUN LENGTH | RUN RECOVERY | RQD RECOVERY | PERCENT RECOVERY | RQD

DEPTH (FEET): 64, 66, 68, 70, 72, 74, 76, 78, 80, 82, 84, 86, 88, 90, 92, 94

ELEVATION (FEET): 792, 790, 788, 786, 784, 782, 780, 778, 776, 774, 772, 770, 768, 766, 764

GRAPHIC LOG

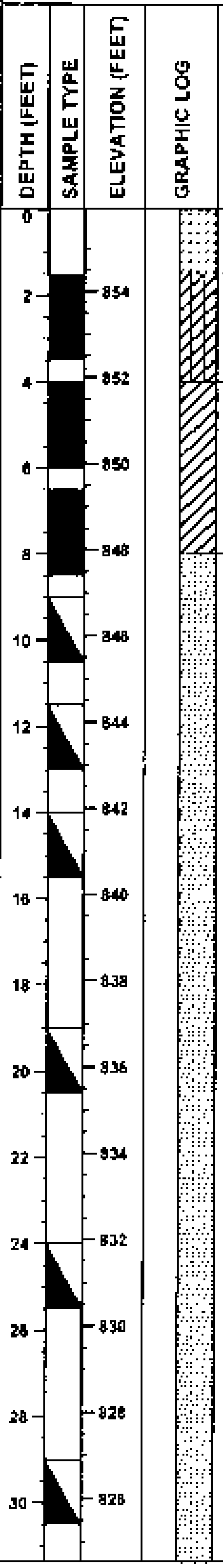
BLACK & VEATCH

CONFIDENTIAL BUSINESS INFORMATION
BORING LOG

BORING NO. BV-7
SHEET 1 OF 3

CLIENT Interstate Power & Light	**PROJECT** Sutherland Station		**PROJECT NO.** 145491
PROJECT LOCATION Marshalltown, Iowa	**COORDINATES** N 3479095.0' E 5097105.0'	**GROUND ELEVATION (DATUM)** 855.9 ft (MSL)	**TOTAL DEPTH** 80.5 (feet)
SURFACE CONDITIONS Agricultural field off access road	**COORDINATE SYSTEM** State Plane	**DATE START** 04/11/07	**DATE FINISHED** 04/12/07
LOGGED BY R. S. Edwards VB	**CHECKED BY** V. Bhadriraju VB	**APPROVED BY** E. Meyer	

SOIL SAMPLING: SAMPLE TYPE	SAMPLE NUMBER	SET 6 INCHES	2ND 6 INCHES	3RD 6 INCHES	N VALUE	SAMPLE RECOVERY	CLASSIFICATION OF MATERIALS	REMARKS
ROCK CORING: CORE SIZE	RUN NUMBER	RUN LENGTH	RUN RECOVERY	RQD RECOVERY	PERCENT RECOVERY	RQD		
							Silty CLAY; dark gray; moist; low plasticity (TOPSOIL)	Boring advanced w/4-1/2" ID hollow stem auger SPT performed w/ automatic hammer.
							1.5	
							Silty CLAY; dark gray; moist; low plasticity	
TW	1	-	-	-	-	1.5		
							4.0	Below 4' continued w/ 2-15/16" tricone roller bit using bentonite mud as drilling fluid.
							CLAY; gray-brown; mottled; moist; high plasticity	
TW	2	-	-	-	-	1.5		
TW	3	-	-	-	-	1.5		
							8.0	
							SAND; yellow-brown; loose; wet; fine to medium grained; well graded; w/rounded to subrounded gravel	
SPT	4	2	3	3	6	1.0		
SPT	5	5	4	5	9	0.8		
							grading medium dense	
SPT	6	6	7	7	14	0.6		
							grading loose	
SPT	7	5	4	2	6	0.8		
								Driller reports cobbles @ 23.4'.
							grading w/cobbles	
SPT	8	3	4	4	8	1.4		
							grading medium dense; cobbles grade out	
SPT	9	8	10	10	20	1.3		



BLACK & VEATCH

CONFIDENTIAL BUSINESS INFORMATION

BORING LOG

BORING NO. BV-7

SHEET 2 OF 3

CLIENT Interstate Power & Light	**PROJECT** Sutherland Station	**PROJECT NO.** 145491

PROJECT LOCATION Marshalltown, Iowa	**COORDINATES** N 3479095.0' E 5097105.0'	**GROUND ELEVATION (DATUM)** 856.9 ft (MSL)	**TOTAL DEPTH** 80.5 (feet)
SURFACE CONDITIONS Agricultural field off access road	**COORDINATE SYSTEM** State Plane	**DATE START** 04/11/07	**DATE FINISHED** 04/12/07

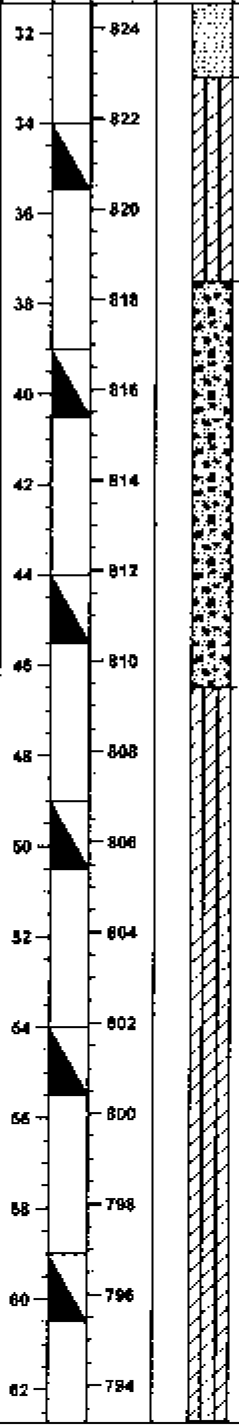
LOGGED BY R. S. Edwards vg for ss	**CHECKED BY** V. Bhadriraju vg	**APPROVED BY** E. Meyer

SOIL SAMPLING

SAMPLE TYPE	SAMPLE NUMBER	SET 6 INCHES	2ND 6 INCHES	3RD 6 INCHES	N VALUE	SAMPLE RECOVERY
SPT	10	4	4	5	9	2.0
SPT	11	17	4	7	11	0
SPT	12	37	31	16	47	1.8
SPT	13	9	12	13	25	1.7
SPT	14	8	16	17	33	1.4
SPT	15	13	14	13	27	1.0

ROCK CORING

CORE SIZE	RUN NUMBER	RUN LENGTH	RUN RECOVERY	RQD RECOVERY	PERCENT RECOVERY	RQD



CLASSIFICATION OF MATERIALS	REMARKS
33.0 Clayey SILT; dark gray; stiff; moist; low plasticity	PP = 1.0 tsf
37.5 Gravelly SAND; gray; medium dense; wet; medium to coarse grained; poorly graded; angular	
grading dense	
46.5 Clayey SILT; dark gray; very stiff; moist; low plasticity; w/trace angular sand; (Glacial Till)	PP = 4.5 tsf
grading hard	PP = 4.5 tsf
grading very stiff	PP = 2.5 tsf Below 60' continued w/ 4-1/4" ID hollow stem auger.

BLACK & VEATCH

CONFIDENTIAL BUSINESS INFORMATION
BORING LOG

BORING NO. BV-7
SHEET 3 OF 3

CLIENT Interstate Power & Light	**PROJECT** Sutherland Station	**PROJECT NO.** 145491

PROJECT LOCATION Marshalltown, Iowa	**COORDINATES** N 3479095.0' E 5097105.0'	**GROUND ELEVATION (DATUM)** 855.9 ft (MSL)	**TOTAL DEPTH** 80.5 (feet)
SURFACE CONDITIONS Agricultural field off access road	**COORDINATE SYSTEM** State Plane	**DATE START** 04/11/07	**DATE FINISHED** 04/12/07
LOGGED BY R. S. Edwards VB SE	**CHECKED BY** V. Bhadriraju VB	**APPROVED BY** E. Meyer	

SOIL SAMPLING												
SAMPLE TYPE	SAMPLE NUMBER	SET 6 INCHES	2ND 6 INCHES	3RD 6 INCHES	N VALUE	SAMPLE RECOVERY						
ROCK CORING												
CORE SIZE	RUN NUMBER	RUN LENGTH	RUN RECOVERY	RQD RECOVERY	PERCENT RECOVERY	RQD	DEPTH (FEET)	SAMPLE TYPE	ELEVATION (FEET)	GRAPHIC LOG	CLASSIFICATION OF MATERIALS	REMARKS
							64		792			
SPT	16	8	13	14	27	1.2		◣				PP = 3.75 tsf
							66		790			
							68		788			
SPT	17	8	12	13	25	1.2	70	◣	786			PP = 4.0 tsf
							72		784			
							74		782			
SPT	18	9	13	12	25	2.0		◣				PP = 3.0 tsf
							76		780			
							78		778			
SPT	19	9	11	12	23	2.0	80	◣	776			PP = 3.0 tsf
												Bottom of boring @ 80.5'. Water level not recorded. Boring backfilled w/ cement bentonite grout on 04/12/07
							82		774			
							84		772			
							86		770			
							88		768			
							90		766			
							92		764			
							94		762			

CONFIDENTIAL BUSINESS INFORMATION

Attachment F

Deep Soil Borings
Sutherland Generating Station

Source:
Subsurface Exploration, Sutherland Air Heater Building
TEAM Services, December 3, 2007

CONFIDENTIAL BUSINESS INFORMATION

LOG OF BORING NO. 1

Page 1 of 2

OWNER

ARCHITECT/ENGINEER

SITE: Marshalltown, Iowa

PROJECT: Sutherland Air Heater Building

DESCRIPTION Approx. Surface Elev.: 859.3 ft.		DEPTH (ft.)	USCS SYMBOL	SAMPLES				TESTS		
				NUMBER	TYPE	RECOVERY	SPT - N BLOWS / FT.	MOISTURE, %	DRY DENSITY PCF	UNCONFINED STRENGTH PSF
Fill -- SAND, with gravel and coal debris, very dark gray			SP	1	AS			8.4		
2.0	857.3				HS					
3.0 Fine SAND	856.3									
Lean CLAY, trace sand and ferrous staining, dark grayish brown and yellowish brown, medium stiff			CL	2	SS	12"	3	28.2		1500*
		5			HS					
8.0	▽ 851.3									
Silty fine to medium SAND, yellowish brown, very loose			SP	3	SS	10"	1	17.2		
		10			HS					
12.0	847.3									
Silty fine to coarse SAND, trace gravel, dark grayish brown, very loose			SP	4	SS	1"	1	13.2		
		15			HS					
			SP	5	SS	1"	1			
		20			HS					
			SP	6	SS	0"	1			
		25			HS					
27.0	832.3									
Fine to coarse SAND, trace gravel and silt, light brownish gray, medium dense			SP	7	SS	14"	12	11.2		
		30			HS					
			SP	8	SS	11"	16	13.5		
		35								

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL.

Calibrated Hand Penetrometer*

WATER LEVEL OBSERVATIONS		
WL	▽ 8'	WD ▼
WL		
WL		

TEAM Services, Inc.

BORING STARTED	11-13-07		
BORING COMPLETED	11-13-07		
RIG	Rig 112	FOREMAN	MG
APPROVED	RED	JOB #	1-2125

CONFIDENTIAL BUSINESS INFORMATION

LOG OF BORING NO. 1

Page 2 of 2

OWNER

ARCHITECT/ENGINEER

SITE Marshalltown, Iowa

PROJECT Sutherland Air Heater Building

GRAPHIC LOG	DESCRIPTION	DEPTH (ft.)	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY	SAMPLES SPT - N BLOWS / FT.	TESTS MOISTURE, %	TESTS DRY DENSITY PCF	TESTS UNCONFINED STRENGTH PSF
	Fine to coarse SAND, trace gravel and silt, light brownish gray, medium dense 38.0 821.3				HS					
	Silty fine to coarse SAND, trace gravel and ferrous staining, olive gray, medium dense		SP	9	SS	17"	14	15.0		
		40			HS					
			SP	10	SS	18"	19	14.1		
	46.0 813.3	45			HS					
	Sandy lean CLAY, trace gravel, very dark gray, very stiff 48.0 811.3		CL	11	SS	18"	19	10.7		7500*
	Bottom of Boring									

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL

Calibrated Hand Penetrometer*

WATER LEVEL OBSERVATIONS		
WL	▽ 8'	WD ▼
WL		
WL		

TEAM Services, Inc.

BORING STARTED 11-13-07

BORING COMPLETED 11-13-07

RIG Rig 112

FOREMAN MG

APPROVED RED

JOB # 1-2125

CONFIDENTIAL BUSINESS INFORMATION

LOG OF BORING NO. 2

OWNER

ARCHITECT/ENGINEER

SITE Marshalltown, Iowa

PROJECT Sutherland Air Heater Building

Approx. Surface Elev.: 859.7 ft.

GRAPHIC LOG	Depth	DESCRIPTION	Elev.
▩	2.0	Fill -- Lean CLAY, trace sand, gravel, and organic matter, very dark brown	857.7
▨	8.0	Lean CLAY, trace sand and ferrous staining, dark gray, stiff	851.7
░	12.0	Silty fine to medium SAND, yellowish brown, loose ∇	847.7
░	17.0	Silty fine to coarse SAND, trace gravel, light yellowish brown, loose	842.7
░		Silty fine to coarse SAND, trace gravel and ferrous staining, light olive brown, medium dense -- color change to gray @ 22' -- becomes loose @ 28' -- color change to grayish brown, becomes medium dense @ 32'	

DEPTH (ft.)	USCS SYMBOL	SAMPLES NUMBER	TYPE	RECOVERY	SPT-N BLOWS / FT.	TESTS MOISTURE %	DRY DENSITY PCF	UNCONFINED STRENGTH PSF
	CL	1	AS			19.1		
			HS					
	CL	2	SS	12"	5	22.4		2500*
5			HS					
	SP	3	SS	16"	5	17.7		
10			HS					
	SP	4	SS	13"	4	14.5		
15			HS					
	SP	5	SS	12"	13	6.4		
20			HS					
	SP	6	SS	14"	10	12.6		
25			HS					
	SP	7	SS	10"	7	11.8		
30			HS					
	SP	8	SS	8"	20	10.1		
35								

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES IN-SITU. THE TRANSITION MAY BE GRADUAL.

Calibrated Hand Penetrometer*

WATER LEVEL OBSERVATIONS		
WL	∇ 9'	WD ∇
WL		
WL		

TEAM Services, Inc.

BORING STARTED	11-13-07		
BORING COMPLETED	11-13-07		
RIG	Rig 112	FOREMAN	MG
APPROVED	RED	JOB #	1-2125

CONFIDENTIAL BUSINESS INFORMATION

LOG OF BORING NO. 2

Page 2 of 3

OWNER

ARCHITECT/ENGINEER

SITE
Marshalltown, Iowa

PROJECT
Sutherland Air Heater Building

GRAPHIC LOG | DESCRIPTION

Silty fine to coarse SAND, trace gravel and ferrous staining, grayish brown, medium dense

43.0 | 816.7

Sandy lean CLAY, trace gravel, very dark gray, very stiff

DEPTH (ft.)	USCS SYMBOL	SAMPLES NUMBER	TYPE	RECOVERY	SPT - N BLOWS / FT.	TESTS MOISTURE, %	DRY DENSITY PCF	UNCONFINED STRENGTH PSF
			HS					
	SP	9	SS	10"	15	10.7		
40			HS					
	CL	10	SS	16"	13	12.4		
45			HS					
	CL	11	SS	8"	20	12.7		
50			HS					
	CL	12	SS	18"	20	10.9		
55			HS					
	CL	13	SS	18"	16	11.8		
60			HS					
	CL	14	SS	18"	19	12.5		
65			HS					
	CL	15	SS	18"	21	12.4		
70								

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES IN-SITU, THE TRANSITION MAY BE GRADUAL

Calibrated Hand Penetrometer*

WATER LEVEL OBSERVATIONS

WL	▽ 9'	WD ▼
WL		
WL		

TEAM Services, Inc.

BORING STARTED	11-13-07		
BORING COMPLETED	11-13-07		
RIG	Rig 112	FOREMAN	MG
APPROVED	RED	JOB #	1-2125

CONFIDENTIAL BUSINESS INFORMATION

LOG OF BORING NO. 2

Page 3 of 3

OWNER	ARCHITECT/ENGINEER
SITE Marshalltown, Iowa	PROJECT Sutherland Air Heater Building

GRAPHIC LOG	DESCRIPTION	DEPTH (ft.)	USCS SYMBOL	SAMPLES				TESTS		
				NUMBER	TYPE	RECOVERY	SPT - N BLOWS / FT.	MOISTURE, %	DRY DENSITY PCF	UNCONFINED STRENGTH PSF
▨					HS					
▨			CL	16	SS	18"	21	12.3		
▨		75			HS					
▨	-- becomes hard @ 77'									
▨			CL	17	SS	18"	29	12.3		
▨	80.0 779.7	80								
	Bottom of Boring									

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL.

Calibrated Hand Penetrometer*

WATER LEVEL OBSERVATIONS		
WL	∇ 9'	WD ▼
WL		
WL		

TEAM Services, Inc.

BORING STARTED	11-13-07		
BORING COMPLETED	11-13-07		
RIG	Rig 112	FOREMAN	MG
APPROVED	RED	JOB #	1-2125

CONFIDENTIAL BUSINESS INFORMATION

LOG OF BORING NO. 3

Page 1 of 2

OWNER	ARCHITECT/ENGINEER
SITE Marshalltown, Iowa	PROJECT Sutherland Air Heater Building

Approx. Surface Elev.: 859.9 ft.

GRAPHIC LOG	DESCRIPTION	Depth (ft.)	Elev.
▩	Fill – Lean CLAY, with sand, trace gravel, organic matter, and coal debris, very dark brown	3.0	856.9
▨	Lean CLAY, trace sand and ferrous staining, dark gray and olive brown, medium stiff	8.5	851.4
⁘	Silty fine to medium SAND, dark yellowish brown, very loose ¥	12.0	847.9
⁘	Silty fine to coarse SAND, trace gravel, light yellowish brown, medium dense – color change to gray @ 23' -- color change to grayish brown @ 28' -- becomes dense @ 33'		

		SAMPLES				TESTS		
DEPTH (ft.)	USCS SYMBOL	NUMBER	TYPE	RECOVERY	SPT - N BLOWS / FT.	MOISTURE, %	DRY DENSITY PCF	UNCONFINED STRENGTH PSF
	CL	1	AS			5.6		
			HS					
5	CL	2	SS	13"	6	24.4		1500*
			HS					
10	SP	3	SS	10"	3	18.1		
			HS					
15	SP	4	SS	11"	11	16.4		
			HS					
20	SP	5	SS	9"	16	18.2		
			HS					
25	SP	6	SS	8"	19	13.7		
			HS					
30	SP	7	SS	12"	16	9.9		
			HS					
35	SP	8	SS	10"	35	16.0		

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES. IN-SITU, THE TRANSITION MAY BE GRADUAL.

Calibrated Hand Penetrometer*

WATER LEVEL OBSERVATIONS		
WL	¥ 10'	WD ¥
WL		
WL		

TEAM Services, Inc.

BORING STARTED	11-13-07		
BORING COMPLETED	11-13-07		
RIG	ATV	FOREMAN	DC
APPROVED	RED	JOB #	1-2125

CONFIDENTIAL BUSINESS INFORMATION

LOG OF BORING NO. 3

Page 2 of 2

OWNER	ARCHITECT/ENGINEER
SITE Marshalltown, Iowa	PROJECT Sutherland Air Heater Building

GRAPHIC LOG	DESCRIPTION		DEPTH (ft.)	USCS SYMBOL	SAMPLES				TESTS		
					NUMBER	TYPE	RECOVERY	SPT - N BLOWS / FT.	MOISTURE, %	DRY DENSITY PCF	UNCONFINED STRENGTH PSF
	Silty fine to coarse SAND, trace gravel, grayish brown, dense					HS					
	40.0	819.9	40	SP	9	SS	9"	37	15.6		
	40.5 Sandy lean CLAY, trace gravel, very dark gray, very stiff	819.4									
	Bottom of Boring										

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL.

Calibrated Hand Penetrometer*

WATER LEVEL OBSERVATIONS				
WL	∇ 10'	WD	▼	
WL				
WL				

TEAM Services, Inc.

BORING STARTED	11-13-07		
BORING COMPLETED	11-13-07		
RIG	ATV	FOREMAN	DC
APPROVED	RED	JOB #	1-2125

Attachment G

Well Record

Well Number 6A, Permit No. 3090

Source:
Iowa Department of Natural Resources, Geological Survey Bureau

Iowa Department of Natural Resources Geological Survey Bureau
109 Trowbridge Hall Iowa City, Ia. 52242-1319 PH (319) 335-1575

WELL RECORD

Permit No. 3090

CONFIDENTIAL BUSINESS INFORMATION

Site Identification

Property Owner IES U[illegible] Well Number [illegible]
Address E. MAIN ST ROAD; MARSHALLTOWN
Tenant
Well Depth 252 ft Date Completed 5 / 18 / 94

Drill method

☒ [illegible] ☐ [illegible] ☐ cable other

Hole size

60 inch from 0 ft to 63 ft
54 inch from 63 ft to 252 ft

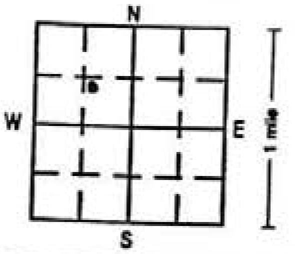
hole size continued
___ inch from ___ ft to ___ ft
___ inch from ___ ft to ___ ft

Record all depth measurements from ground level (GL). Use (+) for above GL measurements.

Location

County MARSHALL
___ mi. N/S and ___ mi. E/W of intersection of ___ and ___
NW 1/4 of the SE 1/4 of the NW 1/4 of Sec 32 TWP 84N RNG 17 E/W

Show exact location of well in section grid with a dot (●).



Sketch map of well location on property

N
200 ft

☐ upland ☐ hillside ☒ valley Elevation (if known)

Formation log

From	To	Color	Hardness	Formation description
0	8	BLACK		FILL MATL
8	11	BLACK		TOP SOIL
11	18	GRAY		CLAY
18	22	GRAY		SAND / GRAVEL
22	44	BROWN		SAND/GRAVEL/COBBLE
44	46	GRAY		SANDY CLAY
46	58	BROWN		SAND/GRAVEL/COBBLES
58	127	GRAY		CLAY W/COBBLES
127	132	GRAY		SANDY CLAY
132	140	GRAY		SAND, GRAVEL
140	152	GRAY		CLAY WITH SAND
152	168	GRAY		SAND GRAVEL
168	173	GRAY		CLAY, COBBLES
173	185	GRAY		SAND
185	192	GRAY		FINE SAND
192	241	GRAY		SANDY CLAY
241	252	GRAY		SAND GRAVEL
252		GRAY		LIMESTONE

use additional sheets as needed

Casing

Drive shoe (~~yes~~ / no) Pitless adaptor (yes / no)

Size (ID/OD)	Type / Wt	Depth top	Depth bottom	Amount (length)
54" ID	STEEL	0	63	63
30" ID	STEEL/119	+2	152	154
"	" "	167	172	5
"	" "	182	240	58

Perforated or slotted casing? (~~yes~~ / no)

Perforated / slotted from ___ ft to ___ ft
Perforated / slotted from ___ ft to ___ ft

Casing grouted? (yes / ~~no~~)

Type	Depth Top	Depth Bottom	Amount
CEMENT	0	63	11 YD³ OUTSIDE
CEMENT	0	20	12 YD³

Well screen? (yes / ~~no~~)

Diameter	Slot size	Depth Top	Depth Bottom	Length	Material
30"	.075	152	167	15	SST
30"	.075	172	182	10	SST
30"	.075	240	250	10	SST

Bottom capped (yes / ~~no~~) with STAINLESS PLATE
Seals / Packers (~~yes~~ / no) kind ___ depth ___ ft
Gravel packed (yes / ~~no~~) from 120 ft to 252 ft
type NORTH. 3 amount 106 TONS

Well developed? (yes / ~~no~~)

Explain AIR DEVELOPED, SURGED, BAILED, PUMPED

Pump installed? (yes / ~~no~~)

Date 06 / 01 / 94
Installer's name PAUL RENTSCHLER
Type of pump VERTICAL TURB. Depth to intake 150 ft
Pump diameter 12" BOWL Rated capacity 1,000 GPM

Water information

Aquifer: ☒ sand/gravel ☐ limestone ☐ sandstone
Main water-supply zone from 120 ft to 252 ft
Final water level (static water level) 37 ft (below / above) GL
Pumping water level 73.9 ft below GL; ☐ tape airline ☒ E-line
At yield of 1313 GPM; ☒ orifice ☐ volumetric ☐ estimate Date 5-18-94

Water quality test? (yes / ~~no~~)

Date tested 5 / 18 / 94
Tested by UNIV. OF IOWA LAB
Test results

Remarks (including depth of lost drilling fluids, materials, or tools)

Well use

☐ Domestic ☐ Municipal ☒ Industrial
☐ Livestock ☐ Public Supply ☐ Monitoring
☐ Test Well ☐ Irrigation ☐ Other ___ (explain)

Contractor LAYNE-WESTERN
Address 25450 HWY 275; VALLEY, NE 68064
Driller D. DEAVER Certification no. 40259

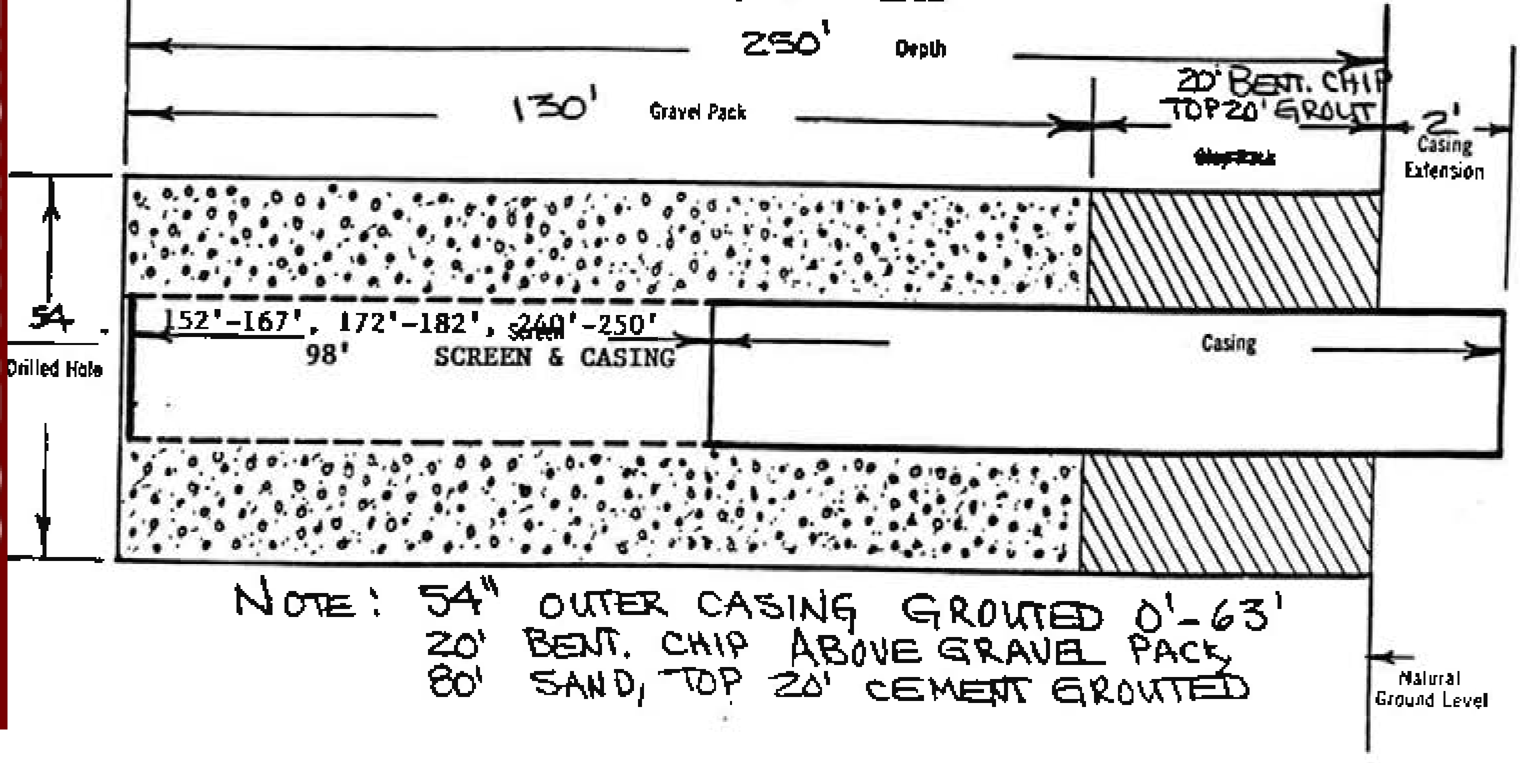
white copy - Iowa DNR, Geological Survey Bureau blue copy - Well Contractor pink copy - Customer yellow copy - County Health Officer

CONTRACT IES UTILITIES, INC. Well No. 6

CONFIDENTIAL BUSINESS INFORMATION

Log of well from ground level:

Feet	to	Feet	Formation
0	to	8	FILL MATERIAL
8	to	11	TOP SOIL
11	to	18	GRAY CLAY
18	to	22	GRAY SAND AND GRAVEL
22	to	44	BROWN SAND AND GRAVEL WITH COBBLES
44	to	46	SANDY GRAY CLAY
46	to	58	BROWN SAND AND GRAVEL WITH COBBLES
58	to	127	GRAY CLAY WITH COBBLES
127	to	132	SANDY GRAY CLAY - SMALL GRAVEL
132	to	140	SAND WITH SMALL GRAVEL
140	to	152	SANDY GRAY CLAY
152	to	168	GRAY SAND AND GRAVEL
168	to	173	GRAY CLAY WITH COBBLES
173	to	185	GRAY SAND
185	to	192	FINE GRAY SAND
192	to	241	SANDY GRAY CLAY WITH COBBLES
241		252.5	SAND AND GRAVEL
252.5			LIMESTONE, TOTAL DEPTH



NOTE: 54" OUTER CASING GROUTED 0'-63'
20' BENT. CHIP ABOVE GRAVEL PACK
80' SAND, TOP 20' CEMENT GROUTED

Attachment H

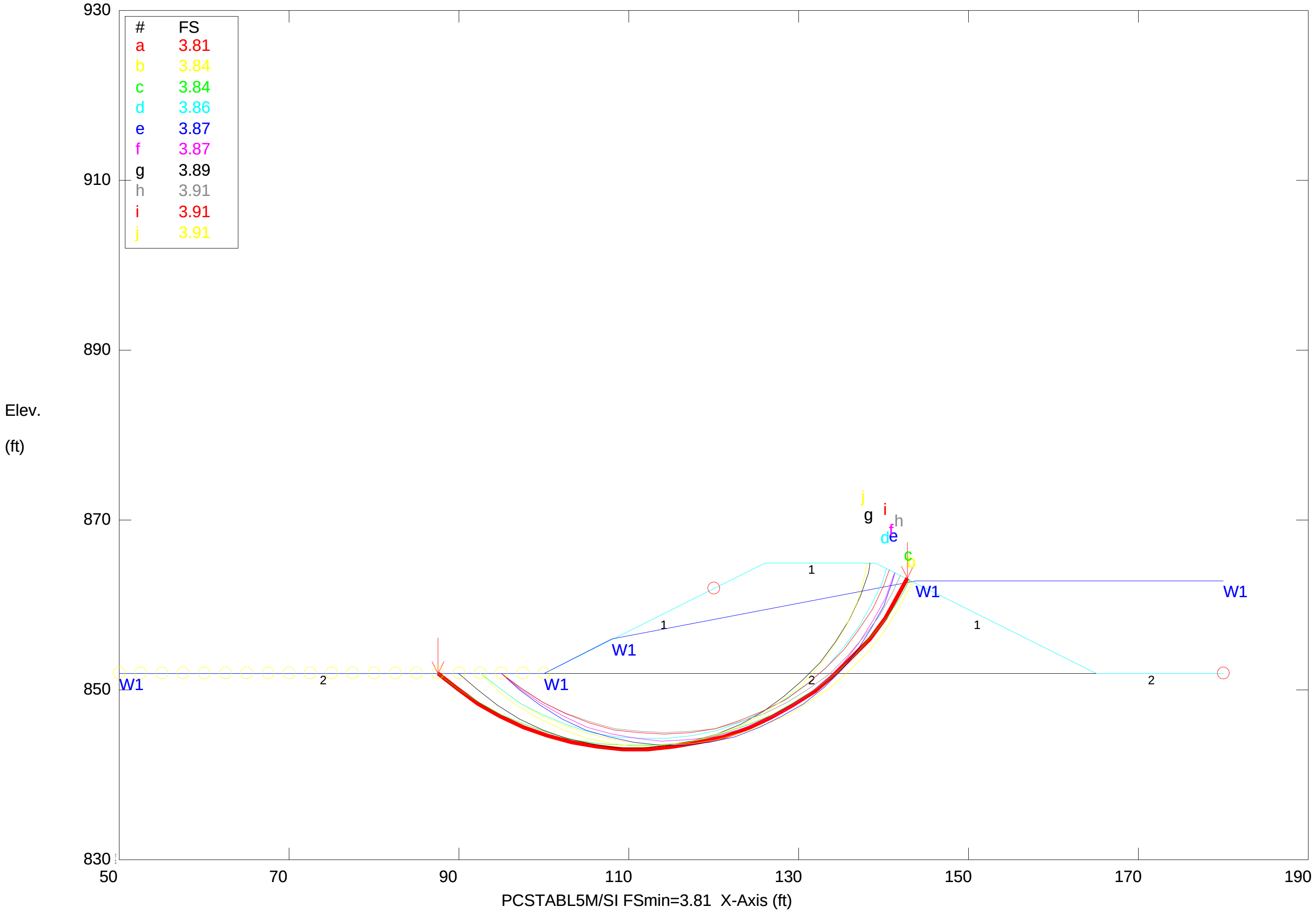
Slope Stability Analyses Results
Ten Most Critical Surfaces Per Analysis
Sutherland Generating Station

Source:
Program pcSTABLE5m/si output by Aether dbs, June, 2011

CONFIDENTIAL BUSINESS INFORMATION

Alliant Energy - Marshalltown, Iowa Static Case

Ten Most Critical. C:MARSH01.PLT By: TCW 06-15-11 4:09pm

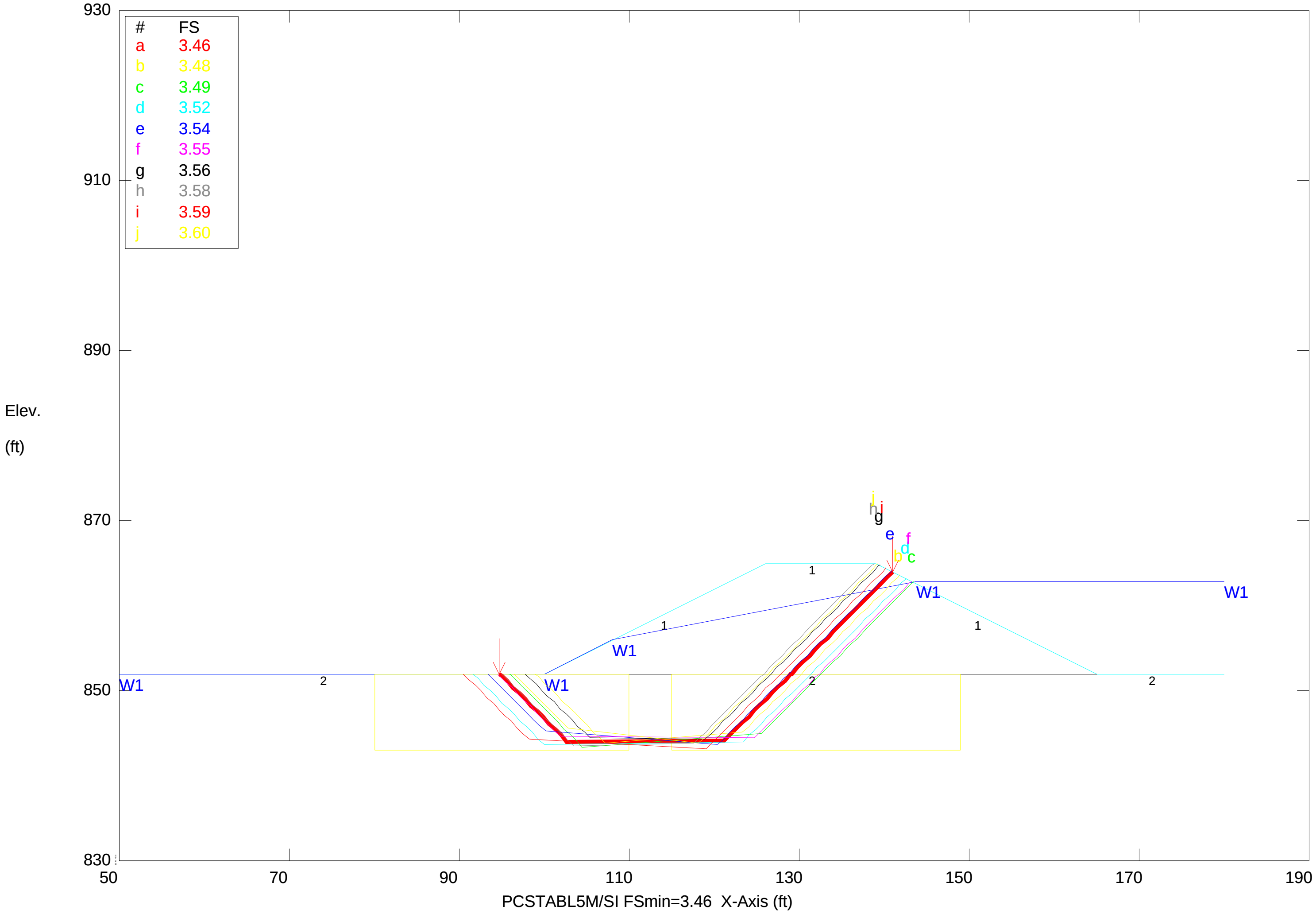


Soil Type No.	Label	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	Dike	130	130	1250	0	0	0	W1
2	Clay	126	126	1000	0	0	0	W1

CONFIDENTIAL BUSINESS INFORMATION

Alliant Energy - Marshalltown, Iowa Static Case

Ten Most Critical. C:MARSH02.PLT By: TCW 06-15-11 4:18pm

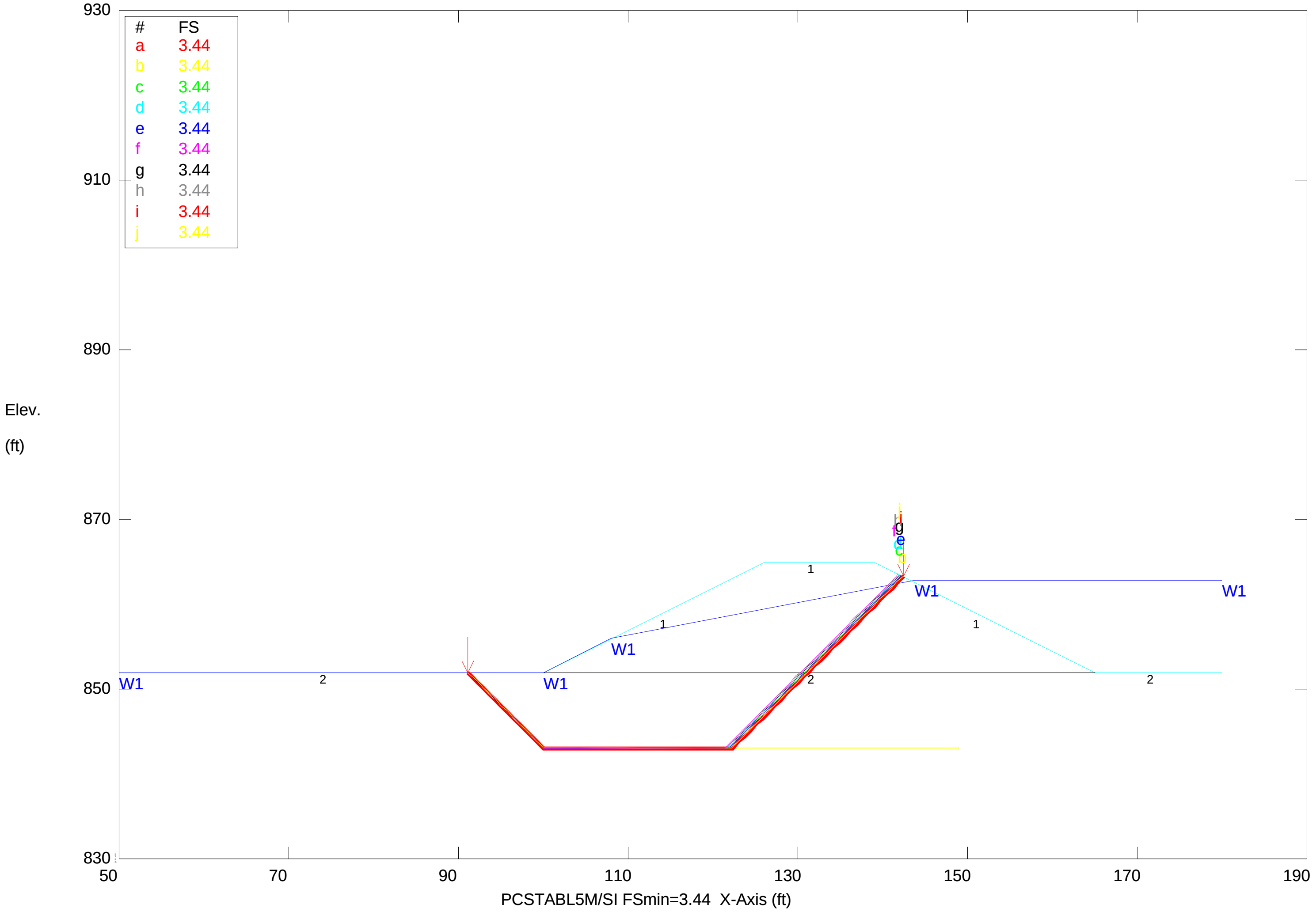


Soil Type No. Label		Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	Dike	130	130	1250	0	0	0	W1
2	Clay	126	126	1000	0	0	0	W1

CONFIDENTIAL BUSINESS INFORMATION

Alliant Energy - Marshalltown, Iowa Static Case

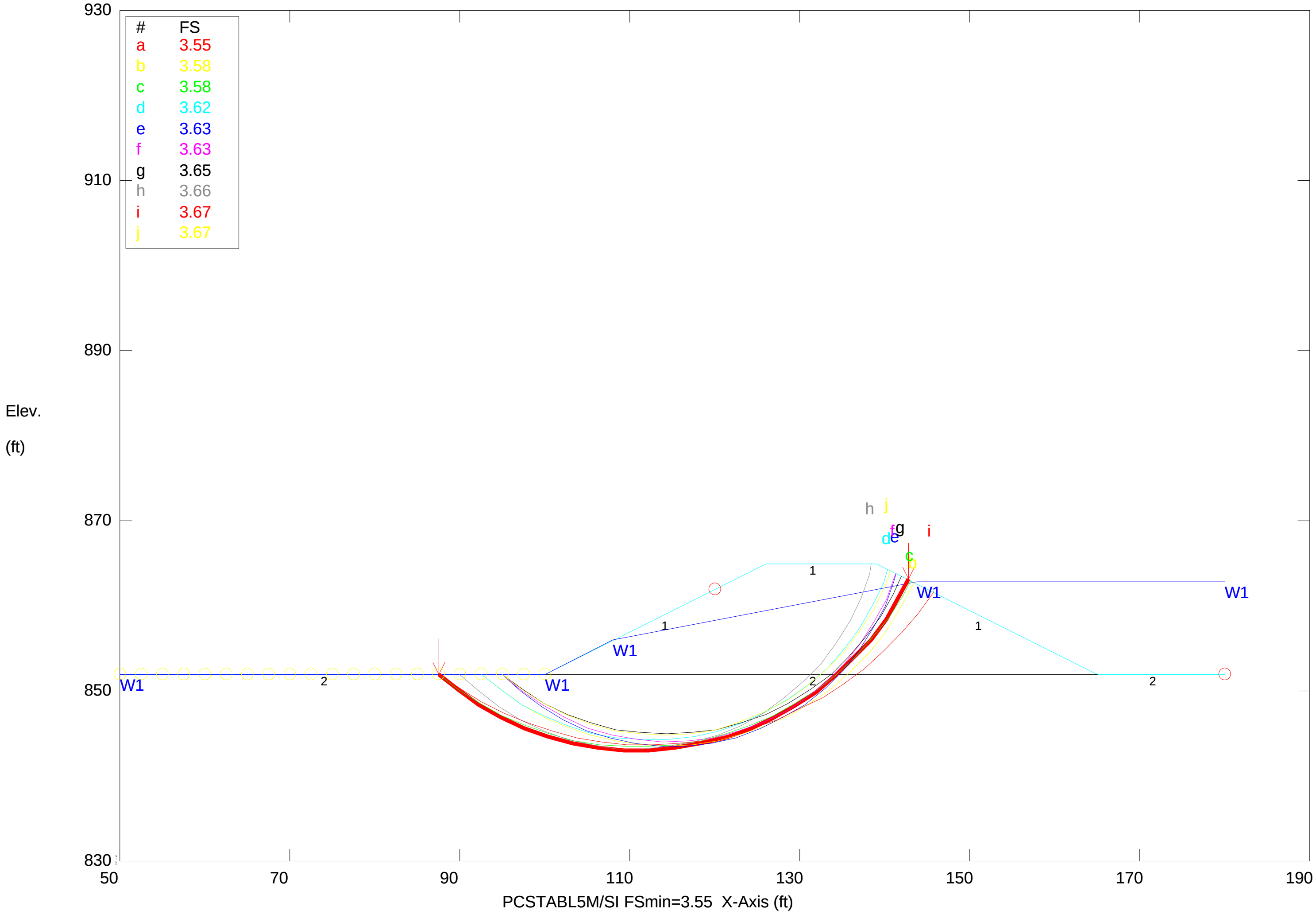
Ten Most Critical. C:MARSH03.PLT By: TCW 06-15-11 4:20pm



Soil Type No.	Label	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	Dike	130	130	1250	0	0	0	W1
2	Clay	126	126	1000	0	0	0	W1

CONFIDENTIAL BUSINESS INFORMATION

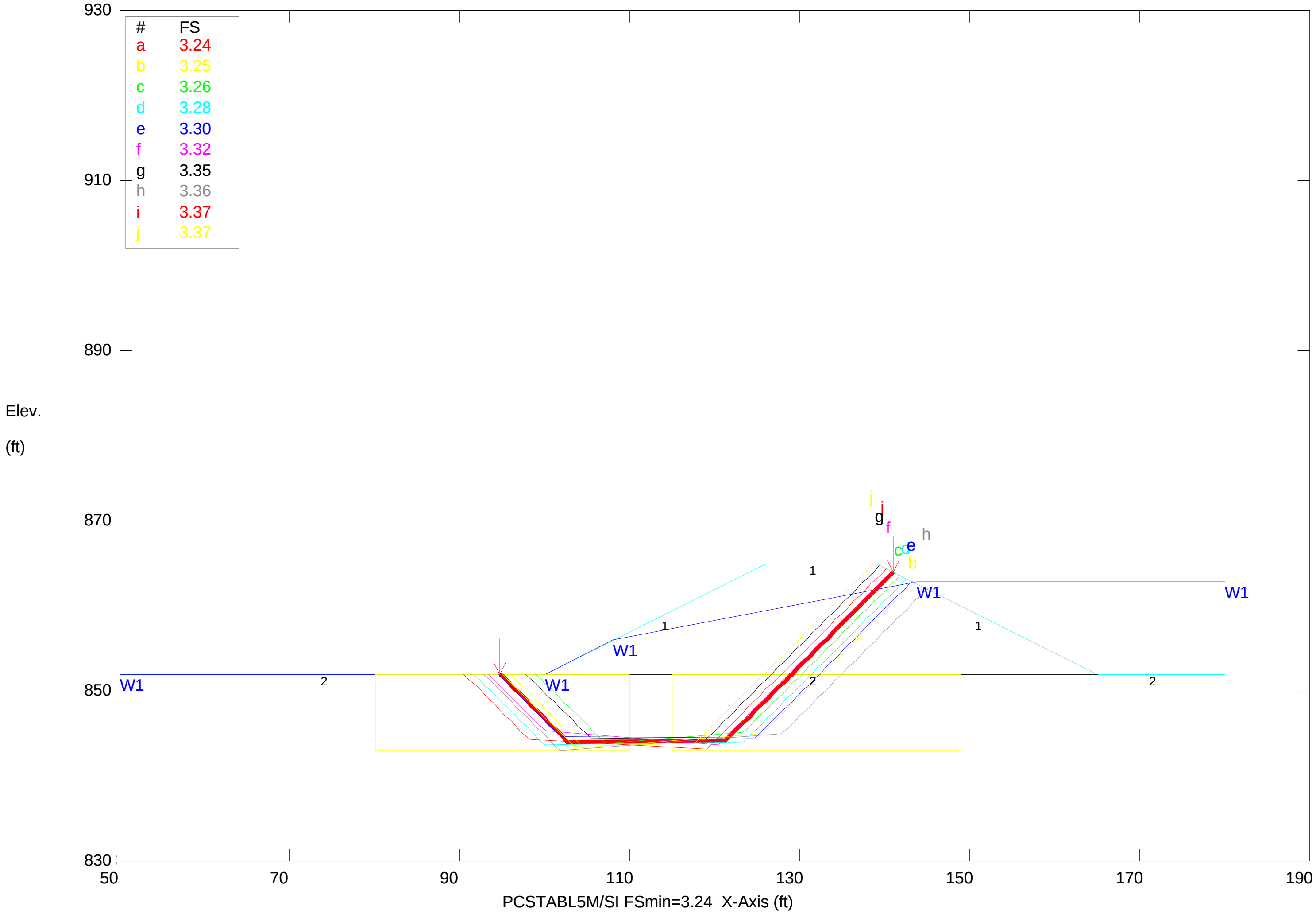
Alliant Energy - Marshalltown, Iowa Earthquake Case (0.019 & -0.013)
Ten Most Critical. C:MARSH11.PLT By: TCW 06-15-11 4:27pm



Soil Type No.	Label	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	Dike	130	130	1250	0	0	0	W1
2	Clay	126	126	1000	0	0	0	W1

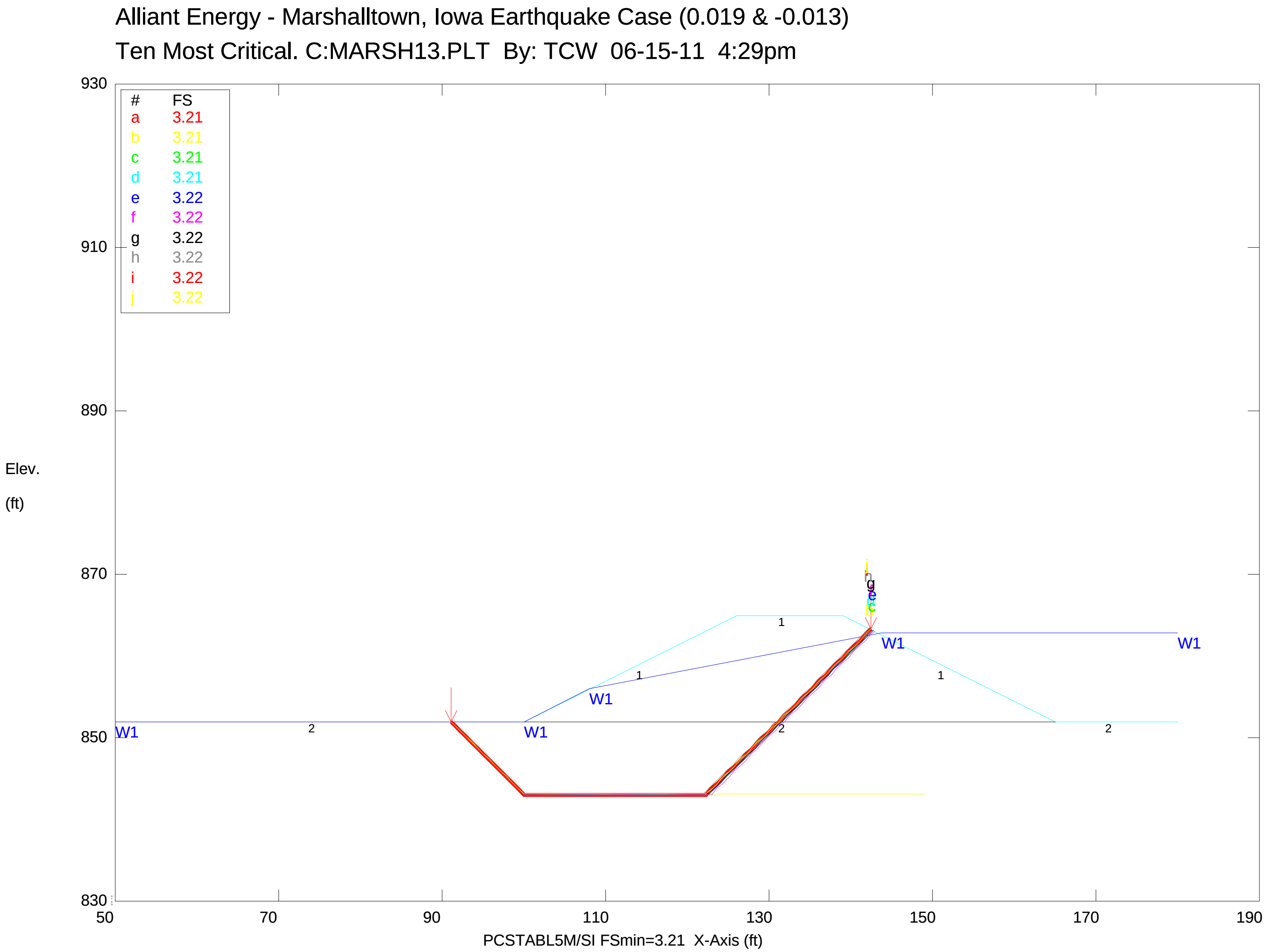
CONFIDENTIAL BUSINESS INFORMATION

Alliant Energy - Marshalltown, Iowa Earthquake Case (0.019 & -0.013)
Ten Most Critical. C:MARSH12.PLT By: TCW 06-15-11 4:28pm



Soil Type No. Label		Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	Dike	130	130	1250	0	0	0	W1
2	Clay	126	126	1000	0	0	0	W1

CONFIDENTIAL BUSINESS INFORMATION



Soil Type No. Label	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1 Dike	130	130	1250	0	0	0	W1
2 Clay	126	126	1000	0	0	0	W1

APPENDIX E

AETHER RESPONSE TO DRAFT REPORT (JULY 2012)

aether dbs
elemental design build solutions

July 18, 2012

154.017.002.002

Mr. William Skalitzky
Alliant Energy Corporate Services
4902 N. Biltmore Lane
Madison, WI 53718

Response
USEPA Draft Report
Safety of Coal Combustion Waste Ponds
Sutherland Generating Station
Marshalltown, Iowa

Dear Mr. Skalitzky

Aether DBS provides a response to the Draft Report issued by United States Environmental Protection Agency (USEPA) commenting on the structural safety analysis of the coal combustion waste pond on the Sutherland Generating Station property. The draft report was prepared by AMEC Earth & Environmental, Inc. (AMEC) and is dated July 2011. Since the time of the AMEC inspection, the Sutherland Generating Station transitioned to natural gas firing the boiler, however fossil fuel (coal) combustion equipment remains installed and could be used in the future. Since coal combustion waste is not presently discharged to the ponds the normal analysis conditions are different than 2011.

Aether DBS concurs with the AMEC finding that the Main Ash Pond on the Sutherland Generating Station is **low hazard potential**. The AMEC report further rates the North and South Primary Settling Ponds as separate structures with a rating of Less than Low Hazard Potential. Aether does not consider these internal structures separate of the single ash pond and the less than low hazard potential is not a category supported by the Interagency Committee on Dam Safety (FEMA).

In the conclusion of the draft report AMEC provides a United States Army Corps of Engineers (USACE) condition rating of **POOR** to the pond. In justification of the **POOR** rating AMEC cites the following:

- Analysis of the embankment stability should be based on long term conditions (effective stress) not short term conditions (total stress).

- Pocket penetrometer tests alone should not be used to determine the strength parameters for the clay embankment.
- A geotechnical engineer should evaluate the use of conservative values for strength properties of the embankment and/or determine if further strength data is needed.
- The critical cross-sections of the embankment should be confirmed by survey measurements separate of the topographic mapping from 2006.
- The east dike where water is present at the toe of the embankment should be evaluated for the impact of high phreatic surface and soft foundation conditions.
- The impacts of rapid drawdown on the upstream embankment should be analyzed.
- Analysis should consider lower strength values to account for inconsistencies within in the fill or the foundation soil.
- The pond freeboard should be increased to keep the internal pond divisions operating as separate ponds at the extreme 100-year return flow event.

In the conclusion of the AMEC report, there is no mention that the total stress stability analysis of the pond embankment by Aether indicated an Earthquake and Long-Term factor of safety that is more than twice the minimums cited in Table 5 of the AMEC report.

In Appendix A of the AMEC report, the Main Ash Pond configuration is selected as DIKED. Aether believes that the correct selection is COMBINED INCISED/DIKED.

<u>Response and Additional Information</u>

The outer embankments of the coal combustion waste impoundment were constructed in 1955 along with the Sutherland Generating Station Units 1 and 2. The embankments were constructed by excavating Zook clay in the impoundment area and using the Zook clay to build embankments with a top elevation equal to the established generating station grade (elevation 865). This is evident from the findings that the hard pond bottom is lower than the surrounding ground surface[1] and that the embankments are constructed of black clay (Zook clay)[2].

The Sutherland Station is located in the alluvial outwash formations of the Iowa River. The TEAM Services deep borings west of the ponds and the Black & Veatch borings south of the ponds indicate that sand is present below elevation 850. The TEAM Services and Black & Veatch boring logs and locations were provided in the Aether stability analysis report[3]. The top elevation of the sand in each boring is tabularized below. (Boring BV-7 is approximately 900 feet down the valley.) The density of the sand immediately below the clay is loose to medium dense.

---

[1] Sheet 2, Final Design of Pond Reconfiguration, Hard Hat Services, Inc., April 19, 2006 (referenced in Appendix C of AMEC report).

[2] Soil Survey of Marshall County, United States Department of Agriculture, Soil Conservation Service.

[3] Aether, "Ash Pond Slope Stability and Hydraulic Analysis, June 2011.

Soil Boring	Boring Depth (Ft.)	Sand Depth (Ft.)	Surface Elevation (Ft.)	Sand Top Elevation (Ft.)
B-1	48	8.0	859.3	851
B-2	80	8.0	859.7	852
B-3	40.5	8.5	859.9	851
BV-6	80.5	7.0	856.6	850
BV-7	80.5	8.0	855.9	848

The general soil stratigraphy in Iowa is windblown loess on the surface with glacial till below the loess. In some locations the loess is eroded away and in river valleys the till is also totally or partially eroded and overlain by alluvial soils. The Marshall County Soil Survey[2] indicates that Zook clay is some of the finest textured soil derived from alluvial deposition and is found in the lower parts of bottom lands below alluvial benches that divide the bottomland of river valleys from the loess deposits. The USGS topographic quadrangle “Marshalltown Southeast” indicates that the natural ground surface adjacent to the impoundments is between elevations 855-860. The USGS elevation range is consistent with the June 2012 cross-section survey results by Aether.

Zook clay is black clay with an organic content of 5-7% due to its deposition in areas where the ground water elevation is coincident with the ground surface most of the year. The Marshall County soil survey indicates that the upper 18 inches is CL or CH and from 18 to 60 inches CH. The liquid limit and plastic index range for Zook Clay is:

Zook Clay	Liquid Limit	Plastic Index
0-18 inches	45-65	20-35
18-60 inches	60-85	35-55

Selected pages from the Marshall County Soil Survey are provided in Attachment A.

The generalized soil conditions at the embankments is compacted Zook Clay from the top elevation at 865 (feet) to elevation 857-855 (assuming some topsoil was stripped prior to compacting the embankment), undisturbed Zook Clay to elevation 850 and loose to medium dense alluvial sand below that elevation. The Zook Clay prior to construction of the embankments was approximately 8-feet thick and was exposed to desiccation and bottom drainage after deposition. In addition to the natural drainage and desiccation, the undisturbed Zook Clay below the embankments has been surcharge loaded by as much as 8-feet of compacted embankment for over 50 years further consolidating the clay under the embankment. The pocket penetrometer results from the Aether borings indicate that Zook Clay under the embankments is over consolidated. Immediately after construction of the embankments and prior to consolidation from the construction, the external embankments were able to withstand normal operational water pressures without distress.

To resolve issues raised by AMEC on the geometric cross-section of the embankments, Aether surveyed the slopes at four locations in June 2012 as identified on Figure 1. The sections correspond to the areas of concern expressed by AMEC and to the original critical cross-section selected by Aether. The survey results are shown on Figure 2 and the field measurements indicate that the downstream (outer) slopes of the embankment range from 2.25:1 to 1.6:1. The results also show that the toe of the embankment is at elevation 857 or 858 and that the embankments are up to 8 feet high. The upstream / inside slopes are much more uneven due to the 2006 ash removal in the main pond and/or wind/wave erosion in the polishing pond.

Since water is not being used to sluice bottom ash from the boilers, the water elevation in the ponds has dropped dramatically, Photo 1. The ponds still receive storm water runoff, blow down water from the cooling water loop, sump water and air compressor cooling water. Without the sluicing water, the water elevation in the main ash pond is at the ground surface elevation outside the pond, Photo 1. Cattails growing at the outside base of the embankment indicate that the groundwater is at or near the ground surface.

Photo 1 - South western corner of the Main Ash Pond looking west. (Aether 6/19/2012)

Without the bottom ash sluicing water, there is no flow to the Polishing pond which shows a dry bottom, photo 2.

Photo 2 - Looking north along the eastern outer embankment. (Aether 6/19/2012)

The low water elevation indicates that exfiltration through the bottom of the Main Ash Pond into the underlying sand is sufficient to balance present operational flows such that the Main Ash Pond water level is close to the natural groundwater table elevation. Under the present conditions, Aether estimates that the 100-year, 24-hour SCS design storm runoff would fit in the Main Ash Pond and would not discharge into the Polishing Pond.

To address stability concerns raised by AMEC, Aether modeled cross-section 2 on Figure 1 using total stress soil strength for the embankment. Cross-section 2 has the greatest height of the three sections measured on the Main Pond. The slope stability soil profile includes loose sand below elevation 850, a consolidated and/or compacted Zook Clay embankment, consolidated clay under the embankment, and a weak normally consolidated Zook Clay at the toe of the embankment.

With the pond water elevation nearly the same as the outside groundwater elevation, the critical loading case is the sudden filling and emptying of the Main pond due to an extreme storm event. Since the pond would fill relatively quickly during a storm, a total stress analysis is appropriate. Conservatively, the Zook Clay embankment and subgrade is assigned the minimum cohesion value measured by pocket penetrometer testing during the 2006 investigation (1,000 PSF). The clay at the toe of the embankment and in the pond is assumed to remain normally consolidated with cohesion of 250 psf (soft clay). The sand is assigned a friction angle of 28° representing loose sand.

Program STABL5M (1996) from Purdue University[4] was used to analyze hundreds of potential slip surfaces. The program calculates a factor of safety based on the ratio of the driving forces to the resisting forces along each potential slip surface. A calculated factor of safety greater than one indicates stability along the surface analyzed. The ten most

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[4] STABL User Manual, By Ronald A. Siegel, Purdue University, June 4, 1975 and STABL5 …The SPENCER Method of Slices: Final Report, By J.R.Carpenter, Purdue University, August 28, 1985

critical circular failure surfaces are shown in Attachment B. All ten surfaces extend into the sand layer because of the uplift water pressure in the sand. (Disproportional head loss or exfiltration through the pond's bottom was ignored.) The lowest calculated Factor of Safety is greater than 3.3. Because of the high factor of safety there is no need to obtain more accurate soil strength data.

To analyze for the impact of converting back to coal firing of the boiler and refilling the ash ponds with water, Aether analyzed the stability with the pond at previous water operating elevation. In this case the cross-section 4 on the polishing pond has the greatest overall embankment height and steepest outboard slope. Effective stress soil parameters were assigned to the compacted clay, consolidated clay under the embankment, and normally consolidated clay at the toe of the embankment. As discussed by the Bureau of Reclamation[5], average compacted clay strength parameters for CH clay may be used for dams of **Low Hazard** potential without further testing. Based on the Bureau of Reclamation compilation, a friction angle of 19° and cohesion of 240 psf was assigned to the embankment and the consolidated clay under the embankment. For the normally consolidated clay at the toe of the embankment, the friction angle is chosen as 24°based on a plastic index of 55 and the relationship reported by Kenney in 1959[6] between plastic index and friction angle for normally consolidated clay. The stiff clay in the embankment above the phreatic surface that would be established under effective stress conditions is conservatively ignored and the thin clay layer at the toe is assumed to be normally consolidated which is not likely for such a thin deposit subject to easy drainage and surface dessication.

The results of the stability analysis with the the ultra-conservative assumption of effective stress parameters using STABL5M is a safety factor of 1.6 with the pond at normal overflow operating elevations, Attachment B. The results indicate that there is no need to perform further laboratory analysis on the soils of this **Low Hazard** embankment.

A specific response to each of the issues raised by AMEC is:

1. Effective versus Total Stress -- The AMEC report makes reference to normally consolidated clay which means clay that has not been consolidated by previous loadings other than its self-weight (i.e., not preloaded by an ice sheet over the clay, eroded soil over the clay, or a lowered ground water elevation). There is no indication in the literature on the soil formation processes for Marshall County or in the conditions at the site that Zook Clay is normally consolidated. However, Aether made very conservative assumptions as recommended by the US Bureau of Reclamation for **Low Hazard** potential embankments and finds that the embankments are stable with an effective stress analysis.
2. Pocket Penetrometer Testing Alone Unacceptable --The observation of the personnel taking the samples is also factored into the determination of the clay strength. Pocket penetrometer results alone are not the sole determinate.

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[5] United States Bureau of Reclamation, Design of Small Dams, pages 136-139, 1977.
[6] Kenney, T. C., Discussion, Proc. ASCE, Vol 85, No. SM3, pp. 67-79

Experienced personnel are able to see the physical difference between stiff clay and soft clay. The lowest observed clay strength is used in the analysis even though it is obvious that the upper part of the embankment above the saturation point is much stiffer. The LOW HAZARD potential of the embankments and determinate strength does not warrant more extensive testing.

3. <u>Qualified Geotechnical Engineer Needs to Review Strength Properties</u> -- Both of the authors have Masters Degrees in Geotechnical Engineering with over 35 years of experience in the field of geotechnical engineering, Attachment C provides the resume's of each author.
4. <u>Critical Cross-Section Needs to be Measured</u> – The results on Figure 2 show the measurements made at the two cross-sections noted by AMEC and two other locations selected by Aether. Due to the very short height of the embankments (eight feet versus thirteen feet), compared to the original analysis, the variations from 2 horizontal to 1 vertical on the outer slope are insignificant.
5. <u>Water at Toe of East Dike</u> – The section was measure by survey and found to be no different than the other sections. Groundwater surface and ground surface are approximately the same as shown on Photo 1 where cattails are prevalent at the natural ground surface below the toe of the embankment.
6. <u>Analysis with Lower Strength Values</u> – The cross-section was changed to include soft clay at the toe of the embankment and to show very loose sand under the Zook Clay. The changes result in total stress failure potential that is deeper than the previous analysis but approximately the same factor of safety. Results assuming a full pond and very conservative effective stress soil parameter show a failure surface that is through the embankment and into the normally consolidated clay assumed at the toe. Even when the stiff clay on top of the embankment is ignored, the safety factor still remains above 1.5.
7. <u>Increase Pond Freeboard</u> –The division embankment between the Main pond and the Polishing pond was designed to overtop in severe flow events. With the Sutherland facility no longer sluicing coal combustion waste the entire pond capacity is available as freeboard under gas-fired operations.

<u>Summary</u>

The available site information provides sound information on the characteristics of the small embankments that contain the coal combustion waste at Sutherland Generating Station. The information indicates that the embankments are constructed of the native clay that was present at the site and that the clay was excavated from the interior of the impoundment to create the embankments. Site information also shows that alluvial sand and gravel deposits exist below the clay.

Reasonable conservative soil strength assumptions demonstrate the factors of safety for an unusual loading event, a 100- year flood flow, is far greater than the required minimum. Very conservative assumptions of soil strength under full impoundment and effective stress analysis show an acceptable factor of safety.

The conversion of the Sutherland Generating Station to natural gas has changed the pond operations with no coal combustion waste being sent to the pond. As shown an extreme flow event to the Main Pond will satisfy the acceptable margins of safety with soil strengths that are conservative for the conditions at the site. In the event the station returns to coal firing, the Long Term (effective stress) strength of the embankment is adequate for a LOW HAZARD embankment.

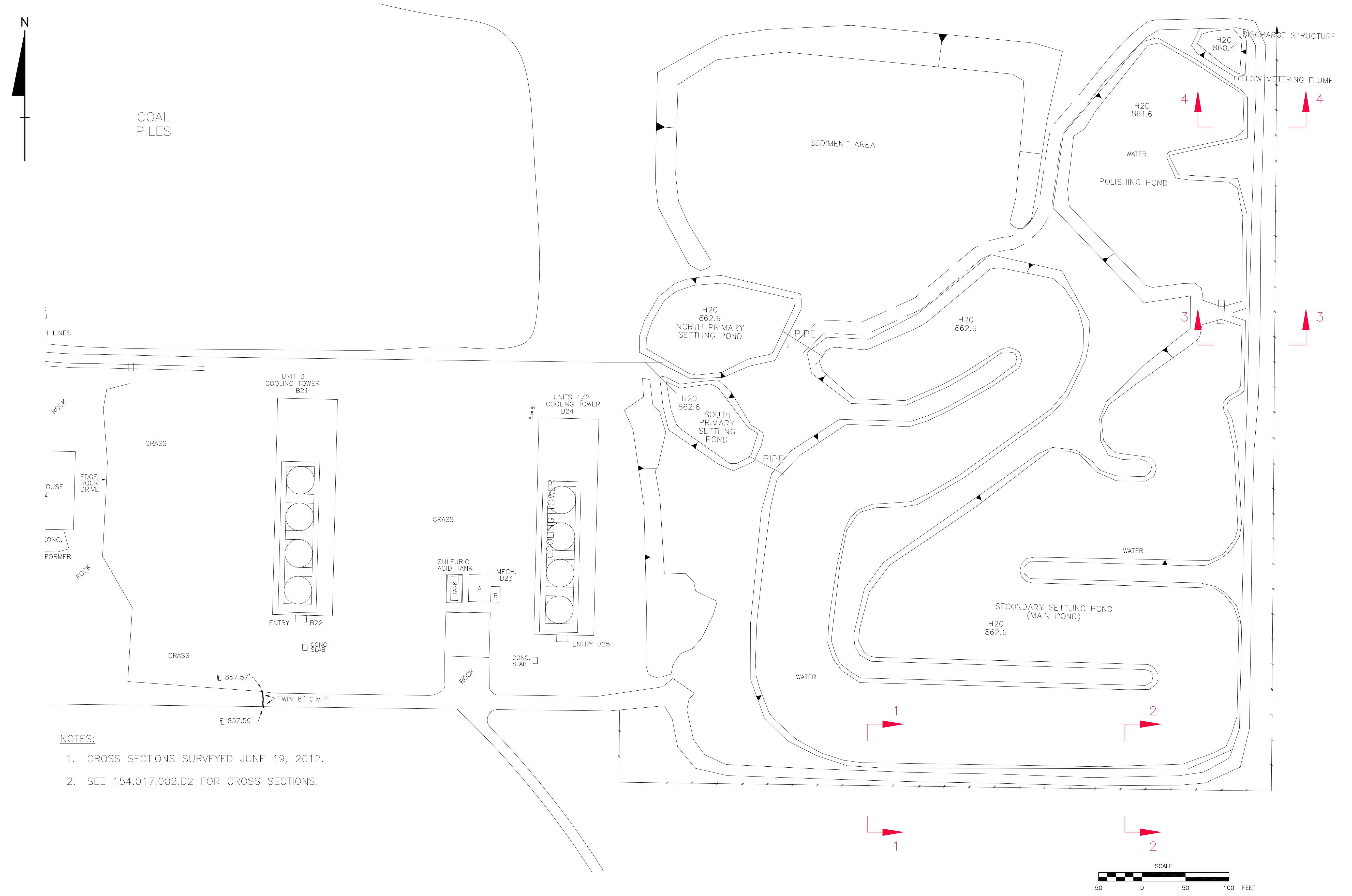
Aether DBS believes the condition assessment for the Sutherland Coal Combustion Waste Pond should be a **SATISFACTORY** rating.

If you have any questions, please call or e-mail.

Very truly yours,

Timothy J. Harrington, P.E.

Thomas C. Wells, P.E.



NOTES:

1. CROSS SECTIONS SURVEYED JUNE 19, 2012.
2. SEE 154.017.002.D2 FOR CROSS SECTIONS.

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REV	DATE	BY	DESCRIPTION
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aether dbs
www.aetherdbs.com

SCALE: AS SHOWN
DATE: 06–26–2012
DRAWN BY: M A M
CHKD. BY:
APPROVED:

CLIENT / LOCATION
INTERSTATE POWER & LIGHT COMPANY
SUTHERLAND GENERATING STATION
MARSHALLTOWN, IOWA

DRAWING DESCRIPTION
CROSS SECTION LOCATIONS

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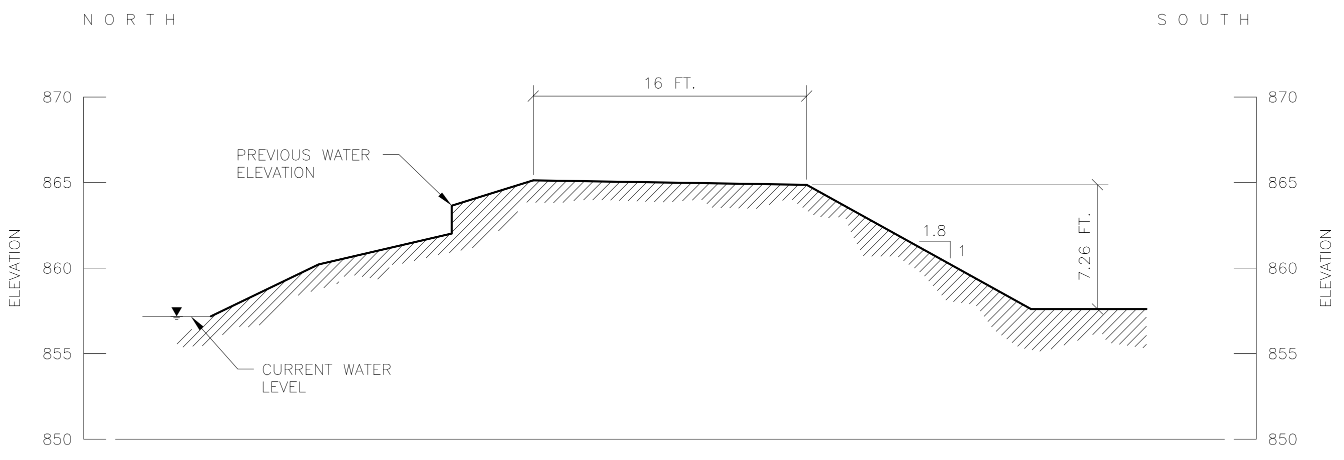
SHT. SHEET 1
DWG. 154.017.002.D1



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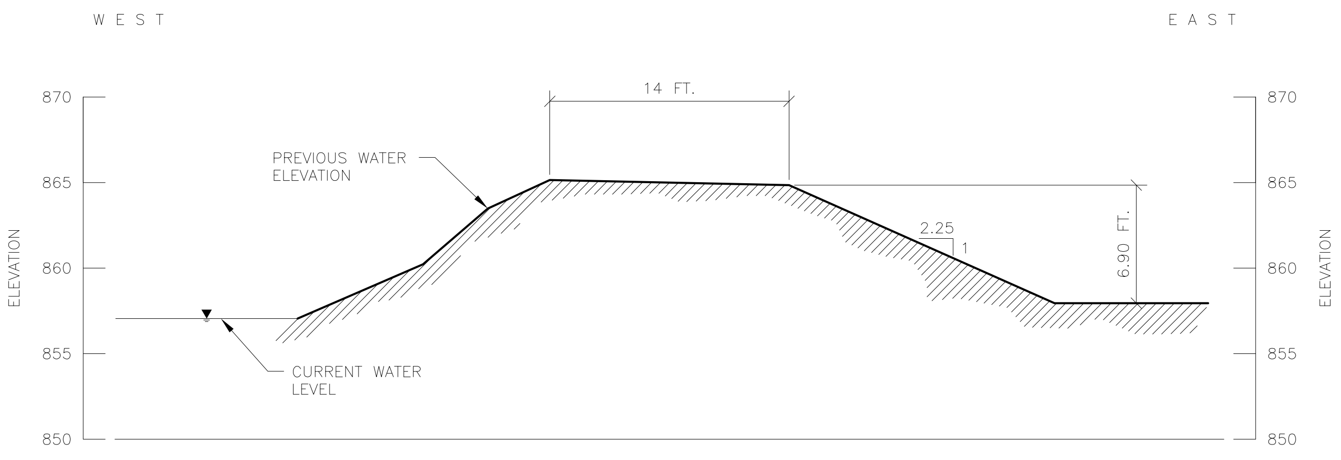

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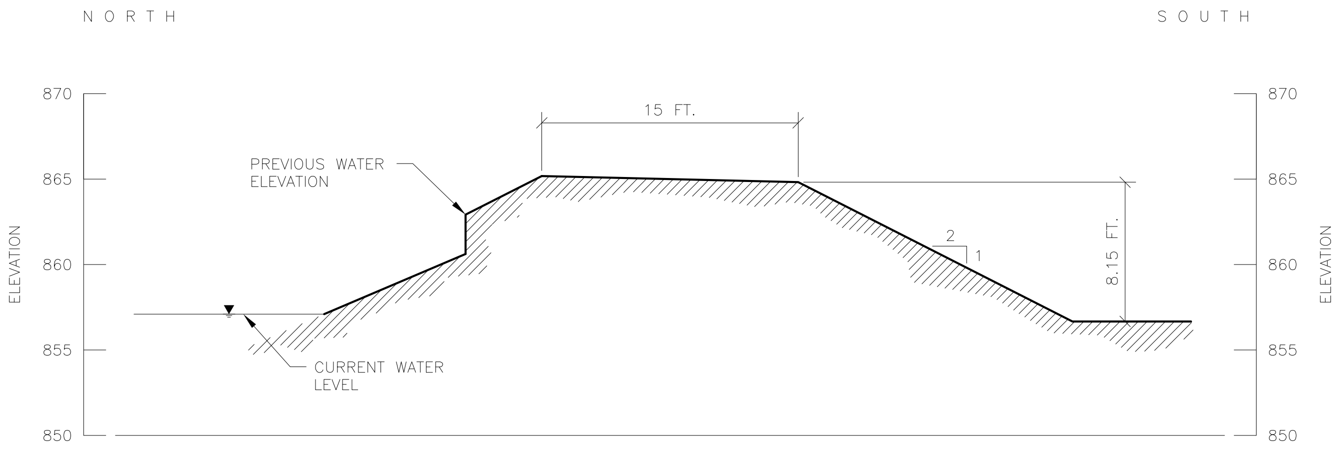

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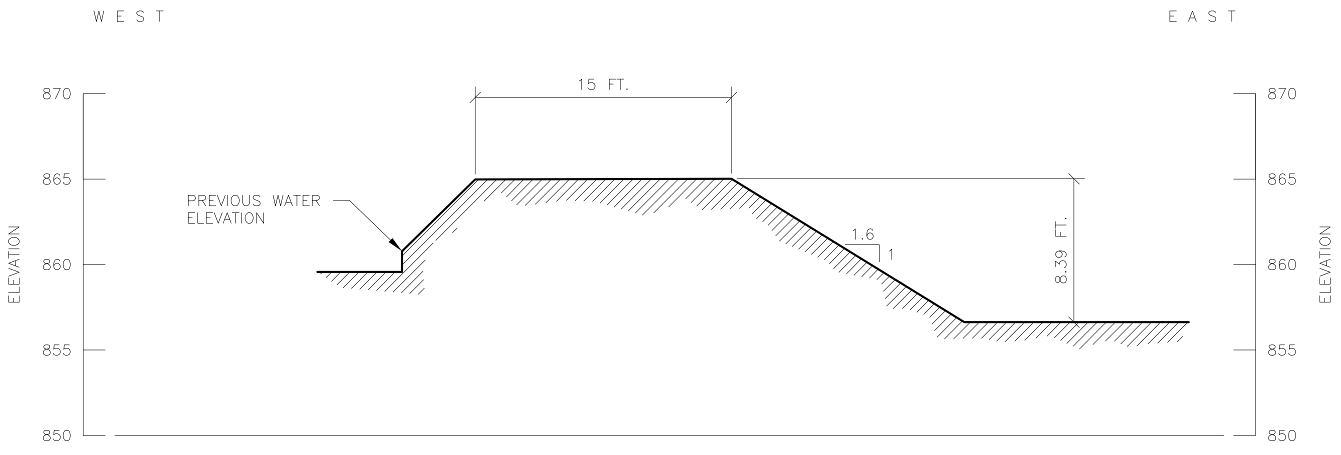
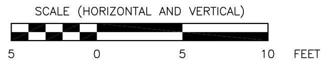


LOCATION 4

NOTES:

1. CROSS SECTIONS SURVEYED JUNE 19, 2012.



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DATE: 06-26-2012
DRAWN BY: M__A__M
CHKD. BY:
APPROVED:

CLIENT / LOCATION
INTERSTATE POWER & LIGHT COMPANY
SUTHERLAND GENERATING STATION
MARSHALLTOWN, IOWA

DRAWING DESCRIPTION
CROSS SECTIONS

JOB 154.017.002
SHT. SHEET 2
DWG. 154.017.002.D2

Attachment A

Soil Survey of Marshall County, Iowa

United States Department of Agriculture &

Soil Conservation Service

Excerpted Pages

Soil Survey of

Marshall County, Iowa

United States Department of Agriculture, Soil Conservation Service
in cooperation with the
Iowa Agriculture and Home Economics Experiment Station
Cooperative Extension Service, Iowa State University
and Department of Soil Conservation, State of Iowa

general soil map units

The general soil map at the back of this publication shows broad areas, called soil associations, that have a distinctive pattern of soils, relief, and drainage. Each soil association on the general soil map is a unique natural landscape. Typically, a soil association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one association can occur in other associations but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one association differ from place to place in slope, depth, drainage, and other characteristics that affect management.

1. Colo-Lawson-Zook association

Nearly level, poorly drained and somewhat poorly drained, silty soils formed in alluvium; on bottom lands and alluvial fans

This association consists of nearly level soils on flood plains and fans along major streams and in river valleys. These soils are subject to flooding. In places near the natural water course, the flood plains are severely dissected, and water stands in old channels.

This association makes up 10 percent of the county. It is about 29 percent Colo soils, 13 percent Lawson soils, 10 percent Zook soils, and 48 percent soils of minor extent (fig. 2).

Colo soils, on flood plains and alluvial fans, are nearly level and are poorly drained. Typically, the surface layer is black silty clay loam about 11 inches thick. The subsurface layer is black silty clay loam about 26 inches thick. The next layer is very dark gray silty clay loam about 14 inches thick. The substratum to a depth of about 60 inches is light brownish gray silty clay loam.

Lawson soils, on first and second bottoms, are nearly level and are somewhat poorly drained. Typically, the surface layer is black silty clay loam about 6 inches thick. The subsurface layer is black and very dark brown silty clay loam in the upper part and very dark grayish brown silty clay loam in the lower part. The substratum to a depth of about 60 inches is dark grayish brown silty clay loam.

Zook soils, on low flood plains, are nearly level and are poorly drained. Typically, the surface layer is black silty clay loam about 9 inches thick. The subsurface layer is black silty clay loam and silty clay about 31 inches thick. The subsoil to a depth of about 60 inches is very dark gray and grayish brown, friable silty clay loam.

Soils of minor extent in this association are the Ackmore, Hanlon, Lawler, Nevin, Nodaway, Saude, and Wiota soils. The poorly drained and somewhat poorly drained Ackmore soils and moderately well drained Nodaway and Hanlon soils are on broad flood plains and bottom lands near the natural stream channel. In addition, Ackmore and Nodaway soils are on alluvial fans near tributaries. The somewhat poorly drained Lawler soils and well drained Saude soils are on stream benches and outwash plains. The somewhat poorly drained Nevin soils are on high bottoms and low stream benches. The well drained and moderately well drained Wiota soils are on stream benches.

Most areas of this association are used for cultivated crops. Channeled and dissected areas of the flood plain are used for pasture and trees. The main enterprise is growing cash grain crops. The soils are well suited to cultivated crops if they are adequately drained and protected from flooding. They are poorly suited to building site development and sanitary facilities.

Corn, soybeans, oats, hay, and pasture grow well on the soils of this association. The organic matter content and the available water capacity of these soils are high. The main concerns of management are improving drainage and protecting the soils from flooding. These soils can be drained by tile and surface drains if adequate outlets are available. Diversions, levees, and channel improvements help to provide flood protection and control runoff from adjacent areas.

2. Muscatine-Tama-Garwin association

Nearly level and gently sloping, somewhat poorly drained, well drained, and poorly drained, silty soils formed in loess; on uplands

This association consists of wide areas of nearly level soils on divides and gently sloping soils on side slopes. The landscape is mostly gently undulating and undulating.

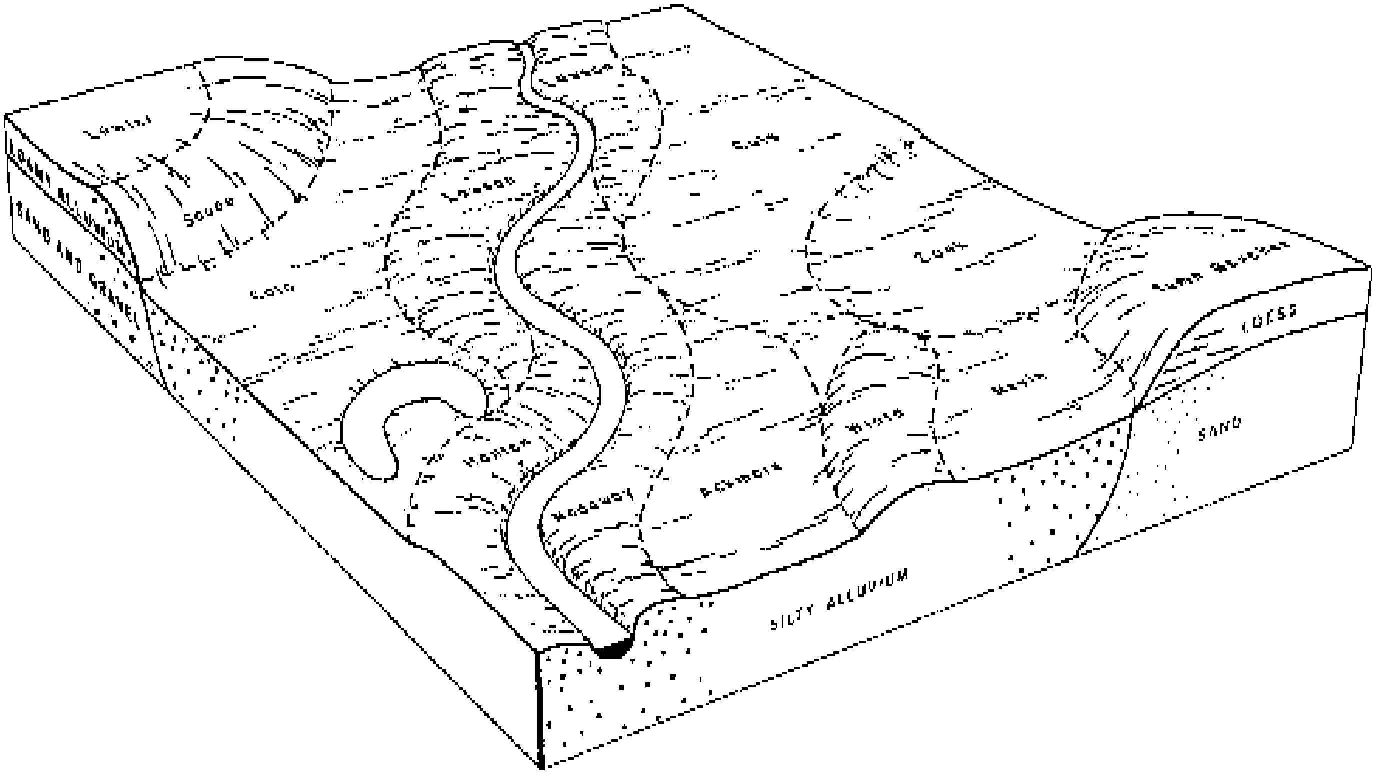


Figure 2.—Typical pattern of soils and parent material in the Colo-Lawson-Zook soil association

This association makes up about 21 percent of the county. It is about 43 percent Muscatine soils, 38 percent Tama soils, 13 percent Garwin soils, and 6 percent soils of minor extent.

Muscatine soils, on moderately wide divides, are very gently sloping and are somewhat poorly drained. Typically, the surface layer is black silty clay loam about 8 inches thick. The subsurface layer is black and very dark brown silty clay loam about 10 inches thick. The subsoil is silty clay loam about 27 inches thick. It is very dark grayish brown and dark grayish brown in the upper part and mottled grayish brown and light olive brown in the lower part. The substratum to a depth of about 60 inches is grayish brown, mottled silty clay loam.

Tama soils, on broad convex ridgetops and side slopes, are nearly level and gently sloping and are well drained. Typically, the surface layer is very dark brown silty clay loam about 7 inches thick. The subsurface layer is very dark brown and very dark grayish brown silty clay loam about 9 inches thick. The subsoil is friable silty clay loam about 31 inches thick. It is brown in the upper part, yellowish brown in the middle part, and dark yellowish brown and yellowish brown in the lower part. The substratum to a depth of about 60 inches is yellowish brown, mottled silty clay loam.

Garwin soils, on wide divides and concave heads of drainageways, are nearly level and are poorly drained. Typically, the surface layer is black silty clay loam about 8 inches thick. The subsurface layer is black and very dark gray silty clay loam about 9 inches thick. The subsoil is friable silty clay loam about 26 inches thick. It is dark gray and gray in the upper part and mottled olive gray in the lower part. The substratum to a depth of about 60 inches is light olive gray, mottled silty clay loam.

The soils of minor extent in this association are the Colo, Ely, Harpster, and Sperry soils. The poorly drained Colo soils are in upland drainageways. The somewhat poorly drained Ely soils are on foot slopes. The poorly drained, calcareous Harpster soils are on wide divides and at the heads of drainageways. The very poorly drained Sperry soils are in slight depressions on wide divides.

Most areas of this association are used for row crops (fig. 3). The main enterprise is growing cash grain crops. These soils are well suited to all cultivated crops commonly grown in the county.

Corn, soybeans, oats, and hay grow well on the soils of this association. The available water capacity is high to very high. The organic matter content of these soils is moderate to high. The main concerns of management are controlling erosion and improving drainage.

phosphorus, and low in available potassium. This soil has good tilth.

Most areas of this soil are in cropland. This soil is well suited to cultivated crops, hay, and pasture if protected from run-on water and if tile outlets are available. It is poorly suited to sanitary facilities and building site development.

This soil is well suited to corn and soybeans if drainage is adequate. Open drains and tile outlets are necessary to adequately drain this soil. This soil generally occurs as small areas within larger areas of better drained soils. Areas of this soil are subject to flooding because of runoff from adjoining soils. Return of all crop residue helps to maintain tilth.

This Vesser soil is in capability subclass IIw.

54—Zook silty clay loam, 0 to 2 percent slopes. This nearly level, poorly drained soil is on flood plains. Areas of this soil are subject to occasional flooding. Typical areas are broad and irregular in shape and range from 5 to more than 100 acres.

Typically, the surface layer is black silty clay loam about 9 inches thick. The subsurface layer is black silty clay loam and silty clay about 31 inches thick. The subsoil is very dark gray and grayish brown, friable silty clay loam to a depth of about 60 inches. Some areas have about 12 inches of silt loam overwash.

Included with this soil in mapping are small depressional areas that are high in organic matter content. These areas contain marsh vegetation. Marsh areas pond water for long periods and are not cultivated. These areas make up 5 percent of this map unit.

Permeability of this Zook soil is slow, and surface runoff is slow to very slow. The available water capacity is high. This soil has a seasonal high water table. The content of organic matter in the surface layer is 5 to 7 percent. The surface layer is slightly acid or neutral, and the subsoil is medium acid to mildly alkaline, low in available phosphorus, and very low in available potassium. This soil has poor tilth.

Most areas of this soil are in cropland. This soil is well suited to cultivated crops if adequately drained and if protected from flooding. It is poorly suited to sanitary facilities and building site development.

This soil is well suited to corn and soybeans if drainage is adequate. Areas can be drained by tile and surface drains if adequate outlets are available. Diversions, levees, and channel improvements are used to control flooding and runoff from adjacent areas. Artificial drainage improves the timeliness of field operations and helps to improve tilth.

This Zook soil is in capability subclass IIw.

55—Nicollet loam, 1 to 3 percent slopes. This very gently sloping, somewhat poorly drained soil is on slightly convex or plane, sloping ground moraines that have low relief. In places, this soil is on toe slopes or in the upper part of drainageways. Individual areas are irregular in shape and range from 5 to 40 acres.

Typically, the surface layer is black loam about 8 inches thick. The subsurface layer is loam about 12 inches thick. It is black in the upper part and very dark gray in the lower part. The subsoil is friable clay loam about 13 inches thick. It is dark grayish brown with dark yellowish brown mottles in the upper and middle parts and dark grayish brown and mottled in the lower part. The substratum to a depth of about 60 inches is grayish brown, mottled loam.

Included with this soil in mapping are a few small areas of Webster and Okoboji soils that are poorly drained or very poorly drained. These soils are on lower areas and have a heavier textured subsoil. The Okoboji soils pond water. These soils make up 5 to 10 percent of this map unit.

Permeability of this Nicollet soil is moderate, and surface runoff is slow. This soil has a seasonal high water table. The available water capacity is high. The surface layer is slightly acid or neutral, and the subsoil is slightly acid or medium acid. The content of organic matter is about 5 to 6 percent in the surface layer. The subsoil is very low in available phosphorus and very low to low in available potassium. This soil has good tilth.

Most areas of this soil are cultivated. This soil is well suited to cultivated crops, hay, and pasture. It is poorly suited to sanitary facilities and moderately suited to building site development.

This soil is well suited to corn and soybeans. If the soil is used for cultivated crops, there is a very slight hazard of erosion on the more sloping areas. Adequate drainage for the fluctuating water table may be beneficial. Conservation tillage, a practice that leaves crop residue on the surface throughout the year, helps to prevent soil loss caused by wind erosion. Returning crop residue helps to maintain good tilth.

If used for pasture or hay, overgrazing or grazing when the soil is wet causes surface compaction and decreased infiltration. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This Nicollet soil is in capability class I.

62D2—Storden loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping, well drained soil is on convex side slopes of the uplands. Typically, the slopes are short. Individual areas are long and narrow and range from 10 to 20 acres.

Typically, the surface layer is light yellowish brown and dark grayish brown, calcareous loam. The substratum to a depth of about 60 inches is calcareous loam. The upper part is light yellowish brown, the middle part is pale brown, and the lower part is light brownish gray.

Included with this soil in mapping are a few small areas that contain more sand and gravel and are droughty. They make up 5 to 10 percent of the map unit.

Permeability of this Storden soil is moderate, and surface runoff is rapid. The available water capacity is roots; few worm channels; slightly acid; gradual smooth boundary.

A13—13 to 18 inches; very dark gray (10YR 3/1) light silty clay loam, very dark grayish brown (10YR 3/2) kneaded, dark grayish brown (10YR 4/2) dry; moderate very fine and fine subangular blocky structure; friable; few fibrous roots; few worm channels; slightly acid; gradual smooth boundary.

A3—18 to 26 inches; very dark grayish brown (10YR 3/2) and dark brown (10YR 3/3) silty clay loam, very dark gray (10YR 3/1) coatings on peds, brown (10YR 5/3) dry; moderate fine subangular blocky structure; friable; few fibrous roots; few worm channels; slightly acid; gradual smooth boundary.

B2t—26 to 37 inches; brown (10YR 4/3) silty clay loam, dark brown (10YR 3/3) coatings on peds; weak medium prismatic structure parting to moderate medium subangular blocky; friable; thin discontinuous clay films; few fibrous roots; few worm channels; slightly acid; gradual smooth boundary.

B3—37 to 49 inches; brown (10YR 4/3) silty clay loam; weak medium prismatic structure parting to weak medium subangular blocky; friable; thin discontinuous silt coats; few fibrous roots; few worm channels; slightly acid; gradual smooth boundary.

C—49 to 60 inches; yellowish brown (10YR 5/4) silty clay loam; few fine faint grayish brown (10YR 5/2) mottles; massive; friable; thin discontinuous silt coats; few fibrous roots; slightly acid.

The solum ranges from 36 to 60 inches in thickness. The mollic epipedon ranges from 18 to 32 inches in thickness.

The A horizon is 25 to 32 percent clay. Reaction ranges from slightly acid to strongly acid. The B horizon is brown (10YR 4/3) or dark yellowish brown (10YR 4/4). The C horizon is silt loam or silty clay loam and is stratified in some pedons.

Zook series

The Zook series consists of poorly drained soils on flood plains commonly adjacent to foot slopes and bench escarpments. Permeability is slow. Zook soils formed in silty alluvium that is less than 15 percent sand. Native vegetation was prairie grasses. Slope ranges from 0 to 2 percent.

Zook soils are similar to Colo soils and are commonly adjacent to Bremer and Nevin soils. Colo soils have less clay in the solum. Bremer soils have thinner A horizons and less clay in the B horizon. They are on second bottoms or low stream benches. Nevin soils have thinner A horizons, are somewhat poorly drained, and are on high second bottoms and low stream benches.

Typical pedon of Zook silty clay loam, 0 to 2 percent slopes, 1,040 feet south and 198 feet east of the northwest corner of sec. 20, T. 84 N., R. 18 W.

Ap—0 to 9 inches; black (N 2/0) silty clay loam, black (N 2/0) dry; weak fine granular structure; friable; common fibrous roots; neutral; abrupt smooth boundary.

A12—9 to 18 inches; black (N 2/0) heavy silty clay loam, black (N 2/0) dry; moderate very fine subangular blocky structure; friable; few fibrous roots; neutral; gradual smooth boundary.

A13—18 to 25 inches; black (N 2/0) light silty clay, black (N 2/0) dry; moderate very fine and fine subangular blocky structure; firm; few fibrous roots; slightly acid; gradual smooth boundary.

A31—25 to 32 inches; black (10YR 2/1) light silty clay, dark gray (10YR 4/1) dry; weak medium prismatic structure parting to fine and medium subangular blocky; firm; few fibrous roots; slightly acid; gradual smooth boundary.

A32—32 to 40 inches; black (10YR 2/1) heavy silty clay loam, dark gray (10YR 4/1) dry; weak medium prismatic structure parting to fine and medium subangular blocky; firm; few fibrous roots; slightly acid; gradual smooth boundary.

B2g—40 to 48 inches; very dark gray (10YR 3/1) silty clay loam; weak medium prismatic structure parting to weak fine subangular blocky; friable; few fibrous roots; slightly acid; gradual smooth boundary.

B3g—48 to 60 inches; grayish brown (2.5Y 5/2) silty clay loam; few fine distinct strong brown (7.5YR 5/6) mottles; weak medium prismatic structure; friable; few fibrous roots; neutral.

The solum ranges from 45 to 64 inches in thickness. The entire solum is 5 to 15 percent sand and below a depth of 16 inches, it is 38 to 46 percent clay.

The A horizon ranges from 30 to 40 inches in thickness. It is black (10YR 2/1, N 2/0) silty clay loam or silty clay. The A horizon is 32 to 42 percent clay. Reaction ranges from neutral to medium acid. The B and C horizons are very dark gray (10YR 3/1), dark gray (10YR to 5Y 4/1), gray (5Y 5/1), or grayish brown (2.5Y 5/2).

formation of the soils

This section discusses the factors of soil formation and relates these factors to the soils in Marshall County.

factors of soil formation

Soil is produced by the action of soil-forming processes on materials deposited or accumulated by geologic agencies. The characteristics of the soil at any given point are determined by the physical and mineralogical composition of the parent material; the climate under which the soil material has accumulated and existed since accumulation; the plant and animal life on and in the soil; the relief, or lay of the land; and the length of time the forces of soil development have acted on the soil materials (*8*).

Climate and vegetation are the active factors in the formation of soil. They act on the parent material and slowly change it into a natural body that has genetically related horizons. The effects of climate and vegetation are conditioned by relief. The parent material also affects the kind of profile that can be formed and, in extreme cases, determines it almost entirely. Finally, time is needed for the changing of the parent material into a soil. It may be much or little, but some time is always required for horizon differentiation. A long period generally is required for the development of distinct horizons.

The factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one unless conditions are specified for the other four. Many of the processes of soil development are unknown.

parent material and its geologic origin

Most of the soils in Marshall County developed from loess (windblown materials), glacial till (ice-laid materials), and alluvium (water-laid materials). A few areas of eolian sand are along the Iowa River and Minerva and Honey Creeks. Parent materials in most places are built up like layers of a cake. These layers can be observed in road cuts and in places on side slopes. In this county, parent material was important in developing the general character of the soil profile.

The major Pleistocene deposits of pre-Wisconsin age are either Kansan drift, Nebraskan drift, or both. The different drifts, or tills, are not readily differentiated in Marshall County. The glacial till ranges from none to over 300 feet in thickness.

Soils developed on the Kansan till plain during the Yarmouth and Sangamon interglacial ages. This soil development was before loess deposition. On nearly level interstream divides, the soils were strongly weathered and had a gray plastic subsoil called gumbotil. This gumbotil remains; it is several feet thick and very slowly permeable. The Clarinda soils developed in this gumbotil (*15*).

Geologic erosion has cut into and below the Yarmouth-Sangamon paleosol and into the Kansan till and older deposits. On the surface formed by this erosion, there is a stone line on top of till and erosional sediment called pedisediment. Soils that have a red clayey subsoil developed in the pedisediment, stone line, and subjacent till. This period of erosion and soil formation is called Late Sangamon. The Adair soils formed in the Late Sangamon paleosols (*9*).

The Kansan till is exposed mostly in hilly areas. The unweathered till is firm, calcareous clay loam. It contains pebbles, boulders, and sand as well as silt and clay. The soils that formed in Kansan till during the Yarmouth and Sangamon ages were covered by loess. Geologic erosion has removed the loess and paleosols on many side slopes. In these places, the till is only slightly weathered at the surface and has been exposed only during the Wisconsin State of the Quaternary period (*15*). Shelby, Gara, and Lindley soils formed in slightly weathered glacial till.

Glacial till is exposed in many rolling areas in the northeastern part of Marshall County. The till in this part of the county was truncated during the early part of loess deposition in the Wisconsin age. The truncated till surface is called the Iowan Erosion Surface (*15*).

The Iowan Erosion Surface is multi-leveled. Several levels of summits occur in a gradual progression from the stream valleys toward the low crests that mark the drainage divides. Other features typical of the Iowan Erosion Surface are erratics and paha. Erratics are large boulders partially buried or lying on the surface. Paha are prominent elongated ridges and are oriented in a distinct northwest-southeast direction. The core of the paha is an erosional remnant of the Kansan till, but the Yarmouth-Sangamon paleosol is intact (*16*). The paha are capped with thick loess or sand and loess.

The Iowan Erosion Surface is about 15 to 60 feet lower than the adjacent Kansan surface. The loess cap on the summits thins on shoulders and side slopes. Dinsdale soils formed in thin loess and glacial till.

The glacial till is less than 100 feet thick in most of the Iowan Erosion Surface areas. Geologic erosion has reworked the glacial till on hillslopes. Liscomb soils formed in loamy surface sediment and glacial till.

Loess of Wisconsin age covers most of Marshall County and is an extensive parent material. It consists mainly of silt and clay particles that have been deposited by wind. Variations in the loess are related to the distance from the source of loess. The source of loess in Marshall County is probably the bottom lands to the northwest and the Iowa River. The major deposits of loess in Marshall County are older than 14,000 years (*15*).

On the stable upland divides of the Kansan till plain, the loess is about 21 feet thick. Killduff, Tama, Muscatine, Garwin and Sperry soils are formed in loess on this landform. On the Iowan Surface, the loess is about 12 feet thick. Tama, Muscatine, Garwin, Sperry, and Harpster soils formed in loess on this landscape. Dinsdale soils formed in both loess and glacial till.

Along the rivers, loess deposits are twice as thick on both the Kansan plain and Iowan Surface. Downs, Fayette, Tama, and Killduff soils formed in this loess. Some of the high stream benches along the major streams and rivers are covered with loess deposits as thin as 7 feet. Tama, Muscatine, and Downs soils formed in this loess.

A glacial till lies above the loess in the western part of Marshall County. This till is part of the Bemis moraine system of the Des Moines Lobe. The till is of Cary age, a subdivision of the Wisconsin Glacial Stage. The evidence for the geologic youth of the Cary Glaciation is the lack of deep weathering, the unleached calcareous till at a shallow depth, the poorly developed surface drainage, and many closed depressions (*15*).

Two major erosional and depositional episodes in recent time have modified the Cary till surface. The initial relief has been reduced by the movement of material from hill summits to depressions and lowland areas. The sediment on hillslopes has selectively sorted from the summits to the toe slopes and into the depressions (*15*). Clarion, Nicollet, Webster, Canisteo, Harps, Lester, and Storden soils formed in the Cary glacial drift.

Alluvium consists of sediment that has been removed and laid down by water. As it moves, this sediment is sorted to some extent, but only in a few places is it as well sorted as the loess. Also, alluvium does not have the wide range of particle sizes that occurs in glacial drift. Because the alluvium in Marshall County is derived from loess and glacial drift, it is largely a mixture of silt and clay, silt and sand, or sand and gravel.

Alluvial sediment is the parent material for the soils on flood plains, on low benches, and in long drainageways. As the river overflows its channels and the water spreads over the flood plains, coarse textured material, such as sand and coarse silt, are deposited first. As the floodwater continues to spread, it moves more slowly, and finer textured sediment is deposited. After the flood has passed, the finest particles, or clay, settle from the water that is left standing in the lowest part of the flood plain. The Hanlon, Spillville, Nodaway, and Lawson soils commonly are closest to the stream channel and are coarser textured than the other soils on flood plains. The Ackmore, Coland, and Colo soils are on upland drainageways as well as on the flood plains of larger streams. Colo soils are extensive. Zook soils commonly are on the lower part of the bottom land and are one of the finest textured soils derived from alluvium in the county.

Alluvial stream benches are intermediate in elevation between the flood plains and the loess-covered benches. The Wiota, Nevin, Koszta, and Bremer soils formed in the silty alluvium on this landform. The Saude, Waukee, Lawler, and Hanska soils formed in loamy-over-sandy alluvium on these benches.

Sediment that has accumulated at the foot of the slope on which it originated is called colluvium or local alluvium. The Ely, Judson, Terril, and Vesser soils formed in the sediment on the foot slopes. Downslope from these soils is alluvial sediment carried in to the area from distant sources.

A secondary topographic form associated with alluvial plains is sand dunes. Fine sand is blown by the wind from stream channel and flood plain surfaces to higher elevations (*12*). Accumulations of dune sand are found on low stream benches, on high loess-covered benches, and upland fringing the leeward side of valleys. Dickinson, Sparta, and Chelsea soils are formed in eolian sand that is more than 5 feet thick.

climate

The soils in Marshall County have been developing under a midcontinental, subhumid climate for the past 5,000 years. The morphology and properties of most of the soils indicate that this climate was similar to the present climate. From 6,500 to 16,000 years ago, however, the climate probably was cool and moist and conducive mostly to the growth of forest vegetation.

The influence of the general climate in a region is modified by local conditions in or near the developing soils. For example, soils on south-facing slopes formed under a microclimate that is warmer and drier than the average climate of nearby areas. The low-lying, poorly drained soils on bottom lands formed under a wetter and colder climate than that in most areas around them. These local differences influence the characteristics of the soil and account for some of the differences among soils in the same climatic region.

vegetation and animal life

Many changes in climate and vegetation have taken place in Iowa during the past 28,000 years (*14*). The period between 28,000 to 11,000 years ago was dominated by coniferous forest with a transitional period of birch and alder. Deciduous forest dominated 11,000 to

9,000 years ago. A very dry period occurred between 9,000 to 3,200 years ago, with prairie vegetation dominating. Trees, especially oak, have invaded the prairie since 3,200 years ago, but the prairie still dominates.

For the past 5,000 years, the soils of Marshall County appear to have been influenced by two main kinds of vegetation—prairie grasses and trees. Big bluestem and little bluestem were the main prairie grasses. The main trees were deciduous, mainly oak, hickory, ash, elm, and maple.

The effects of vegetation on soils similar to those in Marshall County have been studied recently. Evidence shows that vegetation shifted while soils developed in areas bordering both trees and grasses. The morphology of the Downs, Sparta, Gara, and Lester soils reflect the influence of both trees and grasses. The Chelsea, Fayette, and Lindley soils formed under the influence of trees (*11*). Grasses influenced the development of the Tama, Muscatine, Garwin, Clarion, Colo, Dickinson, Killduff, Shelby, and Zook soils and the remaining minor soils in the county.

In most places, the soils that formed under trees are lighter colored, are more acid, and have a thinner surface layer that is lower in organic matter content than soils that formed under grasses. The soils in the county that formed under shifting vegetation or mixed grasses and trees have properties that are intermediate between the properties of soils formed under grasses and those of soils formed under trees.

Animals, such as earthworms and burrowing animals, help to keep the soil open and porous. Bacteria and fungi decompose the vegetation, thus releasing nutrients for plant food.

relief

Relief also may cause important differences among soils. It indirectly influences soil development through its effect on drainage. In Marshall County, the soils range from level to very steep. In many areas of the bottom lands, the nearly level soils are frequently flooded and have a permanently or periodically high water table. In depressions, water soaks into the nearly level soils that are subject to flooding. Much of the rainfall runs off the steep soils or uplands.

Level soils are on the broad upland flats and on the stream bottoms. The very steepest soils in the county are generally on slopes near the major streams and their tributaries. The intricate pattern of upland drainageways indicates that in most of the county the landscape has been modified by geological processes.

Generally, the soils in Marshall County that formed where the seasonal water table was well below the subsoil have a subsoil that is yellowish brown. Examples of such soils are the Clarion, Dickinson, Downs, Killduff, Shelby, and Tama soils. The Lawler, Muscatine, Nevin, and similar soils formed where the seasonal water table fluctuated and was periodically high. The Garwin, Webster, and similar soils formed where the seasonal water table is high and have a subsoil that is dominantly grayish. The Colo, Garwin, Webster, Zook and similar soils developed under prairie grasses and have a high water table. These poorly drained soils contain more organic matter in the surface layer than do well drained soils formed under prairie grasses. Clay accumulates in the subsoil of such soils as Sperry soils that are slightly depressional or nearly level. This is because a large amount of water enters the soils and carries clay particles downward. Sperry soils are called claypan soils because they have a hard layer where the greatest amount of clay accumulates.

The Killduff, Shelby, Tama, and similar soils that have wide slope ranges have some properties that change as slope increases. Two of these properties are the depth to carbonates and the thickness of the surface layer. Depth to carbonates is shallow where slopes are steepest. The surface layer becomes thin in stronger sloping soils.

time

Time is required for a soil to develop. An older and more strongly developed soil shows well defined genetic horizons. A soil with less development shows no horizons, or only weakly defined ones. Most soils on the flood plains are of this kind because these materials have not been in place long enough for distinct horizons to develop.

As an example, the effects of time can be seen by the increase of clay in the subsoil. A high clay content in the subsoil compared to that in the surface soil indicates a high degree of soil profile development has taken place. This can be important because soils with a high clay content in the subsoil generally have poorer drainage.

Material is generally removed from soils on steep slopes before there has been time for a thick profile with strong horizons to develop. Also, much of the water runs off the slopes rather than through the soil material, so that even though the material has been in place for a long time, the soil may exhibit little development.

Most of the parent materials in Marshall County are thousands of years old. The present land surface and many soils are much younger because of recent geologic erosion (*15*).

The oldest soils in Marshall County are those formed in loess on upland summits and on nearly level, loess-covered stream benches. The Garwin, Harpster, Muscatine, Sperry, and Tama soils might be as old as 14,000 years (*13*). The Clarion and other soils that formed in Cary glacial drift are as young as 3,000 years. The Liscomb and other strongly sloping soils on the Iowan Erosion Surface area are as young as or younger than 2,000 years. The Shelby and other strongly sloping or steeper soils on the Kansan till plain are as young as or younger than 6,800 years. Soils formed in alluvium and eolian sand are only a few thousand years old or less. The Wiota, Saude, and other soils that formed in materials on stream benches are the oldest alluvial soils. The Colo, Hanlon, Spillville, and other soils that formed in materials on the flood plains are younger than Wiota and Saude soils. The Dickinson, Sparta, and Chelsea soils are of an age intermediate between Hanlon and Wiota soils. Two soils that formed in alluvium, Nodaway and Ackmore soils, are less than 125 years old.

man's influence on the soil

Important changes take place if the soil is cultivated. Some of these changes have little effect on productivity; others have a drastic effect. Changes caused by erosion generally are most apparent. On many of the cultivated soils in the county, particularly the gently rolling to hilly soils, part or all of the original surface layer has been lost through sheet erosion. In some places, shallow to deep gullies have formed.

A study of eroded soils in Iowa, including Marshall County, was started in 1974 by the Iowa Cooperative Soil Survey. Soil descriptions and laboratory data of selected sites are available. Initial results show a lower organic matter content in eroded soils.

Nodaway and Ackmore soils formed in stratified silt loam alluvium on alluvial fans and flood plains. This alluvium has been deposited on the bottom during the past 125 years of cultivation. Many sloping soils have lost topsoil through water erosion to form these recent flood plain deposits. About 23 percent of the soils in Marshall County are eroded.

In many continuously cultivated fields, the granular structure that was apparent when the grassland was undisturbed is no longer present. In these fields the surface tends to bake and harden when it dries. Fine textured soils that have been plowed when too wet tend to puddle and are less permeable than similar soils in undisturbed areas. Poor seedling emergence and root penetration result in these areas.

Man has done much to increase the productivity of the soils and to reclaim areas not suitable for crops. He has made large areas of bottom land suitable for cultivation by digging drainage ditches and constructing diversions and dikes. Broad flats and nearly level soils, such as Garwin and Webster soils, have been greatly improved for cultivation by installing some kind of drainage system. By adding commercial fertilizers, man has counteracted deficiencies in plant nutrients and has made some soils more productive than they were in their natural state.

processes of horizon differentiation

Horizon differentiation is caused by four basic kinds of change—additions, removals, transfers, and transformation in the soil system (*18*). Each of these four kinds of change affects many substances that compose soils, such as organic matter, soluble salts, carbonates, sesquioxides, or silicate clay materials. In general, these processes tend to promote horizon differentiation, but some tend to offset or retard it. These processes and the changes brought about proceed simultaneously in soils, and the ultimate nature of the profile is governed by the balance of these changes within the profile.

An accumulation of organic matter is an early step in the process of horizon differentiation in most soils. Soils in Marshall County range from very high to very low in the amount of organic matter that has accumulated in their surface layers. Some soils that were formerly quite high in organic matter content are now low because of erosion. The accumulation of organic matter has been an important process in the differentiation of soil horizons in Marshall County.

The process through which substances are removed from parts of the soil profile is important in the differentiation of soil horizons. The movement of calcium carbonates and bases downward in soils is an example. All the soils in the county, except Canisteo, Harps, Harpster, and Storden soils, have been leached free of calcium carbonates in the upper part of their profile. Some soils have been so strongly leached that they are strongly acid or very strongly acid even in their subsoil.

Phosphorus is removed from the subsoil by plant roots and transferred to other parts of the plant. It is then returned to the surface layer in the plant residue. These processes affect the forms and distribution of phosphorus in the profile.

The translocation of silicate clay minerals is another important process. The clay minerals are carried downward in suspension in percolating water from the surface layer. They accumulate in the subsoil in pores and root channels and as clay films. In Marshall County, this process has had an influence on the profiles of many of the soils. In other soils, the clay content of the horizons are not markedly different and other evidence of clay movement is minimal.

Another kind of transfer that is minimal in most soils, but occurs to some extent in very clayey soils, is that brought about by shrinking and swelling. This causes cracks to form and incorporates some material from the surface layer into lower parts of the profile. Clarinda soils are examples of soils with potential for this kind of physical transfer.

Transformations are physical and chemical. For example, soil particles are weathered to smaller sizes. The reduction of iron is another example of a transformation. This process is called gleying and involves the saturation of the soil with water for long periods in the presence of organic matter. It is characterized by the presence of ferrous iron and gray colors. Gleying is associated with poorly drained soils, such as the Garwin soils. Reductive extractable iron, or free iron, is normally lower in somewhat poorly drained soils, such as Muscatine soils (*20*). Still another kind of transformation is the weathering of the primary apatite mineral present in soil parent materials to secondary phosphorous compounds.

geologic profile of Marshall County

Marshall County has a gently undulating to rolling and steep landscape. It is mainly dissected by the Iowa River and the North Skunk River. Clear Creek, the three Timber Creeks, Linn Creek and three Minerva Creeks, and the two Asher Creeks are the principal interior streams (*4*).

The broad upland areas are dominated by loess at the surface. The soils formed in loess, such as the Muscatine and Tama soils, are the most productive soils in Marshall County and in Iowa. Strongly sloping to steep soils, such as the Shelby soils, formed in glacial till and till-derived materials. These soils are on slopes that descend to the major streams. Along the bottom of the streams are complex patterns of alluvium and related areas of wind-reworked sands. In the western part of the county are Clarion soils formed in Wisconsin glacial till.

Although the unconsolidated materials dominate the present land surface, such bedrock as limestone and sandstone is exposed locally. All the bedrock material would be exposed if the unconsolidated materials were removed. However, the surface exposed would not be flat but would exhibit landforms much like the present surface. There are bedrock valleys and ridges which can affect water movement within the overlying unconsolidated materials.

Bedrock is exposed in about 21 different sections in Marshall County. In most places the natural outcrops are small. The bedrock exposed in Marshall County is primarily of Mississippian and Pennsylvanian age (*7*). The general rock types are mostly dolomite and sandstone. The dolomite is quarried and provides stone for aggregate, road surfacing, and agstone. Some coal measure shales are exposed by Honey Creek.

Information collected during the drilling of wells and test holes is available for over 180 wells in Marshall County (*6*). Detailed information is available for many of those wells. Some of these wells are drilled into rocks that are aquifers. Three distinct levels of rocks that are aquifers occur in Marshall County (*5*).

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
51----------------- Vesser	0-17	Silt loam----------	CL	A-6	0	100	100	98-100	95-100	30-40	10-20
	17-28	Silt loam----------	CL	A-6	0	100	100	98-100	95-100	30-40	10-20
	28-60	Silty clay loam	CL, CH	A-7	0	100	100	98-100	95-100	40-55	20-30
54----------------- Zook	0-18	Silty clay loam	CH, CL	A-7	0	100	100	95-100	95-100	45-65	20-35
	18-60	Silty clay, silty clay loam.	CH	A-7	0	100	100	95-100	95-100	60-85	35-55
55----------------- Nicollet	0-20	Loam---------------	CL, ML, CL	A-6, A-7	0	95-100	95-100	85-98	55-85	35-50	10-25
	20-33	Clay loam, loam	CL	A-6, A-7	0-5	95-100	95-100	80-95	55-80	35-50	15-25
	33-60	Loam---------------	CL, ML	A-6, A-4	0-5	95-100	90-100	75-90	50-75	30-40	5-15
62D2--------------- Storden	0-8	Loam---------------	ML, CL	A-4, A-6	0-5	95-100	95-100	70-85	55-70	30-40	5-15
	8-60	Loam---------------	CL-ML, CL	A-4, A-6	0-5	95-100	85-97	70-85	55-70	20-40	5-15
63C, 63E----------- Chelsea	0-8	Loamy fine sand	SM, SP-SM	A-2-4	0	100	100	65-80	10-35	---	NP
	8-60	Fine sand, sand, loamy sand.	SP, SM, SP-SM	A-3, A-2-4	0	100	100	65-80	3-15	---	NP
65F, 65G----------- Lindley	0-7	Loam---------------	CL-ML, CL	A-4, A-6	0	95-100	90-100	85-95	50-65	15-30	5-15
	7-50	Clay loam, loam	CL	A-6, A-7	0	95-100	90-100	85-95	55-75	30-45	15-25
	50-60	Loam, clay loam	CL	A-6	0	95-100	90-100	85-95	50-70	30-40	15-25
88----------------- Nevin	0-24	Silty clay loam	CL, CH	A-6, A-7	0	100	100	100	90-95	35-45	10-20
	24-47	Silty clay loam	CL	A-7	0	100	100	95-100	90-95	40-50	20-30
	47-60	Silty clay loam, silt loam.	CL	A-7	0	100	100	95-100	90-95	40-50	20-30
93D2*, 93E2*: Shelby------------	0-7	Loam---------------	CL	A-6	0	95-100	85-95	75-90	55-70	30-40	10-20
	7-45	Clay loam----------	CL	A-6, A-7	0-5	90-95	85-95	75-90	55-70	30-45	15-25
	45-60	Clay loam----------	CL	A-6, A-7	0-5	90-95	85-95	75-90	55-70	30-45	15-25
Adair--------------	0-6	Clay loam----------	CL	A-6	0	95-100	80-95	75-90	60-80	30-40	10-20
	6-60	Silty clay, clay, clay loam.	CL, CH	A-7	0	95-100	80-95	70-90	55-80	40-55	20-30
95----------------- Harps	0-18	Loam, clay loam	CL, CH	A-6, A-7	0-5	100	95-100	80-90	65-80	30-55	15-35
	18-43	Loam, clay loam, sandy clay loam.	CL, CH	A-6, A-7	0-5	95-100	95-100	80-90	65-80	30-60	15-35
	43-60	Loam---------------	CL	A-6	0-5	95-100	90-100	70-80	50-75	25-40	10-25
107---------------- Webster	0-20	Silty clay loam	CL, CH	A-7, A-6	0-5	100	95-100	85-95	70-90	35-60	15-30
	20-39	Clay loam, silty clay loam, loam.	CL	A-6, A-7	0-5	95-100	95-100	85-95	60-80	35-50	15-30
	39-60	Loam, sandy loam, clay loam.	CL	A-6	0-5	95-100	90-100	75-85	50-75	30-40	10-20
118---------------- Garwin	0-17	Silty clay loam	CL, CH	A-7	0	100	100	100	95-100	45-55	20-30
	17-60	Silty clay loam	CH, CL	A-7	0	100	100	100	95-100	45-55	25-35
119---------------- Muscatine	0-19	Silty clay loam	CL	A-7	0	100	100	100	95-100	40-50	15-25
	19-60	Silty clay loam	CL	A-7	0	100	100	100	95-100	40-50	20-30
120, 120B, 120C, 120C2, 120D2, 120E2----------- Tama	0-16	Silty clay loam	ML	A-6, A-7	0	100	100	100	95-100	35-50	10-20
	16-47	Silty clay loam	CL	A-7	0	100	100	100	95-100	40-50	15-25
	47-60	Silty clay loam, silt loam.	CL	A-6, A-7	0	100	100	100	95-100	35-45	15-25
122---------------- Sperry	0-22	Silt loam----------	CL	A-6	0	100	100	100	95-100	30-40	10-20
	22-37	Silty clay loam, silty clay.	CH	A-7	0	100	100	100	95-100	50-65	25-35
	37-60	Silty clay loam, silt loam.	CL	A-7	0	100	100	100	95-100	40-50	20-30
133---------------- Colo	0-11	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	40-60	15-30
	11-60	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	40-55	20-30

See footnote at end of table.

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
								K	T		
	In	Pct	G/cm³	In/hr	In/in	pH					Pct
54 Zook	0-18	32-38	1.30-1.35	0.2-0.6	0.21-0.23	5.6-7.3	High	0.28	5	7	5-7
	18-60	36-45	1.30-1.45	0.06-0.2	0.11-0.13	5.6-7.8	High	0.28			
55 Nicollet	0-20	24-35	1.15-1.25	0.6-2.0	0.17-0.22	5.6-7.3	Moderate	0.24	5	6	5-6
	20-33	24-35	1.25-1.35	0.6-2.0	0.15-0.19	5.6-7.8	Moderate	0.32			
	33-60	22-28	1.35-1.45	0.6-2.0	0.14-0.19	7.4-7.8	Low	0.32			
62D2 Storden	0-8	18-27	1.35-1.45	0.6-2.0	0.20-0.22	7.4-8.4	Low	0.28	5	4L	.5-2
	8-60	18-27	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	Low	0.37			
63C, 63E Chelsea	0-8	8-15	1.50-1.55	6.0-20	0.10-0.15	5.6-7.3	Low	0.17	5	2	<.5
	8-60	5-10	1.55-1.70	6.0-20	0.06-0.08	5.1-5.5	Low	0.17			
65F, 65G Lindley	0-7	18-27	1.20-1.40	0.6-2.0	0.16-0.18	4.5-7.3	Low	0.32	5	6	.5-1
	7-50	25-35	1.50-1.75	0.2-0.6	0.14-0.18	4.5-6.5	Moderate	0.32			
	50-60	18-37	1.75-1.85	0.2-0.6	0.12-0.16	6.1-7.8	Moderate	0.32			
88 Nevin	0-24	26-29	1.30-1.35	0.6-2.0	0.21-0.23	5.6-7.3	Moderate	0.32	5	7	4-6
	24-47	30-35	1.30-1.40	0.6-2.0	0.18-0.20	6.1-6.5	Moderate	0.43			
	47-60	25-36	1.40-1.45	0.6-2.0	0.18-0.20	6.6-7.3	Moderate	0.43			
93D2*, 93E2*: Shelby	0-7	24-27	1.50-1.55	0.6-2.0	0.20-0.22	5.6-7.3	Moderate	0.28	5	6	.5-2
	7-45	30-35	1.55-1.75	0.2-0.6	0.16-0.18	5.6-7.8	Moderate	0.28			
	45-60	30-35	1.75-1.85	0.2-0.6	0.16-0.18	6.6-8.4	Moderate	0.37			
Adair	0-6	27-35	1.45-1.50	0.2-0.6	0.17-0.19	5.6-7.3	Moderate	0.32	2	6	1-3
	6-60	38-50	1.50-1.60	0.06-0.2	0.13-0.16	5.1-6.5	High	0.32			
95 Harps	0-18	25-35	1.35-1.40	0.6-2.0	0.19-0.21	7.9-8.4	Moderate	0.24	5	4L	4-6
	18-43	18-32	1.40-1.50	0.6-2.0	0.17-0.19	7.9-8.4	Moderate	0.32			
	43-60	20-26	1.50-1.70	0.6-2.0	0.17-0.19	7.9-8.4	Moderate	0.32			
107 Webster	0-20	26-36	1.35-1.40	0.6-2.0	0.19-0.21	6.6-7.3	Moderate	0.24	5	6	6-7
	20-39	25-35	1.40-1.50	0.6-2.0	0.16-0.18	6.6-7.8	Moderate	0.32			
	39-60	18-29	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	Moderate	0.32			
118 Garwin	0-17	30-35	1.30-1.35	0.6-2.0	0.21-0.23	5.6-7.3	High	0.28	5	7	6-7
	17-60	28-34	1.28-1.35	0.6-2.0	0.18-0.20	6.1-7.3	High	0.28			
119 Muscatine	0-19	28-30	1.30-1.35	0.6-2.0	0.22-0.24	5.1-7.3	Moderate	0.28	5	6	5-6
	19-60	30-34	1.28-1.35	0.6-2.0	0.18-0.20	5.1-7.3	Moderate	0.43			
120, 120B, 120C, 120C2, 120D2, 120E2 Tama	0-16	24-29	1.25-1.30	0.6-2.0	0.22-0.24	5.1-7.3	Moderate	0.32	5	7	1-5
	16-47	28-34	1.30-1.35	0.6-2.0	0.18-0.20	5.1-6.0	Moderate	0.43			
	47-60	22-28	1.35-1.40	0.6-2.0	0.18-0.20	5.6-7.3	Moderate	0.43			
122 Sperry	0-22	18-22	1.35-1.40	0.6-2.0	0.22-0.24	5.6-7.3	Moderate	0.28	5	6	3-4
	22-37	38-45	1.40-1.45	0.06-0.2	0.14-0.16	5.1-6.5	High	0.43			
	37-60	26-34	1.45-1.50	0.2-0.6	0.19-0.21	5.6-6.5	High	0.43			
133 Colo	0-11	27-32	1.28-1.32	0.6-2.0	0.21-0.23	5.6-7.3	High	0.28	5	7	5-7
	11-60	30-35	1.25-1.35	0.6-2.0	0.18-0.20	6.1-7.3	High	0.28			
133+ Colo	0-11	20-26	1.25-1.30	0.6-2.0	0.22-0.24	6.6-7.3	Moderate	0.28	5	6	3-5
	11-60	30-35	1.25-1.35	0.6-2.0	0.18-0.20	6.1-7.3	High	0.28			
133B Colo	0-11	27-32	1.28-1.32	0.6-2.0	0.21-0.23	5.6-7.3	High	0.28	5	7	5-7
	11-60	30-35	1.25-1.35	0.6-2.0	0.18-0.20	6.1-7.3	High	0.28			
135 Coland	0-40	27-35	1.40-1.50	0.6-2.0	0.20-0.22	6.1-7.3	High	0.28	5	7	5-7
	40-60	27-35	1.40-1.50	0.6-2.0	0.20-0.22	6.1-7.3	High	0.28			

See footnote at end of table.

Attachment B

Main Ash Pond Stability Analyses Results

Ten Most Critical Surfaces

Sutherland Generating Station

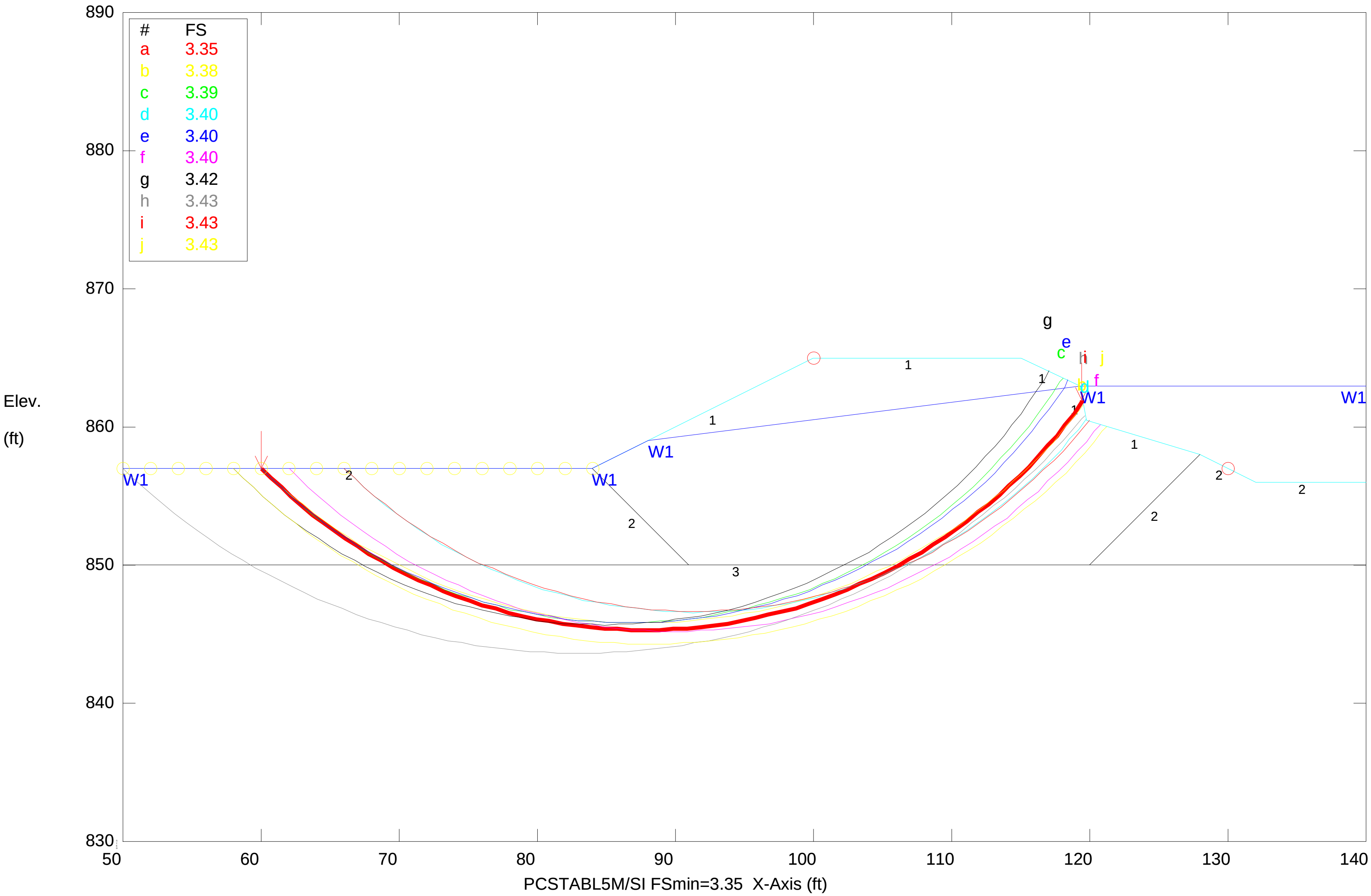
Source:

Program psSTABL5m/SI output by Aether dbs, July 2012

CONFIDENTIAL BUSINESS INFORMATION

Alliant Energy - Marshalltown, Iowa Static Case - Total Stress Analysis

Ten Most Critical. C:MARSH42.PLT By: TCW 06-26-12 1:59pm

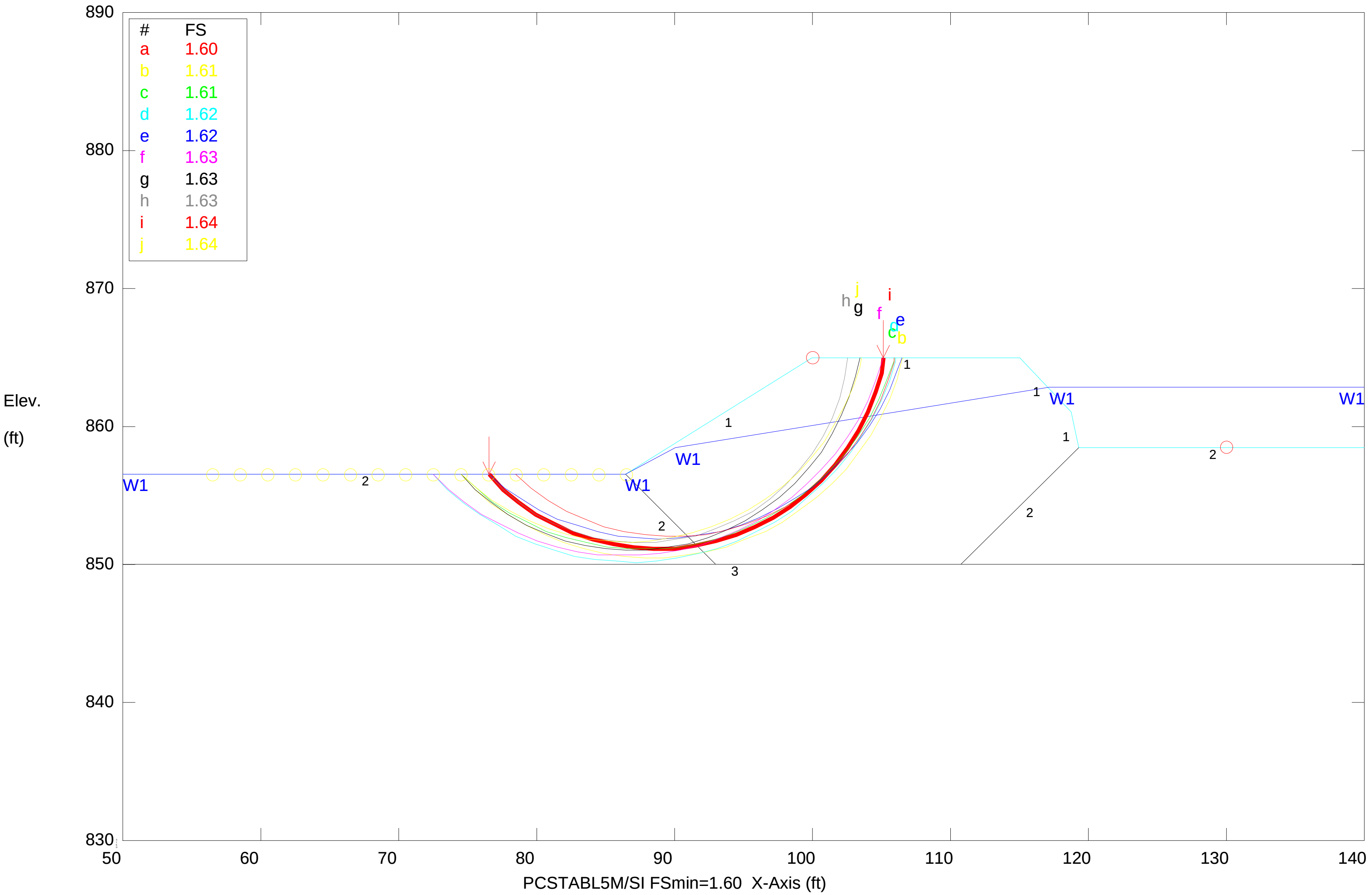


Soil Type No.	Label	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	Dike	120	120	1000	0	0	0	W1
2	NC Clay	100	110	250	0	0	0	W1
3	Sand	120	120	0	28	0	0	W1

CONFIDENTIAL BUSINESS INFORMATION

Alliant Energy - Marshalltown, Iowa Static Case - Effective Stress

Ten Most Critical. C:MARSH31.PLT By: TCW 06-25-12 10:07am



Soil Type No.	Label	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	Dike	120	120	240	19	0	0	W1
2	NC Clay	100	110	0	24	0	0	W1
3	Sand	120	120	0	28	0	0	W1

Attachment C

Curriculum Vita

Mr. Timothy J. Harrington, P.E.

Mr. Thomas C. Wells, P.E.

Aether DBS

TIMOTHY HARRINGTON, P.E.

Principal

PROFESSIONAL ENGINEERING LICENSES

New Jersey, 1985 (GE 30238); Delaware, 1987 (7145); New York, 1986 (62728-1); Pennsylvania, 1979 (28505-E); Michigan, 1980 (27309); Indiana, 1981 (19646); Illinois, 1984 (062-041983); California, 1983 (35743); Georgia, 1984 (14874); Florida, 1982 (31484); Wisconsin 2003 (36243)

QUALIFICATIONS

Mr. Harrington has 37 years in the application of engineering solutions to the management and completion of projects involving many geotechnical, and environmental remediation components, specializing in soil and sediment remediation. He has:

- Managed Large Remediation Projects from design through construction
- Managed complex Superfund projects with intertwined design, regulatory and construction issues
- Negotiated for single and multiple PRP groups to receive agency approval of remedial actions
- Negotiate for single and multiple PRP groups to drive completion of construction remediation
- Developed innovative solutions that satisfy agency objectives and reach owner goals for the project
- Recognized as an expert on contaminate sediment and soil remediation in several USEPA regions
- Consulted on the recovery of fly ash from the Emory River in Kingston, Tennessee

Geotechnical Engineering Experience:

Mr. Harrington has consulted on the design and construction of systems to control slope stability and liquefaction of loose soils.

- Consultant on the means and methods of recovering 2.5 million cubic yards of fly ash from the Emory River near Kingston Tennessee.
- Personal observation of the fly ash impoundment failure at Kingston shortly after the failure and before the start of remedial action.
- Stability analysis and design for facilities in dune sand around Lake Michigan to maintain excavations.
- Stability analysis of Uranium Tailings ponds constructed by hydraulic placemnt methods in New Mexico.
- Design of systems to stabilize Uranium Tailings ponds by controlling seepage on the embankment face.
- Design of methods to remediate loose soil to control liquefaction by compaction and/or drainage methods.

- Liquefaction testing of soils by both laboratory and field methods.

EXPERIENCE

Principal and Senior Environmental Engineer, aether DBS., Naperville , IL

Mr. Harrington's firm was acquired in January of 2006 by Hard Hat Services (now aether DBS). Both firms coming together increased respectively each others' capabilities as well as offered additional services to their clients. Mr. Harrington manages major environmental remediation efforts and solutions as well as being responsible for the Chesterton, Indiana office. His expertise is in soils, sediment and marine environments.

President, Harrington Engineering & Construction, Inc., Chesterton, IN

Mr. Harrington was owner and provider of engineering and construction management services on domestic and international projects. Projects include design and construction management for the rebuilding of intake structures in Lake Michigan, removal and processing of sediment containing lead shot to restore beneficial reuse of a critical ocean shore environment, design of an upland landfill to contain sediment from the Fox River in Green Bay, Wisconsin, design of an in-water landfill in Auckland, New Zealand to contain low solids content sediment, and services on numerous facilities to construct or repair dock walls and marinas, resolve drainage problems and repair unstable slopes.

Canonie Environmental Services Corporation, Chesterton, IN

As vice president of the construction services division, Mr. Harrington was responsible for the direction of operations in the eastern USA. Projects included the construction of an upland disposal facility at the 102nd street site in Tonowanda, New York and the excavation of sediment from the St. Lawrence River, soil thermal treatment on high plasticity clay in Memphis, Tennessee, and site restoration including the removal of lime sludge and riverbank restoration in western Pennsylvania.

Rust Remedial Services Inc., Chicago, IL

Mr. Harrington served as Vice President and General Manager responsible for the operations of the Northern Region and the Thermal Operations groups. He managed work under contract totaling approximately $400,000,000 and including numerous jobs where sediment remediation was a part of the total remedy including the Brio site in Houston, Texas, the construction of landfills in New York and Massachusetts, and removal of solidified sludge from two 20-acre basins in Southern New Jersey.

Canonie Environmental Services Corporation, Chesterton, IN

Mr. Harrington served as vice president of eastern operations responsible for design and construction projects, project manager, and project engineer for design and construction field engineering. Work included the design and construction of in-water and upland landfill's at Waukegan Harbor, Illinois, design and construction of a cap and slope protection for remnant sediments in the Hudson River, work on landfills caps in New Jersey and Indiana, and numerous projects working as a geotechnical engineering consultant on failure investigations.

D'Appolonia Consulting Engineers, Inc., Pittsburgh, PA
Mr. Harrington worked as a project engineer on projects to build power plants, on the investigation and design of mine tailing impoundments for uranium tailings in New Mexico, on design of underground mine works for the waste isolation pilot plant in New Mexico, and on several projects for water supply and dewatering of aquifer formations.

EDUCATION

Michigan State University – Masters of Science in Civil Engineering (Geotechnical and Structural Engineering Specialty)
Michigan State University – Bachelor of Science in Civil Engineering

CERTIFICATIONS

- 40-Hour OSHA HAZWOPER Training
- 8-Hour Refresher for 40-Hour Hazardous Training
- Certificates for Continuing Education from ACI, AISI, SJI and others for Renewal of Professional Licensing

PROFESSIONAL ACTIVITIES

American Society of Civil Engineers
American Concrete Institute

THOMAS CHARLES WELLS, P.E.

Senior Project Engineer

PROFESSIONAL ENGINEERING LICENSE

Michigan, 1991 (6201036924)

QUALIFICATIONS

Mr. Wells has over 35 years of geoenvironmental engineering and database management / programming experience. As a senior engineer for Aether DBS, Mr. Wells has supplied both office and field based engineering and information technology support services.

As a Professional Engineer, Mr. Wells has considerable experience in the key areas of geotechnical, environmental, hydrology, hydraulic, and foundation engineering. He has continued to practice in these areas as a part of his engineering/database focus.

Geotechnical Engineering Experience:
Mr. Wells has contributed to many heavy construction projects involving industrial facilities and environmental remediation. Geotechnical engineering related projects / tasks have included:

- Performed stability analyses for 8 miles of I-74 in Dearborn County, Indiana following a major interstate highway embankment failure. The stability investigation led to the design of a corrective berm on a similar nearby side-hill highway embankment.
- Performed stability analyses for a riparian fill design following the foundation soil failure of approximately 800 feet of ore yard at Sparrows Point, Maryland.
- Analyzed the extreme settlement (3-4 feet) of Chemical Storage Tanks in Paulsboro, New Jersey.
- Investigated and analyzed a slope stability failure along the St. Joseph River in Michigan.
- Analyzed a slope stability failure along the Grand Calumet River in Gary, Indiana and designed a corrective slope.
- Development and improvement of a 1-D finite-difference numerical model to simulate large-strain soil/sediment consolidation for use in predicting the large settlements that occur in hydraulically placed sediment.

EXPERIENCE

<u>WELLS Technical Services, Chesterton / Union Mills, IN</u>
As a sole Proprietor serving primarily Aether DBS (formerly Harrington Engineering & Construction), Envirocon, Inc. and Locus Technologies, Mr. Wells supplies engineering and information technology support services on a project-by-project basis. Aether DBS specializes in Sediment Restoration Services, Marine Design, Environmental Engineering, and Site Remediation. Envirocon is a full-service environmental remediation, demolition and civil construction contractor. Locus Technologies is an engineering and construction management firm based in northern California and serving primarily the environmental market. Locus Technologies is the leader in on-demand world-wide-web based Environmental Data Management Software, Services and Solutions.

Harding Lawson Associates, Chicago, IL

As an associate engineer in the Chicago office, Mr. Wells contributed to multiple projects and systems including HLADBMS (the Harding Lawson Associates DataBase Management System). HLADBMS was used to manage site characterization data generated by environmental projects. Mr. Wells also served as the North Carolina Low Level Radioactive Waste Facility feasibility project database administrator in Raleigh, NC during the project start-up phase November 1996 through March 1997.

Canonie Environmental Services Corporation

Mr. Wells served as a Technical Manager / Staff Consultant where he provided engineering and information technology support to both the technical and administrative staffs. Mr. Wells also acted as the drafting supervisor and network administrator at times (while performing his other roles). Geotechnical and Environmental project work included ground water & hydraulic modeling, geotechnical analysis & foundation design and geoenvironmental data management.

Environmental construction management tasks included the development of a construction equipment cost management system and the development of a companywide environmental construction cost estimating system used to estimate project costs totaling millions of dollars.

D'Appolonia Consulting Engineers, Inc., Pittsburgh, PA

Mr. Wells acted as the Computer department's liaison with the technical staff, supported project usage of the PRIME® super-minicomputers, and Mr. Wells also assisted with ground water modeling projects. During his first project assignment beyond graduate school, Mr. Wells authored a flood-routing program for a probable maximum flood study. During this period as a staff engineer, Mr. Wells performed pile driving, slope stability, and foundation analyses. He designed foundations, waste embankments, earthen dams, drainage channels, and spillways.

EDUCATION

Penn State University – Certificate in Geographic Information Systems
Michigan State University – Masters of Science in Civil Engineering (Geotechnical and Hydraulics / Hydrology Engineering Specialty)
Michigan State University – Bachelor of Science in Civil Engineering

CERTIFICATIONS

- 40-Hour OSHA HAZWOPER Training
- 8-Hour Refresher for 40-Hour Hazardous Training
- Certificates for Continuing Education from ASTM, Purdue University and others

PROFESSIONAL ACTIVITIES

American Society of Civil Engineers