FINAL

Coal Combustion Waste Impoundment
Round 7- Dike Assessment Report

Lawrence Energy Center

Ash Impoundment Dike
Westar Energy
Lawrence, Kansas

Prepared for:

United States Environmental Protection Agency
Office of Resource Conservation and Recovery

Prepared by:

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Fairfax, Virginia

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INTRODUCTION, SUMMARY CONCLUSIONS AND RECOMMENDATIONS

The release of over five million cubic yards from the Tennessee Valley Authority's Kingston, Tennessee facility in December 2008, which flooded more than 300 acres of land, damaging homes and property has led USEPA to consider how to best manage coal combustion waste disposal units. A first step is to assess the stability and functionality of ash impoundments and other units across the country, and take any needed corrective measures.

This assessment of the stability and functionality of the Lawrence Energy Center Ash Dike management unit is based on a review of available documents and on the site assessment conducted by Dewberry personnel on Thursday, September 24, 2010. We found the supporting technical documentation adequate (Section 1.1.3). As detailed in Section 1.2.5 and 1.2.7, there are two recommendations based on field observations that may help to maintain a safe and trouble-free operation,

In summary, the Lawrence Energy Center Ash Impoundment is **SATISFACTORY** for continued safe and reliable operation, with no recognized existing or potential management unit safety deficiencies.

PURPOSE AND SCOPE

The U.S. Environmental Protection Agency (EPA) is embarking on an initiative to investigate the potential for catastrophic failure of Coal Combustion Surface Impoundments (i.e., management unit) from occurring at electric utilities in an effort to protect lives and property from the consequences of a dam failure or the improper release of impounded slurry. The EPA initiative is intended to identify conditions that may adversely affect the structural stability and functionality of a management unit and its appurtenant structures (if present); to note the extent of deterioration (if present), status of maintenance and/or a need for immediate repair; to evaluate conformity with current design and construction practices; and to determine the hazard potential classification for units not currently classified by the management unit owner or by a state or federal agency. The initiative will address management units that are classified as having a Less-than-Low, Low, Significant or High Hazard Potential ranking. (For Classification, see pp. 3-8 of the 2004 Federal Guidelines for Dam Safety).

In early 2009, the EPA sent its first wave of letters to coal-fired electric utilities seeking information on the safety of surface impoundments and similar facilities that receive liquid-borne material that store or dispose of coal combustion waste. This letter was issued under the authority of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 104(e), to assist the Agency in assessing the structural stability and functionality of such management units, including which facilities should be visited to perform a safety assessment of the berms, dikes, and dams used in the construction of these impoundments.

EPA requested that utility companies identify all management units including surface impoundments or similar diked or bermed management units or management units designated as landfills that receive liquid-borne material used for the storage or disposal of residuals or by-products from the combustion of coal, including, but not limited to, fly ash, bottom ash, boiler slag, or flue gas emission control residuals. Utility companies provided information on the size, design, age and the amount of material placed in the units. The EPA used the information received from the utilities to determine preliminarily which management units had or potentially could have High Hazard Potential ranking.

The purpose of this report is to evaluate the condition and potential of waste release from management units for hazard potential classification. This evaluation included a site visit. Prior to conducting the site visit, a two-person team reviewed the information submitted to EPA, reviewed any relevant publicly available information from state or federal agencies regarding the unit hazard potential classification (if any) and accepted information provided via telephone communication with the management unit owner.

Factors considered in determining the hazard potential classification of the management units(s) included the age and size of the impoundment, the quantity of coal combustion residuals or by-products that were stored or disposed of in these impoundments, its past operating history, and its geographic location relative to down gradient population centers and/or sensitive environmental systems.

This report presents the opinion of the assessment team as to the potential of catastrophic failure and reports on the condition of the management unit(s).

LIMITATIONS

The assessment of dam safety reported herein is based on field observations and review of readily available information provided by the owner/operator of the subject coal combustion waste management unit(s). Qualified Dewberry engineering personnel performed the field observations and review and made the assessment in conformance with the required scope of work and in accordance with reasonable and acceptable engineering practices. No other warranty, either written or implied, is made with regard to our assessment of dam safety.

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1.0 CONCLUSIONS AND RECOMMENDATIONS

1.1 CONCLUSIONS

Conclusions are based on visual observations from a one-day site visit and review of technical documentation provided by Westar Energy.

1.1.1 Conclusions Regarding the Structural Soundness of the Management Unit(s)

The dike embankments appear to be structurally sound based on a review of the engineering data provided by the owner’s technical staff and Dewberry engineers’ observations during the site visit.

1.1.2 Conclusions Regarding the Hydrologic/Hydraulic Safety of the Management Unit(s)

Hydrologic and hydraulic data provided to Dewberry for review indicate adequate impoundment capacity to contain the 1 percent probability design storm without overtopping the dikes.

1.1.3 Conclusions Regarding the Adequacy of Supporting Technical Documentation

The supporting technical documentation is adequate. Engineering documentation reviewed is referenced in Appendix A.

1.1.4 Conclusions Regarding the Description of the Management Unit(s)

The description of the management unit provided by Westar Energy was an accurate representation of what Dewberry observed in the field.

1.1.5 Conclusions Regarding the Field Observations

Dewberry staff was provided access to all areas in the vicinity of the management units required to conduct a thorough field observation. The visible parts of the dike embankments were observed to have no signs of overstress, significant settlement, shear failure, or other signs of instability, although visual observations were hampered by the presence of thick vegetation in some areas. A recommendation is included in Section 1.2.5 that could improve the ability to inspect and possibly prevent future seepage problems associated with large tree and vegetation growth on the embankments. Currently the embankments visually appear structurally sound. There are no indications of unsafe conditions or conditions needing remedial action.

1.1.6 Conclusions Regarding the Adequacy of Maintenance and Methods of Operation

The current maintenance and methods of operation appear to be adequate for the ash management unit. There was no evidence of repaired embankments or prior releases observed during the field inspection.

1.1.7 Conclusions Regarding the Adequacy of the Surveillance and Monitoring Program

The surveillance program appears to be adequate. A recommendation is included in Section 1.2.3 that could assist in ensuring the adequacy of the surveillance program. The management unit dikes are not instrumented. Based on the size of the dikes, the history of satisfactory performance and the current inspection program, installation of a dike monitoring system is not needed at this time.

1.1.8 Classification Regarding Suitability for Continued Safe and Reliable Operation

The facility is SATISFACTORY for continued safe and reliable operation. No existing or potential management unit safety deficiencies are recognized. Acceptable performance is expected under all applicable loading conditions (static, hydrologic, seismic) in accordance with the applicable criteria.

1.2 RECOMMENDATIONS

1.2.1 Recommendations Regarding the Field Observations

The large trees along the lower section of the western embankment should be removed. A vegetation control program should be instituted to control the type, amount, and height of vegetation on the outer embankment slopes. Implementation of this recommendation will prevent the creation of potential seepage paths in the embankment and allow for easier inspection of the outer slopes and toes of the embankment.

1.2.2 Recommendations Regarding the Maintenance and Methods of Operation

These recommendations should improve the safety and operation of the dike system:

- Continually repair animal burrows
- Implement the recommendation above in Section 1.2.1

1.2.3 Recommendations Regarding the Surveillance and Monitoring Program

A written program should be developed to detail a regular scheduled inspection of the dikes.

1.3 PARTICIPANTS AND ACKNOWLEDGEMENT

1.3.1 List of Participants

Craig Swartzendruber, Westar Energy
Dave Claussen, Westar Energy
David Walter, P.E., Westar Energy
Andy Rietcheck, P.E., Westar Energy
Bill Eastman, Westar Energy
Jared Morrison, Westar Energy
Jeff Culp, Westar Energy
Ed Noll, Westar Energy
Tom Morey, Kansas Dept. of Agriculture
Edward Byrd, Kansas Dept. of Agriculture—DWR
Gary Christensen, KDHE
Gib Jones, P.E., Dewberry
Frank Lockridge, P.E., Dewberry

1.3.2 Acknowledgement and Signature

We acknowledge that the management unit referenced herein has been assessed on September 24, 2010.

GILBERT RAYMOND JONES
18547
Gilbert R. Jones
Gilbert Jones, P.E. (KS#18547)

Frank Lockridge
Frank Lockridge, P.E.

2.0 DESCRIPTION OF THE COAL COMBUSTION WASTE MANAGEMENT UNIT(S)

2.1 LOCATION AND GENERAL DESCRIPTION

The Lawrence Energy Center is located in Douglas County, Kansas in the City of Lawrence. It is bounded on the Northeast by the Kansas River and the other sides by developed farmland. The plant is operated by Westar Energy.

The Center utilizes four staging areas for drying the Coal Combustion Wastes (CCW). These four areas are adjacent to the plant and shown on the project location aerial photograph provided in Figure 2.1-1. CCW flows from the plant into Area 2, then to Area 3, then to Area 4, and finally to Area 1, from which it is discharged to the Kansas River via a NPDES-permitted outlet.

As shown in the figure, a perimeter dike runs along the northeast, northwest, west and southwest edges of the CCW pond area. The southeast portion of Area 3, all of Area 2, and the eastern end of Area 1 are all at grade. The Dewberry engineers evaluated the perimeter dike as a single structure. The internal dikes are occasionally shifted to accept varying amounts of wash from the plant. An investigation was obtained from Golder Associates to assist in the safe reconstruction of the internal dikes and is included in Appendix A – Doc 03.

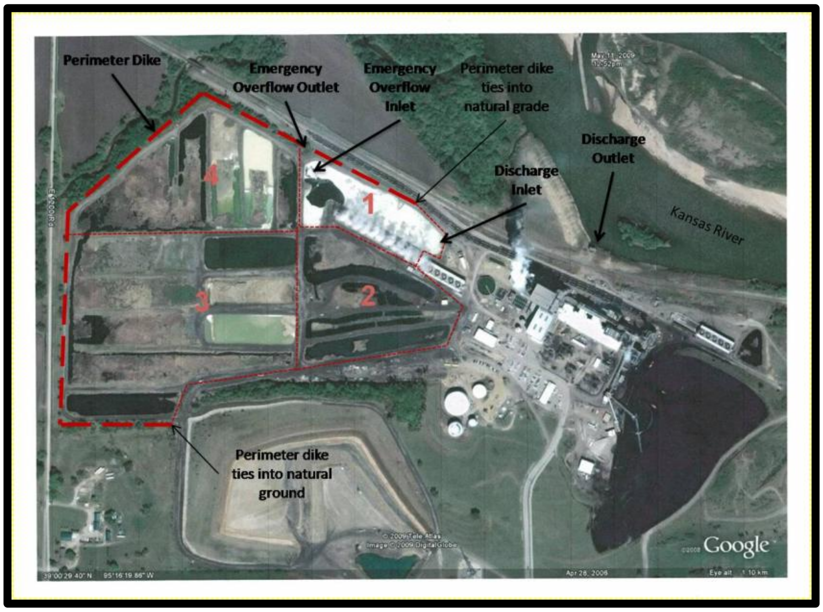

Figure 2.1–1: Configuration of Ash Ponds at Lawrence Energy Center, Lawrence, KS.

The Lawrence Energy Center Ash Dike is constructed of silty clay. This material was obtained by excavation of existing grades in the area. The first two units (Areas 1 and 2) were constructed in 1969 and Areas 3 and 4 added in 1976. The crest elevation of the perimeter dike is 839. A review of the design drawings indicates a maximum perimeter dike height of 15 feet along the northwestern section of the dike.

The impoundment area is approximately 47.4 acres and has a storage capacity of 683.5 acre-ft (See Appendix A – Doc 2). The storage in each of the cells is also listed in this document and it is noted that the actual amount of storage varies from zero to total capacity depending on plant operation.

2.2 SIZE AND HAZARD CLASSIFICATION

The classification for size, based on the height and storage capacity of the dam is “Small” in accordance with the USACE Recommended Guidelines for Safety Inspection of Dams ER 1110-2-106 criteria summarized in Table 2.2a.

Table 2.2a: USACE ER 1110-2-106 Size Classification

	Impoundment	
Category	**Storage (Ac-ft)**	**Height (ft)**
Small	?	25 and < 40
Intermediate	1,000 and < 50,000	40 and < 100
Large	> 50,000	> 100

Dams in the state are regulated by the Kansas Department of Agriculture. This dike is not in the National Inventory of Dams, therefore the dike does not have an established hazard classification. Dewberry conducted a qualitative hazard classification based on the 2004 Federal Guidelines for Dam Safety classification system (shown in Table 2.2b).

Table 2.2b: FEMA Federal Guidelines for Dam Safety Hazard Classification

	Loss of Human Life	**Economic, Environmental, Lifeline Losses**
Low	None Expected	Low and generally limited to owner
Significant	None Expected	Yes
High	Probable. One or more expected	Yes (but not necessary for classification)

Loss of human life is not probable in the event of a catastrophic failure of the perimeter dike. However, a failure of the perimeter dike could have an economic and environmental impact. Therefore, Dewberry evaluated the perimeter dike (Areas 1, 4, and 3) as **“significant hazard potential.**”

2.3 AMOUNT AND TYPE OF RESIDUALS CURRENTLY CONTAINED IN THE UNIT(S) AND MAXIMUM CAPACITY

The Westar response attached as Doc 02 in Appendix A indicates that there is no permanent storage or disposal in the units. The amount stored in each cell varies from minimal to full capacity. Materials staged in the ponds include fly ash, bottom ash, boiler slag and flue gas emission residues.

2.4 PRINCIPAL PROJECT STRUCTURES

2.4.1 Earth Embankment

The perimeter dike is an earthen embankment that merges into natural grade on the south and northeast sides. The crest width is approximately 30 feet. The perimeter of the CWW impoundment area is approximately 2000 feet, with the perimeter dike being approximately 1100 feet and the rest being at grade. The inside and outside slopes of the perimeter dike embankment were designed to be 3:1, however some areas of the northern slope were steeper. The Golder Report, Appendix A, Doc 04, indicates that some of the inner slopes are steeper than 1H to 1V.

The southern and eastern areas of the impoundment are formed by excavation of the original grade and merging the embankment into the natural grade.

2.4.2 Outlet Structures

Water is discharged from Area 1 via an underground pipe to the Kansas River, located approximately 0.1-mile to the northeast.

In addition, there is an emergency overflow structure in Area 1 that discharges into a ditch at the toe of the northeastern portion of the perimeter dike. Details of the structure are shown in Appendix A – Doc 05. The plant personnel believe the emergency overflow structure has never been used.

The impoundment has no emergency spillway.

2.5 CRITICAL INFRASTRUCTURE WITHIN FIVE MILES DOWN GRADIENT

Critical infrastructure inventory data were not provided to Dewberry for review.

Based on available area topographic maps, surface drainage in the area of the Ash Pond is to the northwest. Baldwin Creek intercepts surface runoff and carries it to the Kansas River. (Appendix A – Doc 01) Releases from the west side of the impoundment will discharge into Baldwin Creek and/or agriculture fields. Discharges from the northeastern portion of the perimeter dike will flow into Baldwin creek and/or the Kansas River. Based on available aerial photographs and a brief driving tour of the area, Dewberry did not identify any critical infrastructure assets down gradient of the Ash Pond.

3.0 SUMMARY OF RELEVANT REPORTS, PERMITS, AND INCIDENTS

Westar Lawrence Energy Center staff provided both hard copies and digital copies of the documents listed in Appendix A.

3.1 SUMMARY OF LOCAL, STATE, AND FEDERAL ENVIRONMENTAL PERMITS.

The State of Kansas Department of Agriculture regulates dams; however, the dikes at this location are not currently regulated. Discharge from the impoundment outlet is regulated by the Kansas Department of Health & Environment under a National Pollutant Discharge Elimination System Permit (Permit No. KS0079821).

Data reviewed by Dewberry did not indicate any spills, unpermitted release, or other performance-related problems with the dam over the last 10 years.

4.0 SUMMARY OF HISTORY OF CONSTRUCTION AND OPERATION

4.1 SUMMARY OF CONSTRUCTION HISTORY

4.1.1 Original Construction

The first two areas (Areas 1 and 2) of the impoundment were constructed beginning in 1969 and the last two (Areas 3 and 4) were completed in 1976. The original design crest elevation was 839 feet (See Appendix A – Doc 06).

4.1.2 Significant Changes/Modifications in Design since Original Construction

Since the addition of Areas 3 and 4, the plant effluent wash moves through Area 2 to parts of Area 3, then through Area 4 and finally to Area 1. The cells within Areas 3 and 4 routinely undergo clean-out and are occasionally reconfigured depending on plant demand. At the time of the site visit, clean-out and reconstruction were taking place in Area 3, and an 18” clay liner was being placed over the bottom and inner slopes.

4.1.3 Significant Repairs/Rehabilitation since Original Construction

No information was provided regarding major repairs or rehabilitation. No evidence of prior releases, failures, or patchwork was observed on the earthen embankment during the visual site assessment and no documents or statements were provided to the dam assessors that indicate that prior releases or failures have occurred.

4.2 SUMMARY OF OPERATIONAL PROCEDURES

4.2.1 Original Operational Procedures

The impoundment was designed and operated for CCW sedimentation and control. The pond receives plant coal combustion waste slurry and stormwater runoff from the pond embankments. Treated (via sedimentation) process water is discharged through the NDPES discharge point. An overflow outlet structure in Area 1 is present, but there is generally no overflow.

4.2.2 Significant Changes in Operational Procedures and Original Startup

No documents were provided to indicate any operational procedures have changed.

4.2.3 Current Operational Procedures

Operations are conducted the same as stated above with the exception that the plant coal combustion waste may be placed in different cells within each Area depending on availability.

4.2.4 Other Notable Events Since Original Startup

No additional information was provided to Dewberry of other notable events impacting the operation of the impoundment.

5.0 FIELD OBSERVATIONS

5.1 PROJECT OVERVIEW AND SIGNIFICANT FINDINGS

Dewberry personnel Gilbert Jones, P.E. and Frank Lockridge, P.E. performed a site visit on Thursday, September 24, 2010 in company with the participants.

The site visit began at 9:00 AM. The weather was warm and sunny. Photographs were taken of conditions observed. The Dam Inspection Checklist is provided in Appendix B. Selected photographs are included here for ease of visual reference. All pictures were taken by Dewberry personnel during the site visit.

The overall assessment of the dam was that it was in satisfactory condition and no significant findings were noted.

5.2 NORTHEASTERN PORTIONS OF PERIMETER DIKE (AREAS 1 AND 4)

5.2.1 Crest

The crest of the northeastern portion of the perimeter dike had no signs of depressions, tension cracks, or other indications of settlement or shear failure, and appeared to be in satisfactory condition. Figure 5.2.1-1 shows the condition of the crest of the northeastern portion of the perimeter dike.

Figure 5.2.1-1: Crest of Northeastern Portion of the Perimeter Dike.

5.2.2 Inside Slope

The inside dike embankments are mostly unprotected. Much of the interior embankment was substantially vegetated. Figure 5.2.2-1 shows the general condition of the inside slope of the northeastern portion of the perimeter dike (Area 1).

Figure 5.2.2-1: Inside Slope of the Northeastern Portion of the Perimeter Dike.

There were no observed scarps, sloughs or other indications of slope instability.

5.2.3 Outside Slope and Toe

The outside slope of the northeastern portion of the perimeter dike embankment is bordered by a small ditch that drains to Baldwin Creek and runs along the railroad embankment, see Figure 5.2.3-1. The outside slope is covered with various species of tall grass and other vegetation. The steepness of the slope makes access difficult. Dewberry inspectors were not able to access parts of the toe of the embankment.

Figure 5.2.3-1: Outside Slope of Northeastern Portion of Perimeter Dike (Area 1).

The emergency overflow outlet discharges at the base of the northeastern slope of the perimeter dike. The heavy vegetation made access to this area impossible, see Figure 5.2.3-2.

Figure 5.2.3-2: Vegetative Growth in the Area of the Overflow Outlet.

5.2.4 Abutments and Groin Areas

The perimeter dike is continuous therefore there are no abutments. Descriptions of groin areas are included in the description of the perimeter dike crest and slopes.

5.3 NORTHWESTERN AND WESTERN PORTIONS OF PERIMETER DIKE (AREAS 4 AND 3)

5.3.1 Crest

The crest of the northwest and west portions of the perimeter dike had no signs of any depressions, tension cracks, or other indications of settlement or shear failure, and appeared to be in satisfactory condition.

5.3.2 Upstream/Inside Slope

The inside slope of the western portion of the perimeter dike revealed varying amounts of exposed earth embankment depending on the amount of sediment or plant wash contained in them. Similar to most areas, substantial vegetation was observed on the interior of the perimeter dike in Area 4, see Figure 5.3.2-1.

Figure 5.3.2-1: Inside Slope of Northwest Portion of Perimeter Dike (Area 4).

At the time of the site visit, Area 3 was drained and the ash was being removed. A clay liner was being installed and the slope was being restored to 3:1, see Figure 5.3.2-2.

Figure 5.3.2-2: Inside Slope of Western Portion of Perimeter Dike (Area 3).

5.3.3 Outside Slope and Toe

Figure 5.3.3-1 shows the general condition of the outside slope. The outside slope of the northwestern and western portions of the perimeter dike is heavily vegetated, including some large trees in the lower portion and toe areas, see Figure 5.3.3-2. The northwestern portion of the perimeter dike is bordered by Baldwin Creek and a dirt road, which appeared to be seldom-used based upon the vegetation growing in the roadway, see Figure 5.3.3-3. There were no observed scarps, sloughs, bulging, cracks, or depressions or other indications of slope instability or signs of erosion.

Figure 5.3.3-1: Typical Condition of Outside Slope of Western Portion of Perimeter Dike.

Figure 5.3.3-2: Trees on Outside of Western Portion of Perimeter Dike.

Figure 5.3.3-2: Agricultural Land to West of the Ash Ponds.

5.3.4 Abutments and Groin Areas

The perimeter dike is continuous therefore there are no abutments on the northwestern or western side.

5.4 SOUTHERN PORTION OF PERIMETER DIKE (AREA 3)

5.4.1 Crest

The crest of the southern portion of the perimeter dike had no signs of depressions, tension cracks, or other indications of settlement or shear failure, and appeared to be in satisfactory condition. This is the section of the impoundment that merges into natural terrain. It currently is bordered by a laydown yard, storm water pond, and solid waste disposal area to the south.

5.4.2 Inside Slope

There were no observed scarps, sloughs, bulging, cracks, or depressions or other indications of slope instability or signs of erosion. Figure 5.4.1-1 above shows the general condition of the inside slope of the southern portion of the perimeter dike.

Figure 5.4.1-1: Looking East Across Storm Water Pond on South Side of Ash Pond Area (Southern Edge of Area 3). Closed landfill is seen in background.

5.4.3 Outside Slope and Toe

The south side of Area 3 is bordered by a storm water pond, which is contained within the perimeter dike, see Figure 5.4.3-1.

Figure 5.4.3-1: Outside of the Stormwater Pond Embankment on South Side.

A shallow ditch connecting Areas 2 and 3 is immediately adjacent to the southern portion of Area 2 of the ash pond area, see Figure 5.4.3-2. The banks of the ditch are at natural grade.

Figure 5.4.3-2: Ditch Connecting Areas 2 and 3.

5.4.4 Abutments and Groin Areas

The east end of the southern portion of the perimeter dike, along the south edge of the storm water pond, ties into a road embankment, see Figure 5.4.4-1.

Figure 5.4.4-1: Tie-in of southern portion of perimeter dike to road embankment.

5.5 OUTLET STRUCTURES

5.5.1 Overflow Structure

The plant personnel believe the overflow structure in Area 1 has never been used. It visibly appears to be in working condition; however, we were not able to access the discharge outlet, see Figure 5.5.1-1.

Figure 5.5.1-1: Overflow Outlet Structure (Area 1).

5.5.2 Outlet Conduit

Water from Area 1 is discharged via a pipe in the northeast corner of Area 1 to the Kansas River (Figure 5.5.2-1).

Figure 5.5.2-1: Inlet end of the Area 1 Outlet Structure that leads to the Kansas River.

5.5.3 Emergency Spillway

No emergency spillway is present.

5.5.4 Low Level Outlet

No low level outlet is present.

6.0 HYDROLOGIC/HYDRAULIC SAFETY

6.1 SUPPORTING TECHNICAL DOCUMENTATION

6.1.1 Flood of Record

No documentation has been provided about the flood of record.

6.1.2 Inflow Design Flood

No documentation has been provided about the inflow design. Note that the stormwater flow into the ash pond system in minimal; nearly all stormwater on the plant is directed to a separate storm water pond and/or drains.

6.1.3 Downstream Flood Analysis

No downstream flood analysis data were provided for review

6.2 ADEQUACY OF SUPPORTING TECHNICAL DOCUMENTATION

Supporting hydrologic documentation is inadequate.

6.3 ASSESSMENT OF HYDROLOGIC/HYDRAULIC SAFETY

Stormwater flow into the ash pond system is minimal based upon a review of available topographic information, site plans, and field observations. Nearly all stormwater on the plant is directed to a separate storm water pond and/or drains. Therefore dike failure by overtopping seems improbable.

7.0 STRUCTURAL STABILITY

7.1 SUPPORTING TECHNICAL DOCUMENTATION

7.1.1 Stability Analyses and Load Cases Analyzed

After responding to the 2009 EPA Request for Information in preparation for this site visit, Westar Energy commissioned an evaluation of the ash pond berm stability. This study was performed by Golder Associates in December 2009 and is attached in Appendix A – Doc 04. Field sampling and laboratory testing were performed on samples obtained from four soil test borings performed on the perimeter dike along the north and western boundaries of the impoundment. Ground water was not encountered in any of the borings.

Stability analyses were run on two cross sections of the berm believed to represent the typical construction of the berm. An analysis was performed for two conditions:

- Static conditions based on assumed CCW and water levels shown in the report.
- Seismic loading applied to steady state loading. A horizontal acceleration of 0.05 g was used for seismic loading

Based on the results of the analyses it was concluded that the embankments have stability safety factors at or above the minimum recommended values.

7.1.2 Design Parameters and Parameters of Materials

The documentation indicated the stability analyses assumed three material strata. The stratigraphy of the berms consisted of 1-5 feet of asphalt and bottom ash road base underlain by layers of low plastic clay and with higher plastic clay in the lower parts of the berm. The material properties used for the primary stability analyses are shown in Table 7.1.2.

Table 7.1.2: Engineering Properties

Material	Unit Weight	Friction Angle	Cohesion
CCW	85 pcf	No strength	
Clay (PI=39)	116 pcf	26	260 psf
Clay (PI=50)	116 pcf	28	410 psf

7.1.3 Uplift and/or Phreatic Surface Assumptions

The phreatic surface assumed a straight line between the upstream edge of the berm crest and the static groundwater level at the borehole location.

7.1.4 Factors of Safety and Base Stresses

The safety factors computed in the Slope Stability Analysis report (See Appendix A - Doc 04) are listed in Table 7.1.4.

Table 7.1.4: Stability Analysis Results

Cross Section	Computed Factor of Safety	Minimum Factor of Safety
Sect. 1-Static	3.0	1.5
Sect. 1-Seismic	2.7	1.1
Sect. 2-Static	3.1	1.5
Sect. 2-Seismic	2.5	1.1

The slope stability analyses indicate that the calculated safety factors against slope failures are greater than the recommended minimum values.

7.1.5 Liquefaction Potential

The documentation reviewed by Dewberry did not include an evaluation of liquefaction potential. Foundation soil conditions do not appear to be susceptible to liquefaction.

7.1.6 Critical Geological Conditions

Surficial geologic deposits are sedimentary alluvial and low terrace deposits consisting of firm to stiff silty clays and/or clayey silts.

In the stability analyses (See Appendix A-Doc 04) a peak ground acceleration of 0.05g was used for seismic loading. This corresponds to a 2% probability of exceedance in 50 years in accordance with the current USGS Seismic Risk Map of the United States. The seismic design criteria used in the analyses are appropriate for the Lawrence Energy Center Ash Pond.

7.2 ADEQUACY OF SUPPORTING TECHNICAL DOCUMENTATION

Structural stability documentation is adequate.

7.3 ASSESSMENT OF STRUCTURAL STABILITY

Overall, the structural stability of the perimeter dike appears to be satisfactory based on the observations during the Sept. 24, 2010 field visit by Dewberry and the 2010 Slope Stability Analysis report (See Appendix A - Doc 04):

- The crest appeared free of depressions and no significant vertical or horizontal alignment variations were observed,
- There were no indications of major scarps, sloughs or bulging along the dikes,
- Boils, sinks or uncontrolled seepage was not observed along the slopes, groins or toe of the dikes,
- The computed factors of safety comply with accepted criteria.

8.0 ADEQUACY OF MAINTENANCE AND METHODS OF OPERATION

8.1 OPERATIONAL PROCEDURES

The facility is operated for temporary storage of fly ash, bottom ash, boiler ash, and flue gas emission control residual deposits. Treated coal combustion process waste water is discharged through an NPDES monitored outlet structure.

8.2 MAINTENANCE OF THE IMPOUNDMENT DIKE AND PROJECT FACILITIES

Plant management has established the following maintenance procedures:

- Daily inspection by plant personnel.
- Review of the status of each cell by senior plant personnel on a weekly basis.
- Maintaining a uniform cover of suitable species of grass on embankment slopes.
- Protecting dam crests by a suitable thin asphalt or granular surface.
- Not allowing trees and woody brush on the outside slopes, crest and along the water line of the dikes.

8.3 ASSESSMENT OF MAINTENANCE AND METHODS OF OPERATIONS

8.3.1 Adequacy of Operational Procedures

Based on the assessments of this report, operation procedures seem to be adequate.

8.3.2 Adequacy of Maintenance

Although maintenance appears to be adequate, several recommendations have been made. These include:

- Immediately implementing a program to remove the large trees along the outside slope of the northwestern portion of the perimeter dike
- Develop and implement a vegetation control program for all the dikes
- Develop a written periodic inspection program of the dike condition
- Check the serviceability of the overflow structure

9.0 ADEQUACY OF SURVEILLANCE AND MONITORING PROGRAM

9.1 SURVEILLANCE PROCEDURES

Weekly Inspections

Weekly inspections are conducted by plant personnel.

Special Inspections

No special inspections have been conducted at the Lawrence Energy Center ash pond by regulatory or plant personnel.

9.2 INSTRUMENTATION MONITORING

The Lawrence Energy Center ash impoundment dikes do not have an instrumentation monitoring system.

9.3 ASSESSMENT OF SURVEILLANCE AND MONITORING PROGRAM

9.3.1 Adequacy of Inspection Program

Based on the data reviewed by Dewberry, including observations during the site visit, the inspection program is adequate.

9.3.2 Adequacy of Instrumentation Monitoring Program

The Lawrence Energy Center ash dikes are not instrumented. Based on the size of the dikes, the portion of the impoundment currently used to store wet fly ash and stormwater, the history of satisfactory performance and the current inspection program, installation of a dike monitoring system is not needed at this time

APPENDIX A

ADDITIONAL INFORMATION

DOC01: AERIAL MAP


May 11, 2009
12:52pm
E 1200 Rd
4
1
3
2
© 2009 Tele Atlas
Image © 2009 DigitalGlobe
©2008 Google
39°00'29.40" N 95°16'19.86" W
Apr 28, 2006
Eye alt 1.10 km

DOC02: WESTAR RESPONSE TO EPA REQUEST FOR INFORMATION

Westar Energy.

May 18, 2009

Mr. Richard Kinch
US Environmental Protection Agency (5306P)
1200 Pennsylvania Avenue, NW
Washington, DC 20460

Re: Westar Energy, Lawrence Energy Center
Reply to Request for Information Under Section 104 (e) of the Comprehensive Environmental Response, Compensation, and Liability Act, 42 U.S.C. 9604(e)

Dear Mr. Kinch,

Enclosed is Westar Energy's Lawrence Energy Center response to the recently received information collection request. The response details the applicable coal combustion waste management units and provides Westar's response to each question in the request.

> I certify that the information contained in this response to EPA's request for information and the accompanying documents is true, accurate, and complete. As to the identified portions of this response for which I cannot personally verify their accuracy, I certify under penalty of law that this response and all attachments were prepared in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowing violations.

Sincerely,

John Bridson
Plant Manager

Cc w/o enclosure: C. Swartzendruber, Topeka GO

818 S Kansas Ave / PO Box 889 / Topeka, Kansas 66601-0889

Based on the recently received information collection request (ICR) concerning coal combustion waste (CCW) surface impoundments and similar diked or bermed management units, Westar Energy's Lawrence Energy Center (Westar) is providing this response with respect to the applicable areas at the facility. Based on the past and current operational scheme of the plant, the areas deemed applicable to this request are the NPDES Ash Ponds and Clear Pond. The aerial photograph attached as Figure 1 provides an overview of the site CCW waste management areas.

In general, the facility sluices CCW from the boilers and air pollution control equipment to the NPDES Ash Ponds where waste is temporarily staged prior to de-watering and transport to the dry ash landfill on-site. The site has two active dry landfills permitted with the Kansas Bureau of Waste Management. No CCW is permanently stored in wet surface impoundments at the Lawrence Energy Center. Water removed from the waste travels through the series of NPDES Ash Ponds before arrival at the Clear Pond and discharge at a permitted NPDES outfall.

The ten questions from EPA's ICR appear below followed by Westar's response. Attachments in support of the responses are included according to the following table.

Attachment	Management Unit	Attachment Description
1	Overall Site	Aerial Photograph
2	Area 1	Lawrence Energy Center Construction Drawing G-2
3	Area 1 and Area 2	Lawrence Energy Center Construction Drawing G-3
4	Area 3 and Area 4	Lawrence Energy Center Ash Drawing

1. Relative to the National Inventory of Dams criteria for High, Significant, Low, or Less than Low Hazard Potential, please provide the rating for each management unit and indicate which State or federal regulatory agency assigned that rating. If the unit does not have a rating, please note that fact.

   The CCW temporary staging ponds at Lawrence Energy Center do not have traditionally defined dams. At construction, the ponds were excavated from grade and a minimal height berm was constructed around the perimeter. Do to the nature of the ponds, the berm has not been evaluated by any state or federal regulatory agency and no rating has been established.

2. What year was each management unit commissioned and expanded?

   The staging ponds at Lawrence were constructed at different times. Referencing the areas identified in Attachment 1, construction estimates are as follows:

Area	Year of Construction	Year of Modification
1	1969	NA
2	1969	NA
3	1976	NA
4	1976	NA

3. What materials are temporarily or permanently contained in the unit? Use the following categories to respond to this question: (1) fly ash; (2) bottom ash: (3) boiler slag; (4) flue gas emission control residuals; (5) other. If the management unit contains more than one type of material, please identify all that apply. Also, if you identify "other," please specify the other types of materials that are temporarily or permanently contained in the unit(s).

   The NPDES Ash Ponds are used for staging only. There is no permanent disposal of material in these ponds. Materials that may be staged in the NPDES Ash Ponds include fly ash, bottom ash, boiler slag, and flue gas emission control residues. In addition, the plant uses the ponds to stage and dry sediment from incoming river water that collects in the settlement basins and the cooling tower. Following drying, all materials are permanently contained in the on-site dry landfills.

   The Clear Pond is not used for temporary or permanent disposal of CCW. It contains only water removed from the NPDES Ash Ponds. There is a residual amount of surface water scum collected on the pond. Water is discharged from this pond out the permitted NPDES outfall.

4. Do you have a Professional Engineer's certification for the safety (structural integrity) of the management unit(s)? Please provide a copy if you have one. If you do not have such a certification, do you have other documentation attesting to the safety (structural integrity) of the management unit(s)? If so, please provide a copy of such documentation.

   Each CCW temporary storage area at the Lawrence facility was constructed to an engineered design. Attachments 2, 3, and 4 provide the designs for each area. Areas 1 and 2 were part of the initial plant design by the professional engineering firm Black and Veatch. However, Westar is not currently in possession of the PE stamped designs for any of the temporary storage areas.

5. When did the company last assess or evaluate the safety (i.e., structural integrity) of the management unit(s)? Briefly describe the credentials of those conducting the structural integrity assessments/evaluations. Identify actions taken or planned by facility personnel as a result of these assessments or evaluations. If corrective actions were taken, briefly describe the credentials of those performing the corrective actions, whether they were company employees or contractors. If the company plans an assessment or evaluation in the future, when is it expected to occur?

   As previously described, the NPDES Ash Ponds and Clear Pond were constructed by excavation from grade. The site has not assessed the structural integrity of the perimeter berm as risk of any failure is extremely low. In response to this request, Westar plans to complete an engineering evaluation of pond/berm integrity in 2010.

6. When did a State or a Federal regulatory official last inspect or evaluate the safety (structural integrity) of the management unit(s)? If you are aware of a planned state or federal inspection or evaluation in the future, when is it expected to occur? Please identify the Federal or State regulatory agency or department which conducted or is planning the inspection or evaluation. Please provide a copy of the most recent official inspection report or evaluation.

   Westar has no knowledge of site inspections relating to berm structural integrity.

   Westar isn't aware of any planned state or federal site inspections.

7. Have assessments or evaluations, or inspections conducted by State or Federal regulatory officials conducted within the past year uncovered a safety issue(s) with the management unit(s), and, if so, describe the actions that have been or are being taken to deal with the issue or issues. Please provide any documentation that you have for these actions.

   To Westar's knowledge, there have been no on-site inspections or evaluations relating to berm structural integrity conducted by State or Federal officials in the past year.

8. What is the surface area (acres) and total storage capacity of each of the management units? What is the volume of material currently stored in each of the management unit(s)? Please provide the date that the volume measurement was taken

   Approximate surface area, capacity, and the most recently calculated volume for each unit is included in the following table.

Management Unit	Surface Area (acres)	Total Capacity (acre-ft)	Current Volume CCW Stored	
			(acre-ft)	(Date of Measurement)
Area 1	4.7	70.5	*	*
Area 2	10.3	155	*	*
Area 3	18.2	273	*	*
Area 4	14.2	185	*	*

*Storage in these areas is temporary in nature and varies from no storage to total capacity dependent on current plant operations.

47,4 683.5

9. Please provide a brief history of known spills or unpermitted releases from the unit within the last ten years, whether or not these were reported to State or federal regulatory agencies. For purposes of this question, please include only releases to surface water or to the land (do not include releases to groundwater).

   There are no known spills or unpermitted releases from any of the units in the last ten years. The Clear Pond is permitted to discharge water through an NPDES permitted outfall. Westar interprets any releases under this permit allowance to be outside the scope of this request.

10. Please identify all current legal owner(s) and operator(s) at the facility.

    The current owner and operator of the Lawrence Energy Center is Westar Energy, Inc.

↑N

Baldwin Creek

4 Stormwater runoff pond

Jared S Morrison /WRI
07/08/2009 02:49 PM

To dufficy.craig@epa.gov
cc Craig Swartzendruber/WRI@WRI, Andrew L Evans/WRI@WRI, John Bridson/WRI, Jeff Culp/WRI@WRI, David Walter/WRI@WRI
bcc
Subject Lawrence Energy Center Response to Question

History: This message has been forwarded.

Mr. Dufficy,

In response to your question concerning the dam (berm) height at the Lawrence Energy Center coal combustion waste ponds, I gathered the following information from the design drawings.

As noted in the original ICR response, the Lawrence Energy center coal combustion waste ponds were incised from original grade with a minimal berm constructed around four distinct areas . While the interior of the ponds are incised, the outer edge as depicted in the ICR attachments descends as it approaches river elevation. This outer edge berm height is reported as a maximum of 13 ft in the design drawings included as Attachment 4 of the ICR.

If you have additional questions or need further clarification, please feel free to contact me.

Thanks,

Jared Morrison
Environmental Services
Westar Energy
818 South Kansas Avenue
Topeka, KS 66612
Phone: (785) 575-8273 Fax: (785) 575-8039
Cell: (785) 217-5700
jared.s.morrison@westarenergy.com

DOC03: GOLDER ASSOCIATES STABILITY STUDY OF INTERNAL DIKES

TECHNICAL MEMORANDUM

Date: January 15, 2010

Project No.: 093-81765.2

To: Andy Evans, PE

Company: Westar Energy

From: Jason Obermeyer, PE

cc: Ron Jorgenson

Email: jobermeyer@golder.com

RE: RESULTS OF STABILITY ANALYSES TO SUPPORT REMOVAL OF ASH FROM EXISTING ASH PONDS AT WESTAR ENERGY'S LAWRENCE ENERGY CENTER

Golder Associates Inc. (Golder) has prepared this technical memorandum to provide Westar Energy (Westar) with the results of stability analyses to support ash removal from existing ash ponds at Lawrence Energy Center in Lawrence, Kansas. Recommendations are provided herein for embankment geometries to be left in place, both temporarily and permanently.

1.0 GEOTECHNICAL INVESTIGATION

Eight soil borings, LEC-1 to LEC-8, were completed on October 26, 2009, at the locations shown in Figure 1 to support Golder's stability evaluation. The borehole locations were designated by Golder and Westar. Boreholes were advanced with a truck-mounted CME drill rig using 6-inch-diameter hollow stem continuous flight augers. Relatively undisturbed samples were collected from several boreholes using 2-inch-diameter thin-walled tube samplers (Shelby tubes). Soil samples were visually classified by Golder's geotechnical engineer in accordance with the Unified Soil Classification System (USCS). Borehole depths ranged from 13 to 24 feet. Borehole logs based on field and laboratory soil classification are provided in Attachment A.

The embankments consist primarily of silty clay and bottom ash. Golder also found soft saturated clay in LEC-7 and LEC-8. Photographs from the geotechnical investigation are presented in Attachment B.

2.0 STABILITY EVALUATION

Golder performed the stability analyses using SLIDE, a two-dimensional slope stability computer program developed by Rocscience Inc. (2009). Factors of safety for static conditions were computed for circular failure surfaces using Spencer's method for force and moment equilibrium.

2.1 Cross Sections

Golder developed cross sections for the stability analyses at locations where ash removal will result in an excavated slope approximately 20 feet in height, typically with impounded ash or water on the upstream side, based on Westar's phased ash removal sequence as provided in the Request for Proposal dated October 21, 2009 (Sketches #2 to #5). Golder performed stability analyses for the following cross sections, the locations of which are depicted in Figures 2 to 5:

- 1A, 1B, 1C, and 1D – These four cross sections are associated with the first phase of ash removal, as shown on Sketch #2
- 2A, 2B, 2C, and 2D – These four cross sections are associated with the second phase of ash removal, as shown on Sketch #3
- 3A, 3B, and 3C – These three cross sections are associated with the third phase of ash removal, as shown on Sketch #4.
- 4A, 4B, and 4C – These three cross sections represent the conditions to be left in place following completion of ash removal, as shown on Sketch #5

Golder assumed the depth of ash removal to be 20 feet, based on borehole logs provided by Westar (Terracon Consultants, Inc. 2009a). Golder conservatively assumed the upstream slopes of existing ash pond embankments to be sloped at 0.5 horizontal (H) to 1 vertical (V).

2.2 Engineering Parameters

Golder collected relatively undisturbed soil samples from several boreholes for geotechnical testing to determine engineering parameters for use in the slope stability analyses. Geotechnical test results are presented in Attachment C. For purposes of the stability analyses, Golder represented distinct material layers based primarily on the stratigraphy observed in nearby boreholes, as summarized in Table 1.

TABLE 1
BASIS FOR STRATIGRAPHY USED IN STABILITY ANALYSES

Cross Section	Basis for Assumed Stratigraphy
1A	Borehole LEC-6
1B	Borehole LEC-5
1C	Embankment material (temporary berm)
1D	Borehole LEC-7
2A	Borehole LEC-5
2B	Embankment material (temporary berm)
2C	Borehole LEC-8
2D	Embankment material (temporary berm)
3A	Borehole LEC-7
3B	Borehole LEC-7
3C	Borehole LEC-7
4A	Borehole LEC-6
4B	Borehole LEC-5
4C	Borehole LEC-7

Golder assigned engineering parameters to stratigraphic layers based on field soil classification and laboratory test data. Golder assigned unit weights and strength parameters to silty clay layers based on density testing and consolidated-undrained triaxial testing of an undisturbed soil sample collected at LEC. Golder assigned unit weights and strength parameters to clayey sand layers based on previous experience with similar materials. Golder assigned unit weights and strength parameters to layers consisting primarily of bottom ash based on the results of direct shear testing of recompacted bottom ash collected at LEC by others (Terracon Consultants, Inc. 2009b). Golder reinterpreted these results as appropriate for the relatively low normal stresses in the ash pond embankments, as shown in Attachment D. Golder assigned unit weights and strength parameters to competent ash layers based on previous experience with similar materials that have been placed using appropriate embankment construction techniques, including moisture conditioning and compaction to achieve at least 95 percent of the standard Proctor maximum dry unit weight. Strength characteristics of these materials can vary significantly, and project-specific strength testing should be performed to confirm the assumptions made in these analyses if a combination of bottom ash, fly ash, and/or soil will be used in embankment construction. Golder assigned a unit weight to soft saturated clay layers based on previous experience with similar materials and assigned an undrained strength based on published data for soft clays (e.g. Terzaghi and Peck 1967). Golder assigned a unit weight to impounded ash based on previous experience with similar materials and assumed that ash within the ash ponds is saturated and contributes no strength. Engineering parameters used in the slope stability analyses are summarized in Table 2.

TABLE 2
SUMMARY OF ENGINEERING PARAMETERS USED IN STABILITY ANALYSES

Material	Unit Weight	Strength Parameters			
		Total Stress (Undrained)		Effective Stress (Drained)	
		Friction Angle	Cohesion	Friction Angle	Cohesion
Silty clay	116 pcf	17 degrees	260 psf	26 degrees	260 psf
Clayey sand[1]	125 psf	--	--	35 degrees	0 psf
Bottom ash[1]	92 psf	--	--	37 degrees	0 psf
Competent ash[2]	92 psf	20 degrees	200 psf	30 degrees	200 psf
Saturated soft clay[3]	90 pcf	0 degrees	250 psf	--	--
Impounded ash	85 pcf	No strength			

2.3 Piezometric Line

Based on historic (Geotechnical Services Inc. 1999) and observed piezometric levels in and around the ash pond embankments, dewatering will likely be necessary to facilitate removal of ash to a depth of approximately 20 feet. Accordingly, Golder assumed the piezometric line during ash removal to be a straight line between the upstream edge of the berm crest and the downstream toe of the berm. Golder assumed ash ponds in operation to be filled with saturated ash to within 2 feet of the berm crest. Golder assumed areas containing water to be filled to within 2 feet of the berm crest.

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[1] Based on visual observation, clayey sand and bottom ash layers are assumed to consist of free-draining materials that will exhibit drained strength during and after ash removal.

[2] Competent ash may consist of a mixture of bottom ash, fly ash, and/or clay that will achieve the strength parameters indicated in Table 1 when compacted. Golder is not aware of and has not performed strength testing to confirm the strength parameters used in the stability analyses. If ash will be used to construct temporary embankments, Golder recommends performing a consolidated-undrained triaxial test with pore pressure measurement on a reconstituted sample of the proposed ash mixture to confirm that the required strength parameters will be achieved.

[3] Saturated soft clay layers are assumed to consist of a material that drains slowly and will exhibit undrained strength during ash removal and throughout the relevant period of time following ash removal.

2.4 Results

Golder performed short-term[4] and long-term[5] stability analyses for each temporary cross section, beginning with a 1H to 1V slope and a 12-foot-wide crest. For cross sections that did not exhibit acceptable factors of safety under this configuration, Golder adjusted the slope angle and/or crest width incrementally until slope stability analyses indicated an acceptable factor of safety under short-term and long-term conditions. A factor of safety of 1.3 is generally considered the minimum acceptable value for temporary earthen structures. The factors of safety resulting from the slope stability analyses are summarized in Tables 3 to 13, with the recommended embankment configurations shown in bold text. The results of slope stability analyses for the recommended embankment configurations are shown graphically in Figures 6 to 16.

TABLE 3
RESULTS OF STABILITY ANALYSES FOR CROSS SECTION 1A

Crest Width	Slope (H:V)	Factor of Safety	
		Short-Term	Long-Term
12’	1:1	1.2	1.1
12’	**1.5:1**	**1.3**	**1.3**
20’	1:1	1.2	1.3

TABLE 4
RESULTS OF STABILITY ANALYSES FOR CROSS SECTION 1B

Crest Width	Slope (H:V)	Factor of Safety	
		Short-Term	Long-Term
12’	1:1	1.2	1.3
12’	**1.5:1**	**1.4**	**1.5**
20’	1.1	1.2	1.4

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[4] Short-term analyses are applicable for the condition where construction-induced pore pressures have not dissipated. Specific time periods are not inferred. For short-term analyses, Golder used undrained strength parameters and total stresses for materials that were not assumed to be free-draining and drained strength parameters and effective stresses for materials that were assumed to be free-draining.

[5] Long-term analyses are applicable for the condition where construction-induced pore pressures have dissipated. Specific time periods are not inferred. For long-term analyses, Golder used drained strength parameters and effective stresses for all materials except saturated soft clay.

TABLE 5

RESULTS OF STABILITY ANALYSES FOR CROSS SECTION 1C

Crest Width	Material	Slope (H:V)	Factor of Safety	
			Short-Term	Long-Term
12'	Silty Clay	1:1	1.2	1.4
12'	**Silty Clay**	**1.5:1**	**1.5**	**1.6**
12'	Bottom Ash	1:1	0.8	0.8
12'	Bottom Ash	1.5:1	1.0	1.0
12'	Bottom Ash	2:1	1.1	1.1
12'	Bottom Ash	3:1	1.4	1.4
12'	Competent Ash	1.1	1.3	1.4

TABLE 6

RESULTS OF STABILITY ANALYSES FOR CROSS SECTION 1D

Crest Width	Slope (H:V)	Factor of Safety	
		Short-Term	Long-Term
12'	1:1	0.6	0.6
12'	1.5:1	0.8	0.8
12'	2:1	0.9	0.9
12'	3:1	1.2	1.2
20'	**3:1**	**1.3**	**1.3**

TABLE 7

RESULTS OF STABILITY ANALYSES FOR CROSS SECTION 2A[6]

Crest Width	Slope (H:V)	Factor of Safety	
		Short-Term	Long-Term
12'	1:1	1.2	1.3
12'	**1.5:1**	**1.4**	**1.5**
20'	1:1	1.2	1.4

TABLE 8

RESULTS OF STABILITY ANALYSES FOR CROSS SECTION 2B

Crest Width	Material	Slope (H:V)	Factor of Safety	
			Short-Term	Long-Term
12'	Silty Clay	1:1	1.2	1.4
12'	**Silty Clay**	**1.5:1**	**1.5**	**1.6**
12'	Bottom Ash	1:1	0.8	0.8
12'	Bottom Ash	1.5:1	1.0	1.0
12'	Bottom Ash	2:1	1.1	1.1
12'	Bottom Ash	3:1	1.4	1.4
12'	Competent Ash	1.1	1.3	1.4

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[6] Depending on the embankment geometry resulting from the first phase of ash removal (Section 1B), compacted fill material may need to be added to the south side of the embankment to achieve the embankment geometry recommended for the second phase of ash removal.

TABLE 9

RESULTS OF STABILITY ANALYSES FOR CROSS SECTION 2C

Crest Width	Slope (H:V)	Factor of Safety	
		Short-Term	Long-Term
12'	1:1	0.7	0.7
12'	1.5:1	0.9	0.9
12'	2:1	1.0	1.0
12'	**3:1**	**1.3**	**1.3**

TABLE 10

RESULTS OF STABILITY ANALYSES FOR CROSS SECTION 2D

Crest Width	Material	Slope (H:V)	Factor of Safety	
			Short-Term	Long-Term
12'	Silty Clay	1:1	1.2	1.4
12'	**Silty Clay**	**1.5:1**	**1.5**	**1.6**
12'	Bottom Ash	1:1	0.8	0.8
12'	Bottom Ash	1.5:1	1.0	1.0
12'	Bottom Ash	2:1	1.1	1.1
12'	Bottom Ash	3:1	1.4	1.4
12'	Competent Ash	1.1	1.3	1.4

TABLE 11

RESULTS OF STABILITY ANALYSES FOR CROSS SECTION 3A

Crest Width	Slope (H:V)	Factor of Safety	
		Short-Term	Long-Term
12'	1:1	0.7	0.7
12'	1.5:1	0.9	0.9
12'	2:1	1.1	1.1
12'	**3:1**	**1.4**	**1.4**

TABLE 12

RESULTS OF STABILITY ANALYSES FOR CROSS SECTION 3B

Crest Width	Slope (H:V)	Factor of Safety	
		Short-Term	Long-Term
12'	1:1	0.7	0.7
12'	1.5:1	0.9	0.9
12'	2:1	1.0	1.0
12'	**3:1**	**1.4**	**1.4**

TABLE 13

RESULTS OF STABILITY ANALYSES FOR CROSS SECTION 3C

Crest Width	Slope (H:V)	Factor of Safety	
		Short-Term	Long-Term
12’	1:1	0.7	0.7
12’	1.5:1	0.9	0.9
12’	2:1	1.0	1.0
12’	**3:1**	**1.4**	**1.4**

Golder performed long-term stability analyses for Cross Sections 4A and 4B using a 2H to 1V slope (steepest recommended slope for permanent embankments) and a 12-foot-wide crest and for Cross Section 4C using a 3H to 1V slope and a 12-foot-wide crest to confirm that permanent embankment slopes will remain stable. Consistent with direction from Westar, Golder assumed the excavated areas to be filled with water to within 2 feet of the berm crest. A factor of safety of 1.5 is the minimum acceptable value for permanent earthen structures. The factors of safety resulting from the slope stability analyses are summarized in Tables 14 to 16 and meet or exceed the required factor of safety in each case. The results of slope stability analyses for the recommended embankment configurations are shown graphically in Figures 17 to 19.

TABLE 14

RESULTS OF STABILITY ANALYSIS FOR CROSS SECTION 4A

Crest Width	Slope (H:V)	Factor of Safety
12’	2:1	2.0

TABLE 15

RESULTS OF STABILITY ANALYSIS FOR CROSS SECTION 4B

Crest Width	Slope (H:V)	Factor of Safety
12’	2:1	2.8

TABLE 16

RESULTS OF STABILITY ANALYSIS FOR CROSS SECTION 4C

Crest Width	Slope (H:V)	Factor of Safety
12’	3:1	2.2

3.0 CONCLUSIONS AND RECOMMENDATIONS

Recommended embankment configurations for the analyzed cross sections are summarized in Table 17.

TABLE 17

SUMMARY OF RECOMMENDED EMBANKMENT CONFIGURATIONS

Cross Section	Crest Width (minimum)	Slope (H:V) (maximum)
1A	12'	1.5:1
1B/2A	12'	1.5:1
1C/2D	12'	1.5:1 (Silty Clay)
1D	20'	3:1
2B	12'	1.5:1 (Silty Clay)
2C	12'	3:1
3A/3B/4C	12'	3:1
3C	12'	3:1
4A	12'	2:1
4B	12'	2:1

The stability analyses indicate that some excavation slopes must be 3H to 1V or flatter to meet slope stability requirements. In most cases, this is due to the potential presence and weak nature of soft saturated clay material within the embankment (refer to Photographs 6 and 7 in Attachment B). Prior to ash removal, the excavation contractor should excavate test slots in the embankments in which soft saturated clay was found to delineate the extent of this material and determine whether the material exists in pockets or in continuous layers. If soft saturated clay is not present throughout the embankments, steeper excavation slopes may be feasible in areas where it is not found. If a thicker layer of soft saturated ash is found, flatter excavation slopes may be required. During ash removal, the designated competent person[7], the excavation contractor, and other site personnel should be vigilant in identifying the presence of soft saturated clay and modifying excavation slopes and protocols to account for the weak nature of this material. Additionally, the designated competent person, the excavation contractor, and other site personnel should closely monitor seepage conditions, and Westar should notify Golder in the event that seepage is observed in the embankment slope

Temporary embankments intended to facilitate ash removal should be constructed using generally accepted techniques, including moisture conditioning and compaction to achieve at least 95 percent of the standard Proctor maximum dry unit weight. Silty clay derived from LEC should be used to construct the temporary embankments in the absence of consolidated-drained triaxial testing with pore pressure measurement to confirm the suitability of another material for this purpose. Bottom ash is not well suited for this purpose because it lacks appreciable cohesive strength.

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[7] Refer to 29 CFR Part 1926.650-.652 Subpart P.

For safety and stability under traffic loads and unforeseen loading scenarios, Golder recommends that permanent embankment slopes be left no steeper than 2H:1V. Permanent slopes may need to be left flatter than 2H:1V if indicated by stability analyses.

The stability analyses presented in this technical memorandum are applicable only for the locations and materials described herein. If actual conditions during ash removal differ from the conditions described in this technical memorandum, additional analyses should be performed to confirm the stability of proposed excavation slopes.

4.0 REFERENCES

Geotechnical Services Inc., 1999. Groundwater Flow Maps. January 15, 1999. Provided by Westar Energy.

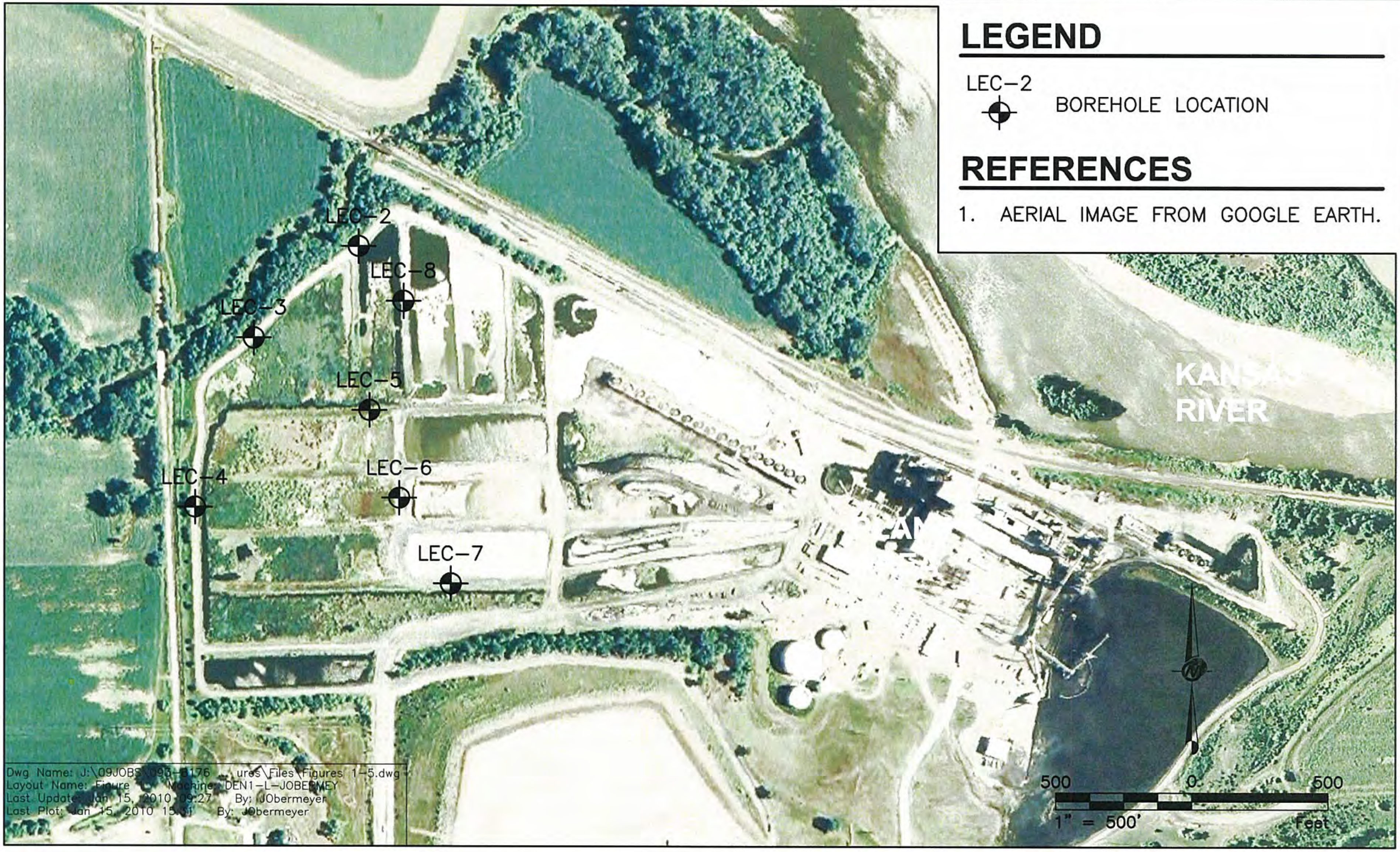
Rocscience Inc., 2009. SLIDE Version 5.043. Build date: September 29, 2009.

Terracon Consultants, Inc., 2009a. Surface Impoundment Boring Logs and Geotechnical Test Data. September-October 2009. Provided by Westar Energy.

Terracon Consultants, Inc., 2009b. Results of Direct Shear Test of Soils Under Consolidated Drained Conditions. October 21, 2009. Provided by Westar Energy.

Terzaghi, K. and Peck, R. B., 1967. *Soil Mechanics in Engineering Practice*. John Wiley, New York.

FIGURES



LEGEND

LEC−2 ⊕ BOREHOLE LOCATION

REFERENCES

1. AERIAL IMAGE FROM GOOGLE EARTH.

SITE LAYOUT AND BOREHOLE LOCATIONS

FIGURE 1

Golder Associates
DENVER, COLORADO

PROJECT No. 09381765 CADD JEO DATE 1/15/10 FILE No. Figures 1−5.dwg

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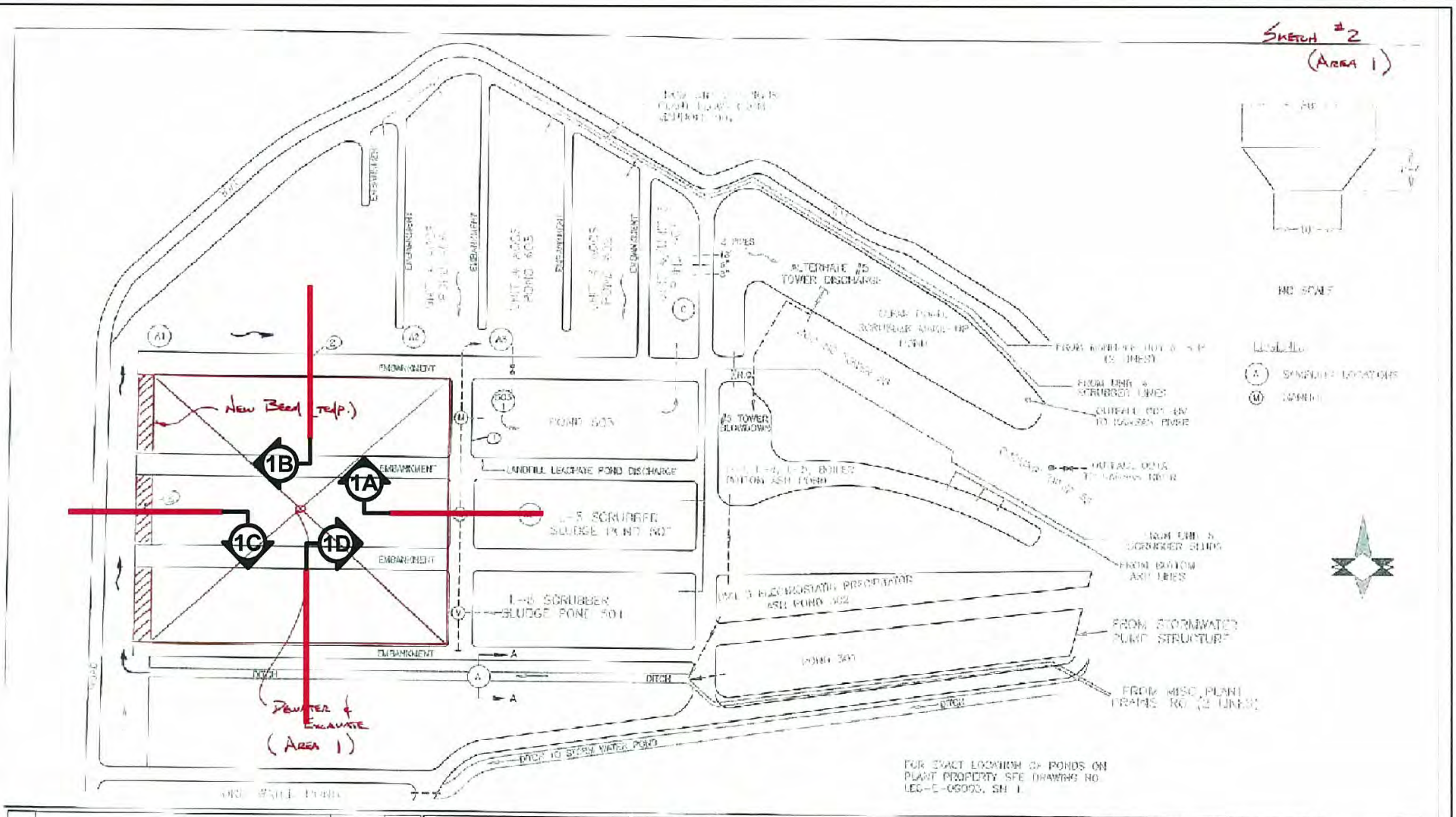

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1	GENERAL FIELD REVISIONS FOR NPDES	05-07-07	LG

DRAWN BY L.G. DATE 04/16/07
CHECKED BY ______ DATE ______
APPROVED BY ______ DATE ______
SCALE 1"=300'
WORK ORDER NO.

TITLE

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Last Update: Jan 15, 2010 09:27 By: JObermeyer
Last Plot: Jan 15, 2010 15:32 By: JObermeyer
OF

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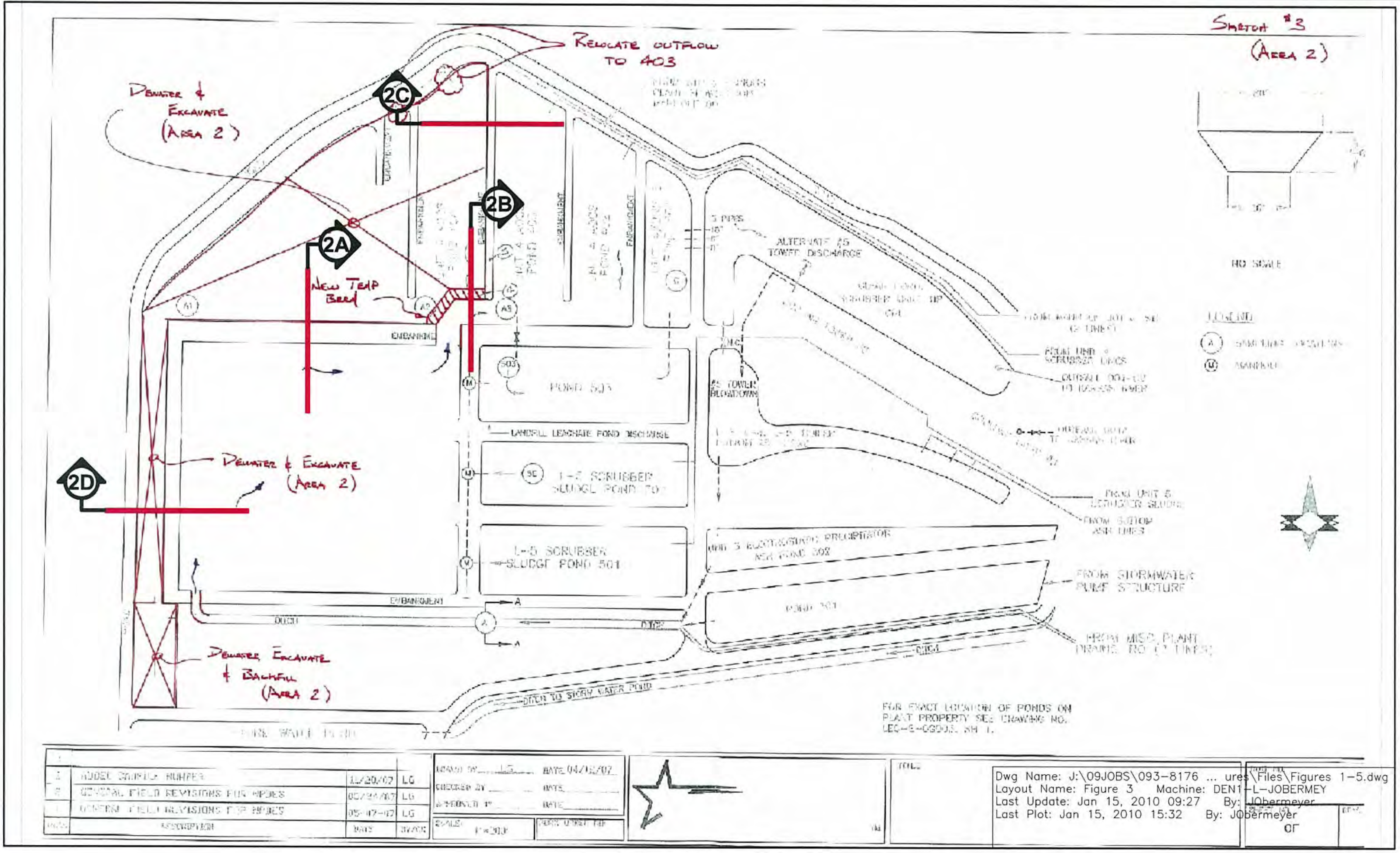
CROSS SECTION LOCATIONS
FIRST PHASE OF ASH REMOVAL

FIGURE 2

PROJECT No. 09381765 CADD JEO DATE 1/15/10 FILE No. Figures 1-5.dwg

Plot Time: 01/15/10 15:32



CROSS SECTION LOCATIONS
SECOND PHASE OF ASH REMOVAL

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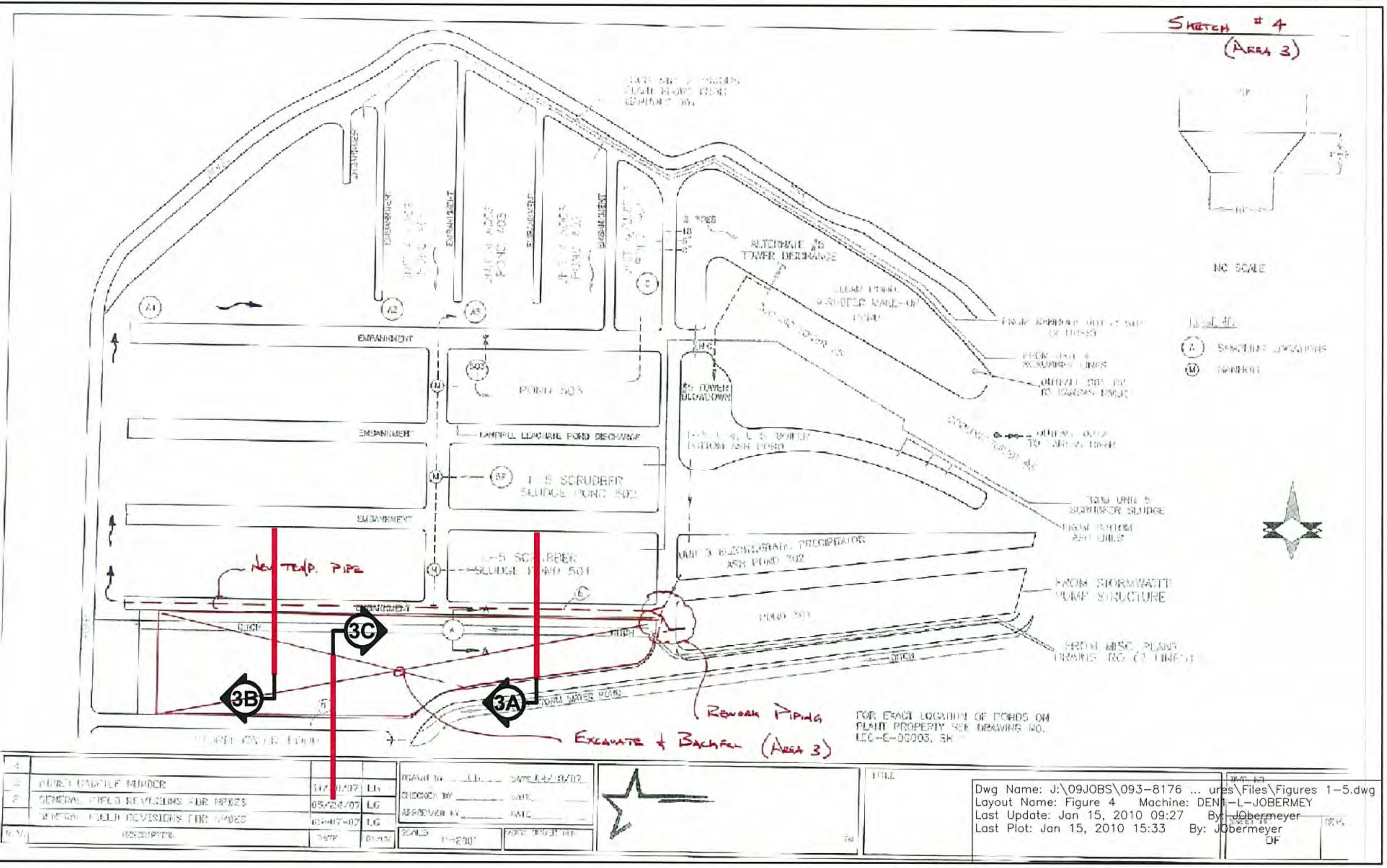
FIGURE 3

PROJECT No. 09381765 CADD JEO DATE 1/15/10 FILE No. Figures 1-5.dwg

Plot Time: 01/15/10 15:32



CROSS SECTION LOCATIONS
THIRD PHASE OF ASH REMOVAL

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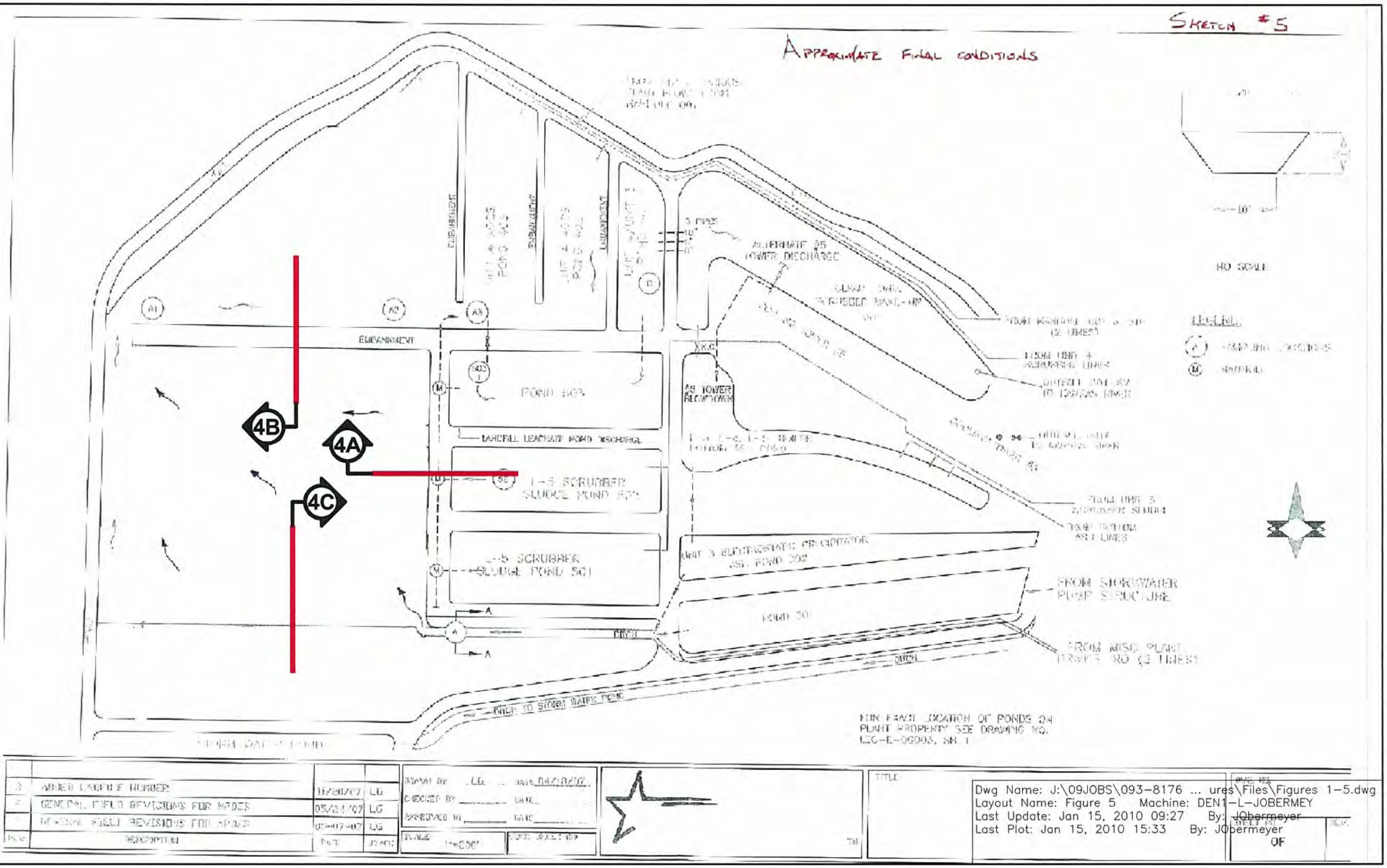
FIGURE 4

PROJECT No. 09381765 CADD JEO DATE 1/15/10 FILE No. Figures 1–5.dwg

Plot Time: 01/15/10 15:33



CROSS SECTION LOCATIONS FINAL CONDITIONS

FIGURE 5

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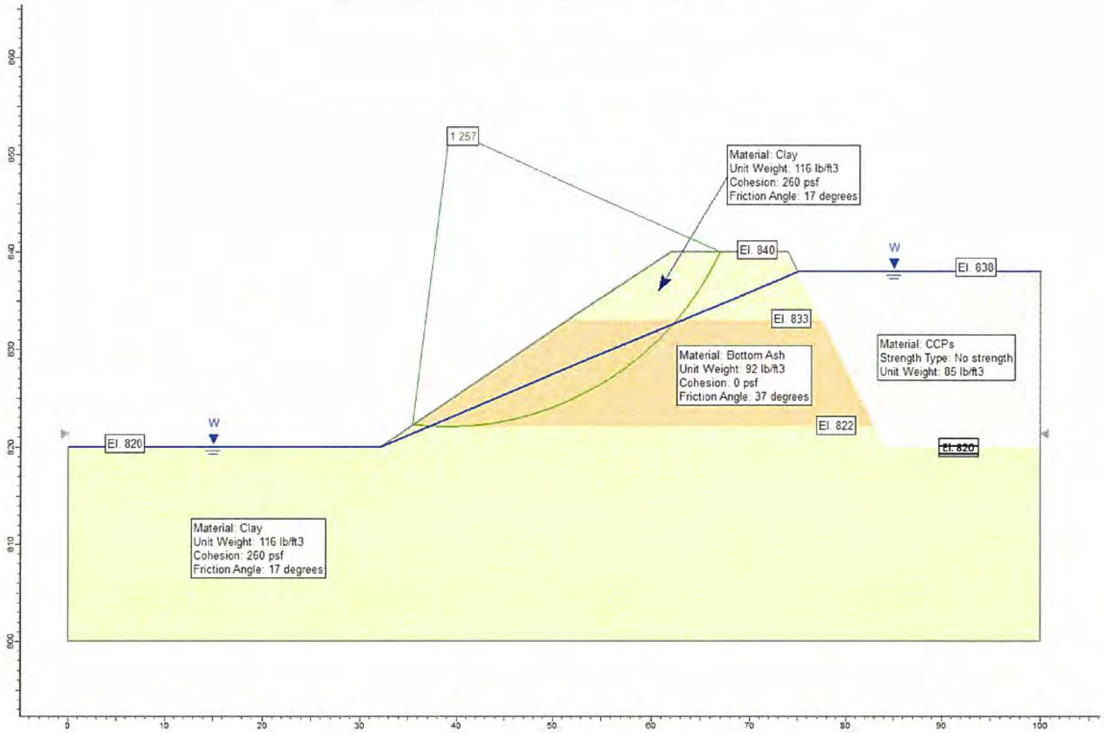
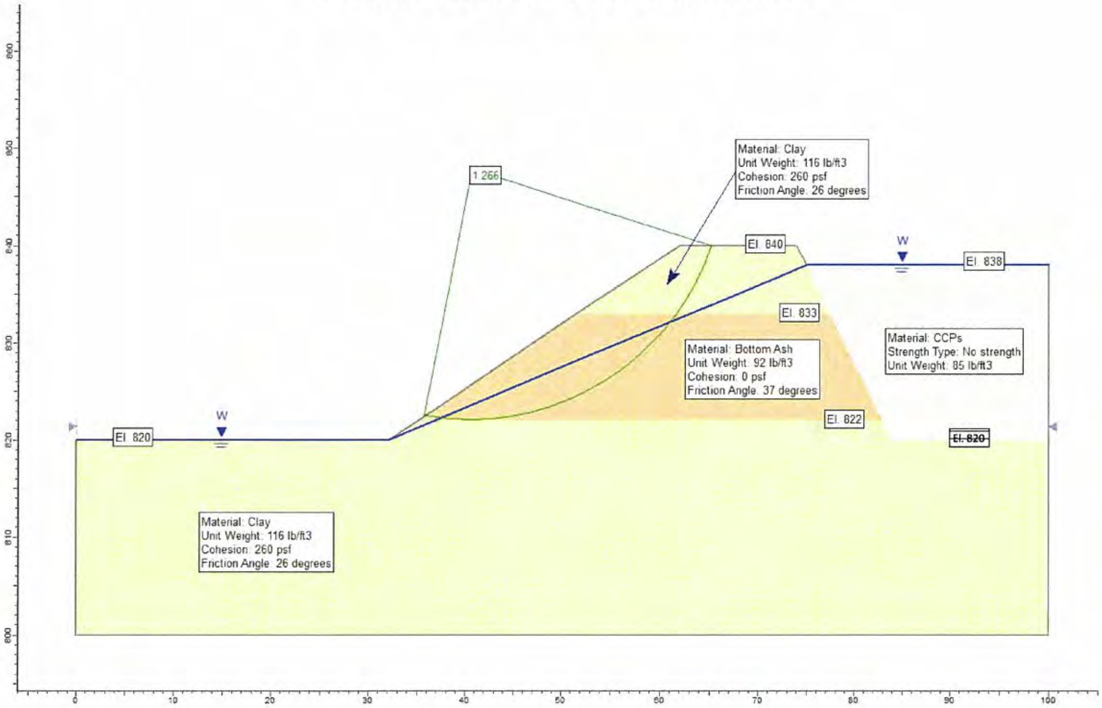
PROJECT No. 09381765 CADD JEO DATE 1/15/10 FILE No. Figures 1-5.dwg

Plot Time: 01/15/10 15:33

CROSS SECTION 1A - SHORT-TERM ANALYSIS



CROSS SECTION 1A - LONG-TERM ANALYSIS



Dwg Name: J:\09JOBS\093-8176 ... es\Files\Slide Figures.dwg
Layout Name: Figure 6 Machine: DEN1-L-JOBERMEY
Last Update: Jan 15, 2010 15:04 By: JObermeyer
Last Plot: Jan 15, 2010 15:28 By: JObermeyer

STABILITY ANALYSES RESULTS
CROSS SECTION 1A

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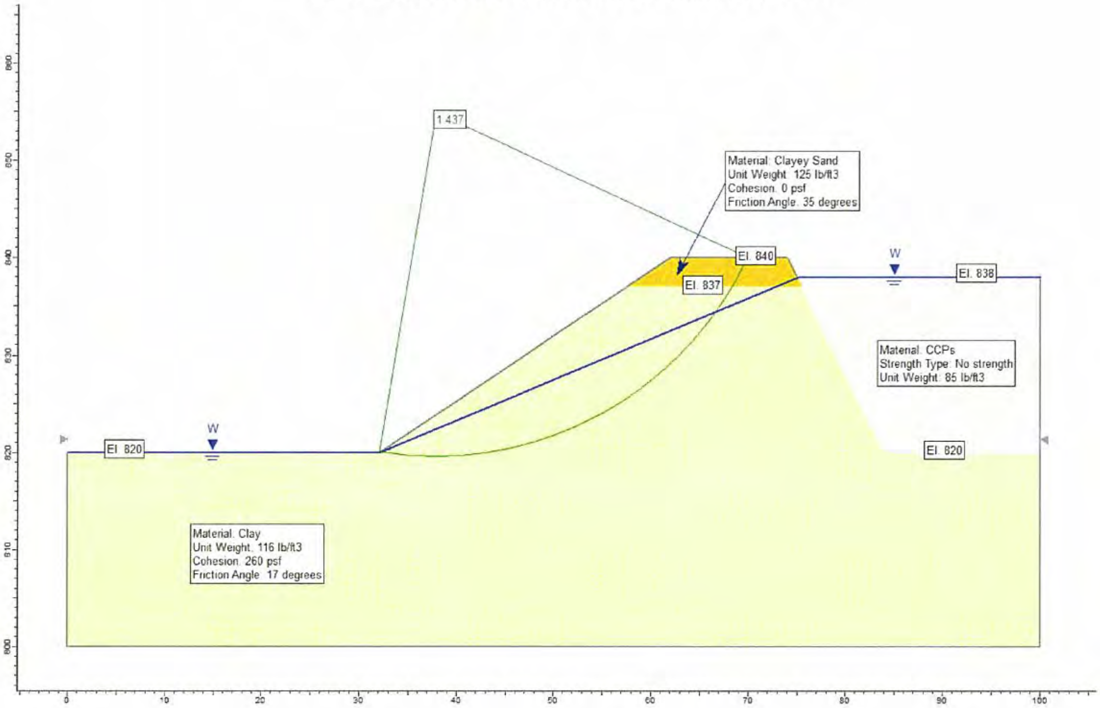
FIGURE 6

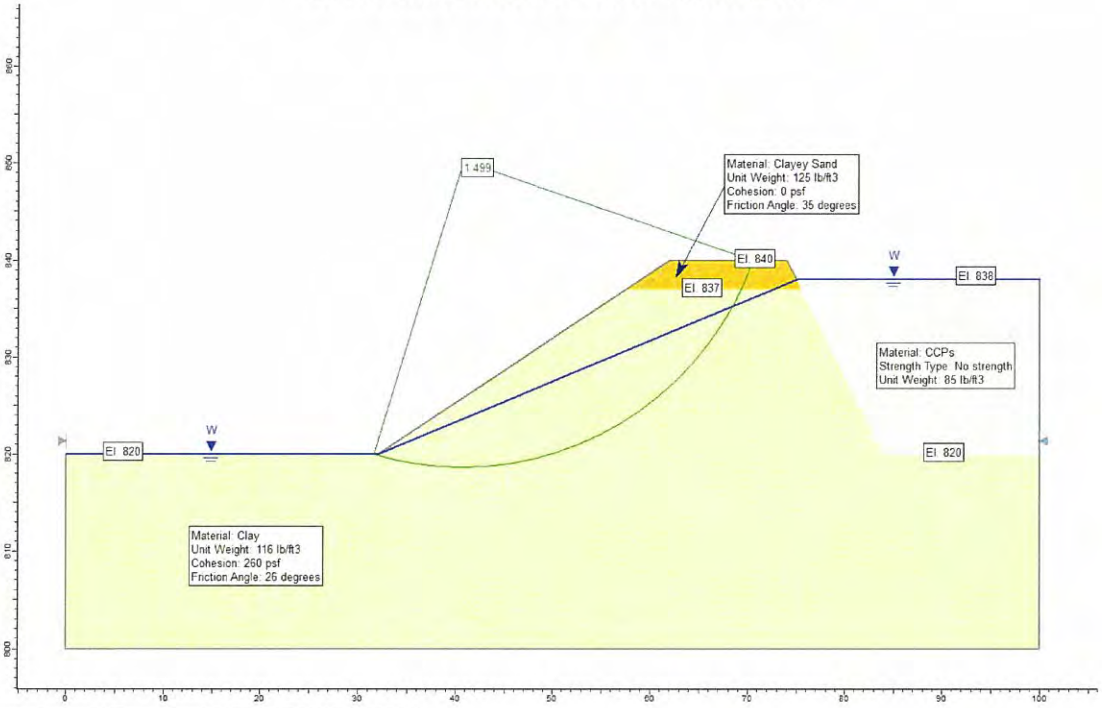
PROJECT No. 09381765 CADD JJS DATE 01/15/10 FILE No. Slide Figures.dwg

Plot Time: 01/15/10 15:28

CROSS SECTION 1B - SHORT-TERM ANALYSIS



CROSS SECTION 1B - LONG-TERM ANALYSIS



Dwg Name: J:\09JOBS\093-8176 ... es\Files\Slide Figures.dwg
Layout Name: Figure 7 Machine: DEN1-L-JOBERMEY
Last Update: Jan 15, 2010 15:04 By: JObermeyer
Last Plot: Jan 15, 2010 15:28 By: JObermeyer

STABILITY ANALYSES RESULTS
CROSS SECTION 1B

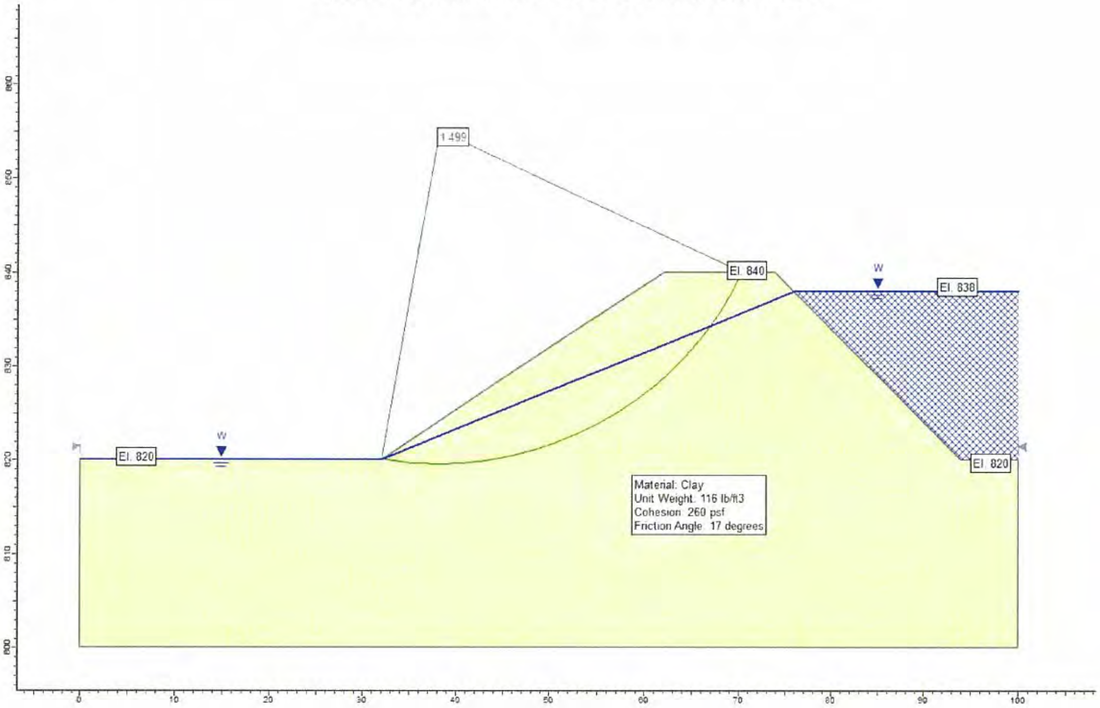
Golder Associates
DENVER, COLORADO

FIGURE 7

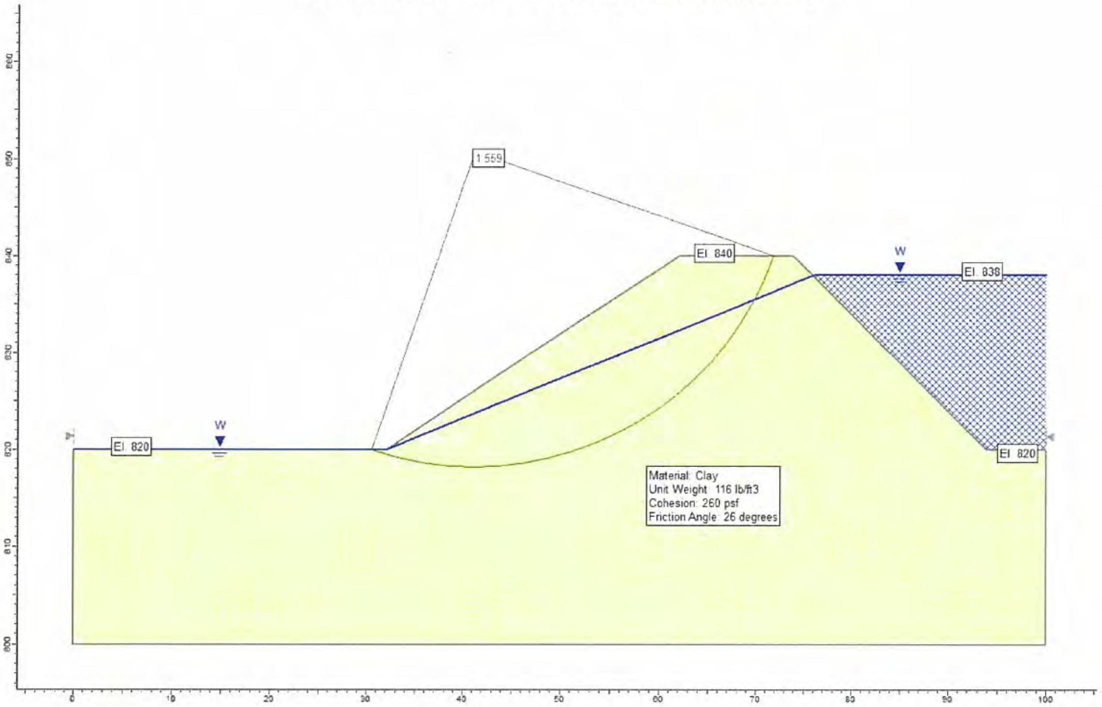
PROJECT No. 09381765 CADD JJS DATE 01/15/10 FILE No. Slide Figures.dwg

Plot Time: 01/15/10 15:28

CROSS SECTION 1C - SHORT-TERM ANALYSIS



CROSS SECTION 1C - LONG-TERM ANALYSIS



Dwg Name: J:\09JOBS\093-8176 ... es\Files\Slide Figures.dwg
Layout Name: Figure 8 Machine: DEN1-L-JOBERMEY
Last Update: Jan 15, 2010 15:04 By: JObermeyer
Last Plot: Jan 15, 2010 15:29 By: JObermeyer

STABILITY ANALYSES RESULTS
CROSS SECTION 1C

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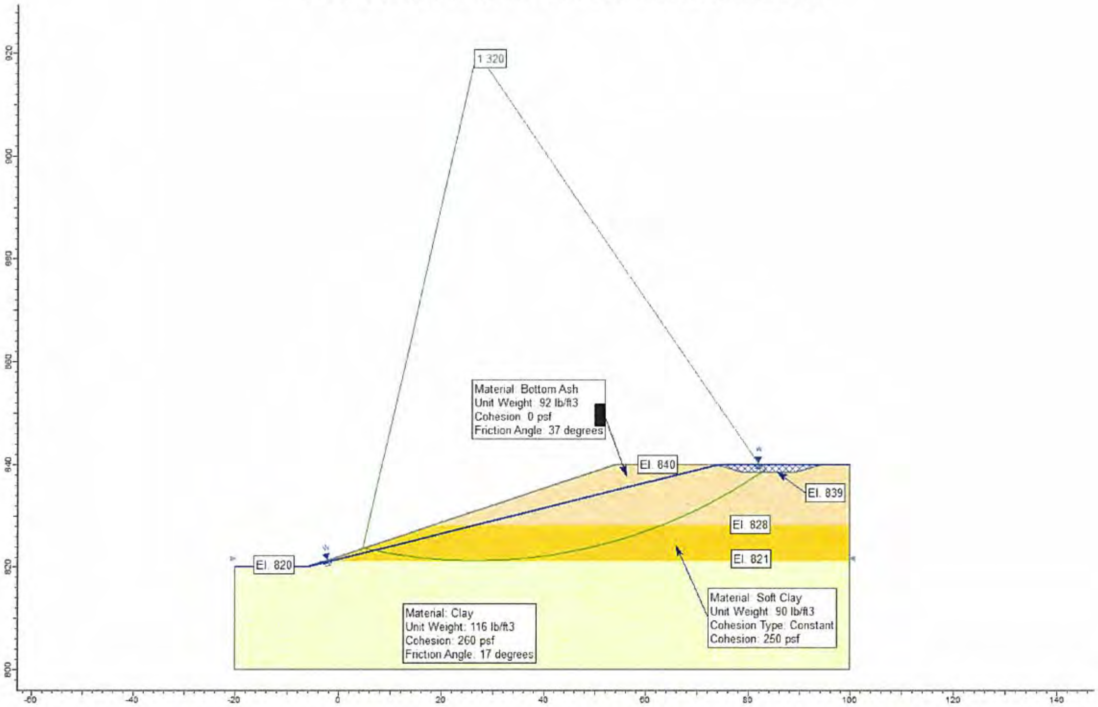
FIGURE 8

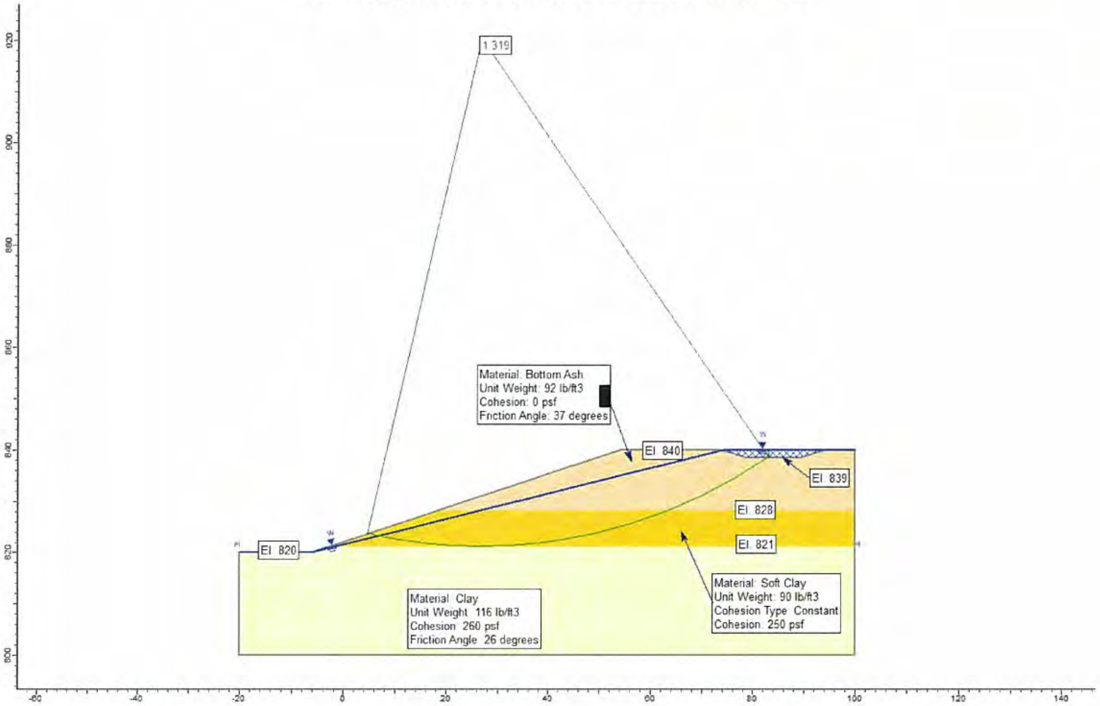
PROJECT No. 09381765 CADD JJS DATE 01/15/10 FILE No. Slide Figures.dwg

Plot Time: 01/15/10 15:29

CROSS SECTION 1D - SHORT-TERM ANALYSIS



CROSS SECTION 1D - LONG-TERM ANALYSIS



Dwg Name: J:\09JOBS\093-8176 ... es\Files\Slide Figures.dwg
Layout Name: Figure 9 Machine: DEN1-L-JOBERMEY
Last Update: Jan 15, 2010 15:04 By: JObermeyer
Last Plot: Jan 15, 2010 15:29 By: JObermeyer

STABILITY ANALYSES RESULTS
CROSS SECTION 1D

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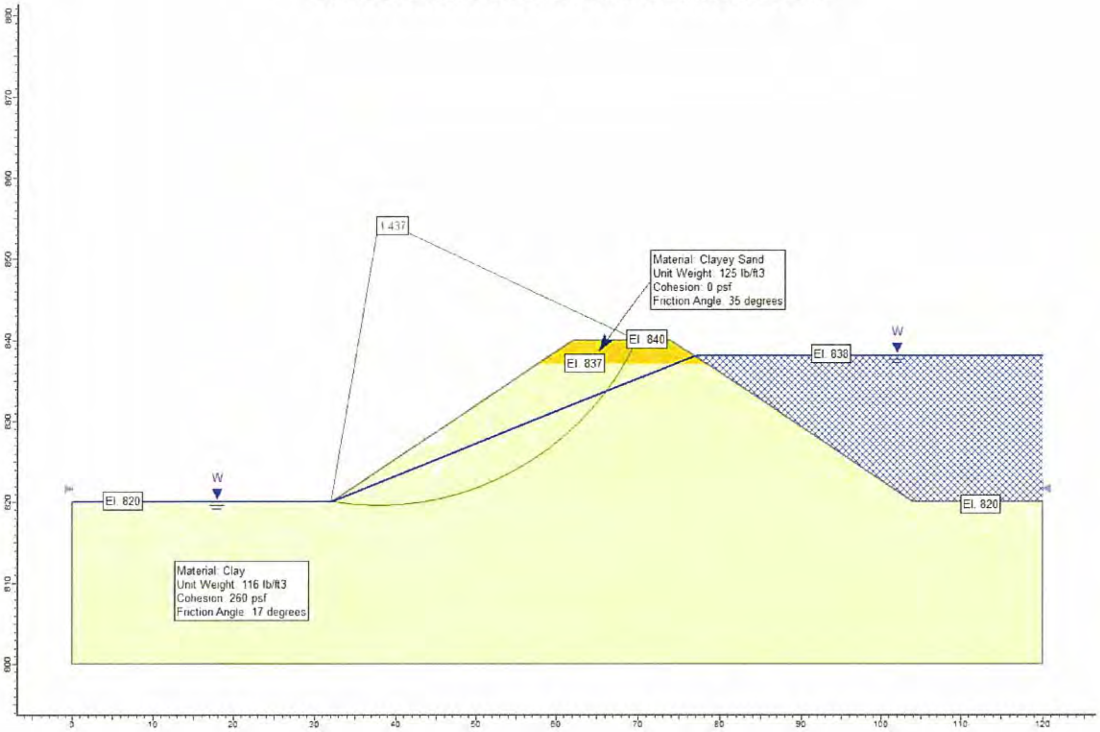
DENVER, COLORADO

FIGURE 9

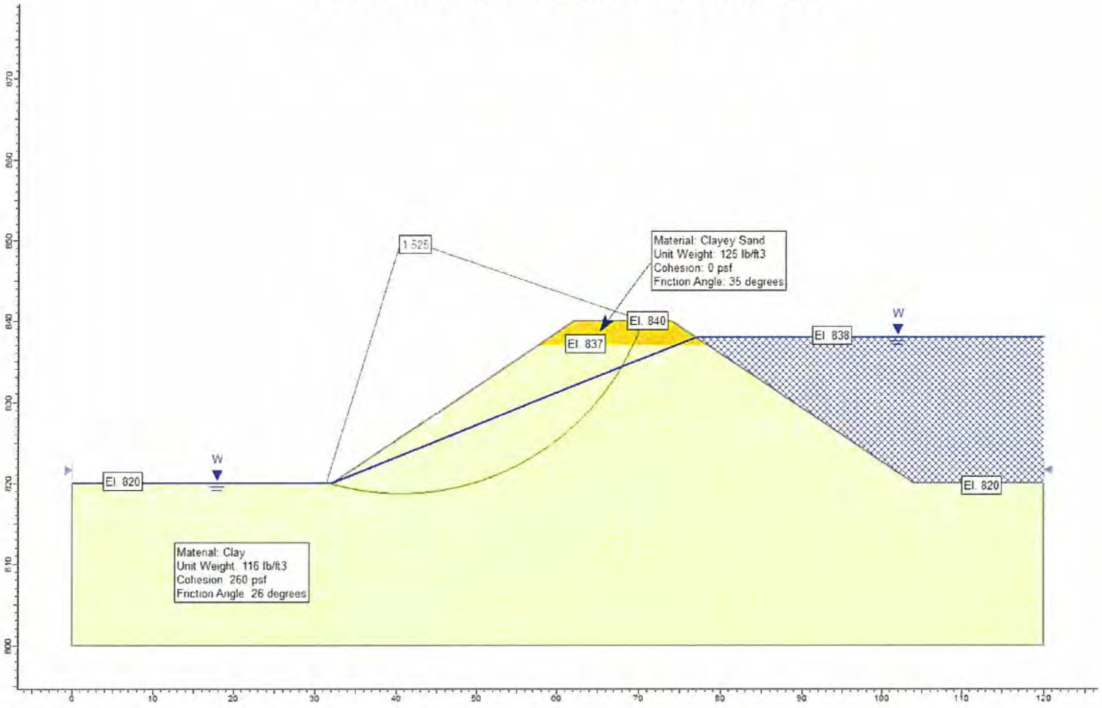
PROJECT No. 09381765 CADD JJS DATE 01/15/10 FILE No. Slide Figures.dwg

Plot Time: 01/15/10 15:29

CROSS SECTION 2A - SHORT-TERM ANALYSIS



CROSS SECTION 2A - LONG-TERM ANALYSIS



Dwg Name: J:\09JOBS\093-8176 ... es\Files\Slide Figures.dwg
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Last Update: Jan 15, 2010 15:04 By: JObermeyer
Last Plot: Jan 15, 2010 15:30 By: JObermeyer

STABILITY ANALYSES RESULTS
CROSS SECTION 2A

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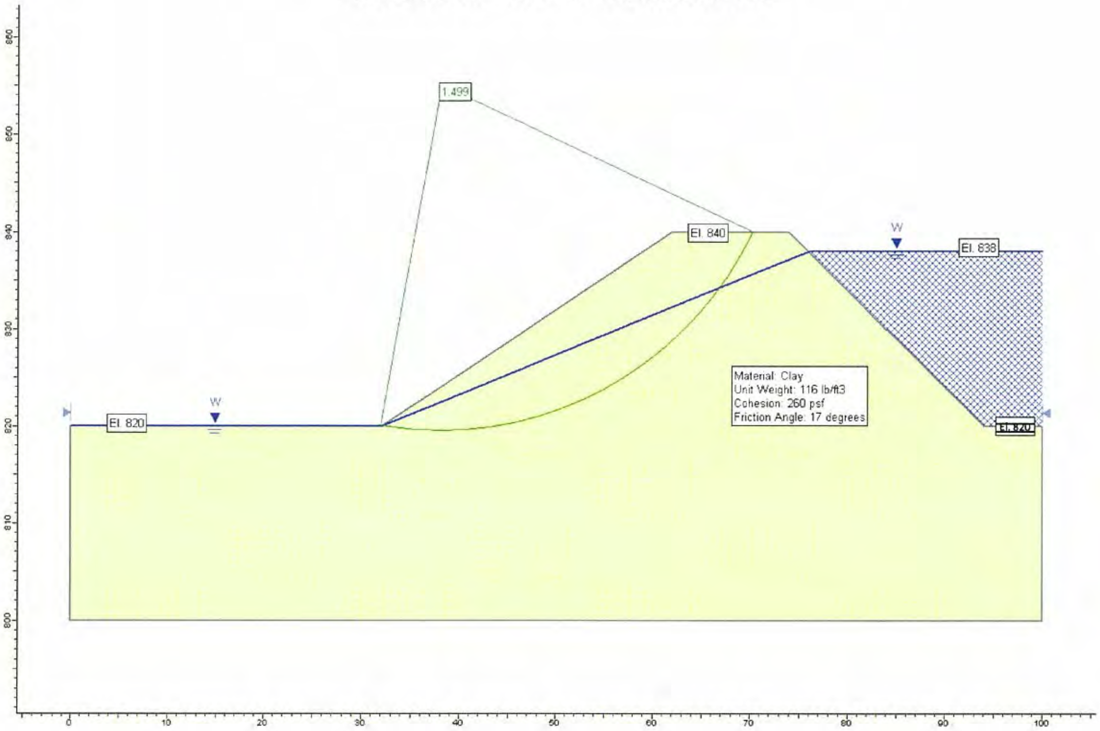
FIGURE 10

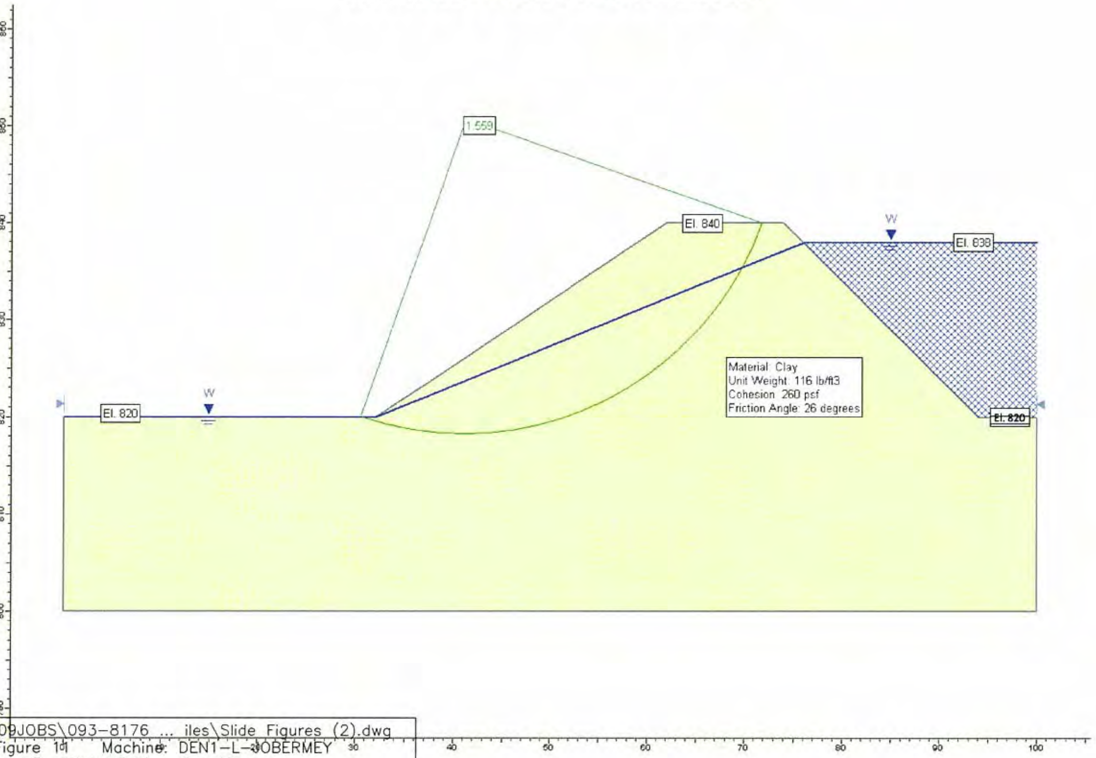
PROJECT No. 09381765 CADD JJS DATE 01/15/10 FILE No. Slide Figures.dwg

Plot Time: 01/15/10 15:30

SECTION 2B - SHORT-TERM ANALYSIS



SECTION 2B - LONG-TERM ANALYSIS



Dwg Name: J:\09JOBS\093-8176 ... iles\Slide Figures (2).dwg
Layout Name: Figure 11 Machine: DEN1-L-JOBERMEY
Last Update: Jan 15, 2010 15:26 By: JObermeyer
Last Plot: Jan 15, 2010 15:27 By: JObermeyer

STABILITY ANALYSES RESULTS
CROSS SECTION 2B

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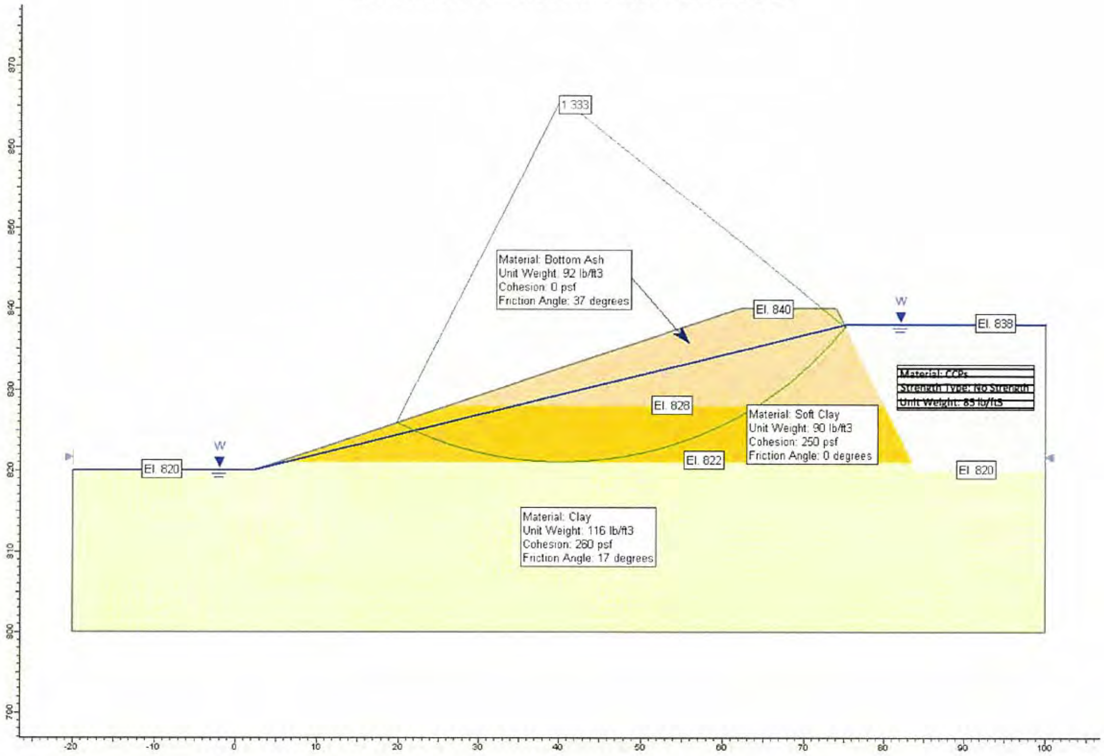
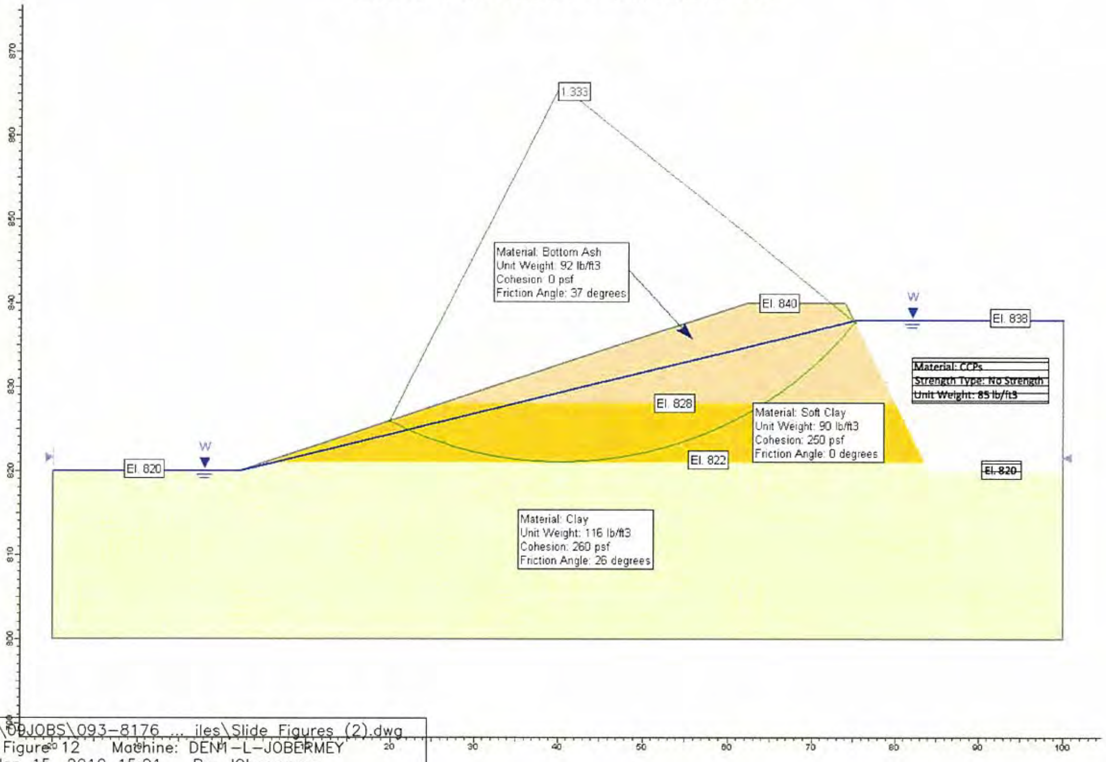
FIGURE 11

PROJECT No. 09381765 CADD JEO DATE 01/15/10 FILE No. Slide Figures (2).dwg

Plot Time: 01/15/10 15:27


SECTION 2C - SHORT-TERM ANALYSIS


SECTION 2C - LONG-TERM ANALYSIS

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Layout Name: Figure 12 Machine: DEN1-L-JOBERMEY
Last Update: Jan 15, 2010 15:21 By: JObermeyer
Last Plot: Jan 15, 2010 15:26 By: JObermeyer

STABILITY ANALYSES RESULTS
CROSS SECTION 2C

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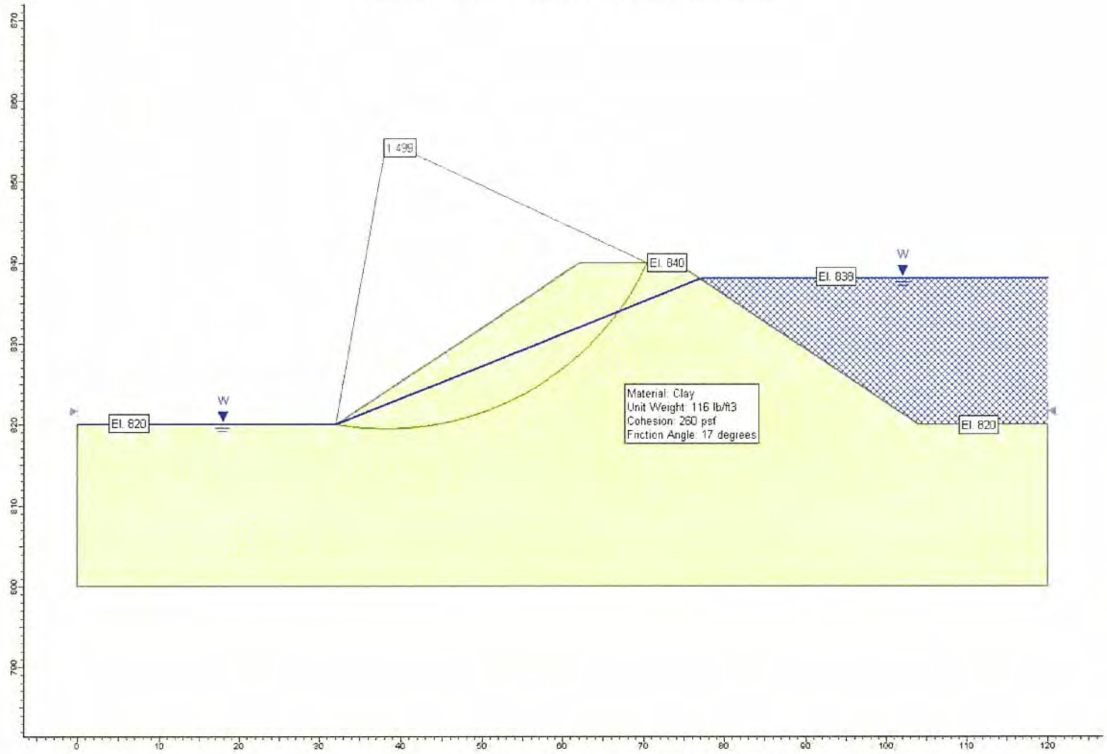
FIGURE 12

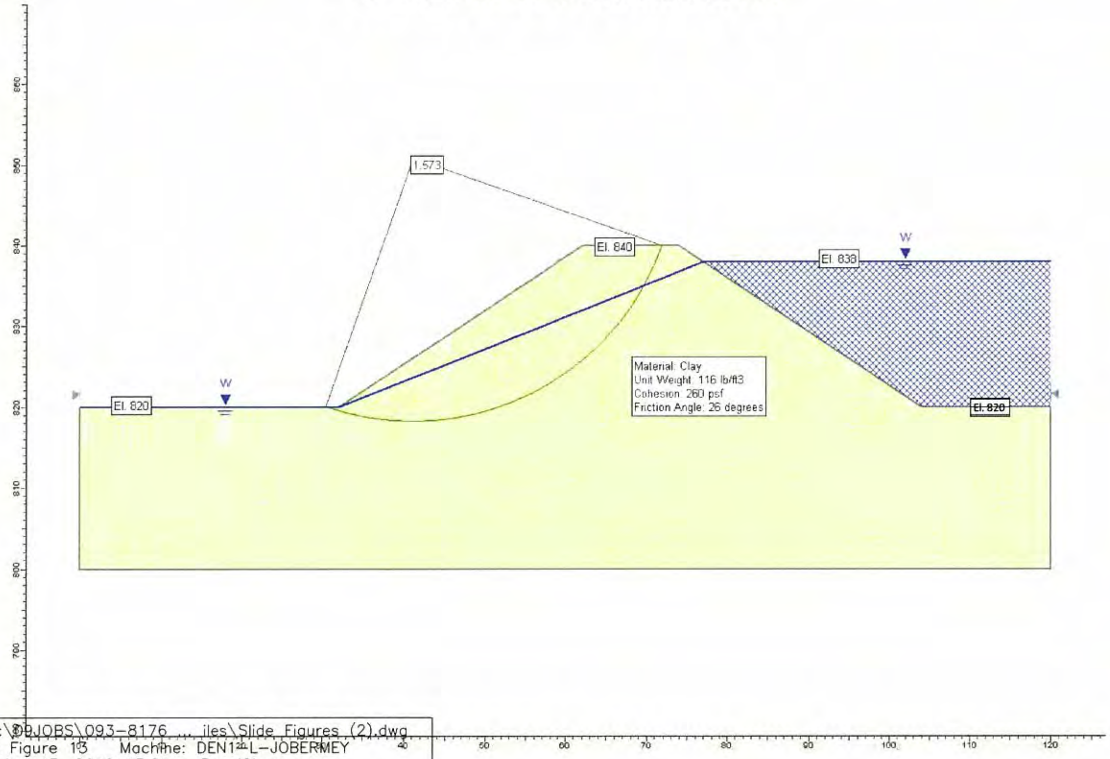
PROJECT No. 09381765 CADD JEO DATE 01/15/10 FILE No. Slide Figures (2).dwg

Plot Time: 01/15/10 15:26

SECTION 2D - SHORT-TERM ANALYSIS



SECTION 2D - LONG-TERM ANALYSIS



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Layout Name: Figure 13 Machine: DEN1-L-JOBERMEY
Last Update: Jan 15, 2010 15:21 By: JObermeyer
Last Plot: Jan 15, 2010 15:25 By: JObermeyer

STABILITY ANALYSES RESULTS
CROSS SECTION 2D

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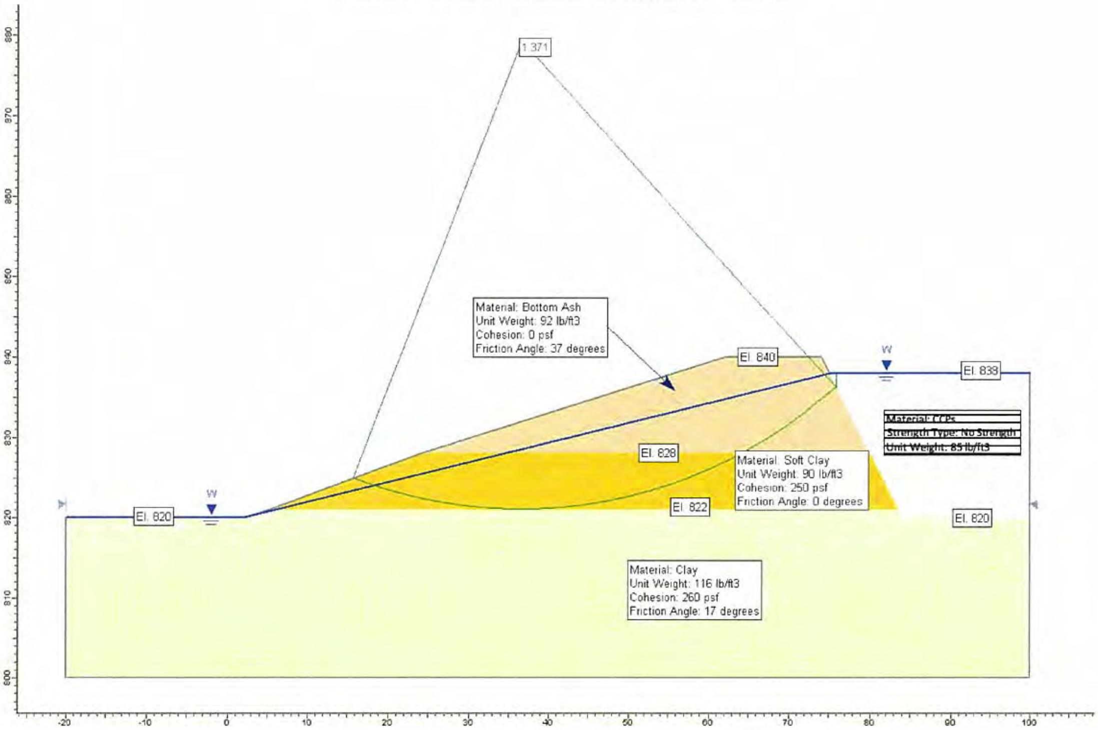
FIGURE 13

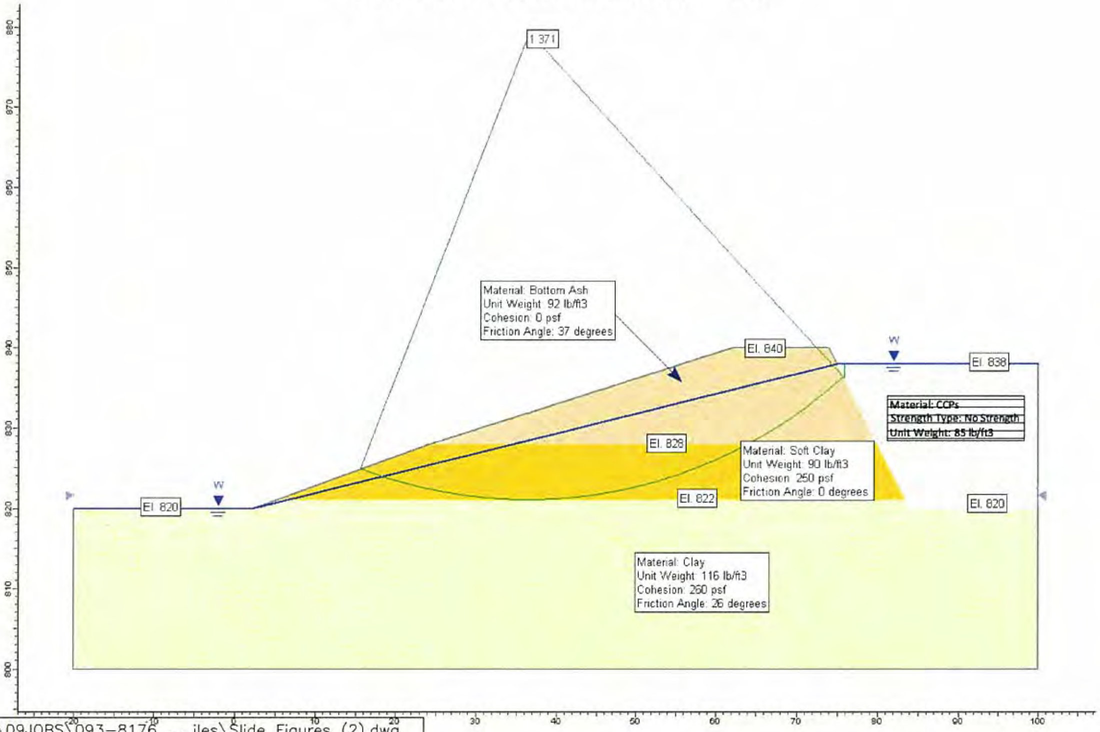
PROJECT No. 09381765 CADD JEO DATE 01/15/10 FILE No. Slide Figures (2).dwg

Plot Time: 01/15/10 15:25

SECTION 3A - SHORT-TERM ANALYSIS



SECTION 3A - LONG-TERM ANALYSIS



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Layout Name: Figure 14 Machine: DEN1-L-JOBERMEY
Last Update: Jan 15, 2010 15:21 By: JObermeyer
Last Plot: Jan 15, 2010 15:24 By: JObermeyer

STABILITY ANALYSES RESULTS
CROSS SECTION 3A

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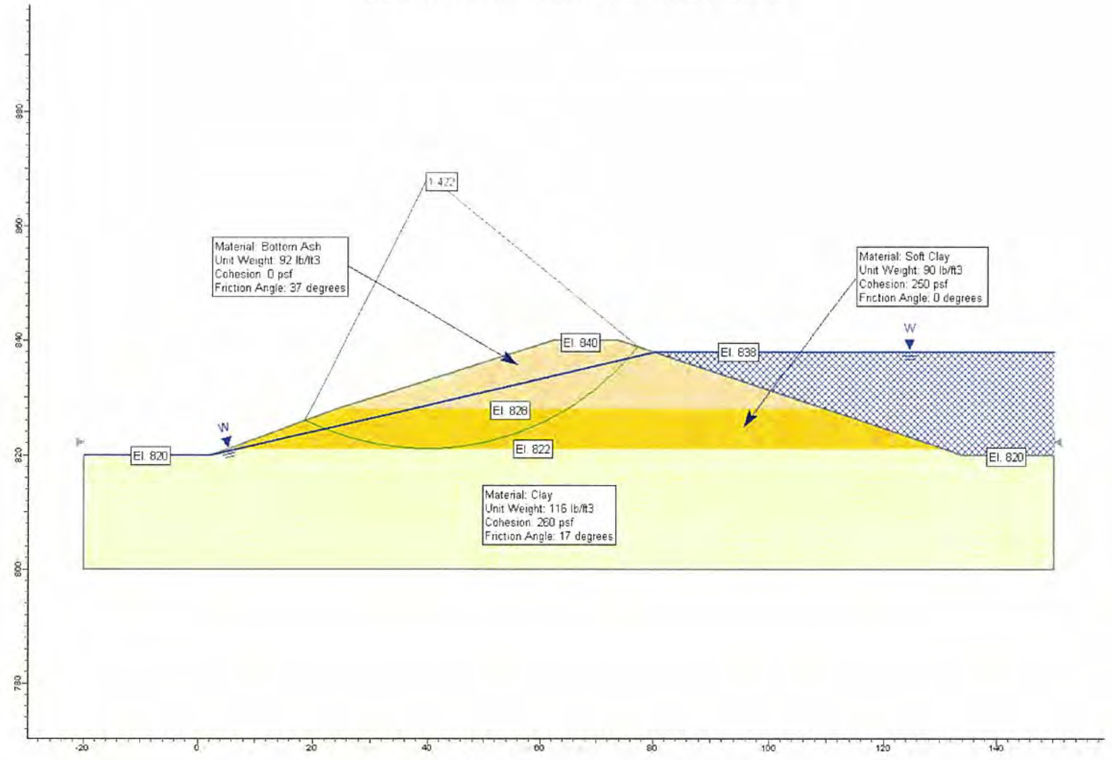
FIGURE 14

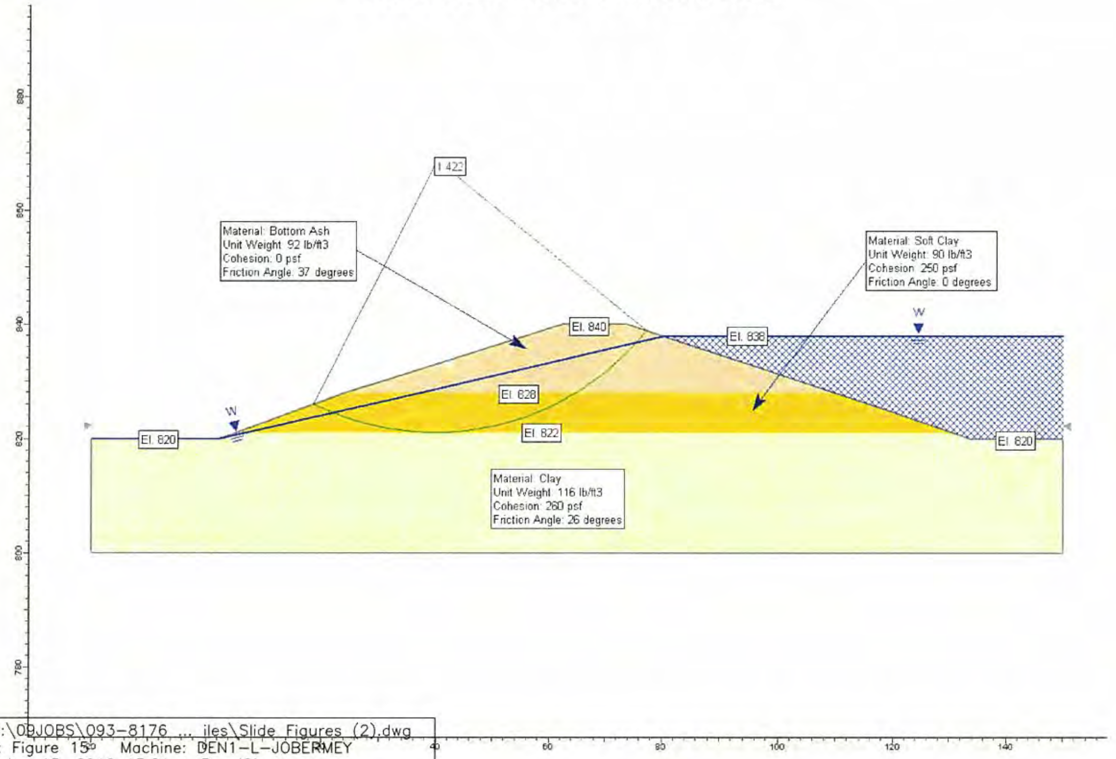
PROJECT No. 09381765 CADD JEO DATE 01/15/10 FILE No. Slide Figures (2).dwg

Plot Time: 01/15/10 15:24

SECTION 3B - SHORT-TERM ANALYSIS



SECTION 3B - LONG-TERM ANALYSIS



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Layout Name: Figure 15 Machine: DEN1-L-JOBERMEY
Last Update: Jan 15, 2010 15:21 By: JObermeyer
Last Plot: Jan 15, 2010 15:22 By: JObermeyer

STABILITY ANALYSES RESULTS CROSS SECTION 3B

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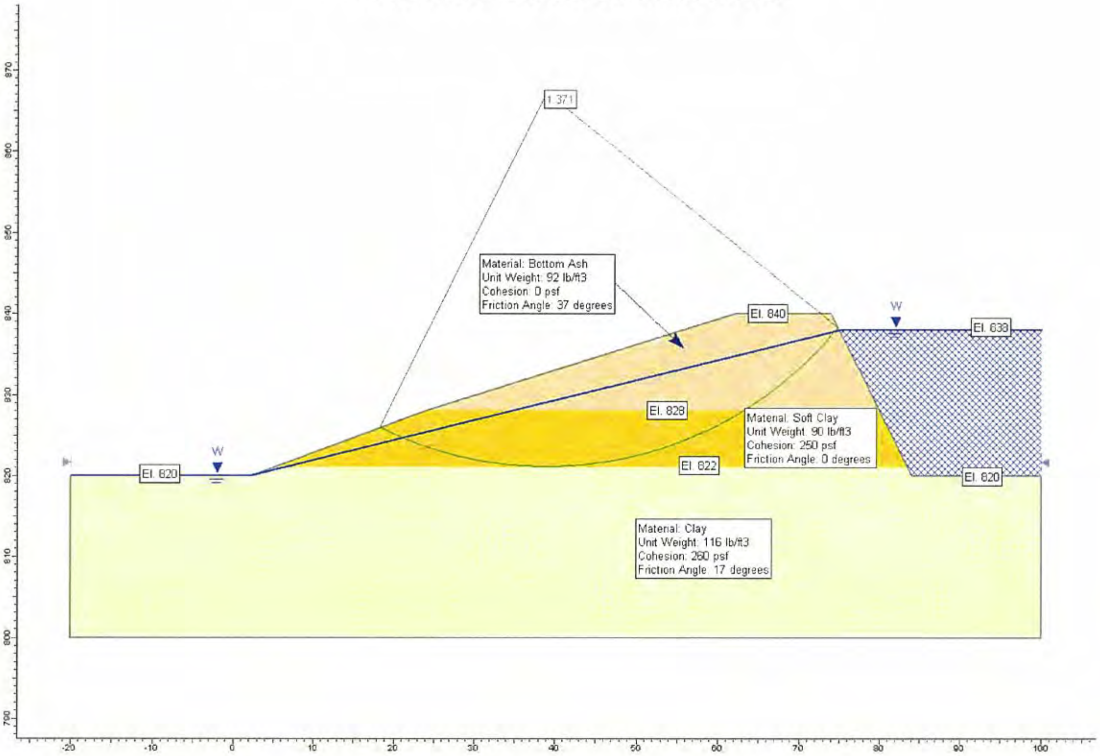
FIGURE 15

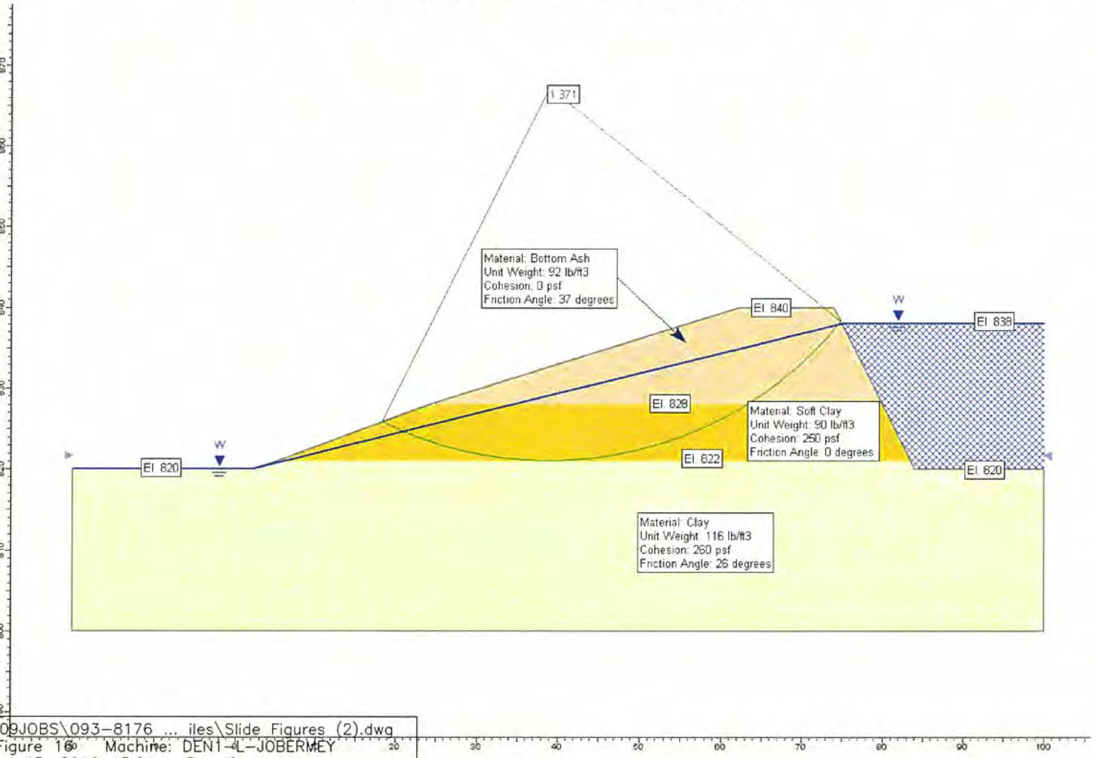
PROJECT No. 09381765 CADD JEO DATE 01/15/10 FILE No. Slide Figures (2).dwg

Plot Time: 01/15/10 15:22

SECTION 3C - SHORT-TERM ANALYSIS



SECTION 3C - LONG-TERM ANALYSIS



Dwg Name: J:\09JOBS\093-8176 ... iles\Slide Figures (2).dwg
Layout Name: Figure 16 Machine: DEN1-L-JOBERMEYER
Last Update: Jan 15, 2010 15:21 By: JObermeyer
Last Plot: Jan 15, 2010 15:22 By: JObermeyer

STABILITY ANALYSES RESULTS
CROSS SECTION 3C

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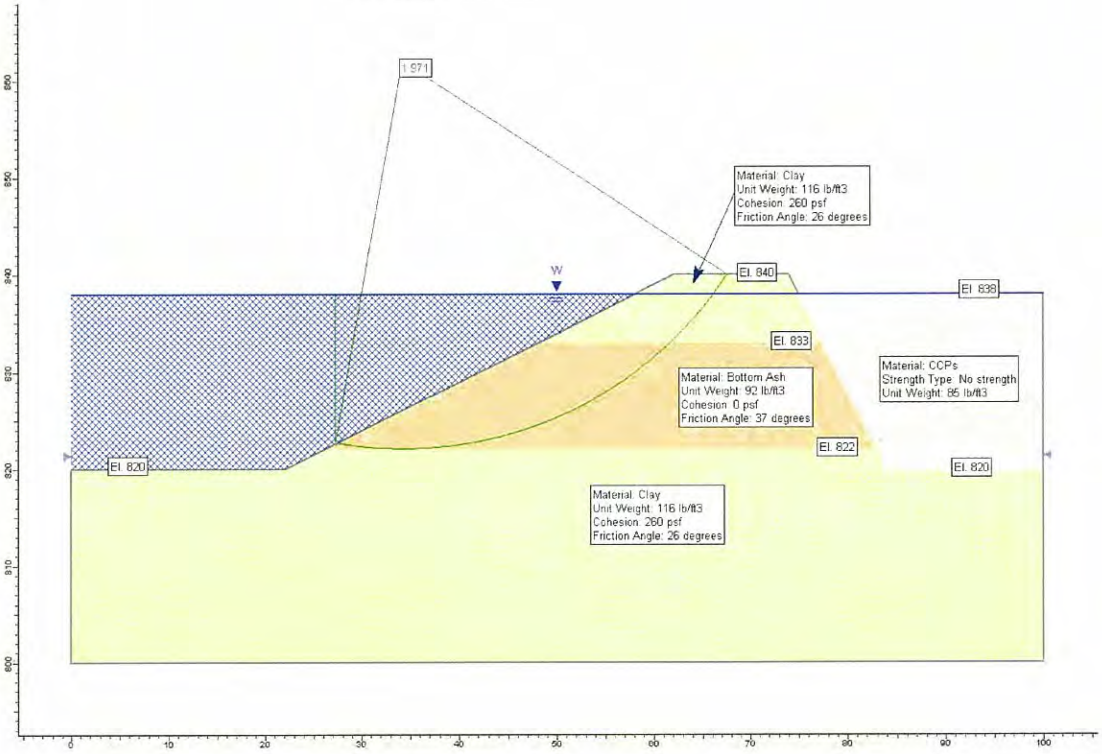
FIGURE 16

PROJECT No. 09381765 CADD JEO DATE 01/15/10 FILE No. Slide Figures (2).dwg

Plot Time: 01/15/10 15:22

SECTION 4A - LONG-TERM ANALYSIS



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Layout Name: Figure 17 Machine: DEN1-L-JOBERMEY
Last Update: Jan 15, 2010 15:21 By: JObermeyer
Last Plot: Jan 15, 2010 15:21 By: JObermeyer

STABILITY ANALYSIS RESULT
CROSS SECTION 4A

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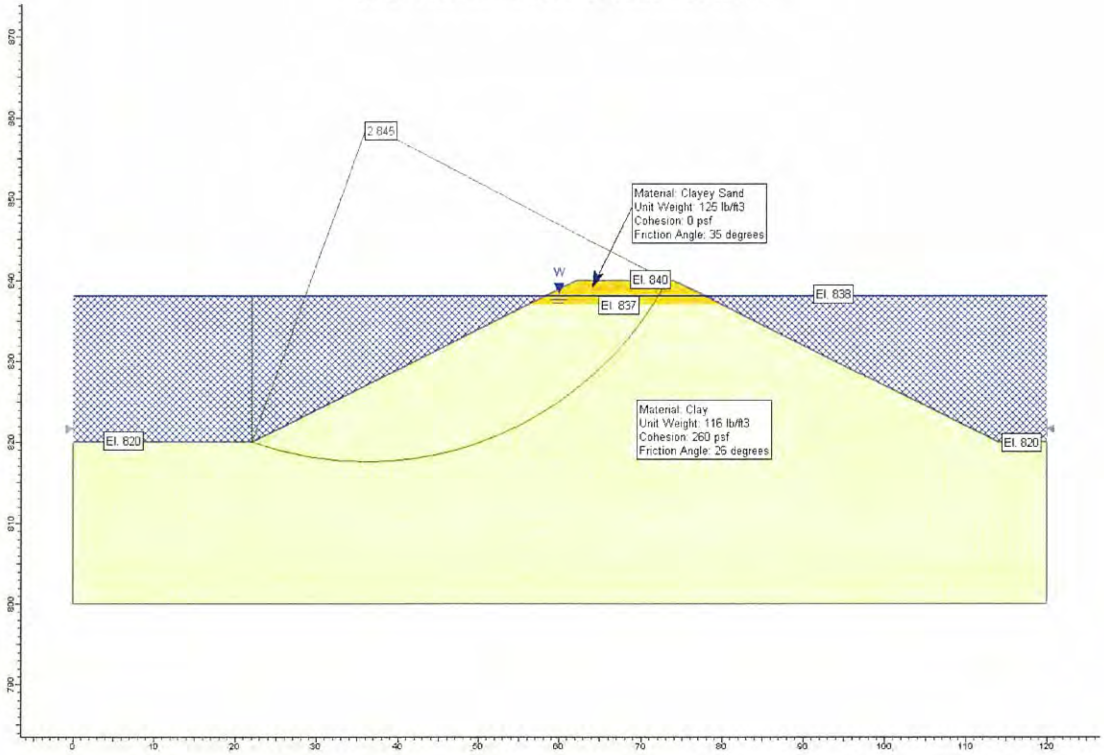
FIGURE 17

PROJECT No. 09381765 CADD JEO DATE 01/15/10 FILE No. Slide Figures (2).dwg

Plot Time: 01/15/10 15:21

SECTION 4B - LONG-TERM ANALYSIS



Dwg Name: J:\09JOBS\093-8176 ... iles\Slide Figures (2).dwg
Layout Name: Figure 18 Machine: DEN1-L-JOBERMEY
Last Update: Jan 15, 2010 15:07 By: JObermeyer
Last Plot: Jan 15, 2010 15:14 By: JObermeyer

STABILITY ANALYSIS RESULT
CROSS SECTION 4B

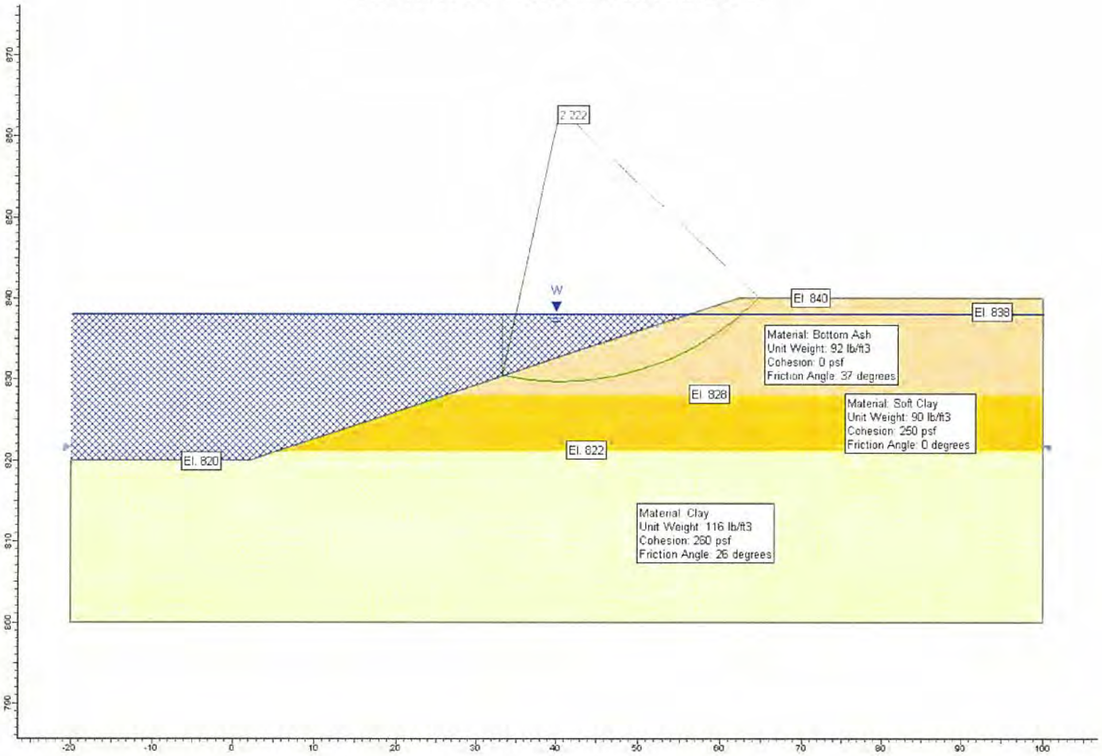
Golder Associates
DENVER, COLORADO

FIGURE 18

PROJECT No. 09381765 CADD JEO DATE 01/15/10 FILE No. Slide Figures (2).dwg

Plot Time: 01/15/10 15:14

SECTION 4C - LONG-TERM ANALYSIS



Dwg Name: J:\09JOBS\093-8176 ... iles\Slide Figures (2).dwg
Layout Name: Figure 19 Machine: DEN1-L-JOBERMEY
Last Update: Jan 15, 2010 15:07 By: JObermeyer
Last Plot: Jan 15, 2010 15:13 By: JObermeyer

STABILITY ANALYSIS RESULT
CROSS SECTION 4C

Golder Associates
DENVER, COLORADO

FIGURE 19

PROJECT No. 09381765 CADD JEO DATE 01/15/10 FILE No. Slide Figures (2).dwg

Plot Time: 01/15/10 15:13

ATTACHMENTS

ATTACHMENT A
BOREHOLE LOGS

Golder Associates

BOREHOLE LOG

Temp: 50ºF Weather: Clear Engineer: J. Obermeyer Operator: J. Johnson Boring LEC-1
Equipment: Truck-mounted CME drill rig Contractor: Terracon Consultants, Inc. Date 10/26/09
Location Lawrence Energy Center Northing 258,450 Easting 2,086,625 Job No. 093-81765.2

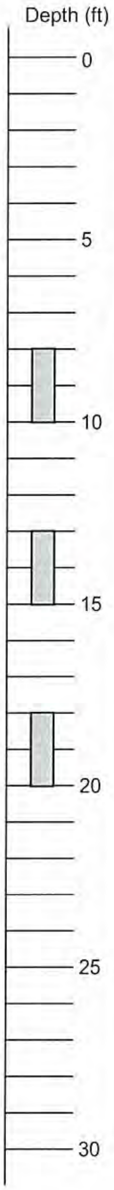
Depth (ft)	Material	Notes
0	0-1' ASPHALT and loose, black, BOTTOM ASH, (ML) 1-5' Firm, brown, SILTY CLAY, trace sand, (CL)	Berm road and road base
5	5-18' Stiff to very stiff, dark brown, SILTY CLAY, trace sand, (CL to CH)	Encountered and penetrated an unidentified 6" PVC pipe at depth of approximately 7' near the centerline of the berm.
10		2" Shelby tube sample (Sample 1) from 13-15' Pocket penetrometer result: 3.25 tsf (15')
15		End of boring at 18'
20		
25		
30		

Sample Descriptions and Boring Notes	Time	Depth of Hole	Depth to Waterline
• Groundwater was not encountered. Water entered the borehole after Westar personnel initiated flow through the 6" PVC pipe to determine its purpose. Westar personnel directed the water into the ash pond. • The 6" PVC pipe was promptly repaired by Schmidtlein Excavating, Inc., personnel. • Northing and easting are approximate (±25'). Borehole location was approximately 25' northwest of the discharge location and approximately 10' from the upstream berm crest.			

Special Notes:
Terracon personnel: John Johnson, Brandon Hall

BOREHOLE LOG

Temp: 50ºF Weather: Clear Engineer: J. Obermeyer Operator: J. Johnson Boring LEC-2
Equipment: Truck-mounted CME drill rig Contractor: Terracon Consultants, Inc. Date 10/26/09
Location Lawrence Energy Center Northing 258,450 Easting 2,086,210 Job No. 093-81765.2



Material	Notes
0-1' ASPHALT 1-5' Loose, black, BOTTOM ASH, (ML)	Berm road Road base and fill
5-16' Very stiff, light gray, SILTY CLAY, trace gravel, trace sand, (CL to CH)	2" Shelby tube sample (Sample 1) from 8-10' (18" recovered) Pocket penetrometer result: 4.5 tsf (10')
	2" Shelby tube sample (Sample 2) from 13-15' (16" recovered) Pocket penetrometer result: 4.25 tsf (15')
16-20' Very stiff, dark brown, SILTY CLAY, trace sand, (CL to CH)	2" Shelby tube sample (Sample 3) from 18-20' (17" recovered) Pocket penetrometer result: 3.75 tsf (20')
	End of boring at 20'

Sample Descriptions and Boring Notes	Time	Depth of Hole	Depth to Waterline
• Groundwater was not encountered. • Northing and easting are approximate (±25'). Borehole location was approximately 21' from the upstream berm crest.			
	Special Notes:		
	Terracon personnel: John Johnson, Brandon Hall		

Golder Associates

BOREHOLE LOG

Temp: 50°F Weather: Clear Engineer: J. Obermeyer Operator: J. Johnson Boring LEC-3
Equipment: Truck-mounted CME drill rig Contractor: Terracon Consultants, Inc. Date 10/26/09
Location Lawrence Energy Center Northing 258,115 Easting 2,085,825 Job No. 093-81765.2

Depth (ft)	Material	Notes
0	0-1' ASPHALT 1-3' Loose, black, BOTTOM ASH, (ML) 3-7' Stiff, gray to brown, SILTY CLAY, trace sand, (CL)	Berm road Road base and fill
5	7-13' Stiff, to very stiff, dark brown, SILTY CLAY, little sand, (CL to CH)	2" Shelby tube sample (Sample 1) from 8-10' (26" recovered) Pocket penetrometer result: 2.75 tsf (10')
10	13-24' Stiff to very stiff, dark brown, CLAY, little sand, (CH)	2" Shelby tube sample (Sample 2) from 13-15' (10" recovered) Pocket penetrometer result: 4.75 tsf (15')
15		2" Shelby tube sample (Sample 3) from 18-20' (24" recovered) Pocket penetrometer result: 1.75 tsf (20')
20		End of boring at 24'
25		
30		

Sample Descriptions and Boring Notes	Time	Depth of Hole	Depth to Waterline
• Groundwater was not encountered. • Northing and easting are approximate (±25'). Borehole location was approximately 21' from the upstream berm crest.			

Special Notes:
Terracon personnel: John Johnson, Brandon Hall

Golder Associates

BOREHOLE LOG

Temp: 50ºF Weather: Clear Engineer: J. Obermeyer Operator: J. Johnson Boring LEC-4
Equipment: Truck-mounted CME drill rig Contractor: Terracon Consultants, Inc. Date 10/26/09
Location Lawrence Energy Center Northing 257,490 Easting 2,085,610 Job No. 093-81765.2

Depth (ft)	Material	Notes
0	0-1' ASPHALT 1-5' Loose, black, BOTTOM ASH, (ML)	Berm road Road base and fill
5	5-17' Very stiff, dark brown, SILTY CLAY, little sand, (CL)	2" Shelby tube sample (Sample 1) from 8-10' (11" recovered) Pocket penetrometer result: 4.25 tsf (10')
10		2" Shelby tube sample (Sample 2) from 13-15' (26" recovered) Pocket penetrometer result: 4.0 tsf (15')
15	17-20' Soft, light gray, CLAYEY SILT, some sand, (ML)	2" Shelby tube sample (Sample 3) from 18-20' (11" recovered) Pocket penetrometer result: 0.5 tsf (20')
20		End of boring at 20'
25		
30		

Sample Descriptions and Boring Notes	Time	Depth of Hole	Depth to Waterline
• Groundwater was not encountered. • Northing and easting are approximate (±25'). Borehole location was approximately 18' from the upstream berm crest.			

Special Notes:
Terracon personnel: John Johnson, Brandon Hall

BOREHOLE LOG

Temp: 50ºF Weather: Clear Engineer: J. Obermeyer Operator: J. Johnson Boring LEC-5
Equipment: Truck-mounted CME drill rig Contractor: Terracon Consultants, Inc. Date 10/26/09
Location Lawrence Energy Center Northing 257,850 Easting 2,086,250 Job No. 093-81765.2

Depth (ft)	Material	Notes
0	0-3' Loose, dark brown, CLAYEY SAND, (SC) 3-5' Stiff, dark brown, CLAY, (CH)	
5	5-18' Very stiff, gray, SILTY CLAY, little sand, (CL)	2" Shelby tube sample (Sample 1) from 8-10' (14" recovered) Pocket penetrometer result: 4.25 tsf (10')
10		
15		End of boring at 18'
20		
25		
30		

Sample Descriptions and Boring Notes	Time	Depth of Hole	Depth to Waterline
• Groundwater was not encountered. • Northing and easting are approximate (±25'). Borehole location was approximately in the center of the berm.			

Special Notes:
Terracon personnel: John Johnson, Brandon Hall

Golder Associates

BOREHOLE LOG

Temp: 50ºF Weather: Clear Engineer: J. Obermeyer Operator: J. Johnson Boring LEC-6
Equipment: Truck-mounted CME drill rig Contractor: Terracon Consultants, Inc. Date 10/26/09
Location Lawrence Energy Center Northing 257,525 Easting 2,086,350 Job No. 093-81765.2

Depth (ft)	Material	Notes
0	0-3' Loose, black, BOTTOM ASH, some gravel, little clay, (ML) 3-5' Stiff, red to brown, SILTY CLAY, little sand (CL)	
5	5-14' Dense, black, BOTTOM ASH, (ML)	
10	14-18' Stiff, red, SILTY CLAY, some sand, (CL)	Bottom ash mixed in; likely a transition zone from the bottom ash layer to an underlying clay layer
15		End of boring at 18'
20		
25		
30		

Sample Descriptions and Boring Notes	Time	Depth of Hole	Depth to Waterline
- Groundwater was not encountered. - Northing and easting are approximate (±25'). Borehole location was approximately 10' from the west berm crest.			

Special Notes:
Terracon personnel: John Johnson, Brandon Hall

I:\09\81765.2\0100\0122\AshRmvlSupport JAN10\AttA\6_LEC-6 Boring Log.docx

Golder Associates

BOREHOLE LOG

Temp: 50ºF Weather: Clear Engineer: J. Obermeyer Operator: J. Johnson Boring LEC-7
Equipment: Truck-mounted CME drill rig Contractor: Terracon Consultants, Inc. Date 10/26/09
Location Lawrence Energy Center Northing 257,200 Easting 2,086,550 Job No. 093-81765.2

Depth (ft)	Material	Notes
0	0-12' Compact, black, BOTTOM ASH, some clay, (ML)	
5 ▼		
10	12-17' Very soft, brown, SLUDGE, (ML)	
15	17-19' Soft, gray, SLUDGE, some sand, (ML) 19-23' Stiff, brown, SILTY CLAY, some sand, (CL)	
20		End of boring at 23'
25		
30		

Sample Descriptions and Boring Notes	Time	Depth of Hole	Depth to Waterline
• Groundwater was encountered at a depth of 6'. • Northing and easting are approximate (±25'). Borehole location was approximately 30' from the north berm crest.			

Special Notes:
Terracon personnel: John Johnson, Brandon Hall

Golder Associates

BOREHOLE LOG

Temp: 50ºF Weather: Clear
Engineer: J. Obermeyer Operator: J. Johnson
Boring LEC-8
Equipment: Truck-mounted CME drill rig
Contractor: Terracon Consultants, Inc.
Date 10/26/09
Location Lawrence Energy Center
Northing 258,250 Easting 2,086,375
Job No. 093-81765.2

Depth (ft)	Material	Notes
0 ▼	0-12’ Compact, black, BOTTOM ASH, some clay, (ML)	
5		
10	12-18’ Very soft, brown, SLUDGE, some sand, (ML)	Driller was able to penetrate stratum without rotating the auger
15		End of boring at 18’
20		
25		
30		

Sample Descriptions and Boring Notes	Time	Depth of Hole	Depth to Waterline
• Groundwater was encountered at a depth of 4’. • Northing and easting are approximate (±25’). Borehole location was approximately 10’ from the west berm crest.			

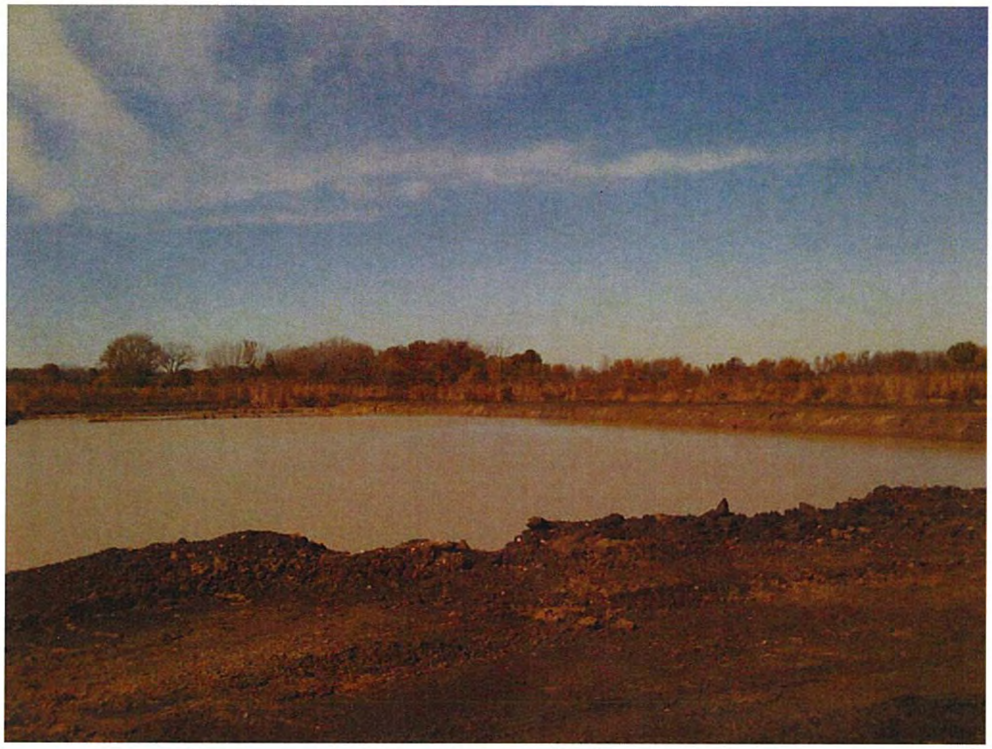
Special Notes:
Terracon personnel: John Johnson, Brandon Hall

ATTACHMENT B
PHOTOGRAPHS

APPENDIX B – PHOTOGRAPHS

1. Exterior of northeastern portion of perimeter dike - Taken from east end of Area 1, looking west.
2. Discharge pipe at east end of Area 1.
3. Interior of northeastern portion of perimeter dike – Taken from east end of Area 1, looking west.
4. Exterior of northeastern portion of perimeter dike – Taken from east end of Area 1, looking west.
5. Emergency overflow structure – west end of Area 1.
6. Outfall of emergency overflow structure – exterior of north side of Area 1 dike. Heavy vegetation made access to outfall impractical.
7. Exterior of dike – Taken from north side of Area 4 looking south, up side of dike.
8. Interior separation dike, separating Area 1 from Area 4 – Taken from north end, looking south.
9. Top of northeastern portion of perimeter dike – Taken from midpoint between Area 1 and 4 looking west.
10. Interior of northeastern portion of perimeter dike in Area 4 – Some minor washout/erosion observed.
11. Close-up of 10.
12. Exterior of northeastern portion of perimeter dike (Area 4) – heavy vegetation observed.
13. Exterior of northwestern portion of perimeter dike (Area 4) – heavy vegetation and tress observed.
14. Interior of northwestern portion of perimeter dike (Area 4).
15. Exterior of northwestern portion of perimeter dike (Area 4) – 10" tree observed at toe of embankment.
16. Exterior of northwestern portion of perimeter dike (Area 4) – multiple trees observed on embankment.
17. Baldwin Creek flow near toe of northwestern portion of perimeter dike (Area 4).
18. Exterior of northwestern portion of perimeter dike (Area 4) – 10" tree observed at toe of embankment.
19. Interior of western portion of perimeter dike – Taken from midpoint (between Area 3 and 4) looking north.
20. Interior of western portion of perimeter dike (Area 3) – Taken from western dike looking south along interior of dike. Clay liner being installed.
21. Interior separation dike (Area 3) – Taken from western portion of perimeter dike looking east along interior separation dike. Clay liner being installed.
22. Looking west towards agricultural fields – Taken from top of western portion of perimeter dike (Area 3).
23. Storm water pond at south end of ash pond area/Area 3 – Taken from western dike looking east.
24. Storm water pond discharge pipe on interior of south side of Area 3.
25. Storm water pond outfall pipes on exterior of south side of Area 3.
26. South side of storm water pond (Area 3).
27. Exterior tie-in of perimeter dike to existing grade/road embankment along south side of Area 3.

28. Interior tie-in of perimeter dike to existing grade/road embankment along south side of Area 3.
29. Area 2/middle cell – Taken from west end looking east.
30. Channel connecting Area 2 and Area 3 – Taken from east end looking west.
31. Area 2/south cell – Taken from southwest corner looking northeast.



Photograph 1 – CCP storage facility (looking northwest)

Photograph 2 – CCP storage facility (looking east)

Photograph 3 – CCP storage facility (looking east)

Photograph 4 – Berm crest near Borehole LEC-1 (looking northwest)

Photograph 5 – Drilling Borehole LEC-5 (looking west)

Photograph 6 – Soft saturated clay found in Borehole LEC-7 (looking northeast)

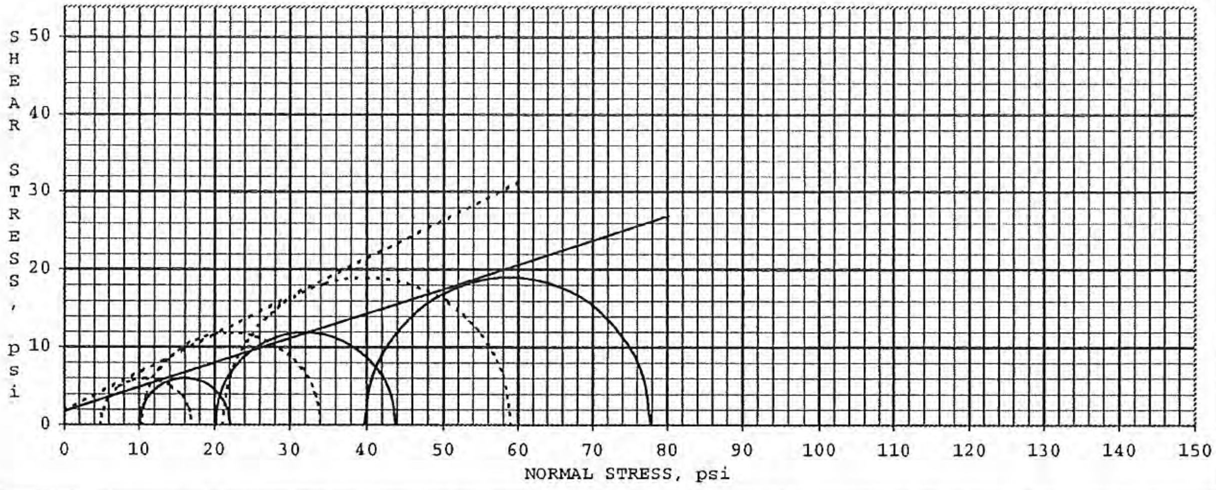
Photograph 7 – Soft saturated clay found in Borehole LEC-7 (looking northeast)

Photograph 8 – Drilling Borehole LEC-8 (looking north)

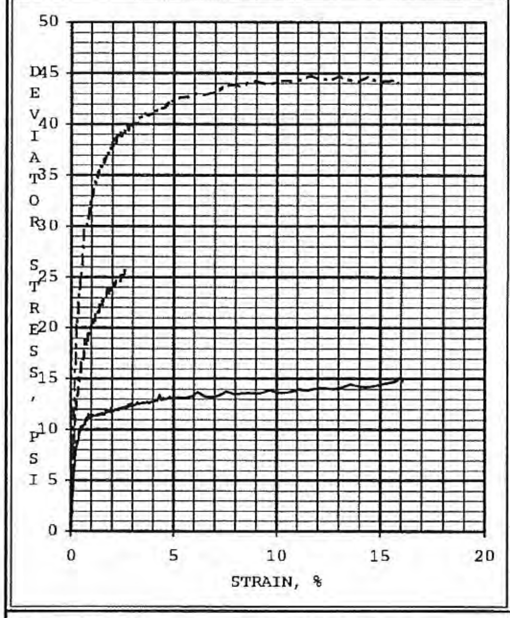
ATTACHMENT C
GEOTECHNICAL TEST RESULTS

EVALUATION OF ASH POND BERMS AT WESTAR ENERGY'S LAWRENCE ENERGY CENTER
SUMMARY OF LABORATORY GEOTECHNICAL TEST DATA

Borehole	Sample	Depth	USCS	Dry Unit Weight	Moisture Content	Liquid Limit	Plasticity Limit	Plasticity Index	Friction Angle	Cohesion
LEC-1	1	13-15'	CL	94 pcf	28%	46	20	26		
LEC-2	1	8-10'	CH	93 pcf	25%	61	22	39	26 deg	250 psf
LEC-3	3	18-20'	CH	91 pcf	27%	74	24	50	28 deg	410 psf
LEC-4	1	8-10'	CL	106 pcf	21%	41	18	23		
LEC-4	2	13-15'			26%					
LEC-4	3	18-20'			27%					



EFFECTIVE STRESS ---	ANGLE OF INTERNAL FRICTION, deg	26.1	COHESION, psi	1.8
TOTAL STRESS ——	ANGLE OF INTERNAL FRICTION, deg	17.4	COHESION, psi	1.8



SPECIMEN ID:		A	B	C
INITIAL	WATER CONTENT, %	26.6	22.8	24.8
	DRY DENSITY, pcf	87.8	97.8	101.0
	SATURATION, %	78	85	100
	VOID RATIO	0.92	0.72	0.67
BEFORE SHEAR	WATER CONTENT, %	33.1	24.8	23.5
	DRY DENSITY, pcf	89.0	100.9	103.2
	SATURATION (B PARAMETER)	0.96	0.99	NA
	VOID RATIO	0.89	0.67	0.63
	FINAL BACK PRESSURE, psi	100.3	94.9	94.8
MINOR PRINCIPAL STRESS, psi		10.0	20.0	39.8
EFFECTIVE STRESS PEAK AT % STRAIN		2.0	2.0	2.0
EFF. DEVIATOR STRESS AT PEAK STRAIN, psi		12.1	23.8	38.1
TOTAL STRESS PEAK AT % STRAIN		2.0	2.0	2.0
TOTAL DEVIATOR STRESS AT PEAK STRAIN, psi		12.1	23.8	38.1
ULTIMATE DEVIATOR STRESS (15% STR), psi		14.5	NA	44.3
TIME TO 50% PRIMARY CONSOLIDATION, min		2.20	31.00	NA
STRAIN RATE, % / hour		4.09	0.57	0.56
INITIAL DIAMETER, inch		1.864	1.841	1.828
INITIAL HEIGHT, inch		3.793	3.731	3.664
AREA AFTER CONSOLIDATION, inch2		2.707	2.601	2.574

CONTROLLED - STRAIN TEST

SAMPLE TYPE: 2" SHELBY TUBE

DESCRIPTION OF SPECIMENS:
FAT CLAY, DARK GRAY

LL 61	PL 22	PI 39	Gs 2.7 EST.

PROJECT NO. 14095047

CIRCLE B & C SAMPLE WAS STAGE LOADED

LABORATORY: TERRACON - LENEXA

DATE: 11/18/2009

PROJECT: LEC / TEC LAB

BORING #: LEC-2

SAMPLE #: 1

DEPTH, feet: 8.0 - 10.0 feet

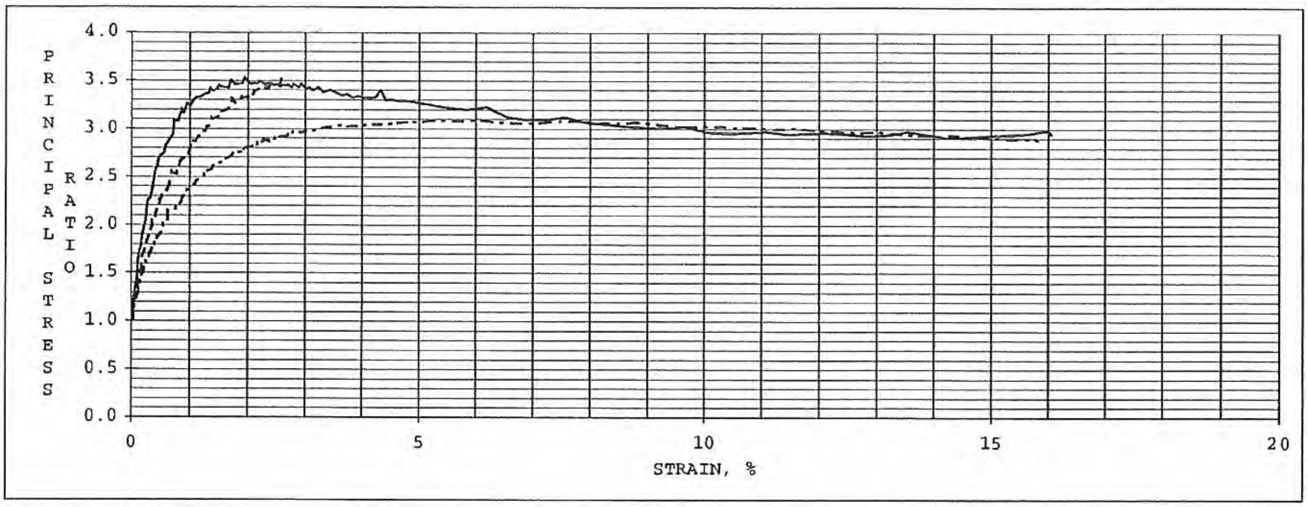
PROCEDURE: ASTM D4767, CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST ON COHESIVE SOILS (TERRACON MODIFIED FOR STAGE LOADING)

Terracon

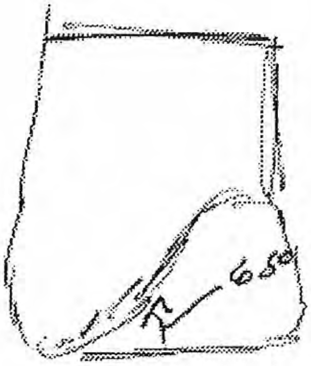
N:\CM\LAB_DATA\00 Projects in Progress\2009 Projects in Progress\14095047\[14095047 Triaxial CU Staged B-C LEC2-1-8.0.xls]REPORT

LEC / TEC LAB

14095047 LEC-2 1 8.0 - 10.0 feet



FAILURE SKETCH

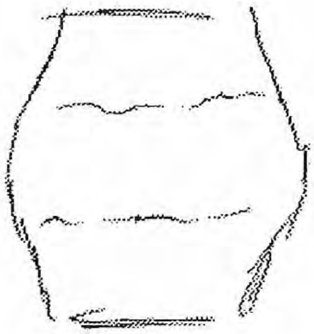


SPECIMEN A

FAILURE SKETCH

SPECIMEN B

FAILURE SKETCH



SPECIMEN C

REMARKS:

SPECIMENS SATURATED BY THE WET METHOD.

EFFECTIVE STRESS FAILURE DATA BASED ON 2 % STRAIN.

EFFECTIVE STRESS MOHR'S CIRCLES DRAWN AT 2 % STRAIN.

TOTAL STRESS FAILURE DATA BASED ON 2 % STRAIN.

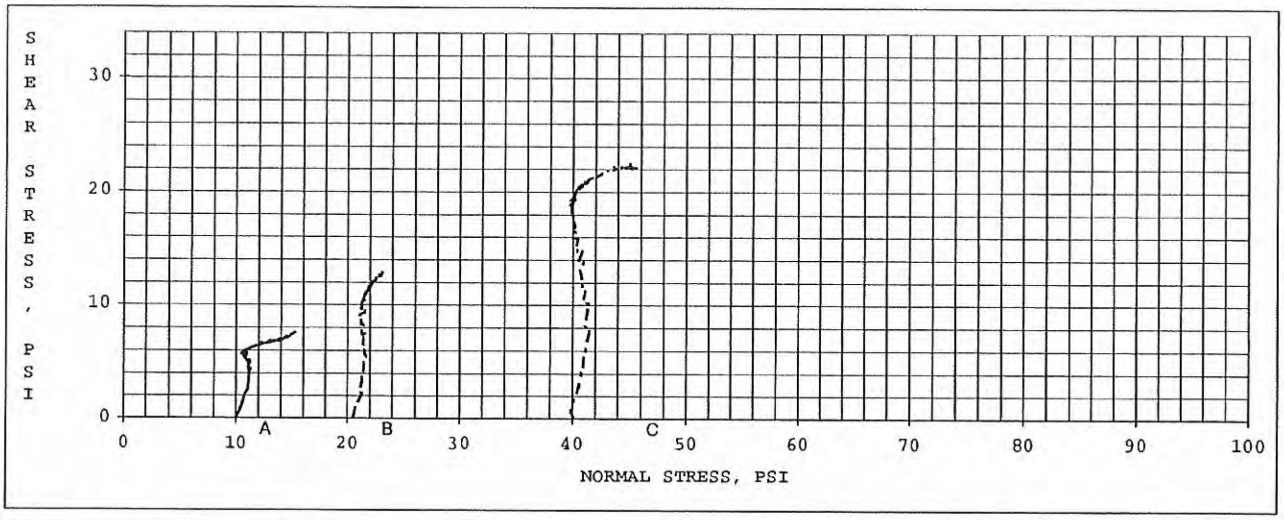
TOTAL STRESS MOHR'S CIRCLES DRAWN AT 2 % STRAIN.

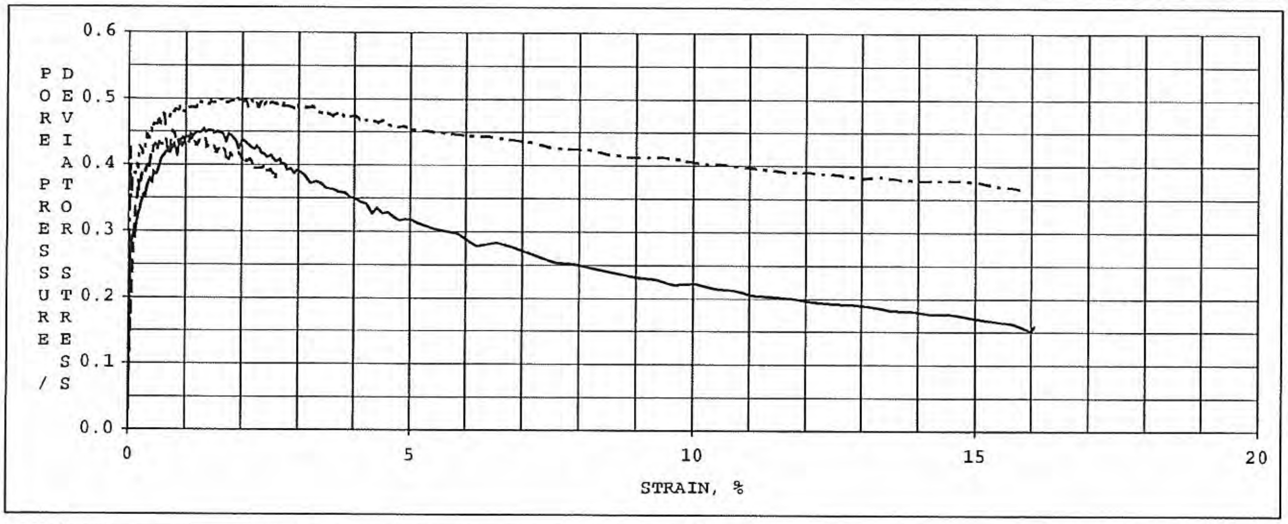
DEVIATOR STRESSES CORRECTED FOR MEMBRANE AND FILTER PAPER EFFECTS.

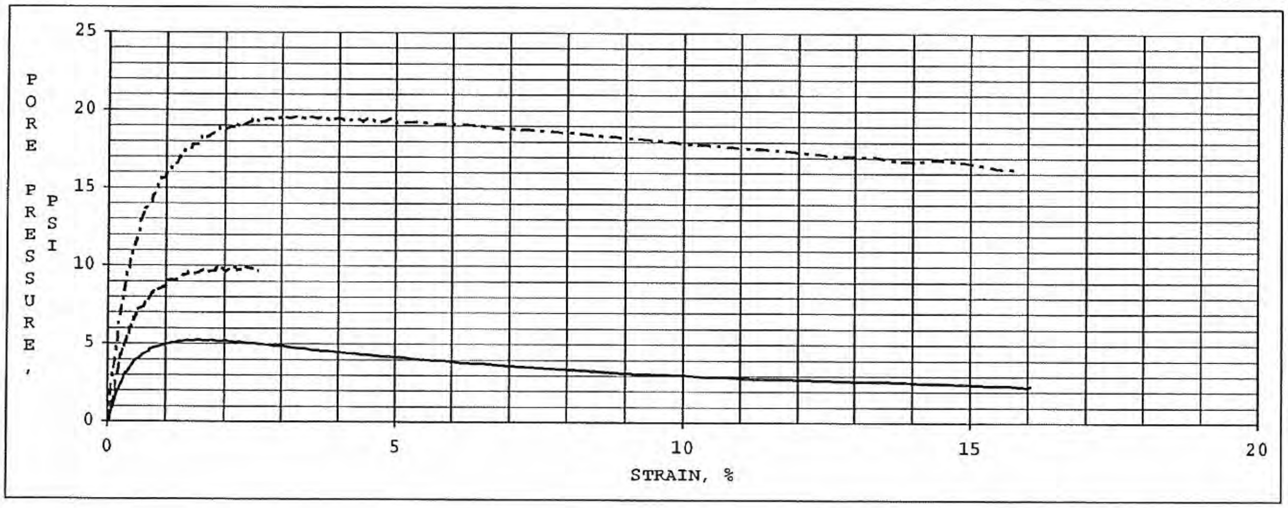
AREA AFTER CONSOLIDATION CALCULATED AS PER SECTION 10.3.2.1 METHOD A

LEC / TEC LAB

14095047 LEC-2 1 8.0 - 10.0 feet







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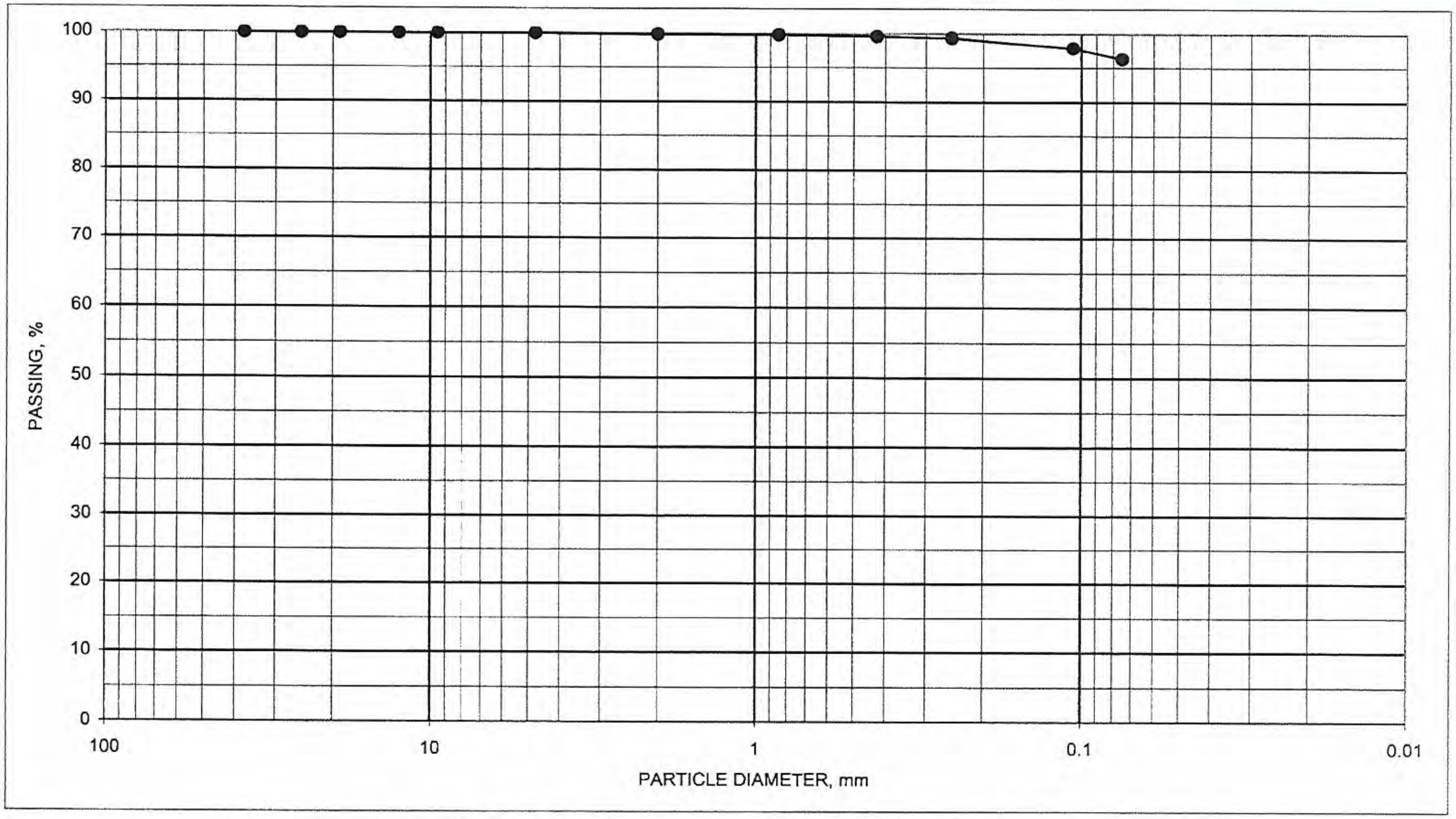
SIEVE SIZE	DIAMETER, mm	PASS, %
1.5"	37.5	100
1"	25.0	100
3/4"	19.0	100
1/2"	12.5	100
3/8"	9.50	100
#4	4.75	100
#10	2.00	100
#20	0.850	100
#40	0.425	100
#60	0.250	99
#140	0.106	98
#200	0.075	96.3



GRAIN SIZE DISTRIBUTION CURVE

BORING ID	SAMPLE ID	DEPTH, feet	USCS DESCRIPTION	UNIFIED SYMBOL	NAT M%	ATTERBERG LIMITS		
						LL	PL	PI
LEC -1	1	13 TO 15	LEAN CLAY DARK GRAY	CL	28.4	46	20	26

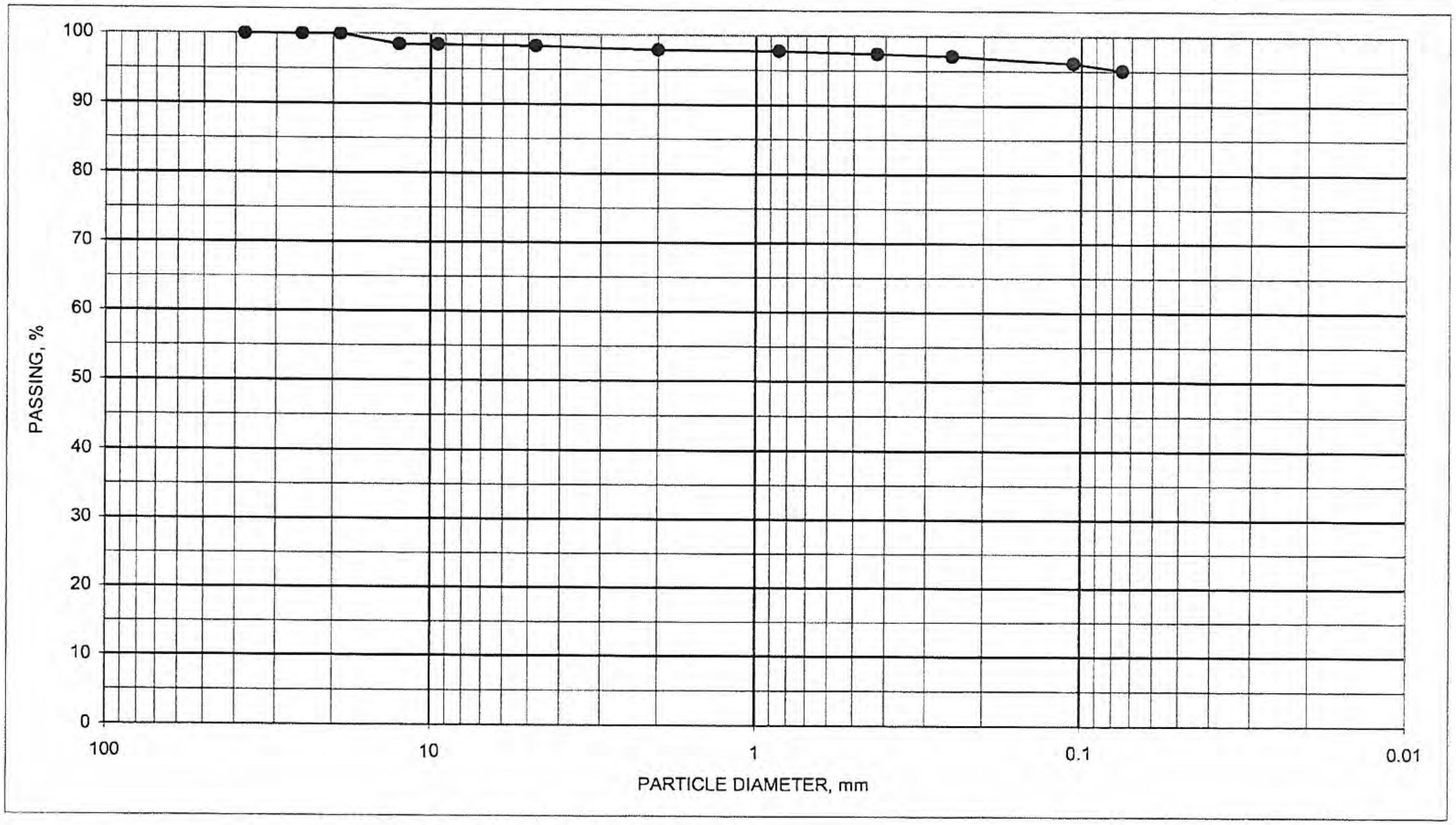
PROJECT LEC / TEC LAB

JOB NO. 14095047 DATE 11/13/2009

N:\CM\LAB_DATA\00 Projects in Progress\2009 Projects in Progress\14095047\[14095047 GradALPlot LEC1-1-13.0.xls]GRADATION

Terracon

SIEVE SIZE	DIAMETER, mm	PASS, %
1.5"	37.5	100
1"	25.0	100
3/4"	19.0	100
1/2"	12.5	99
3/8"	9.50	99
#4	4.75	98
#10	2.00	98
#20	0.850	98
#40	0.425	97
#60	0.250	97
#140	0.106	96
#200	0.075	95.1



GRAIN SIZE DISTRIBUTION CURVE

BORING ID	SAMPLE ID	DEPTH, feet	USCS DESCRIPTION	UNIFIED SYMBOL	NAT M%	ATTERBERG LIMITS LL	PL	PI
LEC -2	1	8 TO 10	FAT CLAY DARK GRAY	CH		61	22	39

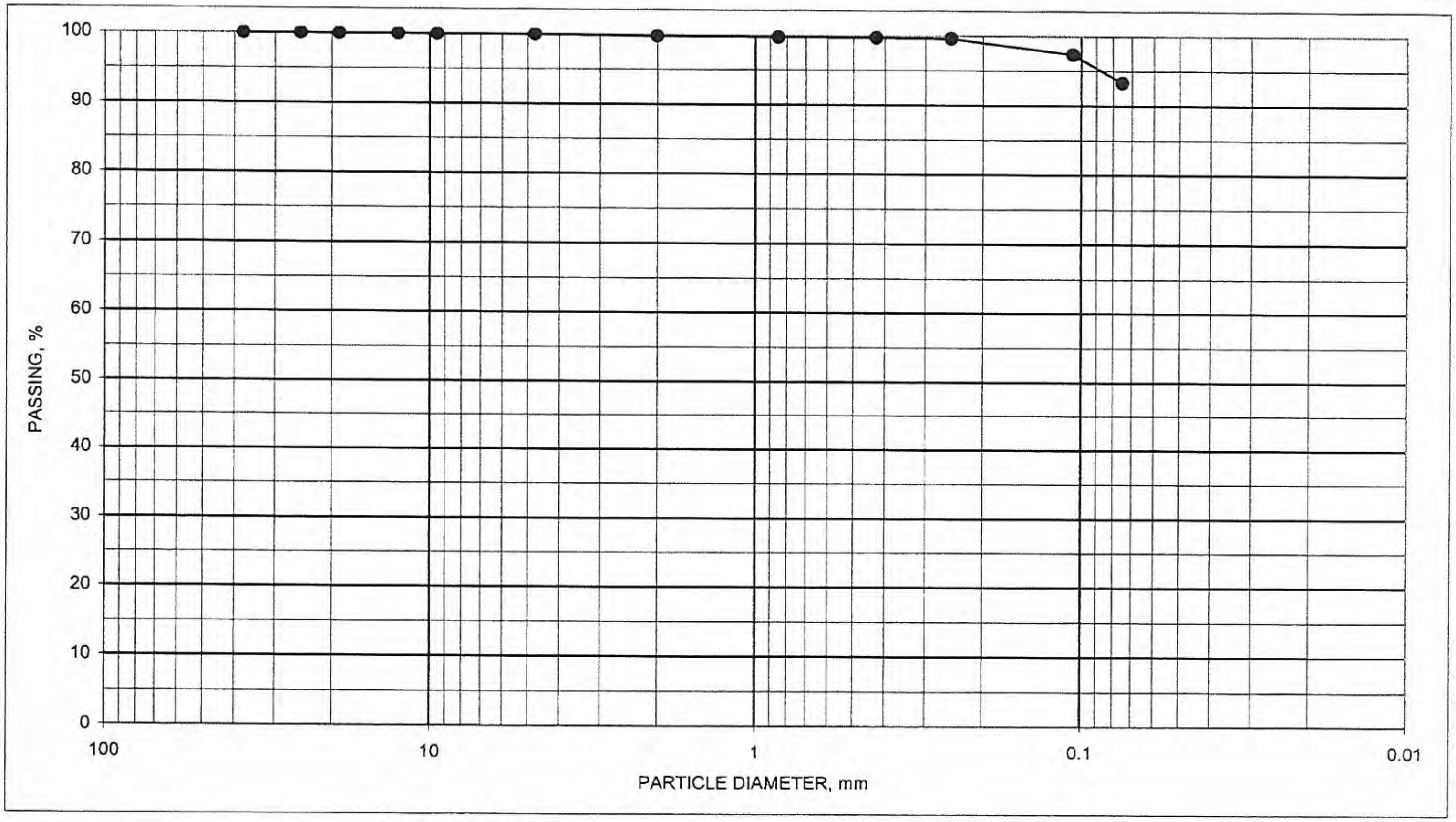
PROJECT LEC / TEC LAB

JOB NO. 14095047 DATE 11/13/2009

N:\CM\LAB_DATA\00 Projects in Progress\2009 Projects in Progress\14095047\[14095047 GradALPlot LEC2-1-8.0.xls]ATTERBERG M%

Terracon

SIEVE SIZE	DIAMETER, mm	PASS, %
1.5"	37.5	100
1"	25.0	100
3/4"	19.0	100
1/2"	12.5	100
3/8"	9.50	100
#4	4.75	100
#10	2.00	100
#20	0.850	100
#40	0.425	100
#60	0.250	100
#140	0.106	97
#200	0.075	93.3



GRAIN SIZE DISTRIBUTION CURVE

BORING ID	SAMPLE ID	DEPTH, feet	USCS DESCRIPTION	UNIFIED SYMBOL	NAT M%	ATTERBERG LIMITS LL	PL	PI
LEC-3	3	18 TO 20	FAT CLAY DARK GRAYISH BROWN & LIGHT GRAY	CH		74	24	50

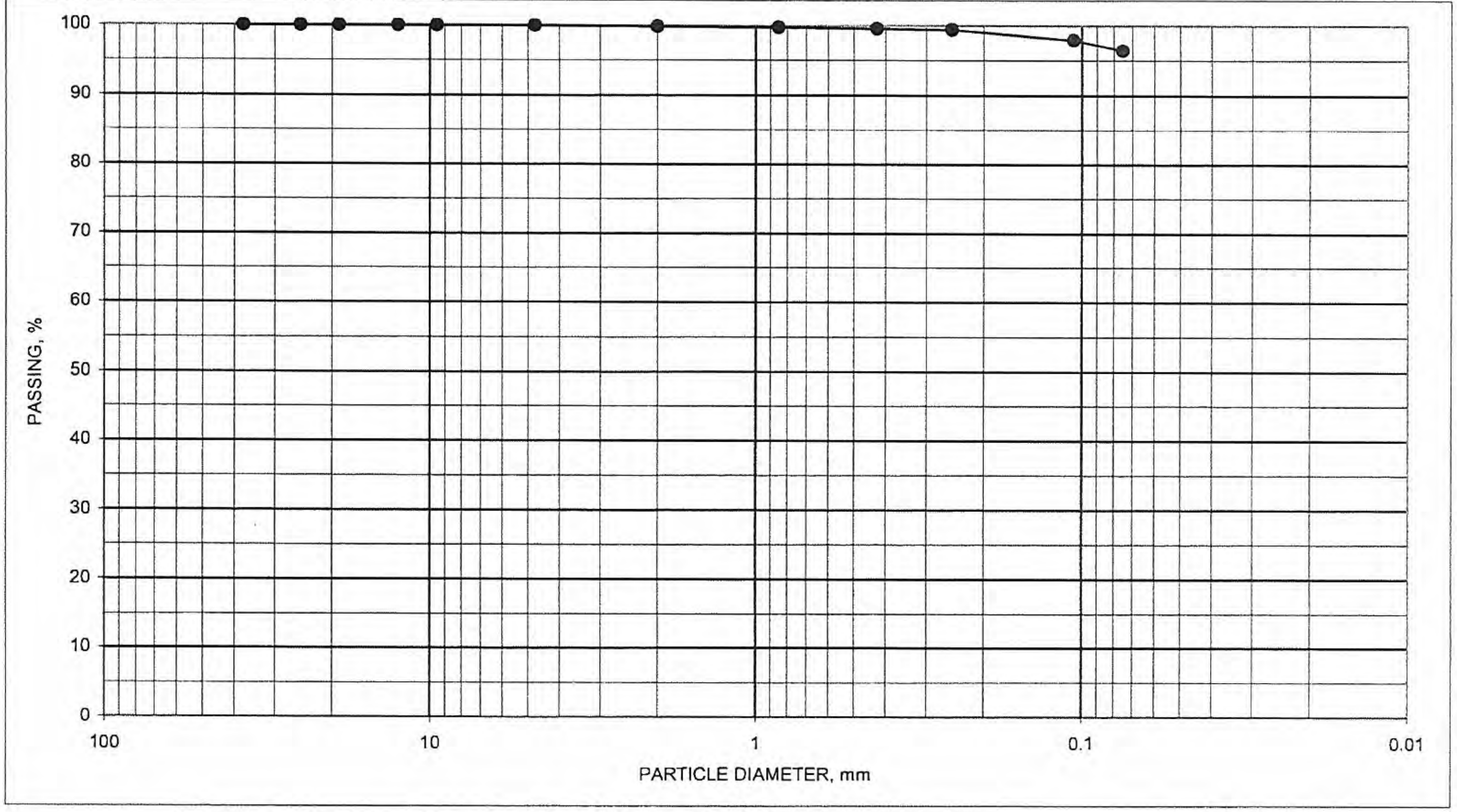
PROJECT LEC / TEC LAB

JOB NO. 14095047 DATE 11/19/2009

N:\CM\LAB_DATA\00 Projects in Progress\2009 Projects in Progress\14095047\[14095047 GradALPlot LEC3-3-18.0.xls]ATTERBERG M%

Terracon

SIEVE SIZE	DIAMETER, mm	PASS, %
1.5"	37.5	100
1"	25.0	100
3/4"	19.0	100
1/2"	12.5	100
3/8"	9.50	100
#4	4.75	100
#10	2.00	100
#20	0.850	100
#40	0.425	100
#60	0.250	99
#140	0.106	98
#200	0.075	96.4



GRAIN SIZE DISTRIBUTION CURVE

BORING ID	SAMPLE ID	DEPTH, feet	USCS DESCRIPTION	UNIFIED SYMBOL	NAT M%	ATTERBERG LIMITS LL	PL	PI
LEC -4	1	8 TO 10	LEAN CLAY DARK GRAY	CL	21.0	41	18	23

PROJECT LEC / TEC LAB

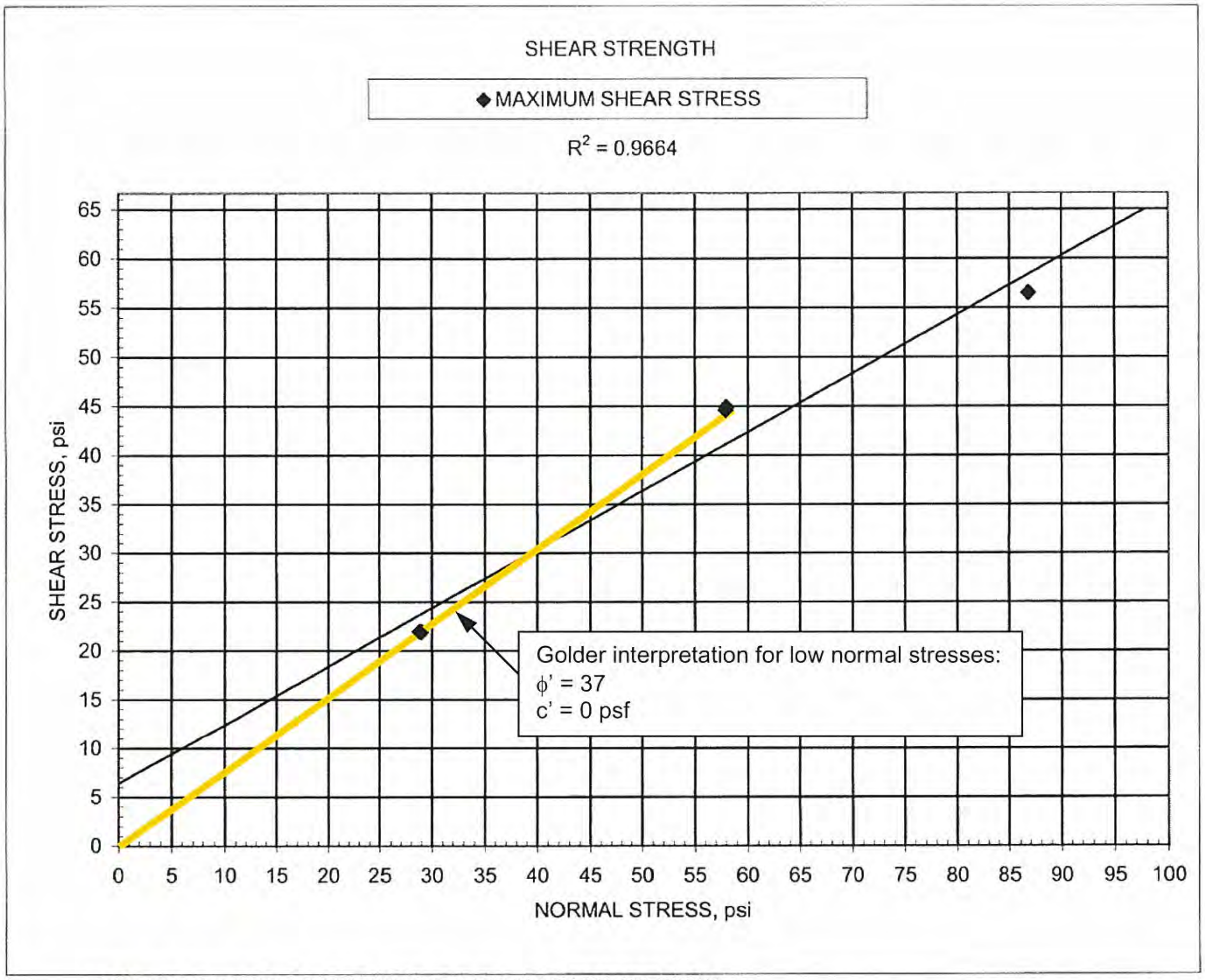
JOB NO. 14095047 DATE 11/13/2009

N:\CM\LAB_DATA\00 Projects in Progress\2009 Projects in Progress\14095047\[14095047 GradALPlot LEC4-1-8.0.xls]ATTERBERG M%

Terracon

ATTACHMENT D
BOTTOM ASH STRENGTH ADJUSTMENT

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS
ASTM D3080



Golder interpretation for low normal stresses:
ϕ' = 37
c' = 0 psf

NOTE: THE COHESION SHOULD NOT BE USED IN ANY CALCULATIONS.

			FRICTION ANGLE	COHESION (apparent)	NORMAL STRESS, psi	NORMAL STRESS, psi	NORMAL STRESS, psi
AT MAXIMUM SHEAR STRESS			**30.9 deg**	**6.4 psi**	28.98	58.00	86.79
INITIAL AREA, mm2	3172.0	INITIAL MOISTURE, %			25.5	25.6	25.4
INITIAL LENGTH, mm	26.16	INITIAL DRY DENSITY, pcf			74.1	75.9	69.7
SPECIFIC GRAVITY	2.70	INITIAL SATURATION, %			54	57	48
SG TESTED	X	INITIAL VOID RATIO			1.27	1.22	1.42
SG ASSUMED		FINAL MOISTURE, %			38.7	35.5	37.5
LIQUID LIMIT		FINAL SATURATION, %			85	84	87
PLASTIC LIMIT		FINAL VOID RATIO			1.23	1.14	1.17
PLASTICITY INDEX		MAXIMUM SHEAR STRESS, psi			21.92	44.89	56.53
SAMPLE TYPE	RECOMPACTED	RATE OF LOADING, in/min			0.0022	0.0022	0.0022
DESCRIPTION	BOTTOM ASH						

PROJECT NAME: LEC - WESTAR

LOCATION: ASH LAGOONS

JOB NO.: 14097035

DATE: 10/21/2009

BORING NO. B-2

SAMPLE NO. BULK

DEPTH, feet 5 TO 11

N:\CM\LAB_DATA\00 Projects in Progress\2009 Projects in Progress\14097035\[14097035 DirectShear B2-BULK-5.0.xls]Report

DOC04: GOLDER ASSOCIATES EVALUATION OF BERMS

REPORT

EVALUATION OF ASH POND BERM STABILITY

Westar Energy – Lawrence Energy Center

Submitted to: Westar Energy
818 Kansas Avenue
Topeka, Kansas 66612 USA
Attn: Andy Evans, P.E.

Submitted by: Golder Associates Inc.
44 Union Boulevard
Suite 300
Lakewood, CO 80228 USA

Distribution: 2 Copies – Westar Energy
2 Copies – Golder Associates Inc.

December 23, 2009 **093-81765.2**

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Golder Associates

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1.0 INTRODUCTION

1.1 Background

Golder Associates Inc. (Golder) has prepared this report to provide Westar Energy (Westar) with the results of Golder's site observations and stability evaluation of coal combustion product (CCP) storage facilities at Westar's Lawrence Energy Center (LEC) in Lawrence, Kansas. This report is in response to the United States Environmental Protection Agency's (EPA's) request for information under Section 104(e) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) regarding impoundments storing liquid-borne CCPs. The report presents a general history of the CCP storage facilities at LEC and a description of Golder's geotechnical investigation (Section 1), the basis and results for Golder's stability analysis (Section 2), a summary of observations made by Golder while visually assessing the CCP storage facilities at LEC (Section 3), and a summary of Golder's conclusions and recommendations (Section 4).

1.2 Site History

Lawrence Energy Center is located in Douglas County, on the north edge of Lawrence, Kansas. Coal combustion products generated at LEC are temporarily staged in impoundments to facilitate dewatering. After the CCPs are dewatered, they are transported to on-site landfills for permanent disposal. Lawrence Energy Center has four staging areas that are separated by earthen embankments, as shown in Figure 1. Areas 1 and 2 were constructed in 1969, concurrent with construction of the energy generation facility, and Areas 3 and 4 were added in 1976. It is Golder's understanding that the staging areas were constructed to an engineered design. However, Westar is not in possession of the design drawings bearing a professional engineer's stamp or the construction records. The staging areas were constructed by excavation from existing grades and have not undergone engineered modifications since initial construction. Agricultural land surrounds the northwest, west, and south sides of the CCP storage facilities, and the energy generation facility and the Kansas River lie to the east and northeast.

1.3 Geotechnical Investigation

Four soil borings, LEC-1, LEC-2, LEC-3, and LEC-4, were completed on October 26, 2009, at the locations shown in Figure 1 to support Golder's stability evaluation. The borehole locations were designated by Golder and Westar in areas where site topography indicated a downstream berm slope height of 12 feet or more, generally around the north and west sides of the CCP storage facilities. Boreholes were drilled near the downstream edge of the berm crest and were advanced with a truck-mounted CME drill rig using 6-inch-diameter hollow stem continuous flight augers. Relatively undisturbed samples were collected from each borehole using 2-inch-diameter thin-walled tube samplers (Shelby tubes). Soil samples were visually classified by Golder's geotechnical engineer in accordance with the Unified Soil Classification System (USCS). Berm stratigraphy was fairly consistent between boreholes and generally consisted of asphalt and bottom ash road base in the top 1 to 5 feet, underlain by low-plasticity clay (CL) and high-plasticity clay (CH) layers to the completed borehole depth. Borehole depths ranged from 18 to 24 feet. Groundwater was not observed in boreholes drilled around the perimeter of the staging areas at LEC. The berm crest is at an elevation of 840 feet above mean sea level. Borehole logs based on field and laboratory soil classification are provided in Appendix A.

2.0 STABILITY EVALUATION

2.1 Slope Geometries

Golder developed two cross sections to evaluate the stability of the embankments surrounding the staging areas at LEC using site topography provided by Westar. The locations of the cross sections are shown in Figure 2. Based on site topography and visual assessment, Golder selected cross section locations to represent the critical slopes for stability analysis of the CCP storage facilities at LEC. Golder conservatively assumed that the staging areas were filled with CCPs to an elevation two feet below the berm crest and that ponded water reached the same elevation as the berm crest. The depth of CCP storage facilities was assumed to be 20 feet based on information provided by Westar (Terracon Consultants, Inc. 2009). Golder conservatively used a 0.5 (horizontal) to 1 (vertical) slope ratio for the upstream berm slopes.

2.2 Engineering Parameters

Golder collected relatively undisturbed soil samples from each borehole for geotechnical testing to determine engineering parameters for use in the slope stability analysis. Geotechnical test results are presented in Appendix B. For purposes of the stability analysis, Golder represented distinct soil layers and assigned engineering parameters based on field soil classification and laboratory test data, primarily plasticity index (PI), as shown in Figure 3. Golder assigned unit weights to each soil layer based on density testing of undisturbed soil samples collected at LEC. Golder assigned effective stress strength parameters to each soil layer based on the results of consolidated-undrained triaxial testing of undisturbed samples collected at LEC. Golder assigned a unit weight to CCPs based on previous experience and assumed that CCPs within the staging areas contribute no strength. Engineering parameters assigned to soil layers are summarized in Table 1.

TABLE 1

SUMMARY OF STABILITY ANALYSIS ENGINEERING PARAMETERS

Material	Unit Weight	Strength Parameters	
		Friction Angle	Cohesion
LEC-2 Sample 1 (PI=39)	116 pcf	26 degrees	260 psf
LEC-3 Sample 3 (PI=50)	116 pcf	28 degrees	410 psf
Coal combustion products	85 pcf	No strength	

2.3 Groundwater Information

Groundwater was not observed in any of the four boreholes drilled around the perimeter of the staging areas at LEC. Therefore, to develop phreatic surfaces within each cross section for stability analysis based on effective stresses, Golder used a straight line between the upstream edge of the berm crest and the static groundwater level at the approximate borehole location, as shown in Figure 3. The static groundwater level is based on information provided by Westar (Geotechnical Services, Inc. 1999) and included in Appendix C.

2.4 Stability Analysis

Golder performed the stability analysis using SLIDE, a two-dimensional slope stability computer program developed by Rocscience Inc. (2009). Factors of safety for static conditions were computed for circular failure surfaces using Spencer's method for force and moment equilibrium, as shown in Figure 4. For seismic analyses, Golder used a seismic coefficient of 0.05 based on the United States Geological Survey (USGS) seismic hazard map corresponding to a two-percent chance of exceedance in 50 years, as shown in Appendix D (USGS 2008). Factors of safety for seismic loading conditions were computed for circular failure surfaces using Spencer's method for force and moment equilibrium, as shown in Figure 5. The computed factors of safety for static and seismic slope stability analyses are summarized and compared with typical minimum acceptable factors of safety for permanent civil engineering structures in Table 2.

TABLE 2

SUMMARY OF STABILITY ANALYSIS RESULTS

Cross Section	Computed Factor of Safety	Minimum Factor of Safety
Section 1 – Static	3.0	1.5
Section 1 – Seismic	2.7	1.1
Section 2 – Static	3.1	1.5
Section 2 – Seismic	2.5	1.1

Based on the factors of safety computed using SLIDE, the CCP storage facilities at LEC should remain stable under maximum anticipated loading conditions.

3.0 VISUAL EVALUATION

3.1 Visual Evaluation Terminology

Visual evaluation terms used in the following discussions are defined as follows:

Condition of Impoundment

Good:	A condition that is generally better than what is minimally expected based on the design criteria and maintenance performed at the facility.
Fair:	A condition that generally meets what is expected based on the design criteria and maintenance performed at the facility.
Poor:	A condition that is generally below what is minimally expected based on the design criteria and maintenance performed at the facility.

Severity of Deficiency

Minor:	An observed deficiency where current maintenance is below what is desired but does not currently pose a threat to the structural safety or stability.
Significant:	An observed deficiency where current maintenance has neglected to improve a condition. Typically, these conditions are identified, but no remedial action has been implemented.
Excessive:	An observed deficiency where current maintenance is worse than what is desired and hinders the ability of the observer to evaluate the structure or poses a significant threat to structural safety and stability.

3.2 Visual Observations

Golder performed a visual observation of the CCP storage facilities at LEC on October 26, 2009. Golder observed the condition of inflow and outflow structures, upstream berm slopes, the berm crest, downstream berm slopes, and the berm toe. Photographs taken during the visual observation are included in Appendix E.

3.2.1 Inflow and Outflow Structures

Inflow piping and structures appeared to be in working order and fair condition at the time of observation. The outflow structure appeared to be in good condition at the time of observation.

3.2.2 Upstream Berm Slopes

The condition of upstream berm slopes was difficult to assess given the high water levels in the CCP storage areas. Freeboard typically ranged from 2 to 6 feet in the various impoundments at the time of observation. Some upstream berm slopes appear to be steeper than 1 (horizontal) to 1 (vertical) in active areas, and riprap is not being used to protect upstream berm slopes against erosion. Wave action did not appear to be occurring at the time of observation. The condition of upstream berm slopes is generally fair.

3.2.3 Berm Crest

The berm crest around the perimeter of the CCP storage facilities is paved to provide an asphalt road with bottom ash road base for normal vehicular traffic. The width of the berm crest is approximately 30 feet, on average. Golder did not observe cracking or excessive settlement in any portion of the berm crest. The berm crest is well-compacted and appears to be in good condition.

3.2.4 Downstream Berm Slope

The downstream berm slope ranges from 0 to 23 feet in height and is heavily vegetated in most areas. The vegetation consists of trees, grasses, and reeds and is not unexpected given that the embankment is a natural slope rather than an engineered structure. Golder did not observe indications of seepage, sloughing, cracking, excessive settlement, or vegetation that seemed to be thriving abnormally. Ground conditions were firm, with the exception of small areas of animal burrowing near the top of the downstream berm slope northeast of the CCP storage facilities. The downstream berm slope is generally in good condition.

3.2.5 Berm Toe

The berm toe is heavily vegetated by grass and mature trees, particularly on the northeast and northwest sides of the CCP storage areas. The creek on the northwest side of the staging areas was approximately 1 foot deep on average and exhibited a relatively low flow rate at the time of observation. Ditches along the road on the west side of the CCP storage areas were dry at the time of observation. The berm toe is generally in good condition.

4.0 CONCLUSIONS AND RECOMMENDATIONS

This report summarizes the results of Golder's stability analysis and visual observations to confirm the stability of CCP storage facilities at LEC. The information provided herein is based on observations made and information gathered by Golder during a site assessment on October 26, 2009.

The CCP storage facilities, portions of which have been in use since 1969, were constructed by excavation from original grade. Therefore, the downstream berm slope consists primarily of natural topography and is heavily vegetated in most locations. The factors of safety resulting from Golder's stability analysis, which range from 3.0 to 3.1 for static conditions and 2.5 to 2.7 for seismic conditions, are well above typical minimum acceptable factors of safety for permanent civil engineering structures (1.5 for static conditions and 1.1 for seismic conditions). Therefore, the CCP storage areas should remain stable under maximum anticipated loading conditions. Golder observed good vegetation and did not identify significant deficiencies such as seepage, excessive erosion or settlement, or cracking during the visual observation of the CCP storage areas at LEC. The overall condition of the CCP storage facilities is good.

Golder recommends that Westar personnel perform quarterly observations of the CCP storage facilities, particularly the berm crest and downstream berm slope, to identify undesirable or changing conditions. Such conditions may include, but are not limited to: seepage, sloughing, cracking, excessive settlement, extensive animal burrowing, excessive erosion, and abnormal thriving of vegetation. Inflow and outflow structures should be observed to confirm that water can continue to be managed in accordance with the design. Westar should regularly monitor groundwater levels in wells adjacent to the CCP storage facilities to identify changing conditions.

GOLDER ASSOCIATES INC.

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Jason E. Obermeyer
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5.0 REFERENCES

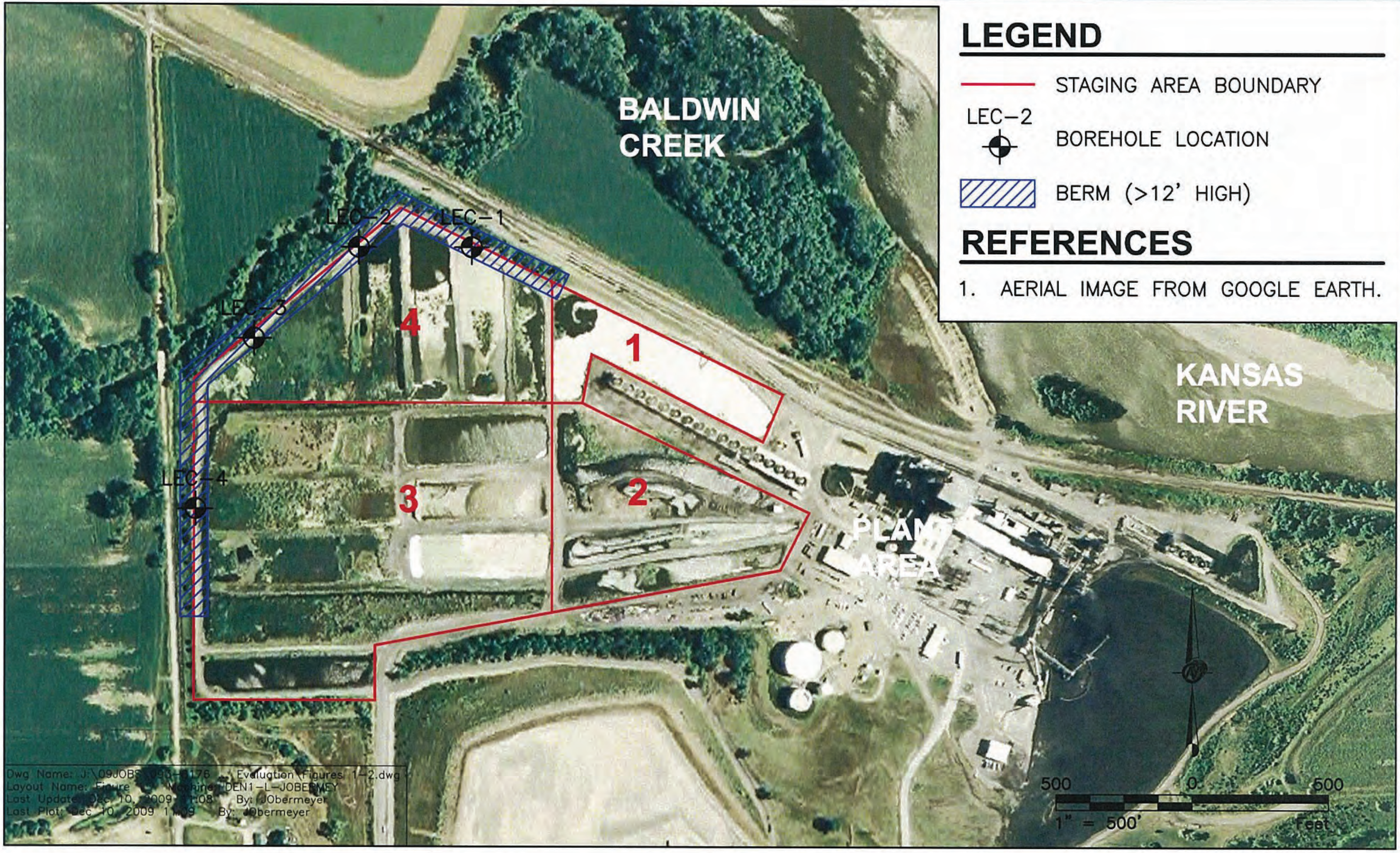
Geotechnical Services, Inc. 1999. Groundwater Flow Rate 12/15/98, Figure 34. Job No. 26W093. January 15, 1999.

Rocscience Inc. 2009. SLIDE Version 5.043. Build date: September 29, 2009.

Terracon Consultants, Inc. 2009. Letter Summary Surface Impoundment Sampling, Lawrence Energy Center, Coal Combustion Waste Surface Impoundments, Lawrence, Douglas County, Kansas, Terracon Project No: 14097035. October 21, 2009.

United States Geological Survey. 2008. National Seismic Hazard Map, Coterminous U.S., 2% in 50 Years, Peak Ground Acceleration. http://earthquake.usgs.gov/hazards/products/conterminous/2008/maps/us/PGA.usa.jpg. Accessed December 9, 2009.

FIGURES



Golder Associates
DENVER, COLORADO

SITE LAYOUT

FIGURE 1

PROJECT No. 09381765 CADD JEO DATE 11/23/09 FILE No. Figures 1-2.dwg

Plot Time: 12/10/09 11:09

LEGEND

🟥 CROSS SECTION LOCATION

LEC-2 ⌖ BOREHOLE LOCATION

REFERENCES

1. AERIAL IMAGE FROM GOOGLE EARTH.
2. TOPOGRAPHY PROVIDED BY WESTAR.

Golder Associates
DENVER, COLORADO

CROSS SECTION LOCATIONS

FIGURE 2

PROJECT No. 09381765 CADD JEO DATE 11/23/09 FILE No. Figures 1-2.dwg

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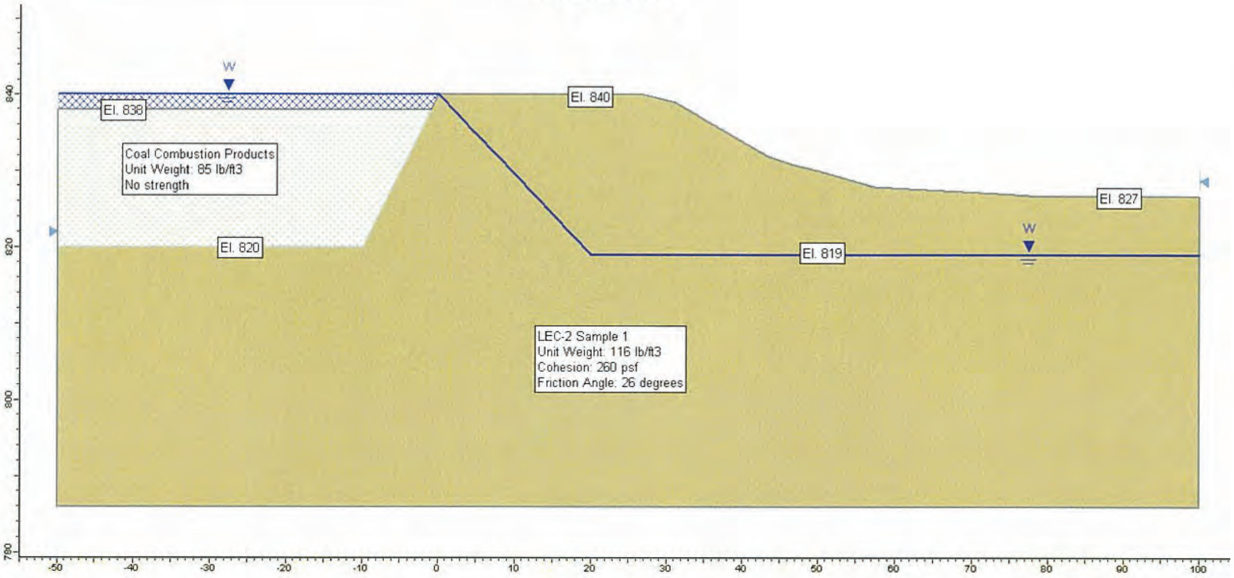
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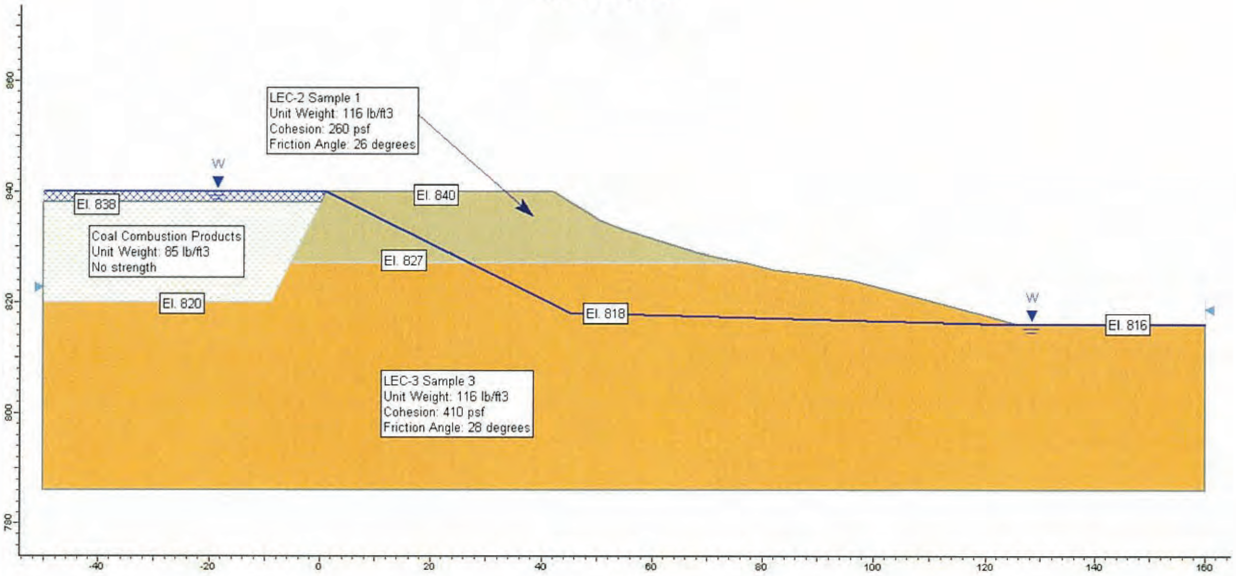
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Last Update: Dec 23, 2009 09:49 By: JObermeyer
Last Plot: Dec 23, 2009 09:51 By: JObermeyer

Golder Associates
DENVER, COLORADO

CROSS SECTIONS

FIGURE 3

PROJECT No. 09381765 CADD JEO DATE 11/24/09 FILE No. Figures 3-5.dwg

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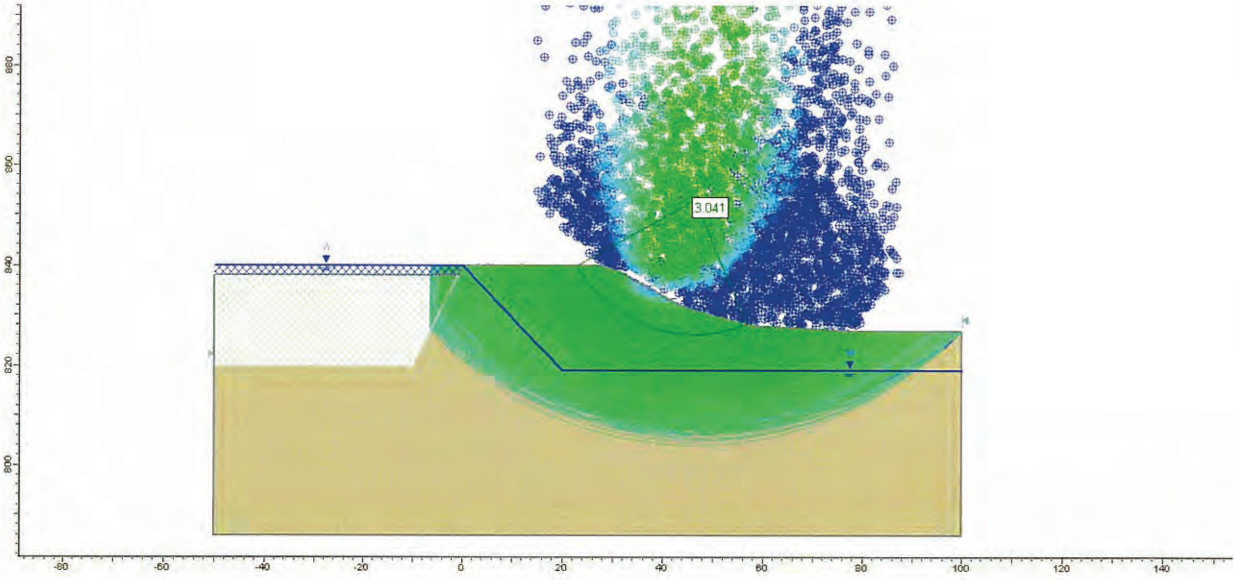

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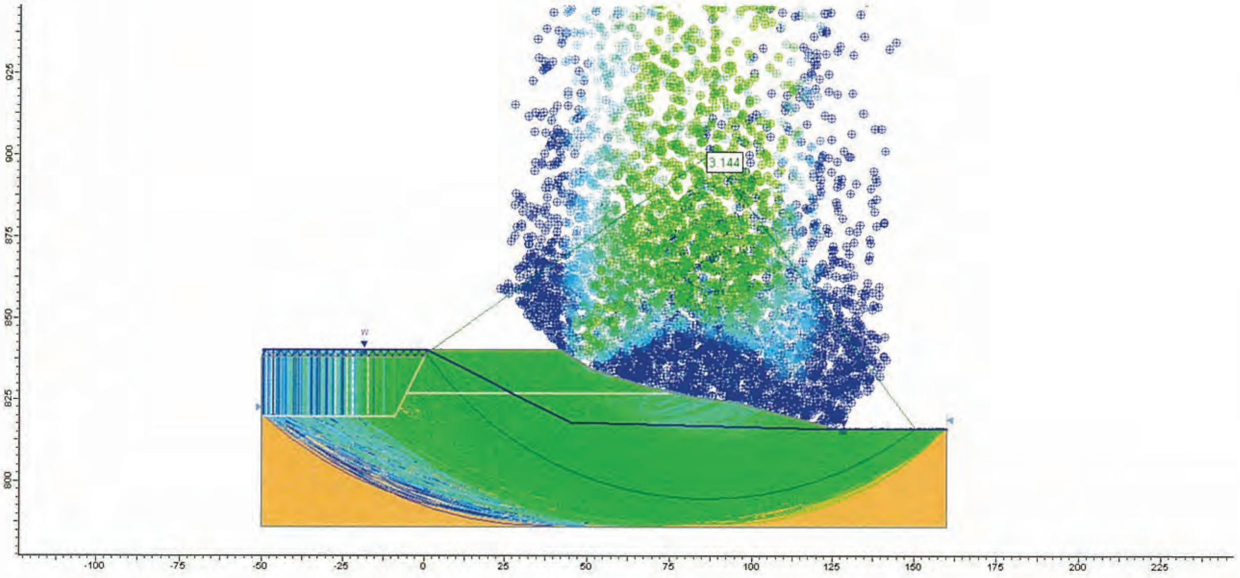

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Last Plot: Dec 23, 2009 09:51 By: JObermeyer

Golder Associates
DENVER, COLORADO

STABILITY ANALYSIS RESULTS - STATIC

FIGURE 4

PROJECT No. 09381765 CADD JEO DATE 11/24/09 FILE No. Figures 3-5.dwg

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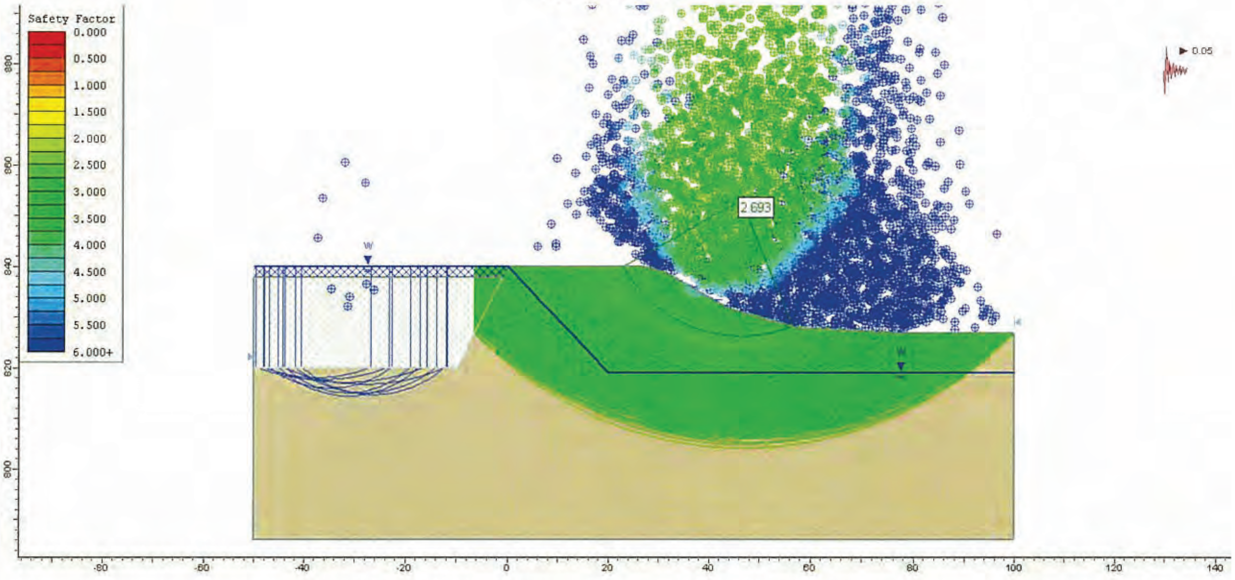

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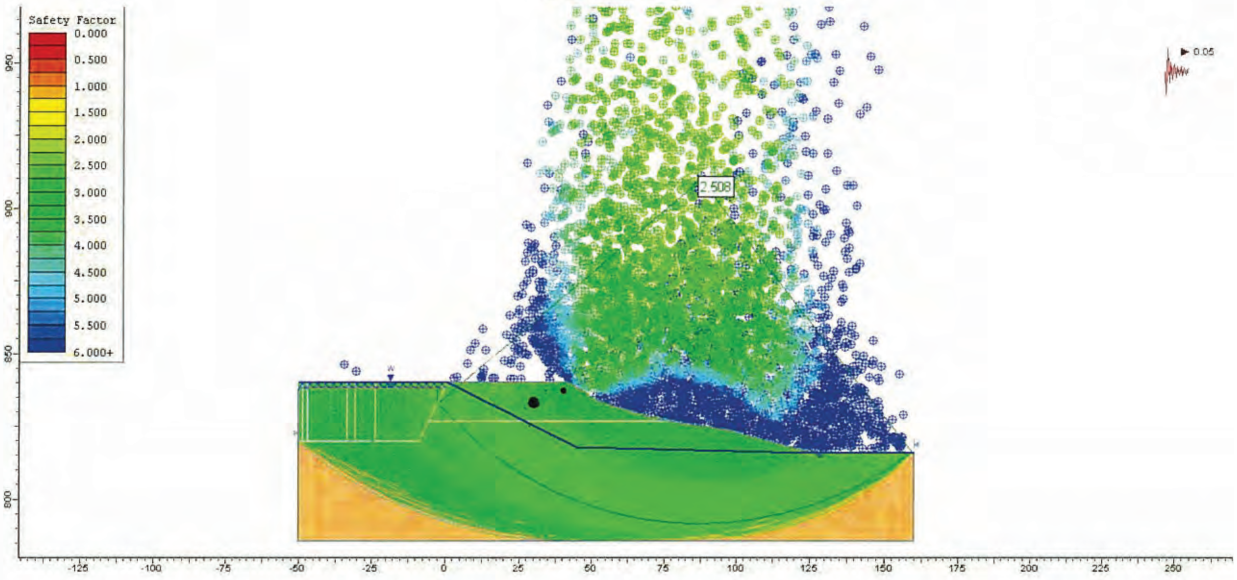

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Last Plot: Dec 23, 2009 09:51 By: JObermeyer

Golder Associates
DENVER, COLORADO

STABILITY ANALYSIS RESULTS - SEISMIC

FIGURE 5

PROJECT No. 09381765 CADD JEO DATE 11/24/09 FILE No. Figures 3-5.dwg

Plot Time: 12/23/09 09:51

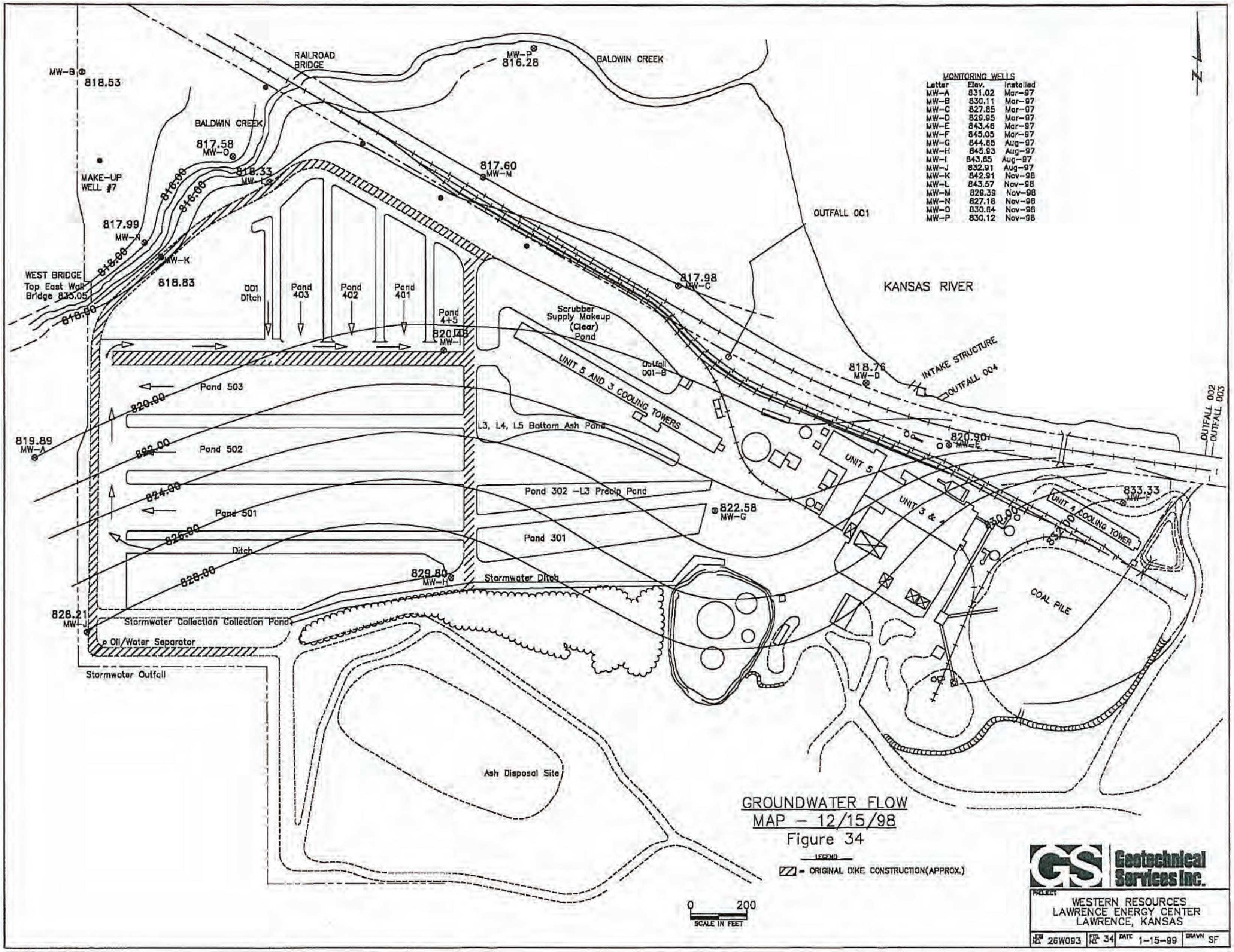
APPENDIX A
BOREHOLE LOGS

(See Attachment A of Doc. 3 - Golder Associates Stability Study of Internal Dikes)

APPENDIX B
GEOTECHNICAL DATA

(See Attachment C of Doc. 3 - Golder Associates Stability Study of Internal Dikes)

APPENDIX C
POTENTIOMETRIC SURFACE MAP



MONITORING WELLS

Letter	Elev.	Installed
MW-A	831.02	Mar-97
MW-B	830.11	Mar-97
MW-C	827.85	Mar-97
MW-D	829.95	Mar-97
MW-E	843.46	Mar-97
MW-F	845.05	Mar-97
MW-G	844.85	Aug-97
MW-H	845.93	Aug-97
MW-I	843.85	Aug-97
MW-J	832.91	Aug-97
MW-K	842.91	Nov-98
MW-L	843.57	Nov-98
MW-M	829.39	Nov-98
MW-N	827.18	Nov-98
MW-O	830.84	Nov-98
MW-P	830.12	Nov-98

GROUNDWATER FLOW MAP - 12/15/98

Figure 34

LEGEND

▨ = ORIGINAL DIKE CONSTRUCTION(APPROX.)

Geotechnical Services Inc.

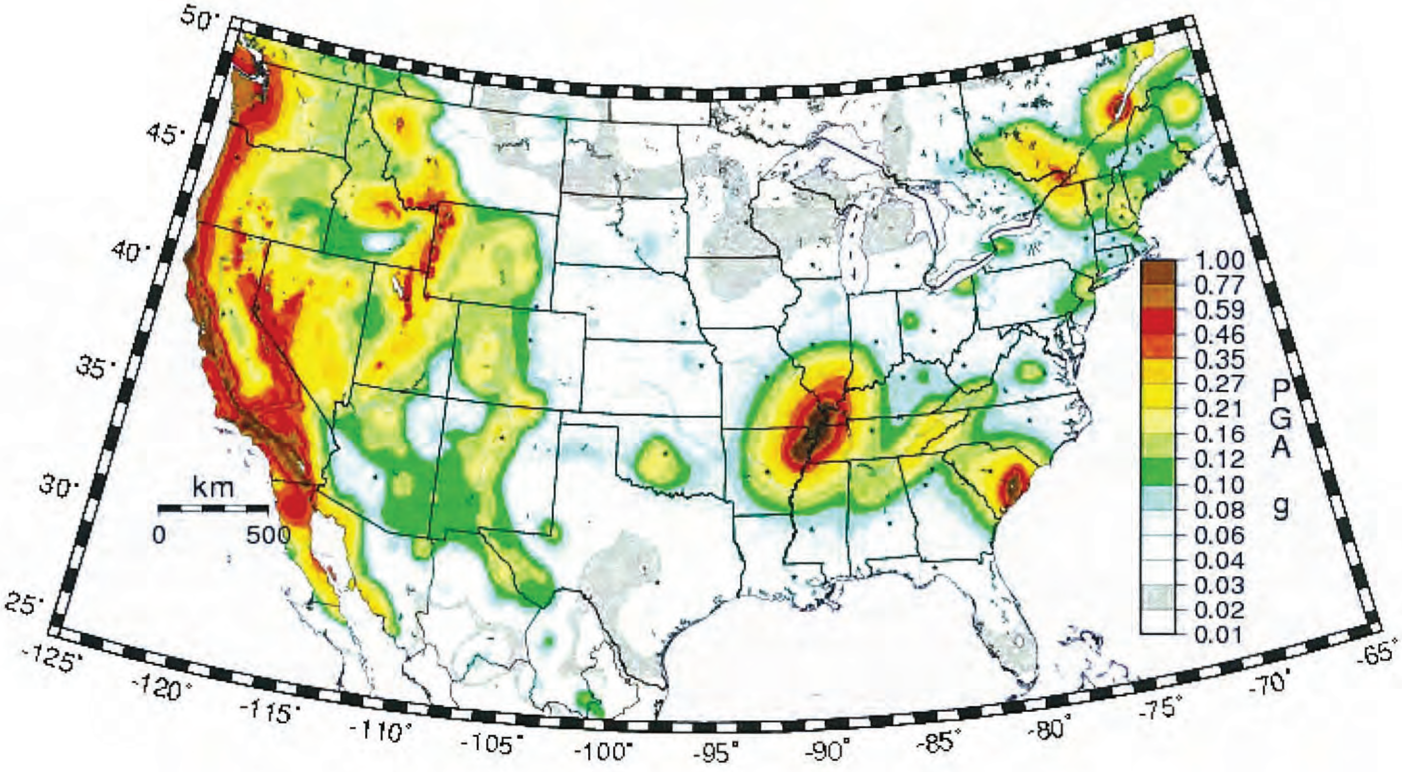
PROJECT
WESTERN RESOURCES
LAWRENCE ENERGY CENTER
LAWRENCE, KANSAS

JOB NO. 26W093	FIG. NO. 34	DATE 1-15-99	DRAWN SF

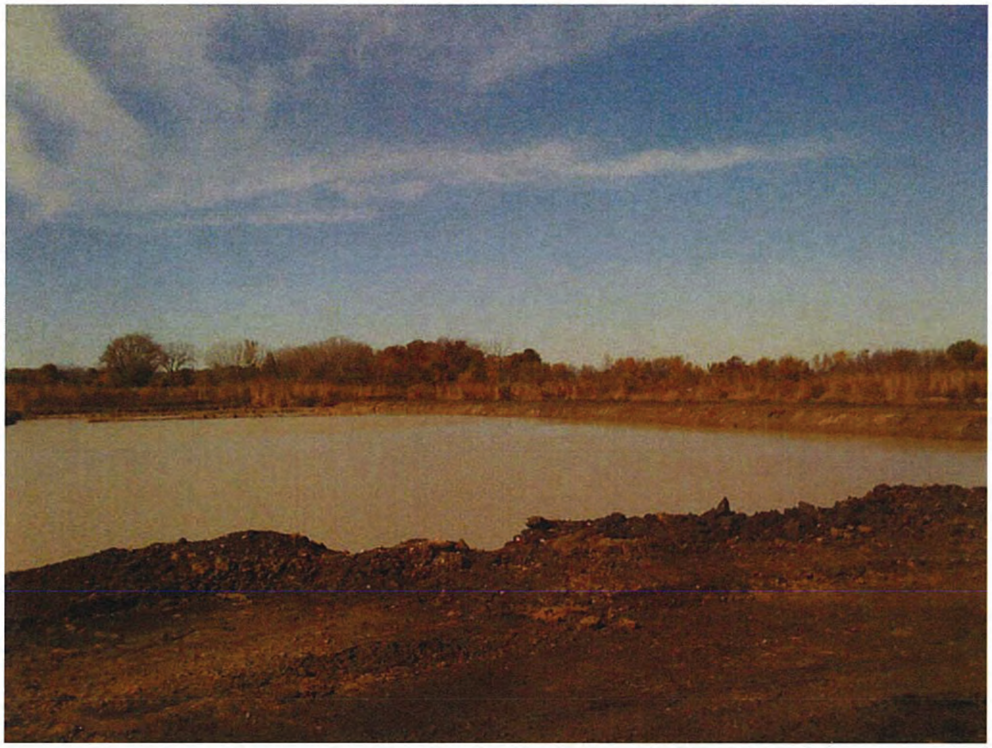
APPENDIX D
SEISMIC HAZARD MAP

Peak ground acceleration with a 2% probability of exceedance in 50 years

Reference: United States Geological Survey (2008)



APPENDIX E
PHOTOGRAPHS



Photograph 1 – CCP storage facility (looking northwest)

Photograph 2 – CCP storage facility (looking east)

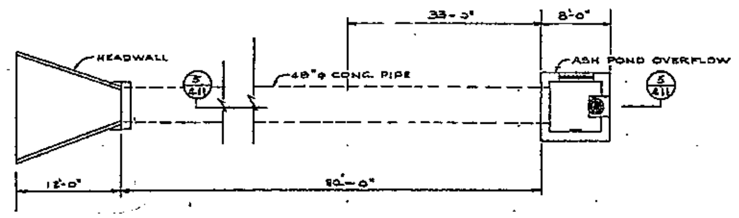
Photograph 3 – CCP storage facility (looking east)

Photograph 4 – CME drill rig used to complete boreholes (looking north)

Photograph 5 – Berm crest (looking northwest)

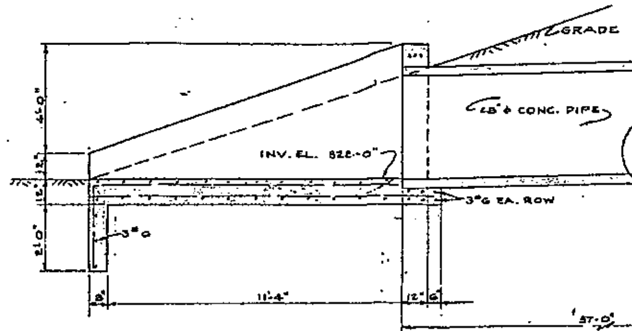
Photograph 6 – Downstream berm slope northwest of CCP storage facilities (looking east)

DOC 05: BLACK & VEATCH CONSTRUCTION DRAWINGS – OUTLET STRUCTURES



PLOT PLAN
ASH POND OVERFLOW
SCALE: 1/8"=1'-0"

NOTE: FOR LOCATION SEE SH. G-2



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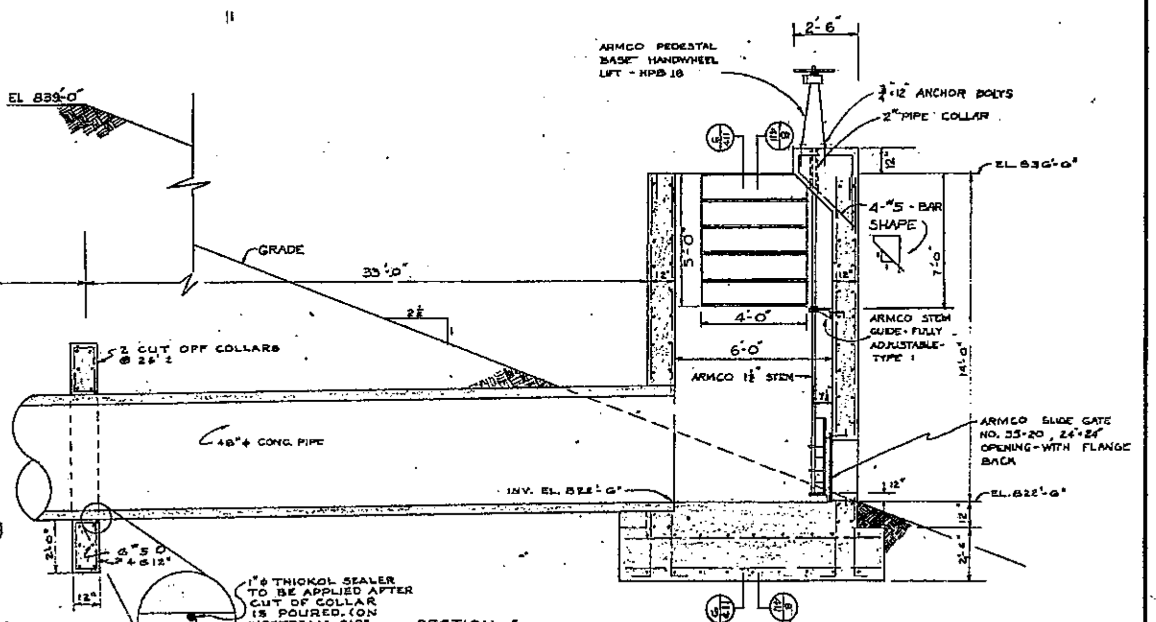

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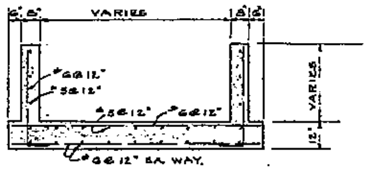

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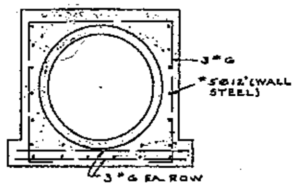

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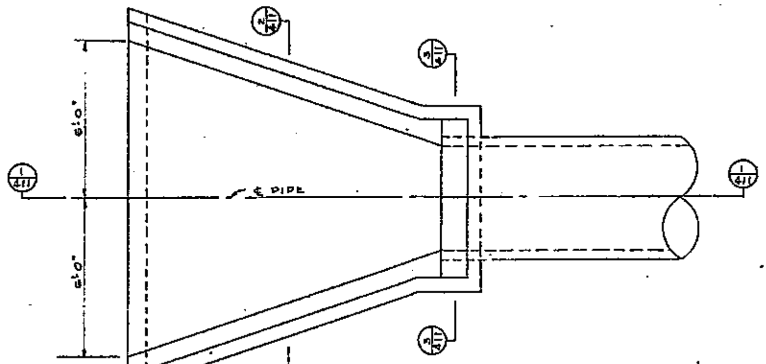
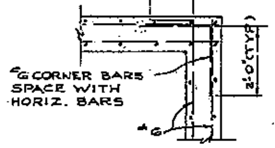
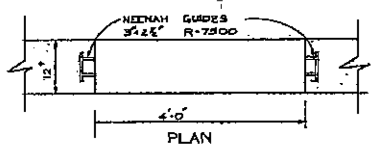


PLAN
HEADWALL
SCALE: 1/2"=1'-0"



TYP WALL CORNER BARS
NO SCALE



PLAN
STOP LOG GUIDE
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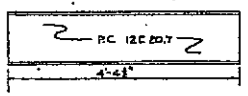

STOP LOG - ELEV
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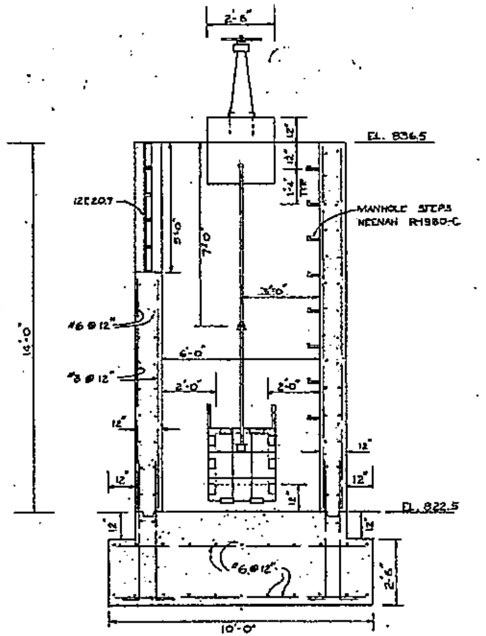

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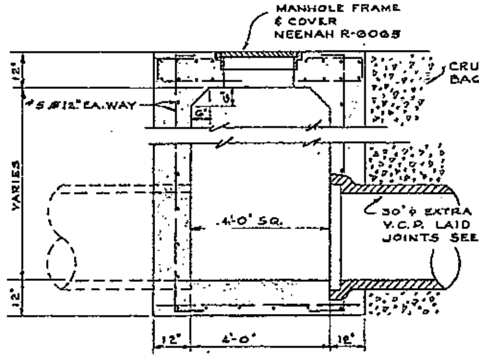

MANHOLE
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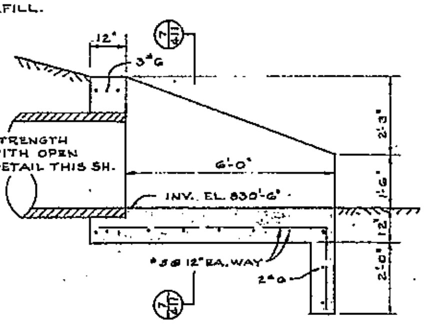

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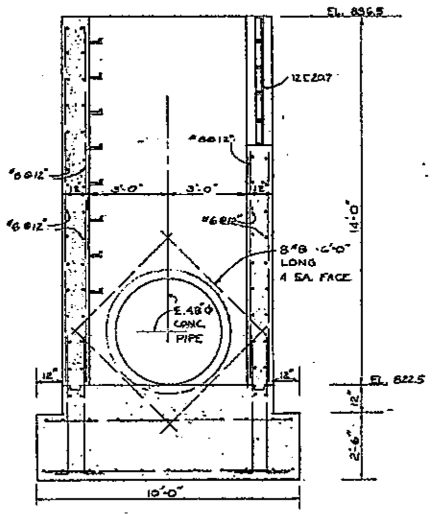

SECTION 6
SCALE 3/8"=1'-0"

SECTION 4
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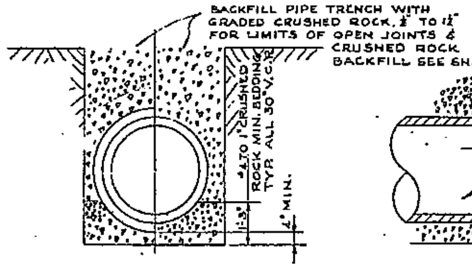

BEDDING & BACKFILL DETAIL
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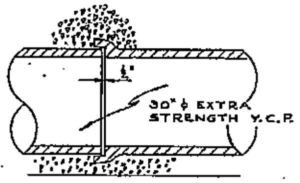
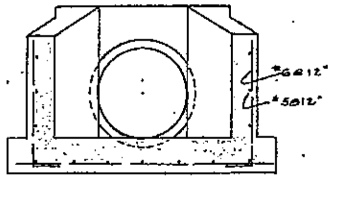
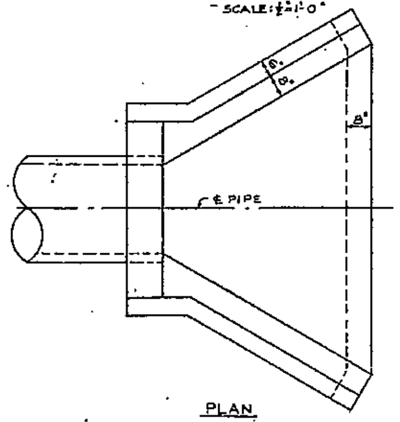


OPEN JOINT DETAIL
NO SCALE

NOTE: CENTER BARREL IN SOCKET AND PROVIDE 1/4" CLEAR BETWEEN END OF BARREL AND END OF SOCKET AS SHOWN.



SECTION 7
SCALE: 1/2"=1'-0"



PLAN
HEADWALL DETAILS
SCALE: 1/2"=1'-0"

COAL PILE AREA DRAIN DETAILS

SCALE AS NOTED

DATE	REVISIONS AND RECORD OF ISSUE	REV. NO.	BY	CK	APP.
10-14-71	CONFORMED TO CONSTRUCTION RECORDS				
3-1-69	APPROVED FOR CONSTRUCTION - PHASE II				
11-15-67	ISSUED FOR CONSTRUCTION				
12-13-67	ISSUED FOR BIDS SPEC. S-GA				
10-6-67	ISSUED WITH ADDENDUM 1 SPEC D-2				
9-15-67	ISSUED FOR BIDS - SPEC. D-2				

THE KANSAS POWER AND LIGHT COMPANY
TOPEKA, KANSAS
LAWRENCE POWER STATION UNIT 5
WORK ORDER NO. 6000

STRUCTURAL
MISCELLANEOUS YARD STRUCTURES

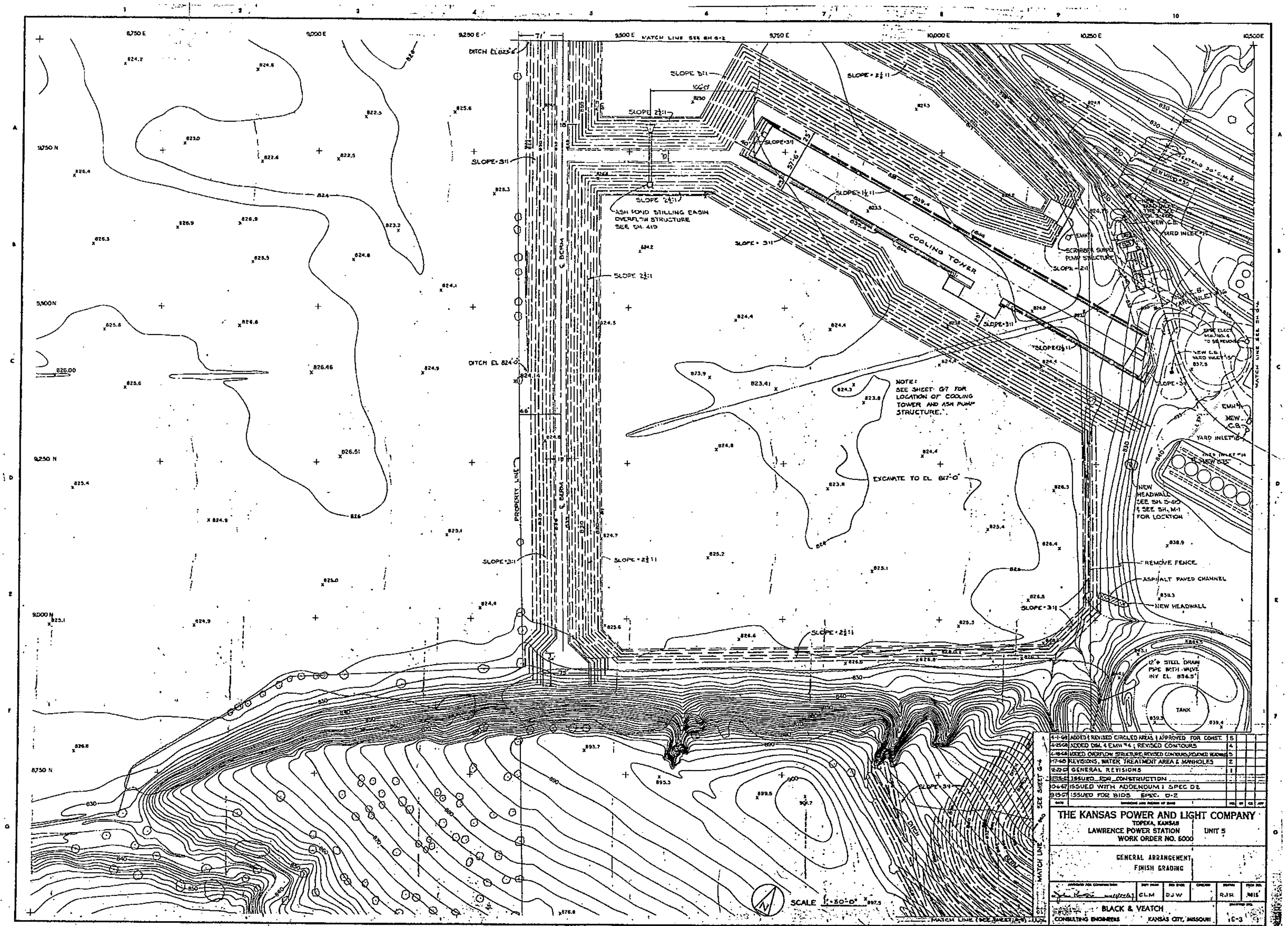
APPROVED FOR CONSTRUCTION	DEPT. HEAD	DES. ENGR.	CHECKED	DRAWN	PROJ. NO.
BY John Kostiga DATE 11/20/67	CLM	DJW		RJR	4815

BLACK & VEATCH
CONSULTING ENGINEERS KANSAS CITY, MISSOURI

DRAWING NO. S-411

30" X 42" = 8.75 SQ. FT.

DOC 06: BLACK & VEATCH CONSTRUCTION DRAWINGS – FINISH GRADING



NOTE:
SEE SHEET G7 FOR LOCATION OF COOLING TOWER AND ASH PUMP STRUCTURE.

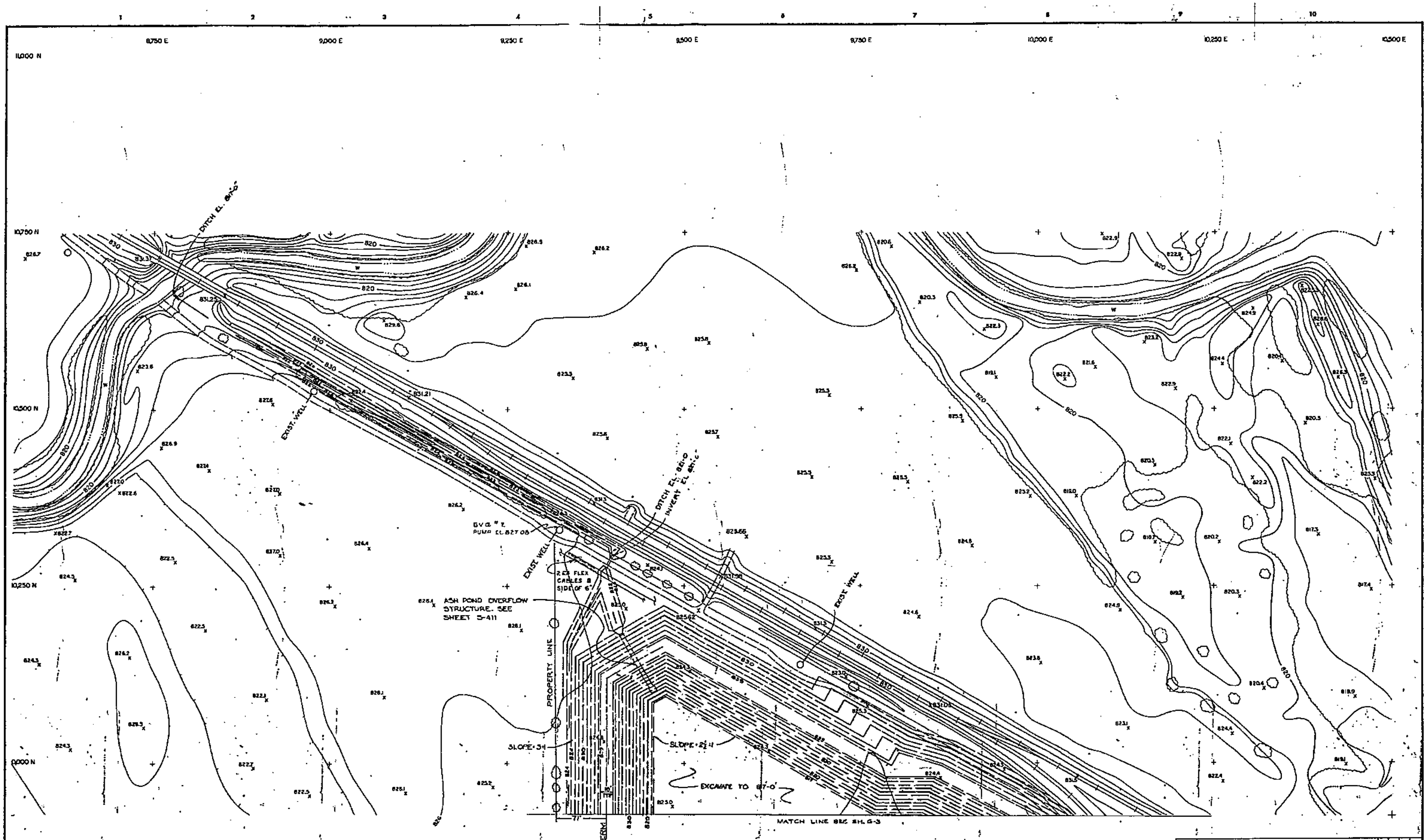
4-1-69	ADDED & REVISED CIRCLED AREAS & APPROVED FOR CONST.	5			
4-25-68	ADDED DIM. & EMH #4; REVISED CONTOURS	4			
4-18-68	ADDED OVERFLOW STRUCTURE; REVISED CONTOURS; REVISED HEADWALLS	3			
1-17-68	REVISIONS, WATER TREATMENT AREA & MANHOLES	2			
12-12-67	GENERAL REVISIONS	1			
11-15-67	ISSUED FOR CONSTRUCTION				
10-6-67	ISSUED WITH ADDENDUM 1 SPEC D2				
9-15-67	ISSUED FOR BIDS SPEC. D-2				

THE KANSAS POWER AND LIGHT COMPANY
TOPEKA, KANSAS
LAWRENCE POWER STATION UNIT 5
WORK ORDER NO. 6000

GENERAL ARRANGEMENT
FINISH GRADING

John Kostrzo	CLM	DJW		RJR	M15

BLACK & VEATCH
CONSULTING ENGINEERS KANSAS CITY, MISSOURI
G-3



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10-6-67	ISSUED WITH ADDENDUM 1 SPEC D2				
9-15-67	ISSUED FOR BIDS SPEC. D-2				
DATE	REVISIONS AND RECORD OF ISSUE	NO.	BY	CK	APP

LEGEND

EXISTING CONTOURS

NEW CONTOURS

EXISTING RR

NEW RR

SCALE 1"=50'-0"

THE KANSAS POWER AND LIGHT COMPANY

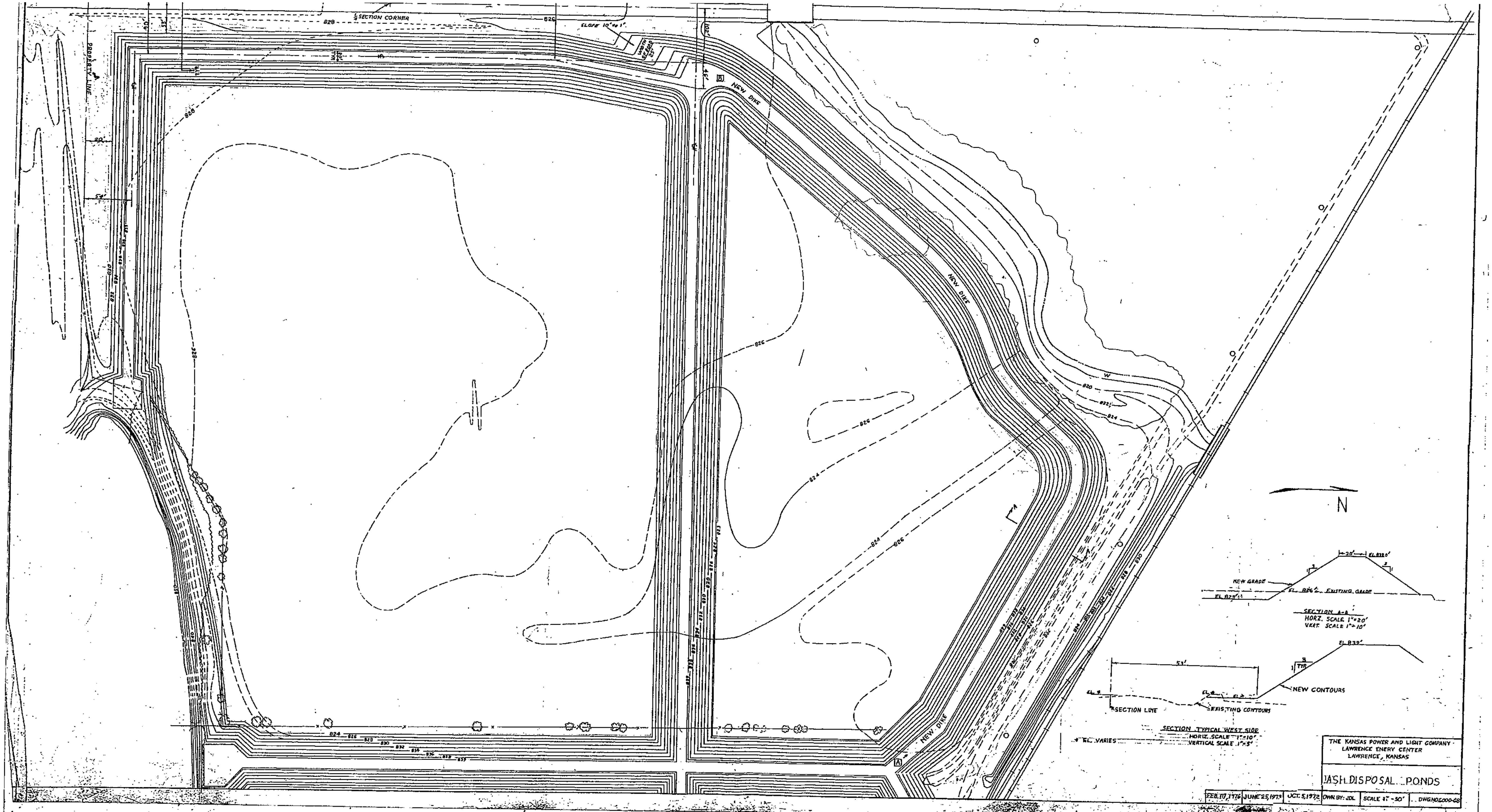
TOPEKA, KANSAS
LAWRENCE POWER STATION UNIT 5
WORK ORDER NO. 6000

GENERAL ARRANGEMENT
FINISH GRADING

APPROVED FOR CONSTRUCTION					PROJ. NO.
	CLM	DJW		RJR	4615

BLACK & VEATCH
CONSULTING ENGINEERS KANSAS CITY, MISSOURI

G-2



THE KANSAS POWER AND LIGHT COMPANY
LAWRENCE ENERY CENTER
LAWRENCE, KANSAS

ASH DISPOSAL PONDS

FEB.10,1976	JUNE 25,1973	OCT. 5,1972	DWN. BY: JDL	SCALE 1" - 50'	DWG. NO. 6000-68

APPENDIX B

PHOTOGRAPHS

PHOTOLOG
SITE VISIT- LAWRENCE ENERGY CENTER COAL ASH PONDS, LAWRENCE, KS
SEPTEMBER 23, 2010

1. EXTERIOR OF NORTHEASTERN PORTION OF PERIMETER DIKE – TAKEN FROM EAST END OF AREA 1, LOOKING WEST

2. DISCHARGE PIPE AT EAST END OF AREA 1

3. INTERIOR OF NORTHEASTERN PORTION OF PERIMETER DIKE – TAKEN FROM EAST END OF AREA 1, LOOKING WEST

4. EXTERIOR OF NORTHEASTERN PORTION OF PERIMETER DIKE – TAKEN FROM EAST END OF AREA 1, LOOKING WEST

5. EMERGENCY OVERFLOW STRUCTURE – WEST END OF AREA 1

6. OUTFALL OF EMERGENCY OVERFLOW STRUCTURE – EXTERIOR OF NORTH SIDE OF AREA 1 DIKE. HEAVY VEGETATION M
ACCESS TO THE OUTFALL IMPRACTICAL.

7. EXTERIOR OF PERIMETER DIKE – TAKEN FROM NORTH SIDE OF AREA 4 LOOKING SOUTH, UP SIDE OF DIKE.

8. INTERIOR SEPARATION DIKE, SEPARATING AREA 1 FROM AREA 4 - TAKEN FROM NORTH END, LOOKING SOUTH.

9. TOP OF NORTHEASTERN PORTION OF PERIMETER DIKE – TAKEN FROM MIDPOINT BETWEEN AREA 1 AND 4 LOOKING WE

10. INTERIOR OF NORTHEASTERN PORTION OF PERIMETER DIKE IN AREA 4 – SOME MINOR WASHOUT/EROSION OBSERVED.

11. CLOSE-UP OF 10.

12. EXTERIOR OF NORTHEASTERN PORTION OF PERIMETER DIKE (AREA 4) – HEAVY VEGETATION OBSERVED.

13. EXTERIOR OF NORTHWESTERN PORTION OF PERIMETER DIKE (AREA 4) – HEAVY VEGETATION AND TREES OBSERVED.

14. INTERIOR OF NORTHWESTERN PORTION OF PERIMETER DIKE (AREA 4)

15. EXTERIOR OF NORTHWESTERN PORTION OF PERIMETER DIKE (AREA 4) – 10” TREE OBSERVED AT TOE OF EMBANKMEN

16. EXTERIOR OF NORTHWESTERN PORTION OF PERIMETER DIKE (AREA 4) – MULTIPLE TREES OBSERVED ON EMBANKMEN

17. BALDWIN CREEK FLOWING NEAR TOE OF NORTHWESTERN PORTION OF PERIMETER DIKE (AREA 4)

18. EXTERIOR OF NORTHWESTERN PORTION OF PERIMETER DIKE (AREA 4) – 10" TREE OBSERVED AT TOE OF EMBANKMEN

19. INTERIOR OF NORTHWESTERN PORTION OF PERIMETER DIKE – TAKEN FROM MIDPOINT (BETWEEN AREA 3 AND 4) LOOKI
NORTH

20. INTERIOR OF WESTERN PORTION OF PERIMETER DIKE (AREA 3) – TAKEN FROM WESTERN DIKE LOOKING SOUTH ALONG INTERIOR OF DIKE. CLAY LINER BEING INSTALLED

21. INTERIOR SEPARATION DIKE (AREA 3) – TAKEN FROM WESTERN PORTION OF PERIMETER DIKE LOOKING EAST ALONG IN
SEPARATION DIKE. CLAY LINER BEING INSTALLED

22. LOOKING WEST TOWARDS AGRICULTURAL FIELDS – TAKEN FROM TOP OF WESTERN PORTION OF PERIMETER DIKE (ARE

23. STORM WATER POND AT SOUTH END OF ASH POND AREA/AREA 3 – TAKEN FROM WESTERN PORTION OF PERIMETER DI
LOOKING EAST.

24. STORM WATER POND DISCHARGE PIPE ON INTERIOR OF SOUTH SIDE OF AREA 3.

25. STORM WATER POND OUTFALL PIPES ON EXTERIOR OF SOUTH SIDE OF AREA 3.

26. SOUTH SIDE OF STORM WATER POND (AREA 3).

27. EXTERIOR TIE-IN OF PERIMETER DIKE TO EXISTING GRADE/ROAD EMBANKMENT ALONG SOUTH SIDE OF AREA 3.

28. INTERIOR TIE-IN OF PERIMETER DIKE TO EXISTING GRADE/ROAD EMBANKMENT ALONG SOUTH SIDE OF AREA 3.

29. AREA 2/MIDDLE CELL – TAKEN FROM WEST END LOOKING EAST.

30. CHANNEL CONNECTING AREA 2 AND AREA 3 – TAKEN FROM EAST END LOOKING WEST.

31. AREA 2/SOUTH CELL – TAKEN FROM SOUTHWEST CORNER LOOKING NORTHEAST.

APPENDIX C

DAM INSPECTION CHECK LIST

Site Name:	WESTAR ENERGY LAWRENCE ENERGY CTR.	**Date:**	Sept. 23, 2010
Unit Name:	AREA 1,2,3,4	**Operator's Name:**	
Unit I.D.:	Combined -PERIMETER DIKE	**Hazard Potential Classification:**	High ☐ Significant ☐ Low ☐
	Inspector's Name:	F. LOCKRIDGE AND G. JONES	

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

	Yes	No
1. Frequency of Company's Dam Inspections?	Nonroutine-bishift	
2. Pool elevation (operator records)?	Varies	
3. Decant inlet elevation (operator records)?	836	
4. Open channel spillway elevation (operator records)?	N/A	
5. Lowest dam crest elevation (operator records)?	840	
6. If instrumentation is present, are readings recorded (operator records)?		X
7. Is the embankment currently under construction?	Internal dikes	External Perimeter-No
8. Foundation preparation (remove vegetation, stumps, topsoil in area where embankment fill will be placed)?	Per Specs Not visible now	
9. Trees growing on embankment? (If so, indicate largest diameter below)	X - 30"	
10. Cracks or scarps on crest?		X
11. Is there significant settlement along the crest?		X
12. Are decant trashracks clear and in place?	N/A	
13. Depressions or sinkholes in tailings surface or whirlpool in the pool area?		X
14. Clogged spillways, groin or diversion ditches?		X
15. Are spillway or ditch linings deteriorated?		X
16. Are outlets of decant or underdrains blocked?		
17. Cracks or scarps on slopes?		X

	Yes	No
18. Sloughing or bulging on slopes?		X
19. Major erosion or slope deterioration?		X
20. Decant Pipes:		
Is water entering inlet, but not exiting outlet?		X
Is water exiting outlet, but not entering inlet?		X
Is water exiting outlet flowing clear?	X	
21. Seepage (specify location, if seepage carries fines, and approximate seepage rate below):		
From underdrain?		N/A
At isolated points on embankment slopes?		X
At natural hillside in the embankment area?		X
Over widespread areas?		X
From downstream foundation area?		X
"Boils" beneath stream or ponded water?		X
Around the outside of the decant pipe?		X
22. Surface movements in valley bottom or on hillside?		X
23. Water against downstream toe?		X
24. Were Photos taken during the dam inspection?	X	

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

Issue #	Comments
	Since internal (cell Separator) dikes are continuously under const. and relocation, it was decided to evaluate the perimeter embankments and consider the 4 cells as comprising one large impoundment.

Coal Combustion Waste (CCW)

Impoundment Inspection

Impoundment NPDES Permit KS0079821 **INSPECTOR**

Date 4/01/2009
Impoundment Name Lawrance Energy Center

Impoundment Company Waster Energy.
EPA Region 7

State Agency Kansas Dept. of Health & Environment - (KDHE)
(Field Office) Address 1900 SW Jackson, Suite 320, Topeka, KS 66612-1366
Name of Impoundment Lawrence Energy Center

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

New ☐ **Update** ☐

	Yes		No
Is impoundment currently under construction?	☒	Note 1	☐
Is water or ccw currently being pumped into the impoundment?	☒		☐

IMPOUNDMENT FUNCTION:

Nearest Downstream Town Name: Lawrence, KS.

Distance from the impoundment: Actually in the city limits

Location:

Latitude	39	Degrees		Minutes	29.40	Seconds	N
Longitude	95	Degrees	16	Minutes	19.86	Seconds	W

State KANSAS **County** DOUGLAS

	Yes	No
Does a state agency regulate this impoundment?	☒	☐

If So Which State Agency? KDHE

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

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

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

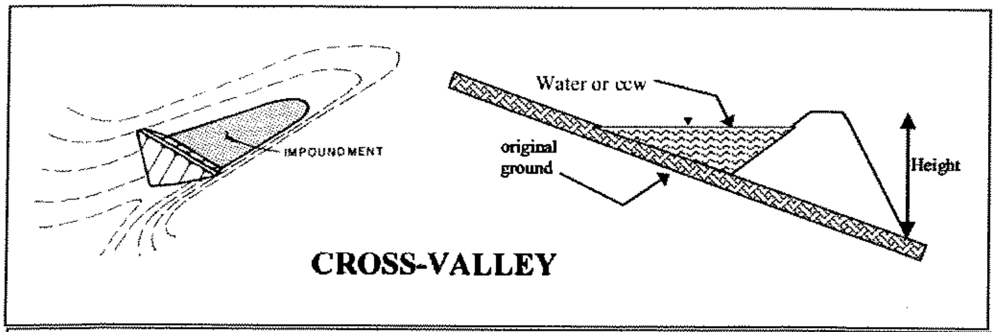
☒ **SIGNIFICANT HAZARD POTENTIAL:** Dams assigned the significant hazard potential classification are those dams where failure or misoperation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or can impact other concerns.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

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

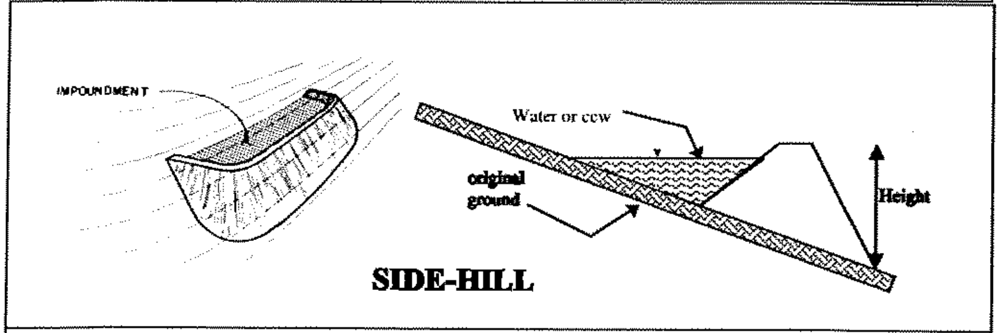
DESCRIBE REASONING FOR HAZARD RATING CHOSEN:

Dike failure at this location would probably not result in loss of human life, but could result in economic loss and environmental damage by contaminating down gradient agriculture fields and the Kansas River.

CONFIGURATION:

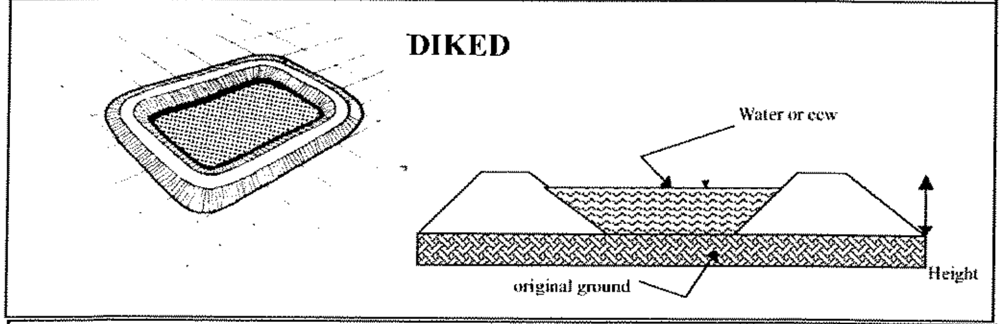


CROSS-VALLEY

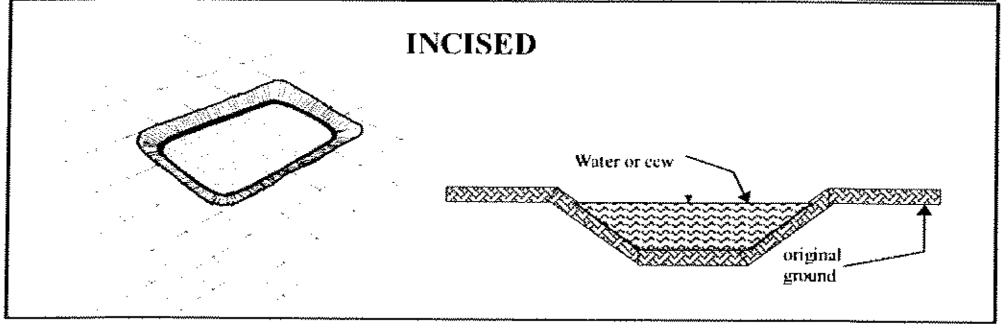


SIDE-HILL

DIKED



INCISED



☐ Cross-Valley ☒ Side-Hill ☐ Diked

☒ Incised (form completion optional) ☒ Combination Incised/Diked

Embankment Height (ft)

Embankment Material Silty Clay*

Pool Area (ac)

Liner

Current Freeboard (ft)

Liner Permeability

*AREA 3 WAS IN THE PROCESS OF BEING EXCAVATED AND THE LINER (3' CLAY) BEING REPLACED. THE LINER OF ALL OTHER AREAS COULD NOT BE INSPECTED DURING THE VISIT SINCE THEY CONTAINED CCW.

TYPE OF OUTLET (Mark all that apply)

☐ **Open Channel Spillway** N/A

☐ Trapezoidal

☐ Triangular

☐ Rectangular

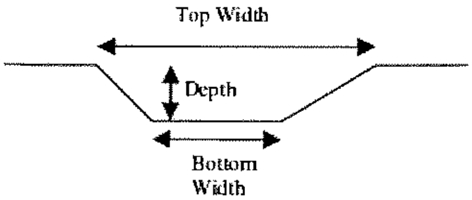
☐ Irregular

depth (ft)

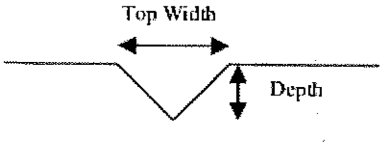
average bottom width (ft)

top width (ft)

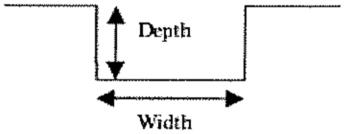
TRAPEZOIDAL



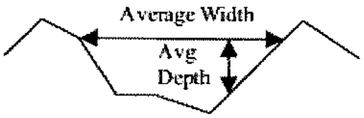
TRIANGULAR



RECTANGULAR

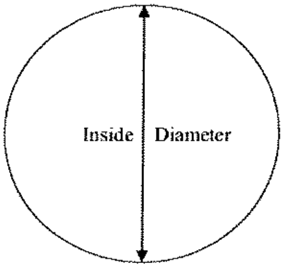


IRREGULAR



☒ **Outlet**

48" ~~18" inside diameter~~
~~(SDR 17 – smooth lined – 19.5" OD)~~



Material

☐ corrugated metal

☐ welded steel

☒ concrete

☐ plastic (hdpe, pvc, etc.)

☐ other (specify):

	Yes	No
Is water flowing through the outlet?	☒	☐

☐ **No Outlet**

☐ **Other Type of Outlet** (specify):

~~The Impoundment was Designed By AEP – in house personnel~~

Black and Veatch

	Yes	No
Has there ever been a failure at this site?	☐	☒

If So When?

If So Please Describe :

No overtopping during '93 flood.

	Yes	**No**
Has there ever been significant seepages at this site?	☐	☒
If So When?		

If So Please Describe :

	Yes	No
Has there ever been any measures undertaken to monitor/lower Phreatic water table levels based on past seepages or breaches at this site?	☐	☒
If so, which method (e.g., piezometers, gw pumping,...)?		

If So Please Describe :

ADDITIONAL INSPECTION QUESTIONS

Concerning the embankment foundation, was the embankment construction built over wet ash, slag, or other unsuitable materials? If there is no information just note that.

No information

Did the dam assessor meet with, or have documentation from, the design Engineer-of-Record concerning the foundation preparation?

No

From the site visit or from photographic documentation, was there evidence of prior releases, failures, or patchwork on the dikes?

No