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Coal Combustion Waste Impoundment

Round 7 - Dam Assessment Report

J.C. Weadock (Site 20)

Fly Ash Dike

Consumers Energy

Bay City, Michigan

Prepared for:

United States Environmental Protection Agency
Office of Resource Conservation and Recovery

Prepared by:

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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, is a wake-up call for diligence on coal combustion waste disposal units. We must marshal our best efforts to prevent such catastrophic failure and damage. A first step toward this goal is to assess the stability and functionality of the ash impoundments and other units, then quickly take any needed corrective measures.

This assessment of the stability and functionality of the J. C. Weadock Plant coal combustion waste management unit is based on a review of available documents and on the site assessment conducted by Dewberry personnel on Tuesday, September 21, 2010. We found the supporting technical documentation adequate (Section 1.1.3).

In summary, the J. C. Weadock Fly Ash Dam is **SATISFACTORY** for continued safe and reliable operation, with no recognized existing or potential management unity 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 February 2009, the EPA sent 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.

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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 that have not been rated 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, September 21, 2010, and review of technical documentation provided by Consumers Energy.

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

Embankments appear to be structurally sound for the purposes of a dry landfill operation.

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

Embankments appear to be safe from a hydrologic and hydraulic standpoint for the purposes of a dry landfill operation.

1.1.3 Conclusions Regarding the Adequacy of Supporting Technical Documentation

Technical documentation is sufficient to assess the safety of the embankments.

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

Embankments are adequately characterized based on descriptive information provided by Consumers Energy.

1.1.5 Conclusions Regarding the Field Observations

During the site visit, Dewberry was provided access to all areas in the vicinity of bottom ash and fly ash disposal areas. There were no visible signs of significant erosion, seepage, settlement clogged spillways or other signs of instability. During the site visit there were no indications of unsafe conditions or conditions needing immediate remedial action.

1.1.6 Conclusions Regarding the Adequacy of Maintenance and Methods of Operation

Embankments appear to be adequately operated and maintained for the purposes of a dry landfill operation.

1.1.7 Conclusions Regarding the Adequacy of the Surveillance and Monitoring Program

Surveillance and monitoring appear to be adequate for the purposes of a dry landfill operation.

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 Structural Stability

No recommendations appear warranted at this time.

1.2.2 Recommendations Regarding the Hydrologic/Hydraulic Safety

No recommendations appear warranted at this time.

1.2.3 Recommendations Regarding the Supporting Technical Documentation

No recommendations appear warranted at this time.

1.2.4 Recommendations Regarding the Description of the Management Unit(s)

No recommendations appear warranted at this time.

1.2.5 Recommendations Regarding the Field Observations

No recommendations appear warranted at this time.

1.2.6 Recommendations Regarding the Maintenance and Methods of Operation

No recommendations appear warranted at this time.

1.2.7 Recommendations Regarding the Surveillance and Monitoring Program

No recommendations appear warranted at this time.

1.2.8 Recommendations Regarding Continued Safe and Reliable Operation

No recommendations appear warranted at this time.

1.3 PARTICIPANTS AND ACKNOWLEDGEMENT

1.3.1 List of Participants

Richard Hall, Consumers Energy
J.R. Register, Consumers Energy
Jon Carpenter, Consumers Energy
Roberto Falco, Consumers Energy
Tom Fox, State of Michigan DNRE
Scott Clarke, Dewberry
Cleighton Smith, Dewberry

1.3.2 Acknowledgement and Signature

We acknowledge that the management unit referenced herein has been assessed on September 21, 2010.

Cleighton D. Smith, P.E.

Scott Clarke, P.E.

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

2.1 LOCATION AND GENERAL DESCRIPTION

The D.E. Karn and J.C. Weadock Generating Facilities, operated by Consumers Energy, consist of two separate power generating plants located in Essexville, Michigan, near Bay City on a peninsula bounded by the mouth of the Saginaw River to the west and Saginaw Bay to the north. The facilities are located on the western shore of Lake Huron (see Document 1). The J.C. Weadock plant was the first to generate power in 1940 and eventually consisted of six coal burning units, Units 1 to 6, which were retired in 1980. Two additional units, Units 7 and 8 were added in 1955 and 1958 and continue to operate. Together, Karn and Weadock burn approximately 3 million tons of coal, 1.3 billion cubic feet of natural gas, and 23 million gallons of fuel oil per year to produce approximately 2,100 megawatts. Aerial views showing the site layout and location of the facilities can be seen on Document 2.

The J.C. Weadock Solid Waste Disposal Area is located east of the Weadock plant as shown on Document 2. According to the 1992 permit application, the landfill covers an area of approximately 292 acres and has a perimeter of approximately 4.85 miles. The perimeter consists of ash containment dikes separating the landfill from the Saginaw Bay, the discharge channel, and the “Waters of the State” (meaning groundwaters, lakes, rivers, and streams and all other watercourses and waters, including the Great Lakes, within the jurisdiction of the State of Michigan under State law). In the discharge channel, the fish barrier is considered to be the boundary between the Plant controlled discharge channel and the “Waters of the State”.

The perimeter dikes have generally a 20-foot wide crest and a typical crest elevation of 590 feet. The containment dike is used as a perimeter access road upon which light utility trucks, large snowplows, and 80-ton haul trucks can be driven. However, heavy traffic is limited on portions of the perimeter access roads due to the presence of a slurry wall constructed in 2008.

Until 1992, the JC Weadock landfill was operated as a surface impoundment. In 1992, Construction Permit No. 0260 was issued by the Michigan Department of Natural Resources and provided for Phase II consolidation and the vertical expansion of an engineered structural fill in portions of the landfill.

The site is designed to store approximately 11,200,000 cubic yards of fly ash, which is sufficient storage for the life of the Weadock generation plant. The total ash disposed annually, including ash produced at Karn, is about 228,000 cubic yards.

Prior to February 2009, fly ash was hydraulically discharged from a trestle near the west end of the disposal area. Fly ash was most recently sluiced eastwardly into a

series of parallel channels, where the majority of ash settles out. Sluice water eventually flows to a ditch before arriving at the NPDES discharge point, where it is discharged to the non-contact cooling water discharge channel (see Document 2).

Currently, the fly ash disposal process is a "dry" operation. The fly ash has a small amount of moisture added for dust control, then is transported by truck to the disposal area. The embankments assessed during the site visit are not impoundments in the true sense, but more like the side slopes of a landfill. The one exception is the Section C embankment in the area of Pond F (P3) (see Document 3). P3 currently stores stormwater and is in the process of being de-watered. Once dewatered, the entire fly ash disposal area will be a dry landfill operation.

Bottom ash is discharged from the discharge trestle into the bottom ash pond where it is allowed to settle out (see Document 2). The bottom ash sluice water is conveyed through a ditch and eventually is discharged via the NPDES discharge point. The bottom ash pond is considered an incision by Consumers, with the spoil stored on the sides of the pond (see Appendix B, Photograph 1). Based on our site visit, we concur with this assessment. Therefore, these spoil piles are not considered embankments for the purposes of this report.

Table 2.1: Summary of Dam Dimensions and Size	
	Weadock Landfill Embankment
Dam Height (ft)	15
Crest Width (ft)	20
Length (ft)	25,608
Side Slopes (upstream) H:V	4:1
Side Slopes (downstream) H:V	4:1

2.2 SIZE AND HAZARD CLASSIFICATION

The Weadock Landfill Embankment is in the small category based on the low height and intermediate based on storage in the table shown below.

Table 2.2a: USACE ER 1110-2-106 Size Classification		
	Impoundment	
Category	**Storage (Ac-ft)**	**Height (ft)**
Small	50 and < 1,000	**25 and < 40**
Intermediate	**1,000 and < 50,000**	40 and < 100
Large	> 50,000	> 100

If the Weadock Landfill Embankment had an unexpected release of materials, there would be little expectation for loss of life, as the location is at the confluence of the discharge channel and Saginaw Bay.

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)

This unit has been given a Hazard Classification of "Low" indicating that "Failure or misoperation of the dam results in no probable loss of human life or economic or environmental losses." The facility is primarily a solid waste management unit and operated as such. A perimeter dike, which includes a recently installed bentonite cut-off wall, surrounds the 292-acre landfill which contains a network of drainage ditches that create the requisite residence time to settle particulates that enter the facility in accordance with the approved NPDES permit for the unit. With the exception of Pond F (P3), which is currently being dewatered and transitioned into part of the landfill, there is minimal wet volume behind the perimeter dikes that could cause a breach failure. Further, the facility is located on the shoreline of Lake Huron. Currently, there are no inhabited buildings, insurable buildings, or public parks between the perimeter dikes and Lake Huron that could be impacted due to a failure of the perimeter dikes. It should be noted, however, that there are sport fisherman in the area at various times throughout the year.

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

The site is designed to store approximately 11,200,000 cubic yards of fly ash, which is sufficient storage for the life of the Weadock generation plant, assuming 80,000 cubic yards of ash production annually.

Table 2.3: Maximum Capacity of Unit	
Weadock Landfill Embankment	
Surface Area (acre)[1]	292

Current Storage Capacity (cubic yards)[1]	560,000
Current Storage Capacity (acre-feet)	347
Total Storage Capacity (cubic yards)[1]	11,200,000
Total Storage Capacity (acre-feet)	6,940
Crest Elevation (feet)	590
Normal Pond Level (feet)	Not applicable [1]

[1]Pond F is currently being de-watered and, when complete, there will be no permanent ponds in the landfill.

2.4 PRINCIPAL PROJECT STRUCTURES

2.4.1 Earth Embankment

Sometime during construction of the Weadock plant, the original dike structures making up the Weadock Ash Disposal Facility were constructed. The Weadock Ash Disposal Facility was developed by reclaiming low-lands through the construction of perimeter dikes and subsequent fly ash filling. No documentation was found regarding the original dike construction; however the current elevation of the perimeter access roads along the west side and portions of the south side suggest a dike was placed to provide ash containment. The geometry of the original ash containment facility can be seen on Document 4. This document shows that ash was deposited primarily along the south side of the containment area through 1963. Soil borings, performed by MTC in 1991 (see Documents 5, 6, and 7) indicate that clay and/or sand was used to raise the elevation of the south dike. These borings also indicate that bottom ash was used to maintain the surface of the perimeter dike roads.

The east portion of the containment area was expanded in 1971 and the perimeter dikes were raised to elevation 590 feet IGLD85(International Great Lakes Datum 1985) . Details of that construction event can be seen in Document 8. The purpose of raising the perimeter dike was to construct a clay perimeter dike that keyed into the hydraulic confining glacial clay till layer located approximately 20 to 25 feet below the current ground surface. This clay dike was designed to prevent any potentially contaminated groundwater from seeping through the dike into Saginaw Bay from the disposal facility.

However, Consumers later determined that this clay dike was not effectively keyed into a confining layer. In 2008, a soil-bentonite slurry wall was installed within the clay dike and keyed into the hydraulically confining glacial clay till layer to cut off groundwater flow through the perimeter dike (see Section 4.1.2 and Document 9).

2.4.2 Outlet Structures

The NPDES outlet structure discharge point is located upstream of the existing fish barrier (see Document 2). Discharge is controlled by a vertical reinforced concrete pipe drop structure connected to a buried horizontal reinforced concrete discharge pipe. This vertical riser consists of a 4.5-foot diameter vertical concrete pipe with a larger diameter (approximately 8-foot) metal skimmer ring mounted to the top (see Appendix B, photographs 8 and 9). Water is forced to flow under the metal ring and over the top of the concrete pipe to skim any floating material and prevent clogging. The water level adjacent to the edge of the riser is monitored to measure discharge flow. Water flowing through the NPDES outfall structure is also monitored for environmental compliance with NPDES permit requirements. A horizontal 3-foot diameter RCP discharges to the channel below the water surface and is not visible (see Appendix B, photograph 11).

Based on calculations submitted to the State by Consumers Energy, the outfall has sufficient capacity to accommodate fly ash and bottom ash sluice water and a 25-year rain event. Now that the facility has converted to dry disposal methods and fly ash sluice water no longer enters the system, it can be concluded that the facility has sufficient discharge and storage capacity while maintaining minimum freeboard.

2.5 CRITICAL INFRASTRUCTURE WITHIN FIVE MILES DOWN GRADIENT

There are no critical structures within five miles down gradient that could be impacted due to a potential failure of the perimeter dikes.

3.0 SUMMARY OF RELEVANT REPORTS, PERMITS, AND INCIDENTS

Summary of Reports on the Safety of the Management Units

After the failure of the TVA's Kingston Fossil Power Plant in December 2008, Consumers Energy contracted AECOM to complete an ash disposal facility risk assessment specifically focused on the stability of the perimeter dikes that retain the coal ash. The results are included in the Potential Failure Modes Analysis (PFMA) Report, dated November 6, 2009 (Document 10).

In addition, AECOM completed a site walkover and visual inspection of the J.C. Weadock Disposal Facility on Monday, August 17, 2009. The results of that inspection are included in an Inspection Report, also dated November 6, 2009 (Document 11).

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

The Weadock plant received an operating license from the State of Michigan, Department of Environmental Quality (License Number 9233) for a Type III low hazard industrial landfill on October 15, 2009 (Document 12).

The Weadock plant operates under NPDES Permit Number M10001978 and Michigan Dam Safety Permit Number 0260.

3.2 SUMMARY OF SPILL/RELEASE INCIDENTS

No spill or releases have been reported to have occurred at the Weadock plant.

4.0 SUMMARY OF HISTORY OF CONSTRUCTION AND OPERATION

4.1 SUMMARY OF CONSTRUCTION HISTORY

4.1.1 Original Construction

The initial site plan is shown in Document 4. In AECOM's PFMA Report (Document 10), it was reported that no documentation was found regarding the original dike construction.

4.1.2 Significant Changes/Modifications in Design since Original Construction

The east portion of the containment area was expanded in 1971 and the perimeter dikes were raised to elevation 590 feet IGLD85. The purpose of raising the perimeter dike was to construct a clay perimeter dike that keyed into the hydraulic confining glacial clay till layer located approximately 20 to 25 feet below the current ground surface. This clay dike was designed to prevent any potentially contaminated groundwater from seeping through the dike into Saginaw Bay from the disposal facility. However, later studies conducted revealed that this clay dike was not effectively keyed into a confining layer.

In 2008, a soil-bentonite slurry wall was constructed along the perimeter dike beginning near the electric fish barrier in the discharge channel clockwise to a location south of the chemical treatment ponds, then north cutting across the site through disposed fly ash until it terminated in the perimeter dike running parallel with the discharge channel. This slurry wall was installed within the clay dike and keyed into the hydraulically confining glacial clay till layer to cut off groundwater flow through the perimeter dike.

4.1.3 Significant Repairs/Rehabilitation since Original Construction

There have not been any significant repairs since the original construction.

4.2 SUMMARY OF OPERATIONAL PROCEDURES

4.2.1 Original Operational Procedures

Prior to 2009, fly ash was hydraulically discharged to the ash disposal area, where the ash was allowed to settle by travel through a series of channels. Bottom ash was hydraulically discharged to the bottom ash

pond, as it does today, where it is allowed to settle and sluice water is conveyed to the NPDES discharge structure though channels and culverts.

4.2.2 Significant Changes in Operational Procedures and Original Startup

In February 2009, the fly ash disposal process was converted to a “dry” operation. The fly ash has a small amount of moisture added for dust control, then in transported by truck to the disposal area, where is placed in compacted. Pond F (P3) is in the process of being dewatered to complete the conversion of the disposal operation to completely “dry”.

4.2.3 Current Operational Procedures

As stated, the current operations consist of trucking the dry ash to the disposal area where it is placed in a manner consistent with landfill operations. Bottom ash disposal is unchaged.

4.2.4 Other Notable Events since Original Startup

None.

5.0 FIELD OBSERVATIONS

5.1 PROJECT OVERVIEW AND SIGNIFICANT FINDINGS

Dewberry personnel Cleighton Smith, P.E. and Scott Clarke, P.E. performed a site visit on Tuesday, September 21, 2010 with four persons from Consumers Energy and a State of Michigan DNRE representative.

The site visit began at 9:00 AM. The weather was warm (mid 70's, sunny, and windy). Photographs were taken of conditions observed. Please refer to photographs in Appendix B and the Dam Inspection Checklist in Appendix C. All pictures were taken by Dewberry personnel during the site visit.

The overall assessment of the impoundment was that it was in satisfactory condition and no significant findings were noted. It is worth noting that vegetation, including large trees, exist on the embankment. Consumers Energy is in active communication with the State of Michigan Dam Safety Office regarding this issue. However, since coal combustion ash is being managed as a dry landfill operation, the existence of trees on the embankment may be less of an issue.

5.2 WEADOCK DISPOSAL AREA PERIMETER EMBANKMENT (SECTIONS A THROUGH F)

5.2.1 Crest

The crest did not show any signs of significant depressions or settlement. A gravel service road covers the entire length of the embankment (see Figures 1 and 2).

Figure 1 - Crest of Section C embankment, Saginaw Bay area on left, Pond F (P3) on right.

Figure 2 - Crest of Section D embankment, outside slope on left, inside slope on right.

5.2.2 Upstream/Inside Slope

The inside slope is heavily vegetated in areas (see Figures 3 and 4). However, a vegetation management plan is in place, and much of the vegetation was being removed during the site visit. Our site investigation

revealed the presence of a non-native invasive species called "phragmites". There were no obvious indications of sloughing or erosion.

Figure 3 - Evidence of vegetation removal on inside slope on embankment Section A

Figure 4 - Evidence of phragmites and other vegetation on inside slope of embankment Section C

5.2.3 Downstream/Outside Slope and Toe

The outside embankment was heavily vegetated and contained several large trees. There was evidence of rip-rap in many locations, but presence

of vegetation and trees made a thorough inspection difficult. There were no obvious indications of sloughing or erosion (Figures 5 and 6).

Figure 5 - Evidence of heavy vegetation and trees on the outside slope of embankment Section A.

Figure 6 - Rip-rap and large tree and heavy vegetation on outside slope of embankment Section C

5.2.4 Abutments and Groin Areas

Not applicable as this is a ring dike.

5.3 OUTLET STRUCTURES

5.3.1 Overflow Structure

Not applicable.

5.3.2 Outlet Conduit

The outlet conduit is a vertical reinforced concrete pipe drop structure connected to a buried horizontal RCP discharge pipe. This vertical riser consists of a 4.5-foot diameter vertical concrete pipe with a larger diameter (8-foot) metal skimmer ring mounted to the top (Figure 7). Water is forced to flow under the metal ring and over the top of the concrete pipe to skim any floating material and prevent clogging. The water level adjacent to the edge of the riser is monitored to measure discharge flow. A horizontal 3-foot-diameter RCP discharges to the channel below the water surface and is submerged and not visible (Figure 8).

Figure 7 - Outlet conduit intake structure

Figure 8 - Area of submerged outlet in discharge channel

5.3.3 Emergency Spillway

Not applicable; no emergency spillway exists at this facility.

5.3.4 Low Level Outlet

Not applicable; no low level outlet exists at this facility.

6.0 HYDROLOGIC/HYDRAULIC SAFETY

6.1 SUPPORTING TECHNICAL DOCUMENTATION

6.1.1 Flood of Record

No information is available regarding the flood of record.

6.1.2 Inflow Design Flood

Inflow design flood is not applicable to this facility.

6.1.3 Spillway Rating

Based on calculations submitted to the State by Consumers Energy, the outfall has sufficient capacity to accommodate fly ash and bottom ash sluice water and a 25-year rain event. Now that the facility has converted to dry disposal methods and fly ash sluice water no longer enters the system, it can be concluded that the facility has sufficient discharge and storage capacity while maintaining minimum freeboard. Currently, there is Pond F (P3) dewatering and bottom ash decant water entering this structure. After dewatering is complete, bottom ash decant and local stormwater will be the only water entering this structure.

6.1.4 Downstream Flood Analysis

No downstream flood analysis was prepared nor appear warranted.

6.2 ADEQUACY OF SUPPORTING TECHNICAL DOCUMENTATION

There is an adequate amount of supporting technical documentation to assess the embankments.

6.3 ASSESSMENT OF HYDROLOGIC/HYDRAULIC SAFETY

These embankments appear to be safe from a hydrologic and hydraulic standpoint, based on the conversion of the facility from wet disposal to a dry landfill.

7.0 STRUCTURAL STABILITY

7.1 SUPPORTING TECHNICAL DOCUMENTATION

7.1.1 Stability Analyses and Load Cases Analyzed

The stability of the ash dike structures has been previously evaluated by Materials Testing Consultants (MTC). The stability of the dike structures was analyzed for stability with a slurry wall by AECOM.(See Document 10).

The following assumptions were made in the MTC analysis:

1. Cohesion and internal friction angle were factored into the analysis (total stress analysis).
2. The beneficial effect of armor stone or slope protection on the downstream side of the dikes was not considered.
3. The beneficial effect of vegetated soil or cement stabilized fly ash on the final slopes of the ash storage pile was not considered.
4. Groundwater was assumed to be at elevation 581 feet on the downstream face and at elevation 591.5 feet at the upstream face (equal to the dike crest) and was assumed to be mounded within the fly ash embankment to 20 feet below the final fill height of elevation 650 feet at elevation 630 feet (IGLD 85).

The stability analysis by AECOM focused on a section of the perimeter dike separating the north side of Pond F from Saginaw Bay with the slurry wall installed and ash fill completed to elevation 650 feet at a 4H:1V slope. The following assumptions were made in the AECOM analysis:

1. Dry moisture conditioned fly ash will be placed and then compacted to 90% of its maximum dry density from the foundation to finished grade. (i.e. Pond F will be dredged of all sluiced fly ash prior to filling.)
2. Groundwater was assumed to be at elevation 576.44 (Lake Huron All-Time Low Water level) on the outboard face of the slope and elevation 583 and 588 on the inboard side.
3. It was assumed that no beneficial vegetative cover or armor stone was in place.
4. Material properties were developed using borings and laboratory tests performed for the design of the slurry wall.
5. Pond F will be dredged of all sluiced fly ash prior to filling.

The stability analyses results for each section considered are summarized as follows:

• Section A – Factors of safety (FS) ranged from 1.42 to 2.0. The minimum FS that could result in a loss of ash containment was reported to be 1.42. The analysis did not consider fully drained conditions or undrained conditions specifically within the wet ash.
• Section B – This section has not been specifically considered in previous stability analyses. Since it is similar to Section A in geometry and ash is not proposed to be stacked in the adjacent Pond P1, this dike is considered stable, provided adequate freeboard is maintained.
• Section C – Factors of safety ranged from 2.1 to 4.2. The minimum FS that could result in a loss of ash containment was reported to be 2.1; greater than the typically accepted value of 1.5. These analyses considered the effect of interior ground water levels on FS. It was concluded that higher interior water levels did not greatly affect the overall stability of the structure. The analyses assumed that the wet loose ash in Pond F would be replaced with compacted ash.
• Section D – Factors of safety ranged from 1.35 to 3.91. The minimum FS that would potentially result in a loss of ash containment was reported to be 1.35. This FS is lower than the typically accepted value of 1.5. The analysis did not consider fully drained conditions or undrained conditions specifically within the wet ash.
• Section E – No stability analyses have been conducted on this section. Section E has remained stable and will not have any additional ash placed adjacent to it, according to the proposed closure plan. Therefore, Section E is considered stable based on its performance history.
• Section F – No stability analyses have been conducted on this section. Ash filling activities are planned adjacent to this section and known wet loose ash is present at this location.

7.1.2 Design Parameters and Dam Materials

Consumers Energy contracted MTC in 1991 to perform soil borings into the existing embankment as part of their design for vertical expansion. Their borings indicated a core of predominantly compacted clay. The borings are included in Documents 5, 6, and 7.

7.1.3 Uplift and/or Phreatic Surface Assumptions

Not applicable.

7.1.4 Factors of Safety and Base Stresses

MTC factors of safety are shown in the following table (see Document 10).

Structure	Loading Conditions	Failure Surface	Developed Factor of Safety
Dike Separating Pond B1 and the Discharge Channel (Section A)	Existing geometry without slurry wall	Deep Seated Failure of Dike	2.0
Dike Separating Pond B1 and the Discharge Channel (Section A)	Completed fly ash fill to el. 650 without slurry wall	Deep Seated Failure of Dike and Ash Fill	1.85
Dike Separating Pond B1 and the Discharge Channel (Section A)	Completed fly ash fill to el. 650 without slurry wall	Deep Seated Failure of Ash Fill	1.42
East Perimeter Dike Bordering Underwood Drain (Section D)	Existing geometry without slurry wall	Deep Seated Failure of Dike	3.91
East Perimeter Dike Bordering Underwood Drain (Section D)	Completed fly ash fill to el. 650 without slurry wall	Deep Seated Failure of Dike and Ash Fill	1.98
East Perimeter Dike Bordering Underwood Drain (Section D)	Completed fly ash fill to el. 650 without slurry wall	Deep Seated Failure of Ash Fill	1.35
South Perimeter Dike Bordering Tayce Drain (Section D)	Existing geometry without slurry wall	Deep Seated Failure of Dike	1.97
South Perimeter Dike Bordering Tayce Drain (Section D)	Completed fly ash fill to el. 650 without slurry wall	Deep Seated Failure of Dike and Ash Fill	1.78
South Perimeter Dike Bordering Tayce Drain (Section D)	Completed fly ash fill to el. 650 without slurry wall	Deep Seated Failure of Ash Fill	1.42

AECOM factors of safety are shown in the following table (see Document 10):

Structure	Loading Conditions	Failure Surface	Developed Factor of Safety
Pond F North Dike (Section C) – Undrained Conditions	Inboard water elevation equal to top of slurry wall (el. 588 feet)	Shallow Failure of Ash Fill	2.3
Pond F North Dike (Section C) – Undrained Conditions	Inboard water elevation equal to static water level in Pond F (el. 583 feet)	Shallow Failure of Ash Fill	2.1
Pond F North Dike (Section C) – Drained Conditions	Inboard water elevation equal to top of slurry wall (el. 588 feet)	Deep Seated Failure of Dike and Ash Fill	2.3
Pond F North Dike (Section C) – Drained Conditions	Inboard water elevation equal to static water level in Pond F (el. 583 feet)	Shallow Failure of Ash Fill	2.3
Pond F North Dike (Section C) – Undrained Conditions	Inboard water elevation equal to top of slurry wall (el. 588 feet)	Shallow Failure of Ash Fill	2.2
Pond F North Dike (Section C) – Undrained Conditions	Inboard water elevation equal to static water level in Pond F (el. 583 feet)	Shallow Failure of Ash Fill	2.2
Pond F North Dike (Section C) – Drained Conditions	Inboard water elevation equal to top of slurry wall (el. 588 feet)	Shallow Failure of Ash Fill	2.4
Pond F North Dike (Section C) – Drained Conditions	Inboard water elevation equal to static water level in Pond F (el. 583 feet)	Shallow Failure of Ash Fill	2.4
Pond F North Dike (Section C) –	Inboard water elevation equal to top of slurry wall (el.	Shallow Failure of	4.2

Undrained Conditions	588 feet)	Dike	
Pond F North Dike (Section C) – Undrained Conditions	Inboard water elevation equal to static water level in Pond F (el. 583 feet)	Shallow Failure of Dike	4.2
Pond F North Dike (Section C) – Drained Conditions	Inboard water elevation equal to top of slurry wall (el. 588 feet)	Shallow Failure of Dike	2.0
Pond F North Dike (Section C) – Drained Conditions	Inboard water elevation equal to static water level in Pond F (el. 583 feet)	Shallow Failure of Dike	2.1

7.1.5 Liquefaction Potential

Not addressed.

7.1.6 Critical Geological Conditions

Seismic analyses were not conducted as the site is in a seismic zone 0.

7.2 ADEQUACY OF SUPPORTING TECHNICAL DOCUMENTATION

Supporting technical documentation is adequate to perform required assessments.

7.3 ASSESSMENT OF STRUCTURAL STABILITY

Overall, the structural stability of the dam appears to be **Satisfactory** based on:

- Plant is converting from a sluicing operation to a dry landfill operation;
- Consumers Energy performed an independent assessment of embankment stability which did not raise any serious stability issues;
- A vegetation management plan is in place;
- The State of Michigan Dam Safety program regulates these embankments and performs site inspections regularly.

- Dewberry's site inspections and review of technical information did not reveal any serious safety issues.

8.0 ADEQUACY OF MAINTENANCE AND METHODS OF OPERATION

8.1 OPERATING PROCEDURES

The Weadock facility has a number of procedures related to standard and emergency operational requirements for the facility. The emergency procedures are contained in the "Spill Control Plan Procedure" which can be found on site at both Karn and Weadock. Standard operations include daily inspections of the NPDES outlet. In addition, regular general site inspections of the Weadock ash disposal facility are made by security staff. Periodically, operators observe the degree of siltation in the intake and discharge channels and if needed, dredging is completed to maintain those channels. Ash filling operations are limited to 12 feet per year with lifts not thicker than 3 feet per site development specifications included in Appendix B of the solid waste permit.

Currently there is no standard operating procedure to maintain a specific elevation in the ditches or internal ponds. Rather, sluice water is allowed to travel 1) by gravity from the discharge point; 2) down ditches, through drop structures, and culverts between internal ponds, and eventually to Pond F; and 3) to the NPDES outlet structure into the plant discharge channel. The ground surface elevation at the discharge pipe in the bottom ash pond is approximately 595 feet. The NPDES outfall weir is at a fixed elevation of 581.45 feet. Assuming a dike crest elevation of 590 feet, the freeboard at the downstream end of the flow path is approximately 8 feet.

The outfall has sufficient capacity to accommodate fly ash and bottom ash sluice water and a 25-year rain event. Now that the facility has converted to dry disposal methods and fly ash sluice water no longer enters the system, it can be concluded that the facility has sufficient discharge and storage capacity while maintaining minimum freeboard. In addition, plant personnel noted that a large storm event was experienced by the outfall structure in the summer of 1994 and was contained with no noted overtopping of the perimeter dike or loss of containment.

8.2 MAINTENANCE OF THE EMBANKMENT AND PROJECT FACILITIES

The Weadock ash disposal facility does not currently have a maintenance specifically for safety of the containment structures. Currently the environmental staff monitors two of the existing wells for environmental compliance and static water level. However, the facility does not review this data with regards to safety of the project structures related to a breach or loss of containment. The current Consumers Energy Operations and Maintenance Manual is Document 13.

8.3 ASSESSMENT OF MAINTENANCE AND METHODS OF OPERATIONS

8.3.1 Adequacy of Operating Procedures

Operating procedures appear to be adequate and consistent with industry standards for landfill operations.

8.3.2 Adequacy of Maintenance

Maintenance procedures appear to be adequate. Even though the vegetation on the outside slopes is not consistent with industry standards, there is a vegetation management plan in place for the inside embankments (see Document 14). Consumers Energy and the State of Michigan Dam Safety office are in a dialogue regarding the vegetation issue on the outside embankments. AECOM, in their PFMA report, stated that “although there are many trees growing on the slopes, it is unlikely than even a large tree uprooting would cause sufficient dike instability to cause a slope failure and loss of containment”. These facts, combined with the conversion of wet sluicing to dry operations, lead to the conclusion that maintenance procedures appear to be adequate.

9.0 ADEQUACY OF SURVEILLANCE AND MONITORING PROGRAM

9.1 SURVEILLANCE PROCEDURES

Weadock plant staff perform visual inspections of the perimeter dikes twice daily. The State of Michigan Dam Safety office performs quarterly inspections.

9.2 INSTRUMENTATION MONITORING

Monitoring wells for measuring water elevation are located on the inside edge of the crest and outside edge of the crest throughout the site (see below). Two monitoring wells are regularly monitored (MW-19 and MW-20). Typical groundwater elevations at these wells are shown in Document 15). There are no survey monuments along the crest to monitor settling.

Figure 9 - Monitoring wells

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, along with the current operation as a dry landfill, the inspection program is adequate.

9.3.2 Adequacy of Instrumentation Monitoring Program

Based on the data reviewed by Dewberry, including observations during the site visit, and current operation as a dry landfill, the inspection program is adequate.

Potential Failure Modes Analysis (PFMA) Report
J.C. Weadock Generating Facility
Ash Dike Risk Assessment
Essexville, Michigan

Consumers Energy Company
Essexville, Michigan
AECOM Project No. 60100985
November 6, 2009

Prepared by:
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1.0 Introduction

In December of 2008, a hydraulically placed ash landfill at the TVA's Kingston Fossil Power plant in Tennessee failed, leading to significant environmental impacts. As a result of this failure and in order to better understand the existing and future structural (geotechnical) and environmental risks related to the J.C. Weadock Ash Disposal Facility, Consumers Energy Company (CEC) contracted AECOM to complete an ash disposal facility risk assessment specifically focused on the stability of the perimeter dikes that retain the coal ash. This report details the assessments made and actions recommended to reduce future risk at the J.C. Weadock Ash Disposal Facility. The following sections discuss those assessments and risks and highlights recommended actions to reduce those risks through a process called Potential Failure Modes Analysis (PFMA), which is similar to that employed by the Federal Energy Regulatory Commission (FERC). The risk evaluation approach used for this project is outlined in Section 1.1.

During the preparation of this PFMA report, the available project data including information gathered at the PFMA session were reviewed and have been summarized in Section 2.0 of this report. The results of the PFMA session are summarized in Sections 3.0 through 7.0 and include Hazard Classification, Potential Failure Modes Identified, Risk Reduction Measures, Findings and Understandings, and Conclusions and Recommendations, respectively.

1.1 Risk Evaluation Approach

The PFMA completed for this project is based on industry-recognized methods and procedures that are familiar and recognized by the regulatory community. The PFMA approach is described in Chapter 14 of the FERC's Engineering Guidelines and was used for the evaluation of this project. The U.S. Army Corps of Engineers (USACE) employs a similar approach for dams at risk based on probability of dam failure and consequences if failure were to occur (USACE Website, 2009). The USACE's program employs a method called Screening Portfolio Risk Analysis which is designed to assess the relative risk of dams similar to the FERC's PFMA approach.

For this project, the PFMA was intended to be a tool to identify possible ash dike failure mechanisms. Traditional dam and project works safety evaluations have tended to focus on a limited number of "standards based" concerns such as hydraulic capacity of spillways and computed stability of structures under a set of pre-defined load conditions to achieve minimum factors of safety against failure. The PFMA is intended to broaden the scope of the safety evaluations to include potential failure scenarios that may have been overlooked in past investigations. By definition, a PFMA is an exercise to identify potential failure modes that result in an uncontrolled release of contents or breach of containment under static loading as well as other loading conditions of the containment dikes and to assess those potential

failure modes of enough significance to warrant continued awareness and attention to visual observation, monitoring, and remediation as appropriate.

The FERC guidelines also include an evaluation of the hazard potential for classification of traditional dam projects. The hazard potential classifications are designated as Low, Significant, or High. The differences between classifications depend upon the potential for loss of human life and impacts to economic, environmental, and lifeline facilities, should an uncontrolled failure occur. The following descriptions summarize each classification (FERC, 2004):

- Low Hazard Potential – No probable loss of human life and low economic and/or environmental losses which are generally limited to the owner's property.
- Significant Hazard Potential – No probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or can impact other concerns.
- High Hazard Potential – Will probably cause loss of human life. Economic, environmental and lifeline losses are also possible but not required for this classification.

As a result of the December 2008 TVA failure, the U.S. Environmental Protection Agency (USEPA) initiated an investigation program in March 2009 of impoundments that contain coal combustion residuals at select facilities in the United States. This program used similar classifications to the FERC to evaluate the hazard potential of coal ash impoundments. The results of the USEPA's investigation programs were published on the USEPA's website on September 16, 2009 (USEPA Website, 2009).

1.2 Description of PFMA Session

The PFMA session for the J.C. Weadock Ash Disposal Facility was conducted on August 13 and 14 of 2009, at the D.E. Karn and J.C. Weadock Generating Facilities in Essexville, Michigan. The Core Team attending the PFMA session included the following people:

Bill Walton - AECOM
Rick Anderson – AECOM
Jamie Matus – AECOM
Mike Carpenter – AECOM
Carlin Fitzgerald – AECOM
Marianne Walter – CEC
JR Register – CEC
Rick Hall – CEC
Jon Carpenter – CEC
Roberto Falco – CEC

The agenda of the PFMA session included the following:

August 13, 2009:

- A site visit was completed to acquaint Core Team members with the facility layout and condition.
- A document reading session was conducted to become familiar with facility history. This involved review of documents available from CEC's records.
- A Site Hazard Classification session took place to determine the appropriate classification for the facility.
- The Potential Failure Modes (PFMs) were identified.
- The PFMs identified were developed by listing any likely or unlikely reasons each particular PFM would be possible.

August 14, 2009:

- The PFMs identified were classified into Category I, II, III, IV, IV-ND, or a combination of categories based on reasons listed during the development process.
- Any Risk Reduction Measures (RRMs) were identified and listed with each applicable PFM.
- Major Findings and Understandings of the Core Team were identified. These items included issues that team members had not considered or were not aware of in relation to the safety of the facility.

2.0 Project Background

2.1 Project Description

The D.E. Karn and J.C. Weadock Generating Facilities consist of two separate power generating plants located in Essexville, Michigan on a peninsula bounded by the mouth of the Saginaw River to the west and Saginaw Bay to the north and is located on the western shore of Lake Huron. The long term mean level of Lake Huron is reported graphically as elevation 176.65 meters (579.56 feet), IGLD85[1] (NOAA Website, 2009). The J.C. Weadock plant was the first to generate power in 1940 and eventually consisted of six coal burning units, Units 1 to 6, which were retired in 1980. Two additional units, Units 7 and 8 were added in 1955 and 1958 and continue to operate. The D.E. Karn Plant consists of two coal burning units, Units 1 and 2, and two oil and gas co-fired units, Units 3 and 4. Units 1 and 2 were constructed in the late 1950's and put into service in 1959 and 1961, respectively. Units 3 and 4 were added in 1975 and 1977, respectively. Together, Karn and Weadock burn approximately 3 million tons of coal, 1.3 billion cubic feet of natural gas, and 23 million gallons of fuel oil per year to produce approximately 2,100 megawatts (CEC Website, 2009). Figure 1 is a site location map showing the facilities' location and the surrounding area. Aerial views showing the site layout and location of the facilities can be seen on Figures 2 and 3.

The J.C. Weadock Solid Waste Disposal Area is located east of the Weadock plant. According to the 1992 permit application, the landfill covers an area of approximately 292 acres and has a perimeter of approximately 4.85 miles. The majority of the perimeter consists of ash containment dikes separating the landfill from the Saginaw Bay, the discharge channel, and Tacey and Underwood Drains (CPC, 1992a), which make up the bordering "Waters of the State". The remainder of the perimeter consists of dikes or upland areas with an unknown construction history. The dikes have generally a 20-foot wide crest and a typical crest elevation of 590 feet IGLD85. The containment dike is used as a perimeter access road upon which light utility trucks, large snowplows, and 80-ton haul trucks can be driven. However, heavy traffic is limited on portions of the perimeter access roads due to the presence of the slurry wall. The facility has been expanded and modified from its original layout in the 1940's to the current layout. Details related to the history of dike construction are discussed in Section 2.1.1.

The governing regulation for industrial waste disposal in the State of Michigan is Michigan's Natural Resources and Environmental Protection Act (NREPA), Part 115, Solid Waste Management. Part 115 provides rules for the operation of solid waste surface impoundments with industrial wastes and free

[1] Unless otherwise stated, elevations in this report are in the historical datum, United States Lake Survey (USLS). To convert to International Great Lakes Datum 1985 (IGLD85) from USLS, subtract 1.05 feet. To convert to NAVD88 from USLS, subtract 0.935 feet.

liquids, with liquids discharged from the facility subject to a National Pollutant Discharge Elimination System (NPDES) permit which is issued under NREPA Part 31. Until 1992, the JC Weadock landfill was operated as a surface impoundment. On April 21, 1992, Construction Permit No. 0260 was issued by the Michigan Department of Natural Resources and provided for Phase II consolidation and the vertical expansion of an engineered structural fill in portions of the landfill (CPC, 2009).

The site is designed to store approximately 11,200,000 cubic yards of fly ash, which is sufficient storage for the life of the Weadock generation plant, assuming approximately 80,000 cubic yards of ash production annually. However, ash from the Karn facility should now be included in the annual disposal quantity beginning circa December 2008, when the Karn and Weadock facilities converted to dry ash disposal at the Weadock disposal area. The total ash disposed annually, including ash produced at Karn is approximately 228,000 cubic yards (CPC, 1992a).

Prior to February 2009, fly ash was hydraulically discharged from a trestle near the west end of the disposal area. Fly ash was most recently sluiced eastwardly into a series of parallel channels, C1, C2 and C3 (see Figure 3), where the majority of ash settled out. During operations, only one of the three parallel channels would be in operation. The channels met back up at a ditch that supplied channels C5 C6 and C4 (C5 was retired early in the operation). The flow splits into channels C4 to the north and C6 to the south. During the summer operations, the ash was routed to C6 then to C8 to Pond P3 or F. Pond F was excavated and reclaimed circa 1991 at the time dredge and stack methods were put into effect, allowing for a decanting pond. During the winter operations, the ash traveled from channel C5 to C4, then to Pond F. Sluice water leaves Pond F through a drop structure at its northwest corner and traveled south west along the perimeter dike through a reinforced concrete pipe to a ditch before arriving at the NPDES discharge point where it was discharged to the plants' non-contact cooling water discharge channel (see Figure 3). According to operations staff, these channels and ponds were dredged periodically. The frequency of dredging was every spring to increase the capacity of the channels and ponds. The sluiced fly ash was dredged using a drag line along the "C" channels running generally east-west through Pond A to the south section of "F" pond (C7, C8 & C9). Dredged ash was stockpiled and allowed to dewater before being placed and compacted within the disposal area limits in accordance with the final closure geometry.

Bottom ash was discharged from the discharge trestle into the bottom ash pond where it is allowed to settle out (see Figure 3). The bottom ash sluice water was conveyed through a ditch and was discharged into the "C" channels where it joined the fly ash sluice water and eventually was discharged via the NPDES discharge point. It now travels through the C1 channel, across the P1 pond (ditch) to the small triangle pond to the cement pipe.

2.1.1 Project History – Timeline and Construction Chronology

Sometime during construction of the Weadock plant, the original dike structures making up the Weadock Ash Disposal Facility were constructed. Figure 9 shows the Weadock Facility in 1950. The Weadock Ash Disposal Facility was developed by reclaiming low-lands through the construction of perimeter dikes and subsequent fly ash filling. No documentation was found regarding the original dike construction; however the current elevation of the perimeter access roads along the west side and portions of the south side suggest a dike was placed to provide ash containment. The geometry of the original ash containment facility can be seen on Figures 10 and 11. Figure 11 shows that ash was deposited primarily along the south side of the containment area through 1963. Soil borings SBW-4, SBW-5, and SBW-6 indicate that clay and/or sand was used to raise the elevation of the south dike. These borings also indicate that bottom ash was used to maintain the surface of the perimeter dike roads.

The east portion of the containment area was expanded in 1971 and the perimeter dikes were raised to elevation 590 feet IGLD85. Details of that construction event can be seen on Figures 4 and 5. The purpose of raising the perimeter dike was to construct a clay perimeter dike that keyed into the hydraulic confining glacial clay till layer located approximately 20 to 25 feet below the current ground surface. This clay dike was designed to prevent any potentially contaminated groundwater from seeping through the dike into Saginaw Bay from the disposal facility. However, later studies conducted revealed that this clay dike was not effectively keyed into a confining layer (CPC, 1992a).

In 2008, a soil-bentonite slurry wall was constructed along the perimeter dike beginning near the electric fish barrier in the discharge channel clockwise to a location south of the chemical treatment ponds, then north cutting across the site through disposed fly ash until it terminated in the perimeter dike running parallel with the discharge channel (see Figure 6). This slurry wall was installed within the clay dike and keyed into the hydraulically confining glacial clay till layer to cut off groundwater flow through the perimeter dike.

In February 2009, sluicing of fly ash ceased at the Weadock facility. Bottom ash from the Weadock plant continues to be sluiced and disposed of within the Weadock disposal area. Some of the fly ash sluicing channels have been converted to bottom ash sluicing channels. However, bottom ash settles out much quicker than fly ash so the new system functions more as a conveyance system then a settling system. Fly ash is now disposed of by dry placement methods where ash is blown to a silo located at the Weadock Disposal Facility from the Karn and Weadock plants and then trucked to an active fill area and compacted to specifications within the Weadock Disposal Facility.

2.1.2 Future Construction

The currently permitted vertical expansion of the Weadock landfill will raise the final elevation of the ash disposal area by up to approximately 60 feet to a final design elevation of 650 feet (CPC, 1992a). Figure 7 shows the current proposed closure topography for the Weadock facility.

2.2 Hydraulics and Hydrology

2.2.1 Outfall

Sluice water flows through Pond P1 through the permitted NPDES discharge point as discussed in Section 2.1. This water is discharged through the NPDES permitted point controlled by a weir at elevation 581.45 feet (NAVD88) located upstream from the electric fish barrier in the discharge channel. Historically there have been two different locations of this discharge point for the Weadock disposal area. Originally, the discharge point was located at the northeast corner of Pond F and was released to Saginaw Bay through a weir and series of manholes. This discharge was retired circa 1978 and pipes have been abandoned.

Around that same time, the discharge point was moved to its current location where water is released to the discharge channel upstream of the existing fish barrier (see Figure 3). Discharge is controlled by a vertical reinforced concrete pipe (RCP) drop structure connected to a buried horizontal RCP discharge pipe. This vertical riser consists of a 4.5-foot diameter vertical concrete pipe with a larger diameter (approximately 8-foot) metal skimmer ring mounted to the top. Water is forced to flow under the metal ring and over the top of the concrete pipe to skim any floating material and prevent clogging. The water level adjacent to the edge of the riser is monitored to measure discharge flow. Water flowing through the NPDES outfall structure is also monitored for environmental compliance with NPDES permit requirements. A horizontal 3-foot-diameter RCP discharges to the channel below the water surface and is not visible.

Based on calculations submitted to the State by CEC, the outfall has sufficient capacity to accommodate fly ash and bottom ash sluice water and a 25-year rain event (CPC, 1992b). Now that the facility has converted to dry disposal methods and fly ash sluice water no longer enters the system, it can be concluded that the facility has sufficient discharge and storage capacity while maintaining minimum freeboard.

2.2.2 Normal and Flood Minimum and Operating Freeboard

The NPDES discharge outfall controls the elevation of water in the channel at elevation prior to discharge. A 40-foot long 36-inch-diameter corrugated metal pipe (CMP) interior decant structure between Ponds F and P1 control the water level in Pond F. An 80-foot-long 36-inch-diamter CMP conveys water from P1 to

the channel leading to the NPDES outfall. There are also several interior decant structures that control the water level in the sluice channels and interior ponds. The water contained by the disposal facility includes storm water runoff and bottom ash sluice water. Under current operating conditions, top of dike freeboard is approximately 6 feet at Pond F and 8 feet at the NPDES discharge point.

The potential for surface water to rise above the available freeboard in the event of a large storm is minimal. According to plant personnel, a large rain event occurred in the summer of 1994, prior to abandoning the sluiced ash operation, without any overtopping occurring. Sluice water introduced to the disposal area has been reduced by more than half. Therefore, it is very unlikely that a large rain event could cause a significant loss in freeboard.

In early 2009, the fire pond located south of the Weadock ash disposal area was full and needed to be pumped down. CEC's procedure for removing water from the fire ponds includes pumping the water to the inner ditches of the ash disposal area inboard of the slurry wall. On this particular occasion, the interior ditch happened to be blocked causing a backup of water unable to drain. This caused the water to flow over the top of the dike and erode the gravel cap; however, the slurry wall was not exposed as a result of this erosion. . A procedure has been developed to repair damage but was not available for review at the time of the PFMA session.

2.2.3 Lake Huron Considerations

Water surface elevations can vary in Saginaw Bay due to wind setup and storms. A fluctuation of several feet has been observed by plant staff in the event of a strong northerly or easterly wind. The wind blows lake water into the Saginaw Bay causing the water surface elevation to rise. Waves created by the wind can also reach the perimeter dikes. It is possible to experience large waves since the fetch to the perimeter dike facing the bay is over 100 miles on the north side of the facility along Pond F. To reduce the impact of rising water surface elevations and large waves on the perimeter dike, shoreline protection was installed in 1973 along the Saginaw Bay portions of the perimeter dike. Details of this protection can be seen on Figure 8.

2.3 Standard Operating Procedures

The NPDES outlet structures are monitored regularly for environmental purposes and daily by site security personnel. Security personnel do not specifically monitor the outlet but make visual observations to ensure no vandalism or trespassing is taking place. Security personnel make a round once per shift during the day and continuously patrol the perimeter roads during the evening.

Currently fly ash from both the Karn and Weadock plants is disposed of at the Weadock facility. Fly ash is blown to a silo where it is moisture conditioned and trucked to an active fill area where it is placed and

compacted. Specifications for placing and compacting fly ash are included in the facility operating permit (CPC, 1992a). Bottom ash continues to be discharged and used as final cover for areas of the Weadock facility that are scheduled for final cover and subsequent closure.

2.4 Current Surveillance and Monitoring Plan

Currently the facility does not have a formal written surveillance and monitoring plan related to project safety of the dikes and outfall structure. However, a number of instrumentation is available to monitor the performance of the facility. These include perimeter monitoring wells and outfall water level monitoring.

Monitoring wells were installed both upstream and downstream of the perimeter dikes in 1982. Only two of the available wells installed are monitored for water levels and environmental compliance to satisfy landfill operating permit requirements. The other wells are not currently monitored on any schedule. Monitor well MW-19 is located near the bottom ash pond and MW-20 is located near the chemical treatment ponds. A summary of the historic average, high, and low water levels and most recent recorded water levels for these wells is included in the following table.

Table 2-1 - Water Level Elevation in Monitoring Wells (feet, IGLD 85)

Monitoring Well	Average (2/1/83 - 2/10/09)	High (02/01/83 - 2/10/09)	Low (02/01/83* - 2/10/09)	Most Recent Reading (7/29/09)
MW-19	586.52	589.14 (02/05/08)	582.53 (08/01/88)	585.86
MW-20	587.40	589.33 (11/01/92)	584.76 (08/07/07)	587.35

*Readings for MW-20 began 11/01/91.

2.5 Geology and Seismicity

2.5.1 Regional Geology

The Karn and Weadock plants are located approximately 30 miles east of the center of the Michigan Basin, a broad structural and depositional basin formed during the Paleozoic time. The site is underlain by about 14,000 feet of Paleozoic sediments deposited on Precambrian basement rock. The formations generally dip toward the northwest into the center of the basin. The bedrock at the site lies approximately 90 feet beneath the surface and is part of the Saginaw formation. This formation, which consists of early Pennsylvanian deposits laid down approximately 300 million years ago, is comprised of gray and black shales, interbedded with sandstones, calcareous sandstones, siltstones and occasional limestone lenses (CPC, 1992a).

Surficial soil deposits near the project site range in thickness from 65 to 90 feet. These deposits consist of unconsolidated glacial, lacustrine (lake) and alluvial (stream) deposits. The glacial deposits are of two

types: outwash which is sorted and stratified sand deposited from glacial melt waters and till which is an unsorted, unstratified mixture of clay interspersed with varying amounts of silt, sand and gravel deposited directly from glacial ice. The lacustrine deposits are organic clays, silts and sands that were deposited in or on the shores of glacial lakes formed during interglacial and postglacial times. The alluvial deposits consist of sands that were deposited by the adjacent Saginaw River (CPC, 1992a). Figure 12 shows the regional Quaternary geology.

2.5.2 Site Geology and Local Soil Conditions

The site is mostly altered from the native conditions by filling and diking with miscellaneous earth fills to generally raise site grades. Below the surficial fills, native alluvium and lacustrine soils are present at varying depths. Generally, the alluvium soils are deeper along the Saginaw River and the lacustrine deposits are shallower at other locations of the site. The alluvial and lacustrine deposits sit above the glacial till layer which is encountered anywhere from 25 feet to 75 feet below the ground surface. Bedrock generally exists at 90 feet below the ground surface (CPC, 1992a).

Many soil borings have been drilled at the project site. Figure 13 shows the known locations of the boreholes and Figures 14, 15, 16, 17, 18, 19, 20, and 21 shows a generalized profile of the subsurface conditions along the perimeter dike where the slurry wall was installed. Soil boring information generally supports the local geologic conditions and dike construction described in the paragraphs above. Copies of soil boring logs and laboratory test results are included on the attached CD.

2.5.3 Seismicity

The closest seismic zones to the facility are the Wabash Valley Fault Zone in southern Indiana and the Eastern Tennessee Fault Zone covering parts of eastern Tennessee and northern Georgia and Alabama. These seismic zones are located over 500 miles away from the project site. The next closest and of largest significance of the three is the New Madrid Fault Zone (USGS, 2008). According to the USGS, the Weadock site is in a seismic Zone 0. The largest earthquake ever recorded in Michigan was a Magnitude 4.60, with a Modified Mercalli Intensity of VI, and was originated south of Kalamazoo, Michigan in 1947 (USGS, 2009).

The published ground acceleration values for the Weadock site as reported by the USGS Earthquake Hazards Program, available on the USGS Website in September 2009, are summarized in the following table. For example the 1% probability of exceedence for earthquakes in 100 years is commonly used for high hazard dams and 2% in 50 years is typical for many building codes. However, for %g values less than 5, seismic stability is typically not considered a credible loading condition. No pseudostatic seismic stability analyses have been completed previously. However, a geotechnical report by PSI for the "Proposed Gas Bridge Foundations" in 2005 designates the Weadock facility as a Site Class D, per the

Michigan Building Code. This classification is designated for sites exhibiting an average soil shear wave velocity, v_s, in the top 100 feet ranging from 600 to 1,200 feet per second.

Table 2-2 - Probabilistic Ground Motion Values, in %g

	2% PE in 50 yr	10% PE in 50 yr
PGA	2.9%	1.2%

2.6 Stability Analyses

2.6.1 Summary of Industry-Accepted Factors of Safety

The ash containment areas are currently classified as Solid Waste Disposal areas, and are regulated by the Michigan Department of Environmental Quality (MDEQ) through Part 115 of the National Resources and Environmental Protection Act, as discussed at the beginning of this report. Although the MDEQ requires that the structural integrity of the containment dikes be evaluated by a registered engineer, the MDEQ does not currently define specific minimum required factors of safety (FS). To establish minimum project FS, AECOM has referenced three documents which can be considered the standard of practice for slope stability analysis, with regards to dams or retention structures. The documents are as follows:

- U.S. Army Corps of Engineers (USACE), "Slope Stability," EM 1110-2-1902, October 2003;
- Federal Energy Regulatory Commission (FERC). "Chapter 4 (Draft Version) – Embankment Dams", September 2006; and,
- Unified Facilities Criteria (UFC), "Soil Mechanics," UFC 3-220-10N, June 2005 (Document is formerly known as U.S. Naval Facilities, "Soil Mechanics – Design Manual 7.01," NAVFAC DM 7.01, September 1986)

Table 2-3 summarizes minimum recommended FS for each reference for various loading conditions.

Table 2-3 – Minimum Industry Factors of Safety

Reference Document	Permanent Sustained Loading (Steady State Seepage)	Temporary Loading (i.e., During or End of Construction)	Earthquake Loading (Transient Loading)	Rapid Drawdown
U.S.A.C.E. EM 1110-2-1902	1.5	1.3	Not Provided	1.1 to 1.3[Note 1]
FERC Chapter 4	1.5	1.3	1.0	1.1 to 1.2[Note 2]
UFC 3-220-10N	1.5	1.25 to 1.3[Note 3]	1.15 to 1.2	N/A

1. FS=1.1 applies to drawdown from maximum surcharge pool; FS=1.3 applies to drawdown from maximum storage pool.
2. FS=1.1 applies to drawdown from maximum pool; FS=1.2 applies to drawdown from spillway crest or top of gates.
3. A FS=1.25 applies only if controls are maintained on the load application.

Based on a review of the industry standard minimum factors of safety, the following factors of safety are recommended for this project:

- Permanent Loading Conditions, Minimum FS of 1.5.
- Temporary Loading Conditions (i.e., post soil-bentonite wall installation, fill placement to final permitted elevation), Minimum FS of 1.3.
- Earthquake Loading, Minimum FS of 1.0. The lower bound minimum factor of safety is recommended since seismic loading is not a credible condition given the proximity to the nearest active seismic zone. Refer to section 2.5.3 of this report for further discussion on Earthquake loading.

The FS provided above are the recommended values for this project; however, in some instances, AECOM has recommended allowing FS as low as 1.3 provided the slopes are instrumented and monitored and if no raise in fills or new loads are added.

2.6.2 Summary of Previous Stability Analyses

The stability of the ash dike structures has been previously evaluated by Materials Testing Consultants (MTC), titled *"Report of Slope Stability Evaluation J.C. Weadock Ashpond Vertical Expansion Project"* (MTC, 1991b). The stability of the dike structures was analyzed for stability with a slurry wall by AECOM in a report titled *"Weadock Coal Ash Berm Stability Analysis"* (AECOM, 2009a). The MTC report is included in Appendix A of the solid waste permit application (CPC, 1992a). Material properties used in the MTC report were determined in a separate report by MTC *titled "Report of Geotechnical Field Investigation and Laboratory Testing for Slope Stability Study, Vertical Expansion of Ashponds Project, J.C. Weadock Generating Complex"*, (MTC, 1991a). The AECOM report, MTC report and CPC permit application are included on the CD attached to this report.

The following assumptions were made in the MTC analysis:

1. Cohesion and internal friction angle were factored into the analysis (total stress analysis).

2. The beneficial effect of armor stone or slope protection on the downstream side of the dikes was not considered.

3. The beneficial effect of vegetated soil or cement stabilized fly ash on the final slopes of the ash storage pile was not considered.

4. Groundwater was assumed to be at elevation 581 feet on the downstream face and at elevation 591.5 feet at the upstream face (equal to the dike crest) and was assumed to be mounded within the fly ash embankment to 20 feet below the final fill height of elevation 650 feet at elevation 630 feet (IGLD 85).

The stability analysis by AECOM focused on a section of the perimeter dike separating the north side of Pond F from Saginaw Bay with the slurry wall installed and ash fill completed to elevation 650 feet at a 4H:1V slope. The following assumptions were made in the AECOM analysis:

1. Dry moisture conditioned fly ash will be placed and then compacted to 90% of its maximum dry density from the foundation to finished grade. (i.e. Pond F will be dredged of all sluiced fly ash prior to filling.)

2. Groundwater was assumed to be at elevation 576.44 (Lake Huron All-Time Low Water level) on the outboard face of the slope and elevation 583 and 588 on the inboard side.

3. It was assumed that no beneficial vegetative cover or armor stone was in place.

4. Material properties were developed using borings and laboratory tests performed for the design of the slurry wall.

5. Pond F will be dredged of all sluiced fly ash prior to filling.

The following tables list the structures and loading conditions evaluated along with the results of the MTC and AECOM stability analyses. The dike structure sections were chosen based on portions of the perimeter dike that have similar subsurface conditions and dike geometry. Figure 6 shows the separate sections considered.

Table 2-4 – MTC Stability Analysis Results (MTC, 1991)

Structure	Loading Conditions	Failure Surface	Developed Factor of Safety	Failure Results in a Release of Ash
Dike Separating Pond B1 and the Discharge Channel (Section A)	- Existing geometry without slurry wall	Deep Seated Failure of Dike	2.0	No
Dike Separating Pond B1 and the Discharge Channel (Section A)	- Completed fly ash fill to el. 650 without slurry wall	Deep Seated Failure of Dike and Ash Fill	1.85	Yes
Dike Separating Pond B1 and the Discharge Channel (Section A)	- Completed fly ash fill to el. 650 without slurry wall	Deep Seated Failure of Ash Fill	1.42	Possible

Structure	Loading Conditions	Failure Surface	Developed Factor of Safety	Failure Results in a Release of Ash
East Perimeter Dike Bordering Underwood Drain (Section D)	- Existing geometry without slurry wall	Deep Seated Failure of Dike	3.91	No
East Perimeter Dike Bordering Underwood Drain (Section D)	- Completed fly ash fill to el. 650 without slurry wall	Deep Seated Failure of Dike and Ash Fill	1.98	Yes
East Perimeter Dike Bordering Underwood Drain (Section D)	- Completed fly ash fill to el. 650 without slurry wall	Deep Seated Failure of Ash Fill	1.35	Possible
South Perimeter Dike Bordering Tayce Drain (Section D)	- Existing geometry without slurry wall	Deep Seated Failure of Dike	1.97	No
South Perimeter Dike Bordering Tayce Drain (Section D)	- Completed fly ash fill to el. 650 without slurry wall	Deep Seated Failure of Dike and Ash Fill	1.78	Yes
South Perimeter Dike Bordering Tayce Drain (Section D)	- Completed fly ash fill to el. 650 without slurry wall	Deep Seated Failure of Ash Fill	1.42	Possible

1. Structures defined in this table correspond with sections used to develop PFMs in Section 4.0.
2. MTC used the computer program STABL3 to compute factors of safety.

Table 2-5 – AECOM Stability Analysis Results (AECOM, 2009a)

Structure	Loading Conditions	Failure Surface	Developed Factor of Safety	Failure Results in a Release of Ash
Pond F North Dike (Section C) - Undrained Conditions	- Inboard water elevation equal to top of slurry wall (el. 588 feet)	Shallow Failure of Ash Fill	2.3	Possible
Pond F North Dike (Section C) - Undrained Conditions	- Inboard water elevation equal to static water level in Pond F (el. 583 feet)	Shallow Failure of Ash Fill	2.1	Possible
Pond F North Dike (Section C) - Drained Conditions	- Inboard water elevation equal to top of slurry wall (el. 588 feet)	Deep Seated Failure of Dike and Ash Fill	2.3	Yes
Pond F North Dike (Section C) - Drained Conditions	- Inboard water elevation equal to static water level in Pond F (el. 583 feet)	Shallow Failure of Ash Fill	2.3	Possible
Pond F North Dike (Section C) - Undrained Conditions	- Inboard water elevation equal to top of slurry wall (el. 588 feet)	Shallow Failure of Ash Fill	2.2	Possible
Pond F North Dike (Section C) - Undrained Conditions	- Inboard water elevation equal to static water level in Pond F (el. 583 feet)	Shallow Failure of Ash Fill	2.2	Possible
Pond F North Dike (Section C) - Drained Conditions	- Inboard water elevation equal to top of slurry wall (el. 588 feet)	Shallow Failure of Ash Fill	2.4	Possible
Pond F North Dike (Section C) - Drained Conditions	- Inboard water elevation equal to static water level in Pond F (el. 583 feet)	Shallow Failure of Ash Fill	2.4	Possible
Pond F North Dike (Section C) -	- Inboard water elevation equal to top of slurry wall (el. 588 feet)	Shallow Failure of Dike	4.2	No

Structure	Loading Conditions	Failure Surface	Developed Factor of Safety	Failure Results in a Release of Ash
Undrained Conditions				
Pond F North Dike (Section C) - Undrained Conditions	- Inboard water elevation equal to static water level in Pond F (el. 583 feet)	Shallow Failure of Dike	4.2	No
Pond F North Dike (Section C) - Drained Conditions	- Inboard water elevation equal to top of slurry wall (el. 588 feet)	Shallow Failure of Dike	2.0	No
Pond F North Dike (Section C) - Drained Conditions	- Inboard water elevation equal to static water level in Pond F (el. 583 feet)	Shallow Failure of Dike	2.1	No

1. Structures defined in this table correspond with structures used to develop PFMs in Section 4.0.
2. AECOM used the computer program Slope/W to compute factors of safety.

The stability analyses results for each section considered are summarized as follows:

- Section A – Factors of safety ranged from 1.42 to 2.0. The minimum FS that could result in a loss of ash containment was reported to be 1.42. This FS is slightly less than the typically accepted value of 1.5 as discussed in Section 2.6.1. The analysis did not consider fully drained conditions or undrained conditions specifically within the wet ash.

- Section B – This section has not been specifically considered in previous stability analyses. Since it is similar to Section A in geometry and ash is not proposed to be stacked in the adjacent Pond P1, this dike is considered stable, provided adequate freeboard is maintained.

- Section C – Factors of safety ranged from 2.1 to 4.2. The minimum FS that could result in a loss of ash containment was reported to be 2.1. This FS is greater than the typically accepted value of 1.5 as discussed in Section 2.6.1. These analyses considered the effect of interior ground water levels on FS. It was concluded that higher interior water levels did not greatly affect the overall stability of the structure. The analyses assumed that the wet loose ash in Pond F would be replaced with compacted ash.

- Section D – Factors of safety ranged from 1.35 to 3.91. The minimum FS that would potentially result in a loss of ash containment was reported to be 1.35. This FS is lower than the typically accepted value of 1.5 as discussed in Section 2.6.1. The analysis did not consider fully drained conditions or undrained conditions specifically within the wet ash.

- Section E – No stability analyses have been conducted on this section. Section E has remained stable and will not have any additional ash placed adjacent to it, according to the proposed closure plan. Therefore, Section E is considered stable based on its performance history.

- Section F – No stability analyses have been conducted on this section. Ash filling activities are planned adjacent to this section and known wet loose ash is present at this location.

3.0 Hazard Classification

During the Potential Failure Mode Analysis (PFMA) session for the J.C. Weadock Ash Disposal Facility, the Core Team discussed and assigned a hazard classification to the facility. It was determined that the Weadock facility was classified as having a low hazard potential. This classification is based on the potential for loss of human life and impacts to economic, environmental, and lifeline facilities, should an uncontrolled failure occur. At the project site there is no probable risk of loss of human life and a low economic and environmental loss potential. There are no nearby public facilities other than a boat launch site located near the southeast corner of the facility. Also, should a failure occur, environmental or economic losses would be generally limited to the Owner.

4.0 Potential Failure Modes Identified

The Core Team identified 32 Potential Failure Modes (PFMs) during the PFMA session. When developing the PFMs, the Core Team identified likely and unlikely conditions that affect the potential that a particular failure mode would occur. These conditions are summarized in the PFMs identified below. In addition, each PFM was classified into one of four risk categories. A description of the categories, as defined in by the FERC Engineering Guidelines, is included in Table 4-1. The subsequent sections describe the failure modes for each category. A list of the PFMs and their loading condition, structure affected, and category is included as Table 4-2. The PFMs were assigned sequential numbers as they were developed during the PFMA session.

Table 4–1 - Potential Failure Mode Categories

Category	Description
I	Highlighted Potential Failure Modes – Those potential failure modes of greatest significance considering need for awareness, potential for occurrence, magnitude of consequence and likelihood of adverse response (physical possibility is evident, fundamental flaw or weakness is identified and conditions and events leading to failure seemed reasonable and credible) are highlighted.
II	Potential Failure Modes Considered but not Highlighted – These are judged to be of lesser significance and likelihood. Note that even though these potential failure modes are considered less significant than Category I they are all also described and included with reasons for and against the occurrence of the potential failure mode. The reason for the lesser significance is noted and summarized in the documentation report or notes.
III	More Information or Analyses are Needed in order to Classify – These potential failure modes to some degree lacked information to allow a confident judgment of significance and thus a dam safety investigative action or analyses can be recommended. Because action is required before resolution the need for this action may also be highlighted.
IV	Potential Failure Mode Ruled Out – Potential failure modes may be ruled out because the physical possibility does not exist, information came to light which eliminated the concern that had generated the development of the potential failure mode, or the potential failure mode is clearly so remote as to be non-credible or not reasonable to postulate. Potential failure modes discussed which were not developed in detail were classified as Category IV-ND (not developed) generally because the PFMA team judged them to be too improbable to warrant an in-depth evaluation of adverse versus positive factors.

For purposes of the PFMA, the disposal area was separated into sections representative of the various site conditions and dike geometry. The location of these sections is shown on Figure 6. The PFMs were considered for the perimeter dikes, interior dikes, and outfall structures identified during the PFMA session.

Table 4–2 - Summary of Potential Failure Modes and Their Category

PFM Number and Description	Loading Condition	Structure	Category
1 – Discharge Flume Fails Backing Up Process Water Leading to Breach in Dike Which Causes Loss of Containment	Maintenance and Human Factors	Outfall	II
2 – A Large Rain Event Overwhelms the Outfall Which Leads to Filling Ponds and Overtopping the Perimeter Dike Causing Loss of Containment	Flood	Outfall	II
3 – Buried Concrete Outfall Pipe Deteriorates, Leads to Ground Loss Then Breach of Surrounding Embankment	Maintenance and Human Factors	Outfall	II
4 – Piping, Seepage, or Collapse of Conveyance Pipe Leads to Ground Loss and Breach of Perimeter Dike Causing Loss of Containment	Maintenance and Human Factors	Outfall	II
5 – Piping, Seepage, or Collapse of Abandoned Pipe Leads to Ground Loss and Breach of Perimeter Dike Causing Loss of Containment	Maintenance and Human Factors	Abandoned Outfall Structures	IV
6 – Outfall Pipes and/or Ditch Along the Interior Side of Section E Become Blocked, Leads to Overtopping and Ground Loss and Breach of Perimeter Dike Causing Loss of Containment	Maintenance and Human Factors	Fire Water Pond Pump	II
7 – Surface Erosion or Internal Seepage Leads to Breach of Perimeter Dike Causing Loss of Containment	Normal Operations	Dike Section A	IV
8 – Channel Hydraulics Leads to Erosion of Perimeter Dike Slope Toe Causing Slope Failure and Loss of Containment	Normal Operations	Dike Section A	IV
9 – Dredging the Discharge Channel Leads to Slope Instability and Loss of Containment	Maintenance and Human Factors	Dike Section A	IV
10 – Static or Seismic Liquefaction of the Loose Wet Ash in the Foundation of the Ash Fill Leads to Slope Failure Which Leads to Loss of Containment	Proposed – Staged Filling and Earthquake	Dike Section A	III
11 – Static or Seismic Liquefaction of the Loose Wet Ash in the Foundation of the Ash Fill Leads to Slope Failure Which Leads to Loss of Containment	Proposed – Staged Filling and Earthquake	Dike Section B	IV-ND
12 – Static or Seismic Liquefaction of the Loose Wet Ash in the Foundation of the Ash Fill Leads to Slope Failure Which Leads to Loss of Containment	Proposed – Staged Filling and Earthquake	Dike Section C	III
13 – Static or Seismic Liquefaction of the Loose Wet Ash in the Foundation of the Ash Fill Leads to Slope Failure Which Leads to Loss of Containment	Proposed – Staged Filling and Earthquake	Dike Section D	III
14 – Static or Seismic Liquefaction of the Loose Wet Ash in the Foundation of the Ash Fill Leads to Slope Failure Which Leads to Loss of Containment	Proposed – Staged Filling and Earthquake	Dike Section E	III
15 – Static or Seismic Liquefaction of the Loose Wet Ash in the Foundation of the Ash Fill Leads to Slope Failure Which Leads to Loss of Containment	Proposed – Staged Filling and Earthquake	Dike Section F	III
16 – Global Slope Instability Leads to Loss of Containment	Normal Operations	Dike Section A	III
17 – Global Slope Instability Leads to Loss of Containment	Normal Operations	Dike Section B	IV
18 – Global Slope Instability Leads to Loss of Containment	Normal Operations	Dike Section C	III
19 – Global Slope Instability Leads to Loss of Containment	Normal Operations	Dike Section D	III
20 – Global Slope Instability Leads to Loss of Containment	Normal Operations	Dike Section E	III
21 – Global Slope Instability Leads to Loss of Containment	Normal Operations	Dike Section F	III
22 – Construction Equipment Loads Causes Perimeter Dike Slope Failure and Loss of Containment	Maintenance and Human Factors	All Dike Sections	IV
23 – Rapidly Raising Ash Causes an Undrained Condition in the Perimeter Dike Foundation Which Leads to Slope Failure and Loss of Containment	Proposed – Staged Filling	Dike Sections A, D, E, and F	III
24 – Rapidly Raising Ash Causes an Undrained Condition in the Ash Fill Foundation Which Topples the Transmission Towers and Leads to Slope Failure and Loss of Containment	Proposed – Staged Filling	Transmission Tower	IV

PFM Number and Description	Loading Condition	Structure	Category
25 – Existing Trees Growing on Perimeter Dike Falling or Rotting Leads to Slope Instability and Loss of Containment	Normal Operations	All Dike Sections	IV
26 – Existing Conduits Buried in the Perimeter Dike Provide a Path for Ash Piping Which Leads to Loss of Containment	Normal Operations	All Dike Sections	IV
27 – Waves or Ice Attacks Perimeter Dike Toe of Slope Causing Damage Resulting in Slope Failure and Loss of Containment	Wave Attack	Dike Section C	IV
28 – Increased Load due to Corner Effects Lead to Slope Failure and Loss of Containment	Normal Operations	Dike Sections C and D	IV
29 – Internal Seepage with a Rise in Phreatic Surface Leads to Slope Failure of the Perimeter Dike Through the Slurry Wall, Ground Loss and/or Piping Which Leads to Loss of Containment	Flood or Proposed Conditions	Dike Sections B, C, D, E and F	IV
30 – Internal Seepage with a Rise in Phreatic Surface Leads to Slope Failure of the Perimeter Dike Through the Slurry Wall, Ground Loss and/or Piping Which Leads to Loss of Containment	Flood or Proposed Conditions	Dike Section A	IV
31 – Failure of Interior Dike Due to Overtopping or Instability Leads to Loss of Containment Along the South Side of the Containment Dike	Normal Operations	Interior Dikes	III
32 – Surface Erosion or Internal Seepage Leads to Breach of Perimeter Dike Causing Loss of Containment	Normal Operations	All Dikes Sections	IV

4.1 Category II – Potential Failure Modes Considered but Not Highlighted

Those potential failure modes judged to be of lesser significance and likelihood. Note that even though these potential failure modes are considered less significant than Category I, they are all also described and included with reasons for and against the occurrence of the potential failure mode. The reasons for the lesser significance are highlighted as follows:

Potential Failure Mode 1 – Outfall Structure – Discharge Outfall Gets Blocked Backing Up Process Water Leading to Breach in Dike Which Causes Loss of Containment

The vertical outfall riser or horizontal discharge pipe becomes clogged with debris causing partial of complete blockage of the outfall. Since water cannot exit, it builds up within the ponds and eventually overtops the perimeter dike, eroding it, and causes a breach and loss of containment.

Likely / Adverse	Not Likely / Positive
Non-contact cooling water has overtopped the dike previously.	The outfall has experienced significantly higher historic flows than what it currently passes.
There is vegetation surrounding the perimeter of the ponds. Dead vegetation or flotsam is prevalent and could cause clogging.	Since there is less flow, there would be more time to identify a clogging problem.
Since water is continuously being discharged, there is always a possibility for clogging.	
The facility experiences freezing weather that could affect the ability of the outfall to pass flows.	

Rational for Characterization:

The water from the sluiced fly ash is no longer being discharged to the disposal area which greatly reduces flow. The reduction in flow creates more time to react if the outfall becomes clogged. However, since the outfall is inspected daily to prevent this failure mode, the Core Team felt that this failure mode was credible but not likely and was classified as a Category II failure mode.

Potential Risk Reduction Measures:

It would be possible to further reduce risk by inspecting the structure daily for any signs of clogging, freezing, or reduced flow due to some other failure within the structure. The approach channel could be dredged and shaped to an optimal geometry to increase flow rate which would reduce the risk of clogging. Some other options requiring permit alterations would be lowering the outlet level to increase freeboard or add an emergency overflow pipe. Also, instrumentation could be installed such as a high water level alarm to warn of a problem before overtopping occurred.

Potential Failure Mode 2 – Outfall Structure – A Large Rain Event Overwhelms the Outfall, Which Leads to Filling Ponds and Overtopping the Perimeter Dike Causing Loss of Containment

A large rain event adds sufficient flow to the sluice water discharge system to overwhelm the hydraulic capacity of the outfall. This will cause the ponds and sluice channels to fill with water and eventually overtop the perimeter dike, eroding it, and causing loss of containment.

Likely / Adverse	Not Likely / Positive
There is only one outlet from the outfall with no emergency outlet to relieve the structure.	The outfall is reportedly designed for a 25-year storm event.
	The outfall has experienced an extreme rain event while discharging both fly ash and bottom ash sluice water and did not overtop.

Rational for Characterization:

The total flow has been greatly reduced since February 2009. Historically the outfall and Pond F have had sufficient freeboard to contain a closed outfall for days at a time without overflowing while accommodating more than twice the current flow. According to hydraulic capacity calculations included in the solid waste permit, the ponds and channels can store 5.5 times the runoff plus process water during a 25 year storm event. Therefore, the outfall and Pond F should have sufficient freeboard to contain the current flow plus a large storm event. However, there is not emergency overflow and the outfall is monitored daily, so this failure mode is considered credible but not very likely. Because the outfall is monitored, the Core Team felt that this is a Category II failure mode but it could also be considered a Category IV because of the very low possibility that a rain event could lead to a loss of containment.

Potential Risk Reduction Measures:

Adding additional outlet capacity such as an emergency overflow would reduce the risk to this failure mode.

Potential Failure Mode 3 – Outfall Structure – Buried Concrete Outfall Pipe Deteriorates, Leads to Ground Loss Then Breach of Surrounding Embankment

The outfall riser and pipe are made from jointed reinforced concrete pipe sections and deteriorate over time. Once the pipes deteriorate to the point of collapse or allow soil to infiltrate from the dike, ground loss occurs which leads to a breach of the surrounding embankment and loss of containment.

Likely / Adverse	Not Likely / Positive
The pipe was approximately 15 years old when it was installed and has a limited design life.	Damage to the pipe due to frost or traffic loading is unlikely because it is buried at least 2 pipe diameters below the ground surface.
The pipes are not currently inspected for wear or signs of deterioration.	Traffic loading is very infrequent because the dike is not commonly driven on.
Joints in the concrete pipe can be weaker than the pipe itself.	The pipe itself is not inspected but surface features of water levels are inspected daily. Any noticeable ground loss would be discovered during those inspections.

Rational for Characterization:

The pipe has a limited design life and was installed when it was already approximately 15 years old. It is not currently inspected and has a higher potential for damage since it is a jointed concrete pipe. However, this pipe is currently functioning properly and is buried at a depth where loading and frost should not affect it. Therefore it is a possible failure mode but is very unlikely and was classified as a Category II failure mode.

Potential Risk Reduction Measures:

This pipe should be inspected periodically for damage with a camera or some other robotic means of visual observation.

Potential Failure Mode 4 – Outfall Structure – Piping, Seepage, or Collapse of Conveyance Pipe Leads to Ground Loss and Breach of Perimeter Dike Causing Loss of Containment

A pipe connecting the triangle pond at the northwest corner of Pond F to the outfall ditch deteriorates collapses or separates in the perimeter dike and either causes ground loss and breach of dike or backs up water causing overtopping and loss of containment.

Likely / Adverse	Not Likely / Positive
The pipe was approximately 15 years old when it was installed and has a limited design life.	Damage to the pipe due to frost or traffic loading is unlikely because it is buried at least 2 pipe diameters below the ground surface.
The pipes are not currently inspected for wear or signs of deterioration and is not visible from the surface.	Traffic loading is very infrequent because the dike is not commonly driven on.
Joints in the concrete pipe can be weaker than the pipe itself.	The pipe itself is not inspected but surface features of water levels are inspected daily. Any noticeable ground loss would be discovered during those inspections.
	The pipe conveys flows at a low velocity.

Rational for Characterization:

The pipe has a limited design life and was installed when it was already approximately 15 years old. It is not currently inspected and has a higher potential for damage since it is a jointed concrete pipe. However, this pipe appears to be currently functioning properly and is buried at a depth where loading and frost should not affect it. Therefore it is a possible failure mode but is very unlikely and was classified as a Category II failure mode.

Potential Risk Reduction Measures:

This pipe should be inspected periodically for damage with a camera or some other robotic means of visual observation. Alternately, the pipe could be removed and process water could be rerouted.

Potential Failure Mode 6 – Fire water pond pump – Outfall Pipes and/or Ditch Along the Interior Side of Section E Become Blocked, Leads to Overtopping and Ground Loss and Breach of Perimeter Dike Causing Loss of Containment

Occasionally the fire ponds need to be pumped down. Water is pumped across the containment dike into an interior ditch which could become clogged and back up fire pond water. This water could overtop the dike leading to ground loss and breach the perimeter dike causing loss of containment. (see Figure 3 for pipe location.)

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Likely / Adverse	Not Likely / Positive
In 2009, the ditch became clogged resulting in an overtopping and surface erosion of the perimeter dike.	The fire ponds are only pumped down when needed, infrequently.
The interior perimeter ditch is shallow and has little freeboard.	The pipe itself is not inspected but surface features of water levels are inspected daily. Any noticeable ground loss would be discovered during those inspections.
Surface features interior of the perimeter ditch are higher than the perimeter dike.	
There are no ditches between the interior ditch and the perimeter dike.	

Rational for Characterization:

Documentation is in place describing the 2009 event. Since the ditch is infrequently maintained or inspected and since the natural path of water, should its path be blocked, is over the perimeter dike the Core Team classified this failure mode as a Category II.

Potential Risk Reduction Measures:

A perimeter storm water ditch or environmental ditch could be installed to reduce risk associated with this failure mode. The existing ditch could be cleaned out and enlarged. Also, an alarm or other warning instrumentation could be installed to prevent overtopping.

4.2 Category III – More Information or Analyses are Needed in Order to Classify

The following potential failure modes, to some degree, lack information to allow a confident judgment of significance and thus a dam safety investigative action or analyses is needed to categorize.

Potential Failure Mode 10 – Dike Section A – Static or Seismic Liquefaction of the Loose Wet Ash in the Foundation of the Ash Fill Leads to Slope Failure Which Leads to Loss of Containment.

Loose wet ash in the foundation of the ash fill becomes liquefied as a result of an earthquake or rapid increase in slope loading due to ash filling. One of these loading conditions leads to a slope failure of the perimeter dike and loss of containment of ash.

Likely / Adverse	Not Likely / Positive
Loose wet ash exists in a submerged condition under compacted ash fill and is liquefiable.	There is a low earthquake potential in this area.
Rapid ash filling can cause saturated loose wet ash to become undrained and unstable.	Rapid ash filling is unlikely because filling is limited to 12 feet max per year in 3 foot lift increments by the solid waste permit.
A ground water gradient exists because there is no slurry wall in this location for the purpose of venting ground water.	The toe of the proposed stacked ash slope over deposits of loose and wet ash is located at least 100 feet away from the perimeter dike.
Soft clay and loose sands are present in the perimeter dike foundation along with a sandy peat layer as indicated in Borings SBW-1, SBW-20, SBW-21.	Drainage layers are present to allow loose wet ash to drain should an earthquake or surcharge load be imposed.

Rational for Characterization:

More information is needed to understand the stability of the ash fill over loose wet sluiced ash. The conditions of the foundation of the ash fill and placement construction is not well characterized and should be further explored. A subsurface exploration program in this area should be considered to characterize the subsurface conditions including any loose ash layers. Those results should be used to evaluate the stability of this slope and the effects of rapid loading and earthquake effects. Since the results of such an investigation are needed to categorize this failure mode, the Core Team classified this failure mode as Category III.

Potential Risk Reduction Measures:

Adding instrumentation such as piezometers to monitor groundwater levels and pore water pressure and inclinometers to measure any slope movements could be used to better quantify the risk associated with this failure mode. Also, evaluating the slope stability assuming earthquake loading and surcharge loading under undrained conditions (total stress analysis) would be helpful in quantifying the actual risk. Raising the ash fill area in pre described stages based on stability analyses and an instrumentation plan would reduce the risk of this failure mode. Also, wet sluiced ash could be excavated prior to ash filling or ground improvement methods could be employed to strengthen the ash layer, such as soil mixing, wicks, or stone columns.

Potential Failure Mode 12 – Dike Section C – Static or Seismic Liquefaction of the Loose Wet Ash in the Foundation of the Ash Fill Leads to Slope Failure Which Leads to Loss of Containment.

Loose wet ash in the foundation of the ash fill becomes liquefied as a result of an earthquake or rapid increase in slope loading due to ash filling. One of these loading conditions leads to a slope failure of the perimeter dike and loss of containment of ash.

Likely / Adverse	Not Likely / Positive
Loose wet ash exists in a submerged condition under compacted ash fill and is liquefiable.	There is a low earthquake potential in this area.
Rapid ash filling can cause saturated loose wet ash to become undrained and unstable.	Rapid ash filling is unlikely because filling is limited to 12 feet max per year in 3 foot lift increments by the solid waste permit.
May not be possible to prevent the bottom of the future fill placement to be placed and compacted in the dry.	The toe of the proposed stacked ash slope over deposits of loose and wet ash is located at least 100 feet away from the perimeter dike.
	Hard clay foundation is present (See SBW-2).
	Higher resistances and sleeve friction from CPT data in CPT 2, 3, and 4.
	No pore pressure development evident from CPT data.
	A stability analysis for this structure was conducted and published showing acceptable Factors of Safety (AECOM, 2009a)
	CEC plans to excavate wet sluiced ash in Pond F prior to dry ash placement.

Rational for Characterization:

The stability analysis by AECOM (2009, 2009a) makes the assumption that the ash above the foundation is placed and compacted in a dry state. However, currently wet loose ash deposits are known to exist within Pond F. Since a plan will need to be developed to ensure complete removal of the wet loose ash, the Core Team categorized this PFM as needing more information. If a plan is developed to ensure that new compacted dry ash can be placed on native foundation in the dry, this PFM can be recategorized as a Category IV failure mode.

Potential Risk Reduction Measures:

Adding instrumentation such as piezometers to monitor groundwater levels and pore water pressure and inclinometers to measure any slope movements could be used to better quantify the risk associated with this failure mode. Also, evaluating the slope stability assuming earthquake loading and surcharge loading under undrained conditions (total stress analysis) would be helpful in quantifying the actual risk. Raising the ash fill area in pre described stages based on stability analyses and an instrumentation plan would reduce the risk of this failure mode. Also, wet sluiced ash could be excavated prior to ash filling or ground improvement methods could be employed to strengthen the ash layer, such as soil mixing, wicks, or stone columns.

Potential Failure Mode 13 – Dike Section D – Static or Seismic Liquefaction of the Loose Wet Ash in the Foundation of the Ash Fill Leads to Slope Failure Which Leads to Loss of Containment.

Loose wet ash in the foundation of the ash fill becomes liquefied as a result of an earthquake or rapid increase in slope loading due to ash filling. One of these loading conditions leads to a slope failure of the perimeter dike and loss of containment of ash.

Likely / Adverse	Not Likely / Positive
Sluiced wet ash exists in a submerged condition under compacted ash fill and is potentially loose.	There is a low earthquake potential in this area.
Rapid ash filling can cause saturated loose wet ash to become undrained and unstable.	Rapid ash filling is unlikely because filling is limited to 12 feet max per year in 3 foot lift increments by the solid waste permit.
Sluiced ash will not be removed prior to dry ash filling.	The toe of the proposed stacked ash slope over deposits of loose and wet ash is located at least 100 feet away from the perimeter dike.
	Borings and CPT probes show dike and foundation are not liquefiable.

Rational for Characterization:

More information is needed to understand the stability of the ash fill over loose wet sluiced ash. The conditions of the foundation of the ash fill and placement construction is not well characterized and should be further explored. A subsurface exploration program in this area should be considered to characterize the subsurface conditions including any loose ash layers. Those results should be used to evaluate the stability of this slope and the effects of rapid loading and earthquake effects. Since the results of such an investigation are needed to categorize this failure mode, the Core Team classified this failure mode as Category III.

Potential Risk Reduction Measures:

Adding instrumentation such as piezometers to monitor groundwater levels and pore water pressure and inclinometers to measure any slope movements could be used to better quantify the risk associated with this failure mode. Also, evaluating the slope stability assuming earthquake loading and surcharge loading under undrained conditions (total stress analysis) would be helpful in quantifying the actual risk. Raising the ash fill area in pre described stages based on stability analyses and an instrumentation plan would reduce the risk of this failure mode. Also, wet sluiced ash could be excavated prior to ash filling or ground improvement methods could be employed to strengthen the ash layer, such as soil mixing, wicks, or stone columns.

Potential Failure Mode 14 – Dike Section E – Static or Seismic Liquefaction of the Loose Wet Ash in the Foundation of the Ash Fill Leads to Slope Failure Which Leads to Loss of Containment.

Loose wet ash in the foundation of the ash fill becomes liquefied as a result of an earthquake or rapid increase in slope loading due to ash filling. One of these loading conditions leads to a slope failure of the perimeter dike and loss of containment of ash.

Likely / Adverse	Not Likely / Positive
Sluiced wet ash exists inboard of Area E.	There is a low earthquake potential in this area.
No stability analyses conducted for the section.	Rapid ash filling is unlikely because filling is limited to 12 feet max per year in 3 foot lift increments by the solid waste permit.
	The toe of the proposed stacked ash slope over deposits of loose and wet ash is located at least 600 feet away from the perimeter dike.

Rational for Characterization:

More information is needed to understand the stability of the ash fill over loose wet sluiced ash. The conditions of the foundation of the ash fill and placement construction is not well characterized and should be further explored. A subsurface exploration program in this area should be considered to characterize the subsurface conditions including any loose ash layers. Those results should be used to evaluate the stability of this slope and the effects of rapid loading and earthquake effects. Since the results of such an investigation are needed to categorize this failure mode, the Core Team classified this failure mode as Category III.

Potential Risk Reduction Measures:

Should the ash fill plan change to allow filling next to the perimeter dike then measures should be taken to ensure risk reduction. Adding instrumentation such as piezometers to monitor groundwater levels and pore water pressure and inclinometers to measure any slope movements could be used to better quantify the risk associated with this failure mode. Also, evaluating the slope stability assuming earthquake loading and surcharge loading under undrained conditions (total stress analysis) would be helpful in quantifying the actual risk. Raising the ash fill area in pre described stages based on stability analyses and an instrumentation plan would reduce the risk of this failure mode. Also, wet sluiced ash could be excavated prior to ash filling or ground improvement methods could be employed to strengthen the ash layer, such as soil mixing, wicks, or stone columns.

Potential Failure Mode 15 – Section F – Static or Seismic Liquefaction of the Loose Wet Ash in the Foundation of the Ash Fill Leads to Slope Failure Which Leads to Loss of Containment.

Loose wet ash in the foundation of the ash fill and internal dike becomes liquefied as a result of an earthquake or rapid increase in slope loading due to ash filling. One of these loading conditions leads to a slope failure of the interior dike. The mobilized ash flows through the bottom ash pond and breaches the perimeter dike resulting in a loss of containment of ash.

Likely / Adverse	Not Likely / Positive
Sluiced wet ash exists in the B Ponds.	There is a low earthquake potential in this area.
Loose wet ash present below elevation 591 with blow counts of 1 and weight of hammer experienced in Borings SBW-26 and SBW-27.	Rapid ash filling is unlikely because filling is limited to 12 feet max per year in 3 foot lift increments by the solid waste permit.
The toe of the proposed stacked ash slope over deposits of loose and wet ash is located 10 feet away from the interior dike.	The area west of Section F is currently part of the Weadock Ash Storage Facility.
The interior dike was not constructed to be a structural dike, only an access road.	
No stability analyses conducted for this section.	

Rational for Characterization:

More information is needed to understand the stability of the ash fill over loose wet sluiced ash. The conditions of the foundation of the ash fill and placement construction is not well characterized and should be further explored. A subsurface exploration program in this area should be considered to characterize the subsurface conditions including any loose ash layers. Those results should be used to evaluate the stability of this slope and the effects of rapid loading and earthquake effects. Since the results of such an investigation are needed to categorize this failure mode, the Core Team classified this failure mode as Category III.

Potential Risk Reduction Measures:

Adding instrumentation such as piezometers to monitor groundwater levels and pore water pressure and inclinometers to measure any slope movements could be used to better quantify the risk associated with this failure mode. Also, evaluating the slope stability assuming earthquake loading and surcharge loading under undrained conditions (total stress analysis) would be helpful in quantifying the actual risk. Raising the ash fill area in pre described stages based on stability analyses and an instrumentation plan would reduce the risk of this failure mode. Also, wet sluiced ash could be excavated prior to ash filling or ground improvement methods could be employed to strengthen the ash layer, such as soil mixing, wicks, or

stone columns. Consideration should be given to evaluate the stability of this area specifically in consideration of any future modifications to site grades.

Potential Failure Mode 16 – Dike Section A – Global Slope Instability Leads to Loss of Containment

Failure of a section through the discharge channel dike and ash fill due to global instability causes a catastrophic failure of the ash fill slope and discharge channel dike and leads to a loss of containment of stacked ash into the discharge channel.

Likely / Adverse	Not Likely / Positive
Effects of loose sluiced ash in the foundation of the ash fill was not considered in the stability analysis by MTC.	No surface sloughs or creep on the outer slope of the dike have been noted.
A layer of peat exists in the perimeter dike. (See soil boring SBW-1)	No seepage outbreaks observed on the slope have been observed.
	MTC stability analyses showed Factor of Safety greater than 1.5, which is typically considered safe.

Rational for Characterization:

The MTC stability analysis provided sufficient factors of safety but did not consider the affects of loose wet sluiced fly ash in the foundation of the ash fill. Since the MTC report did not consider wet loose ash in their analyses, the Core Team was unable to classify this PFM as a Category I, II or IV without additional information. Therefore, Core Team classified this failure mode as Category III.

Potential Risk Reduction Measures:

To reduce risks associated with this PFM, the subsurface conditions should be reevaluated and characterized for strength and hydrogeologic conditions and reanalyzed to include affects of loose wet sluiced ash and surcharge loading associated with ash haul trucks.

Potential Failure Mode 18 – Dike Section C – Global Slope Instability Leads to Loss of Containment

Failure of a section through the perimeter dike and ash fill due to global instability causes a catastrophic failure of the ash fill slope and discharge channel dike and leads to a loss of containment of stacked ash into Saginaw Bay.

Likely / Adverse	Not Likely / Positive
Results of CPT-4 indicate a layer of soft clay in the perimeter dike (Su=400 psf)	No surface sloughs or creep on the outer slope of the dike have been noted.
	No seepage outbreaks observed on the slope have been observed.

Rational for Characterization:

The stability analysis by AECOM makes the assumption that the ash above the foundation is placed and compacted in a dry state. However, currently wet loose ash deposits are known to exist within Pond F. Since a plan will need to be developed to ensure complete removal of the wet loose ash, the Core Team categorized this PFM as needing more information. If a plan is developed to ensure that new compacted dry ash can be placed on native foundation in the dry, this PFM can be recategorized as a Category IV failure mode.

Potential Risk Reduction Measures:

To reduce risks associated with this PFM, the subsurface conditions should be reevaluated and characterized for strength and hydrogeologic conditions and reanalyzed to include affects of loose wet sluiced ash. A plan for excavating and dewatering Pond F should be developed to ensure that new ash fill can be placed in the dry.

Potential Failure Mode 19 – Dike Section D – Global Slope Instability Leads to Loss of Containment

Failure of a section through the perimeter dike and ash fill due to global instability causes a catastrophic failure of the ash fill slope and discharge channel dike and leads to a loss of containment of stacked ash into Saginaw Bay.

Likely / Adverse	Not Likely / Positive
Results of SBW-3 indicate a layer of peat is present in the perimeter dike.	No surface sloughs or creep on the outer slope of the dike have been noted.
	No seepage outbreaks observed on the slope have been observed.

Rational for Characterization:

More information is needed to understand the stability of the ash fill over loose wet sluiced ash. The conditions of the foundation of the ash fill and placement construction are not well characterized and should be further explored. Therefore, Core Team classified this failure mode as Category III.

Potential Risk Reduction Measures:

To reduce risks associated with this PFM, the subsurface conditions should be reevaluated and characterized for strength and hydrogeologic conditions and reanalyzed to include affects of loose wet sluiced ash in the fill area and peat in the perimeter dike.

Potential Failure Mode 20 – Dike Section E – Global Slope Instability Leads to Loss of Containment

Failure of a section through the perimeter dike and ash fill due to global instability causes a catastrophic failure of the ash fill slope and leads to a loss of containment of stacked ash.

Likely / Adverse	Not Likely / Positive
Stability analysis has not been completed for this section.	No surface sloughs or creep on the outer slope of the dike have been noted.
	No seepage outbreaks observed on the slope have been observed.
	Ash fill is not planned within 600 feet of the perimeter dike.

Rational for Characterization:

If the fill plan was altered to allow ash placement near the perimeter dike, then a stability analysis should be completed to determine unknown conditions of the ash fill foundation and stability of the structure. Therefore, Core Team classified this failure mode as Category III.

Potential Risk Reduction Measures:

To reduce risks associated with this PFM, the subsurface conditions should be reevaluated and characterized for strength and hydrogeologic conditions and reanalyzed to include affects of loose wet sluiced ash in the fill area.

Potential Failure Mode 21 – Dike Section F – Global Slope Instability Leads to Loss of Containment

Failure of a section through the interior dike and ash fill due to global instability causes a catastrophic failure of the ash fill slope and interior dike and leads to a loss of containment of stacked ash into the discharge channel.

Likely / Adverse	Not Likely / Positive
Stability analysis has not been completed for this section.	No surface sloughs or creep on the outer slope of the dike have been noted.
Sluiced wet ash exists on both sides of the internal dike at Area F.	No seepage outbreaks observed on the slope have been observed.
Loose wet ash present below elevation 591 with blow counts of 1 and weight of hammer experienced.	The area west of Section F is currently part of the Weadock Ash Storage Facility.
The toe of the proposed stacked ash slope over deposits of loose and wet ash is located 10 feet away from the interior dike.	
The interior dike was not constructed to be a structural dike, only an access road.	

Rational for Characterization:

A stacked ash is permitted to be filled adjacent to this interior dike up to elevation 640 feet. This section of dike was not considered in previous stability analyses. . A stability analysis needs to be completed in order to assign a Category I, II, or IV. Therefore, Core Team classified this failure mode as Category III.

Potential Risk Reduction Measures:

To reduce risks associated with this PFM, the subsurface conditions should be reevaluated and characterized for strength and hydrogeologic conditions and reanalyzed to include affects of loose wet sluiced ash in the fill.

Potential Failure Mode 23 – Dike Section A, D, E, and F – Rapidly Raising Ash Causes an Undrained Condition in the Perimeter Dike Foundation Which Leads to Slope Failure and Loss of Containment.

The fine-grained soils (ash, clay, or silts) in the perimeter dike foundation and in the ash fill foundation become undrained due to new loads from rapidly placing ash. The new load creates an undrained condition within the soils leading to a slope failure of the perimeter dike and loss of containment. Note that this PFM did not apply to Sections B and C. Pond P1 next to Section B is not planned to be filled with ash and all wet loose ash is proposed to be removed from Pond F, which is adjacent to Section C.

Likely / Adverse	Not Likely / Positive
Ash filling is planned to elevation 650 feet from the current average elevation of 590 feet.	Rapid ash filling is unlikely because filling is limited to 12 feet max per year in 3 foot lift increments by the solid waste permit. This filling has rate has been completed successfully to date
Sluiced wet fly ash exists in the foundation of the ash fill in all planned fill areas except Pond F, which is planned to be excavated to natural soils prior to ash filling.	Ash filling is limited by the available amount of ash stored in the silo.
The stability analyses conducted on Sections A and D did not consider the wet loose ash and no stability analyses have been conducted for sections E and F.	

Rational for Characterization:

The rate of filling that would cause instability in the loose wet sluiced ash in the foundation of the ash fill is unknown. Further information is needed to determine the classification of this failure mode as a Category I, II or IV. Subsurface exploration results and a stability analysis are needed to gather required information. The Core classified this failure mode as Category III.

Potential Risk Reduction Measures:

Adding instrumentation such as piezometers to monitor groundwater levels and pore water pressure and inclinometers to measure any slope movements could be used to better quantify the risk associated with this failure mode. Also, characterizing the strengths of the subject soils and evaluating the slope stability assuming surcharge loading under undrained conditions (total stress analysis) would be helpful in quantifying the actual risk. Raising the ash fill area in pre described stages based on stability analyses and an instrumentation plan or raising the ash fill to its final geometry would reduce the risk of this failure mode. Ground improvement methods could be employed to strengthen the problem layers such as soil mixing, wicks, or stone columns.

Potential Failure Mode 31 – Interior Dikes – Failure of Interior Dike into Pond P1 Due to Instability of the Ash Fill Leads to Loss of Containment Along the Discharge Channel.

Interior dikes act as divider dikes between ponds within the disposal area. Due to instability of the ash fill in Pond F, the interior dike fails and allows ash to flow over the perimeter dike into the discharge channel resulting in a loss of containment.

Likely / Adverse	Not Likely / Positive
Interior dikes contain ponds or stacked areas higher in elevation than the crest elevation of the north perimeter dike.	The foundation of ash fill in Pond F will not be affected by wet sluiced ash in the foundation of the fill because CEC plans to excavate the fill area prior to dry ash placement.
There is no containment or freeboard associated with the interior dikes in some areas.	

Rational for Characterization:

It is very unlikely that a failure of the interior dikes would result in a loss of containment beyond the perimeter dike. However, it is unknown exactly how far stacked ash will travel before becoming stable. Therefore, the Core Team felt this failure mode could be ruled out pending further investigation and was classified as a Category III.

Potential Risk Reduction Measures:

Multiple stability analyses for different failure scenarios should be considered to identify any areas of concern and to determine the distance a failed ash slope would travel. Stability analyses should be completed on the interior dike separating Pond F and Pond P1 in the final fill stage conditions defined in the landfill permit, considering loose wet sluiced ash in the base of the ash fill foundation and interior dike.

4.3 Category IV – Potential Failure Mode Ruled Out

Potential failure modes may be ruled out because the physical possibility does not exist, information came to light which eliminated the concern that had generated the development of the potential failure mode, or the potential failure mode is clearly so remote as to be non-credible or not reasonable to postulate.

Potential Failure Mode 5 – Abandoned Outfall Structures – Piping, Seepage, or Collapse of Abandoned Pipe Leads to Ground Loss and Breach of Perimeter Dike Causing Loss of Containment

The former outfall discharge pipes have been abandoned in place. These pipes deteriorate to the point of collapse in the dike and ground loss occurs, leading to a breach of the surrounding embankment and loss of containment. (See Figure 2.)

Likely / Adverse	Not Likely / Positive
Current condition of the structures is unknown.	No problems associated with the structures have been observed to date.

Rational for Characterization:

The pipes were sealed with concrete in April 2009 and documented as part of the Weadock Slurry wall QCA Report. Although it is not know if the pipes were completely filled, the Core Team classified this PFM as a category IV.

Potential Risk Reduction Measures:

The abandoned pipes could be removed and replaced with compacted fill.

Potential Failure Mode 7 – Dike Section A – Surface Erosion or Internal Seepage Leads to Breach of Perimeter Dike Causing Loss of Containment

Surface erosion of the ash fill slopes or internal seepage in the ash fill leads to washing ash across the top of the perimeter dike causing a loss of containment and potentially eroding the dike.

Likely / Adverse	Not Likely / Positive
There is no barrier for surface water runoff from the ash slope in areas where an access road diverts from the perimeter dike up the ash slope.	Daily inspections discover any erosion issues which are repaired as needed.
Perimeter ditches are not well-maintained to promote storm water drainage.	This circumstance is localized to areas with no perimeter ditch between the ash fill and perimeter dike.

Rational for Characterization:

Even though surface erosion has been observed, it is unlikely that surface or seepage water will mobilize significant quantities of ash across the perimeter dike or cause enough damage to breach the perimeter dike. Therefore, the Core Team felt this failure mode could be ruled out and classified as a Category IV.

Potential Risk Reduction Measures:

To further reduce risk, road grades could be sloped inward or crowned to prevent erosion from traveling across the perimeter dike. In addition, the perimeter storm water ditches could be maintained to accommodate significant rainfall events.

Potential Failure Mode 8 – Dike Section A – Channel Hydraulics Leads to Erosion of Perimeter Dike Slope Toe Causing Slope Failure and Loss of Containment

The discharge channel conveys cooling water discharged by the Karn and Weadock plants to Saginaw Bay. This flow erodes the perimeter dike slope toe creating instability and causes a slope failure and loss of containment.

Likely / Adverse	Not Likely / Positive
The exterior slope of the perimeter dike is primarily made of bottom ash and other erodable soils.	The toe of the perimeter dike is armored with riprap stone.
Flow velocities in the discharge channel are 2 to 3 feet per second.	

Rational for Characterization:

Since the perimeter dike along the discharge channel is armored with stone, the Core Team felt this failure mode could be ruled out and classified as a Category IV failure mode.

Potential Risk Reduction Measures:

To reduce potential risk, current channel geometry, low flow velocity, and toe riprap should be maintained.

Potential Failure Mode 9 – Station C to E – Dredging the Discharge Channel Leads to Slope Instability and Loss of Containment

During dredging, the discharge channel is over-dredged near the toe of the perimeter dike along the discharge channel and as a result the dike becomes unstable and fails leading to a loss of containment.

Likely / Adverse	Not Likely / Positive
There is a potential for over-dredging if dredging takes place.	Discharge velocities are estimated at 2 to 3 feet per second.
	Discharge velocities keep channel flushed.
	Channel has not historically needed dredging.
	Dredging contracts will follow a plan.
	The discharge channel has reportedly never needed dredging.

Rational for Characterization:

The discharge channel has not needed dredging in the past. Therefore, the Core Team felt this failure mode could be ruled out and classified as a Category IV failure mode.

Potential Risk Reduction Measures:

If future dredging is needed, a dredging plan should be developed to reduce impact on the perimeter dike slope to reduce risk associated with this failure mode.

Potential Failure Mode 17 – Dike Section B – Global Slope Instability Leads to Loss of Containment

Failure of a section through the discharge channel dike and ash fill due to global instability causes a catastrophic failure of the ash fill slope and discharge channel dike and leads to a loss of containment of stacked ash into the discharge channel.

Likely / Adverse	Not Likely / Positive
Results of CPT-2 show a layer of soft clay from 10 to 12 feet below the ground surface (Su=200 psf)	No surface sloughs or creep on the outer slope of the dike have been noted.
	No seepage outbreaks observed on the slope have been observed.
	No sufficient driving force to cause a slope failure.

Rational for Characterization:

Although a soft clay layer was found, there is not a sufficient driving force to cause a slope failure at this structure. Therefore, Core Team classified this failure mode as Category IV.

Potential Risk Reduction Measures:

To reduce risks associated with this PFM, the subsurface conditions should be reevaluated and characterized for strength and hydrogeologic conditions and analyzed to include affects of loose wet sluiced ash.

Potential Failure Mode 22 – All Dike Sections – Construction Equipment Loads Causes Perimeter Dike Slope Failure and Loss of Containment

Heavy construction equipment is used to transport ash and could potentially use the perimeter dike as a haul route. This heavy load creates instability and cause a slope failure and loss of containment.

Likely / Adverse	Not Likely / Positive
40 to 80-ton articulated trucks are used to haul fly ash to the disposal area.	Load limits are in place to limit large haul trucks from driving on the perimeter dike where the slurry wall is in place.
	Large trucks and equipment have been on the perimeter dike previously with no stress noted in the dike.

Rational for Characterization:

Since large traffic loads have occurred in the past along on the perimeter dike without any slope failures, it is unlikely that the slope would fail now. If heavy trucks are kept off of the perimeter dike, as they are currently, the Core Team felt this failure mode could be ruled out and classified as a Category IV.

Potential Risk Reduction Measures:

To reduce the risk to this potential failure mode, heavy loads should be kept off of the perimeter dikes. A logistics plan should be developed for haul routes and improved roadways, as well.

Potential Failure Mode 24 – Transmission Tower – Rapidly Raising Ash Causes an Undrained Condition in the Ash Fill Foundation Which Topples the Transmission Towers and Leads to Slope Failure and Loss of Containment

The fine-grained soils (ash, clay, or silts) in the transmission tower foundation and in the ash fill foundation become undrained due to new loads from rapidly placing ash. The new load creates an undrained condition within the soils leading to a failure of the transmission tower foundation subsequently causing slope failure of the ash fill and loss of containment.

Likely / Adverse	Not Likely / Positive
Ash filling is planned to elevation 650 feet from the current average elevation of 590 feet.	Rapid ash filling is unlikely because filling is limited to 12 feet max per year in 3 foot lift increments by the solid waste permit. This filling has rate has been completed successfully to date
Sluiced wet fly ash exists in the foundation of the ash fill.	Ash filling is limited by the available amount of ash stored in the silo.
Ash filling is planned for only one area at a time creating uneven loading on either side of the transmission towers.	

Rational for Characterization:

There is a potential for instability of the transmission tower foundation from rapidly loading ash near the tower base. However, the facility employs a 30-foot set back of any activity from the base of the tower limiting the proximity of ash filling. The Core Team felt that this failure mode was possible but very unlikely and classified it as a Category IV.

Potential Risk Reduction Measures:

To reduce risk associated with this failure mode, monuments could be installed on the base of the tower and monitored for movement annually. Also, the ash fill plan could be modified so that ash would be evenly filled around the base of the towers and not filled only on one side at a time.

Potential Failure Mode 25 – All Dike Sections – Existing Trees Growing on Perimeter Dike Falling or Rotting Leads to Slope Instability and Loss of Containment

Trees growing on the perimeter dike slope and ash fill slopes will eventually die or fall over. These trees are likely to have sizable root systems within the dike and ash fill slopes and causes instability of the dike. This instability causes a slope failure and loss of containment.

Likely / Adverse	Not Likely / Positive
There are currently large trees growing on the slopes.	It is unlikely that the root ball intersects the water table, even in a large rain event when the water table under the fill area can become mounded.
Trees and roots can hide surface conditions from view making inspections difficult.	

Rational for Characterization:

Though there are many trees growing on the slopes, it is unlikely that even a large tree uprooting would cause sufficient dike instability to cause a slope failure and loss of containment. Therefore, the Core Team felt this failure mode could be ruled out and classified as a Category IV failure mode.

Potential Risk Reduction Measures:

To reduce the risk associated with this failure mode, trees and stumps should be removed from the perimeter dikes and a maintenance program should be developed to keep woody plants from growing on the perimeter dike.

Potential Failure Mode 26 – All Dike Sections – Existing Conduits Buried in the Perimeter Dike Provide a Path for Ash Piping Which Leads to Loss of Containment

Electric conduits providing power for environmental monitoring at the NPDES discharge point are buried in the perimeter dike. Groundwater flow around these conduits creates piping erosion around the outside of the conduit pipes which leads to loss of containment.

Likely / Adverse	Not Likely / Positive
Conduit is present in the perimeter dike.	Average ground water level is below the conduit elevation. Ground water would have to raise significantly before it could potentially cause a problem.
	Conduits have sealed ends and do not conduct flow.

Rational for Characterization:

Since the groundwater is so much lower than the conduit, the Core Team felt this failure mode could be ruled out and classified as a Category IV failure mode.

Potential Risk Reduction Measures:

To reduce risk associated with this failure mode, the conduit could be removed and re-routed overhead.

Potential Failure Mode 27 – Dike Section C – Waves or Ice Attacks Perimeter Dike Toe of Slope Causing Damage Resulting in Slope Failure and Loss of Containment

Saginaw Bay forms large waves from wind and freezes in the winter months creating large sheets of ice that can be driven into the perimeter dike slope. Wave or ice attacks of the perimeter dikes causes damage to the perimeter dike creating instability and causing slope failure and loss of containment.

Likely / Adverse	Not Likely / Positive
Ice and waves are present yearly.	The perimeter dike is protected by large stone riprap.
	The perimeter dike slope is observed and maintained as needed.

Rational for Characterization:

The perimeter dike contains substantial riprap for erosion protection. It is unlikely that waves or ice would lead to a loss of ash containment. Therefore, the Core Team felt this failure mode could be ruled out and classified as a Category IV failure mode.

Potential Risk Reduction Measures:

To reduce the risk of wave and ice damage, the slopes could be inspected after storms or ice heaves.

Potential Failure Mode 28 – Dike Sections C and D – Increased Load Due to Corner Effects Leads to Slope Failure and Loss of Containment

Lateral forces are induced from two directions at the corners of the containment area causing a greater total force on the containment dike at the corners. Corners begin to fail from the lateral force which leads to a slope failure and subsequently ash is released from the disposal facility (loss of containment).

Likely / Adverse	Not Likely / Positive
Ash fill has not reached the final fill elevation of 650 feet. 60 feet of additional ash could be added to the overall load experienced by the corner.	No distress has been visually observed at the corner.

Rational for Characterization:

The Core Team felt that this failure mode could be classified as a Category IV based on the fact that no distress has been observed and can be ruled out as a failure mode if a plan to construct shallower slopes at the corners is developed and implemented.

Potential Risk Reduction Measures:

It would be possible to further reduce the risk to this failure mode by flattening the slopes of the existing ash fill at the corners or installing an inclinometer at the corner to measure for movement. A plan to construct flatter slopes as the ash is filled could be developed.

Potential Failure Mode 29 – Dike Section B, C, D, E, and F – Internal Seepage with a Rise in Phreatic Surface Leads to Slope Failure of the Perimeter Dike Through the Slurry Wall, Ground Loss, and/or Piping Which Leads to Loss of Containment.

Internal seepage within the ash containment worsens by a rise in phreatic surface above normal levels induced by the slurry wall. Increased seepage leads to slope failure of the perimeter dike, ground loss, and/or piping, all of which results in a breach of the perimeter dike and loss of containment.

Likely / Adverse	Not Likely / Positive
Fly ash and loose granular soils are highly erodable materials.	Input flow has been permanently reduced which should alleviate the superelevated water levels.
Artificially high phreatic surfaces are created by sluice water introduced into the disposal area in combination with the slurry wall.	

Rational for Characterization:

The phreatic surface is monitored and controlled by the owner by the inclusion of process waters. The phreatic surface should lower to an elevation closer to the level of Saginaw Bay over time since the facility is no longer sluicing fly ash. Therefore the Core Team felt that this failure mode was not possible and is a Category IV failure mode.

Potential Risk Reduction Measures:

To keep elevated phreatic surfaces from contributing to this failure mode, operations staff should maintain current operating procedures with regards to fly ash disposal. Tall grasses should be mowed and trees removed to visually observe and monitor slopes for developing seepage problems. Monitoring wells around the perimeter should be monitored for phreatic surface elevation fluctuations on a regular basis.

Potential Failure Mode 30 – Dike Section A – Internal Seepage with a Rise in Phreatic Surface Leads to Slope Failure of the Perimeter Dike, Ground Loss, and/or Piping Which Leads to Loss of Containment.

Internal seepage within the ash containment worsens by a rise in phreatic surface above normal levels induced by the slurry wall. Increased seepage leads to slope failure of the perimeter dike, ground loss, and/or piping, all of which results in a breach of the perimeter dike and loss of containment.

Likely / Adverse	Not Likely / Positive
Fly ash and loose granular soils are highly erodable materials.	Input flow has been permanently reduced which should alleviate the superelevated water levels.
A shallow gradient exists in this area to vent groundwater to the discharge channel from the disposal facility.	

Rational for Characterization:

The phreatic surface is monitored and controlled by the owner by the inclusion of process waters. The phreatic surface should lower to an elevation closer to the level of Saginaw Bay over time since the facility is no longer sluicing fly ash. Therefore the Core Team felt that this failure mode was not possible and is a Category IV failure mode.

Potential Risk Reduction Measures:

To keep elevated phreatic surfaces from contributing to this failure mode, operations staff should maintain current operating procedures with regards to fly ash disposal. Tall grasses should be mowed and trees removed to visually observe and monitor slopes for developing seepage problems. Monitoring wells around the perimeter should be monitored for phreatic surface elevation fluctuations on a regular basis.

4.4 Category IV-ND – Potential Failure Mode Ruled Out and Not Developed

Potential failure modes discussed which were not developed in detail were classified as Category IV-ND (not developed) generally because the PFMA team judged them to be too improbable to warrant an in-depth evaluation of adverse versus positive factors.

Potential Failure Mode 11 – Dike Section B – Static or Seismic Liquefaction of the Loose Wet Ash in the Foundation of the Perimeter Dike Leads to Slope Failure Which Leads to Loss of Containment.

Loose wet ash in the foundation of the perimeter dike becomes liquefied as a result of an earthquake or rapid increase in slope loading due to ash filling. One of these loading conditions leads to a slope failure of the perimeter dike and loss of containment of ash.

Rational for Characterization:

There is no ash fill planned for areas near the perimeter dike at “Section B”. Without a driving force, this failure mode is not a risk to the project structures and was not developed.

5.0 Potential Risk Reduction Measures (RRM)

During the PFMA process, the Core Team identified measures that could reduce the potential for some failure modes from occurring. In general, the greatest measures to control risk are related to diligent observations, monitoring, operation, and maintenance conducted by operators assigned to this project. Specifically, the operators can reduce the risk of failures using the following measures:

1. Existing fill rates should not exceed the current plan of 12-feet max per year and uniformly load large areas to prevent undrained loading. This RRM applies to PFM Nos. 23 and 24.

2. Monitor piezometers to obtain static groundwater levels upstream and downstream of the perimeter dike and to monitor any slope movements. This RRM applies to PFM Nos. 16, 17, 18, 19, 20, 21, 29 and 30.

3. Monitor and record static groundwater levels from existing monitoring wells. This RRM applies to PFM Nos. 29 and 30.

4. Remove trees and stumps and mow tall grasses from perimeter dike slopes. This RRM applies to PFM Nos. 25, 29, and 30.

5. Remove trees and stumps and mow grasses from perimeter storm water collection ditch. This RRM applies to PFM No. 32.

6. The existing fire water ditch could be cleaned out and enlarged. Also, an alarm or other warning instrumentation could be installed to prevent overtopping. This applies to PFM No. 6.

7. Scheduled inspections for surface erosion, cracking, slumping, woody growth on the perimeter dike and ash fill slopes. This RRM applies to PFM No. 27.

8. Scheduled inspections for clogging, freezing, or reduced flow in outlet structures. This RRM applies to PFM Nos. 1 and 3.

9. Installation of emergency overflow devices at discharge locations where overflow is directed back into the containment area to be stored until the problem causing the overflow can be alleviated. This RRM applies to PFM Nos. 1 and 2.

10. Add high water level alarm at outlet structures to warn of overtopping. This RRM applies to PFM No. 1.
11. Raise freeboard at outlet structures to prevent overtopping. This RRM applies to PFM Nos. 1 and 2.

12. Scheduled visual inspections of the interior of the discharge pipes for deterioration or damage. This RRM applies to PFM Nos. 3 and 5.

13. Flatten slopes at corners of fill area. This RRM applies to PFM No. 28.

14. Improve strength in the perimeter dike with ground improvement methods such as soil mixing, wicks, or stone columns. This RRM applies to PFM Nos. 10, 12, 13, 14, 15, 16, 18, 19, 20, 21, 29 and 30.

15. Evaluate current condition of abandoned structures within the perimeter dike and remediate as necessary. This RRM applies to PFM No. 5.

16. Grade perimeter roads inward or crown them to prevent loss of containment from surface water runoff. This RRM applies to PFM Nos. 32.

17. Inspect perimeter dike slopes after storms for ice or wave damage. This RRM applies to PFM No. 27.

In addition, to the measures that should be implemented by the ash landfill operators, the following additional risk reduction measures were developed:

1. Supplemental soil borings and instruments (pneumatic piezometers and inclinometers) are needed to obtain soil properties, monitor static groundwater levels upstream and downstream of the perimeter dike, and monitor for slope movements. This RRM applies to PFM Nos. 10, 12, 13, 14, 15, 23, and 28.

2. Stability analyses should be completed to further identify any instability in the perimeter dike or foundation. Future stability analyses should also consider wedge block-failure surfaces, fully drained and undrained analysis, surcharge loading associated with ash haul trucks, were appropriate, and unstable nature of the sluiced ash under rapid loading conditions, and re-evaluated soil properties and hydrogeologic conditions. This RRM applies to Sections A, D, E,

and F and PFM Nos. 16, 17, 18, 19, 20 and 21. Section B is considered stable and Section C is considered stable, provided Pond F is cleaned of wet loose ash.

3. Develop a staged filling plan for stacking fly ash to limit rate of loading on soft or organic clays and sluiced loose wet ash in the fill area foundations. This RRM applies to PFM Nos. 10, 12, 13, 14, 15, 23 and 24.

4. Develop storm water management plan including pond capacities for a design storm event. This RRM applies to PFM No. 2.

5. Develop a dredging plan for the discharge channel that will prevent negative impacts to the perimeter dikes. This RRM applies to PFM No. 9.

6. A plan for excavating and dewatering Pond F should be developed to ensure that new ash fill can be placed in the dry. This RRM applies to PFM No. 18

6.0 Findings and Understandings

The following is a list of the findings and understandings resulting from the Potential Failure Mode Analysis (PFMA) session for the J.C. Weadock Ash Disposal Facility held on August 13 and 14 of 2009. This list represents the most significant observations made by the individuals involved with the PFMA session that may not have been previously apparent:

1. The slurry wall is not continuous, there is a vent (Section A) allowing ground water flow to the discharge channel.

2. Pond F is planned to be excavated down to natural soils and filled with dry ash.

3. The underground pipe conveying flow from the triangle pond northwest of Pond F to the flow channel leading to the NPDES discharge point could be removed. There are options to bypass this pipe and the flow path simplified to reduce the risk associated with unnecessary underground pipes in the perimeter dike.

4. The majority of existing ash fill is not above elevation 590 feet. Since the final anticipated fill elevation is 650 feet, the facility is still in the early stages of its fill life which allows time for changes to the fill plan, if needed.

5. The “excavate and replace” method has been used in some areas of the facility. In these areas, wet loose fly ash was excavated and replaced by dry compacted ash, which is inherently more stable than wet loose ash.

6. The perimeter dikes appear to have been placed on natural ground based on soil boring information.

7. Soil borings completed within the interior of the facility (Borings SBW-26 and SBW-27) show that loose wet sluiced ash has very low strength and high void ratios with the potential for future stability issues related to undrained conditions.

8. The stability of the interior dikes should be considered related to a loss of containment. For example, an internal failure of ash fill in Pond F into Pond P1 could occur. If the ash flows, the angle of repose could be flat enough that the ash fills Pond P1 and overtops the perimeter dike.

9. There have been very limited occurrences of failures or distress within the facility. A minor failure of an internal channel berm caused some overtopping internally but did not result in a release of ash from the containment of the facility.

10. Vehicle load limitations developed from engineering design have been enforced upon completion of the slurry wall installation in order to minimize the risk of a surcharge induced failure along the top of the dikes.

11. The slurry wall does not extend west to contain the bottom ash pond and former fly ash transport ditch area.

12. Trees, heavy brush, and tall grasses are obstructing the ability to visually monitor slopes for indications of stability problems.

13. The operational switch from wet ash sluiced disposal to dry ash placement has significantly reduced the hydraulic loading into the facility.

14. The rate of ash filling is limited to the amount of ash available in the silo for placement. This reduces the risk of rapid ash filling inducing an unstable condition in loose wet sluiced fly ash from rapid loading.

15. Michigan State University has an archival photograph collection at its library that includes historical aerial photographs of the Karn and Weadock sites providing for increased knowledge of the site history and facility/pond development.

16. Based upon AECOM's past experience, wet sluiced ashes generally will consolidate very little and remain loose under stacked compacted ash. The arrangement of the fly ash particles will resist gradual loading and do not rearrange to consolidate. Some crushing of the particles may occur which will provide space for other particles to occupy, thereby creating room for some consolidation. However, fly ash particles are generally strong and are spherical in shape so particle crushing is minimal (AECOM, 2009b).

17. The discharge point for fly ash into the disposal facility from the plant has been historically in only one spot (west side). Therefore, the coarse fractions of the ash would be generally expected on the west side because it would settle out first, near the discharge point. The finer fraction (slimes) would remain suspended in the sluice water and take longer to settle out, depositing the slimes on the east side near the NPDES discharge point, or in Pond F. Based on this understanding,

there is a potentially higher risk of a slimes-based failure mode in areas not planned to be excavated down to original soils prior to future ash filling.

18. The layout of fly ash transport ditches in combination with the process of dredging and stacking and plans to excavate Pond F reduce the risk of developing a condition where fly ash is stacked over a slimes layer.

19. The current NPDES outfall location is the 2nd point of discharge during the history of the Weadock facility. The original location was at the northwest corner of Pond F (see Section 2.2 for details).

20. Due to conversion from wet to dry ash handling, the flow to the facility was significantly reduced.

21. The internal divider dikes were raised with bottom ash.

22. There is insufficient seismic loading at this site to trigger seismic liquefaction.

7.0 Conclusions and Recommendations

A total of 32 failure modes were developed during the PFMA session by the Core Team members. No Category I failure modes were identified, which indicates that there appears to be no imminent risks to the project structures related to a loss of ash containment. There were six (6) Category II failure modes that suggest active monitoring needs to be maintained to prevent loss of containment. Twelve (12) failure modes were identified that require additional information to categorize. The remainder of the failure modes considered were classified as a Category IV or IV-ND. Table 6-1 summarizes the number of failure modes identified for each category.

Table 6-1 - Summary of Number of Potential Failure Modes for Each Category

Category	Number of PFMs
I – Highlighted Potential Failure Modes	0
II – Potential Failure Modes Considered but not Highlighted	6
III – More Information or Analyses are Needed in order to Classify	11
IV – Potential Failure Mode Ruled Out	14
IV-ND – Potential Failure Mode Ruled Out and Not Developed	1

Based on the results of the PFMA session and in consideration of risk reduction measure associated with the Category II or III failure modes, we recommend the following actions be taken to minimize the risk of a loss of ash containment at the Weadock ash disposal area:

- Conduct supplemental soil borings and conduct stability analyses on the perimeter dikes (Sections A, D, E, and F) adjacent to the areas receiving stacked ash above elevation 590 feet and up to elevation 650 feet with the goal of re-categorizing the related Category III failure modes. A detailed exploration program will need to be developed to supplement the existing subsurface information and support the recommended stability analyses. The analyses should consider drained and undrained conditions, surcharge loading associated with ash haul trucks, were appropriate, the unstable nature of the sluiced loose wet ash in the foundation of the ash fill under rapid loading conditions, and actual ground water conditions. Should an analysis be completed with the above mentioned considerations, the recommendations provided within the stability analysis report should be implemented for further planning related to the safe performance of the ash containment system.

- Develop a plan to ensure removal of wet loose ash from Pond F or conduct a stability analysis that considers the presence of wet loose ash and possibly ash slimes.

- The presence of trees, shrubs, and tall grasses are preventing adequate inspection of the perimeter dike slopes and functioning of the perimeter storm water ditch. We recommend a vegetation maintenance plan be developed to include the removal of trees, stumps, and shrubs, and periodic mowing of grass on the downstream side of the perimeter dikes and within the perimeter storm water drainage ditch. The perimeter storm water ditches should be maintained to provide positive drainage to one of the internal cells and eventually out through the NPDES outfall.

- The functioning of the NPDES outfall is critical to the managing risk associated with loss of containment. We recommend a formal inspection program be developed for documenting the condition of the outfall structure including inspections for clogging, freezing, reduced flow, and deterioration or damage of the discharge pipe. In addition, a formal daily inspection plan for monitoring the performance of the outfall should be implemented and the pipe should be visually inspected. A remotely-monitored high water alarm should be considered for installation at the outfall.

- Although minor, storm events could erode ash across the perimeter access road. We recommend grading the perimeter roads inward to prevent loss of containment from surface water runoff.

- No pipe penetrations of the perimeter dikes should be performed without engineering controls, filters and controlled backfilling.

In addition to actions recommended to be taken in consideration of risk reduction measures associated with Category II or III failure modes, we recommend the following actions associated with risk reduction measures for Category IV failure modes also be taken:

- Develop a staged filling plan for stacking fly ash to limit rate of loading on soft or organic clays and sluiced loose wet ash in the dike and fill area foundations.

- Only two of the many perimeter monitoring wells are currently monitored for water levels. We recommend a formal written plan be implemented to monitor groundwater levels within all perimeter monitoring wells. The data collected from these wells should be used to develop hydrogeologic conditions for a stability analysis of the perimeter dikes.

- Regularly scheduled inspections for surface erosion, cracking, slumping, woody growth on the perimeter dike and ash fill slopes should be identified in a formal written SMP to allow for adequate inspection of the dike slopes.

- Inspection of the perimeter dike slopes after storms for ice or wave damage should be identified in a formal SMP to identify any damage as a result of a storm or ice event.

8.0 Qualifications

AECOM has prepared this report under the direction of experienced, Michigan licensed professional engineers in accordance with practices reputable and appropriate in the evaluation of containment structures for the prescribed use of CEC. The recommendations provided above are based upon the opinions of AECOM and were made independently from CEC, its employees, and its representatives.

9.0 References

(MTC, 1991a) Materials Testing Consultants. *"Report of Geotechnical Field Investigation and Laboratory Testing For Slope Stability Study, Vertical Expansion of Ashponds Project, J.C. Weadock Generating Complex",* November 1991.

(MTC, 1991b) Materials Testing Consultants. *"Report of Slope Stability Evaluation J.C. Weadock Ashpond Vertical Expansion Project"*, November 1991.

(CPC, 1992a) Solid Waste Management Act – Act 641. *"Construction Permit Application and Support Documents J.C. Weadock Ash Disposal Area",* Consumers Power Company, Essexville, MI, January 1992.

(CPC, 1992b) Consumers Power Company, *"J.C. Weadock Solid Waste Disposal Area Construction Permit Application; Transmittal of Supplemental Information",* April 10, 1992.

(FERC, 2004) *Federal Energy Regulatory Commission. "Federal Guidelines for Dam Safety – Hazard Potential Classification System for Dams", April 2004.*

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(USGS, 2008) United States Geologic Survey. *"Documentation for the 2008 Update of the United States National Seismic Hazard Maps"*, Open-File Report 2008-1128, 2008.

(USACE Website, 2009) www.erdc.usace.army.mil, August 2009.

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(USEPA Website, 2009) http://www.epa.gov/epawaste/nonhaz/industrial/special/fossil/surveys2/index.htm, September 2009.

(NOAA Website, 2009) http://www.glerl.noaa.gov/pubs/brochures/lakelevels/lakelevels.pdf, September 2009.

(USGS, 2009) http://earthquake.usgs.gov/regional/states/events/1947_08_10.php, September 2009.

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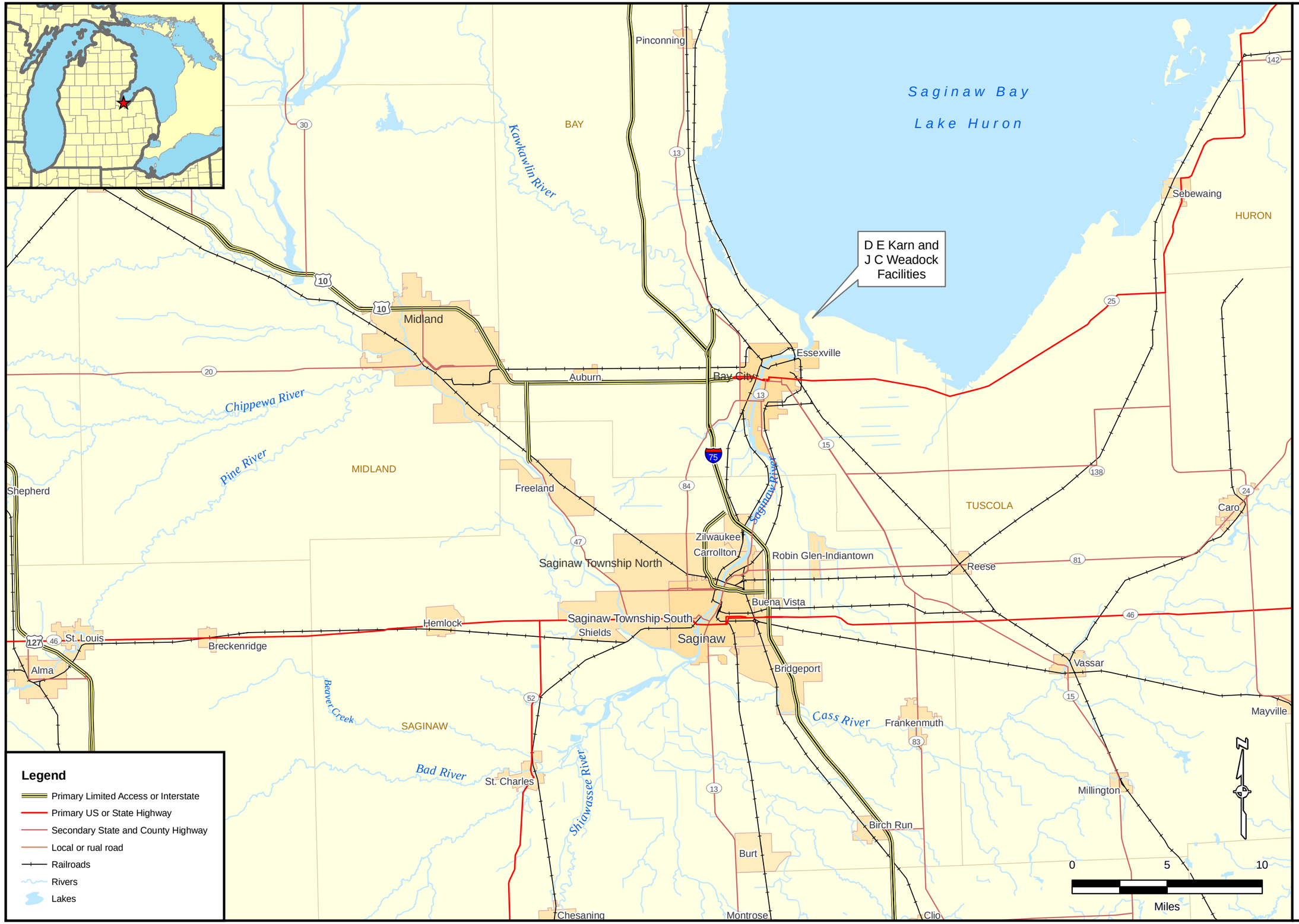
(CEC, 2009) Letter to Mr. Richard Kinch (USEPA) from Mr. Gary A. Dawson (CEC), *“EPA Request for Information Concerning Surface Impoundments”*, March 26, 2009.

Figures



AECOM

www.aecom.com

SITE LOCATION
CONSUMERS ENERGY COMPANY
D E KARN AND J C WEADOCK FACILITIES
ESSEXVILLE, MICHIGAN

Drawn:	JWW	7/29/2009
Approved:	MDC	7/29/2009
Scale:	AS SHOWN	
PROJECT NUMBER	60100985	
FIGURE NUMBER	1	

AERIAL PHOTO SOURCE: 2005 USDA NAIP

Windy Point

Saginaw Bay

Intake Channel

Karn Ash Disposal Area

Coal Pile

KARN PLANT

WEADOCK PLANT

Discharge Channel

Weadock Ash Disposal Area

Saginaw River

Legend

Approx. Ash Disposal Area

N

0 500 1,000

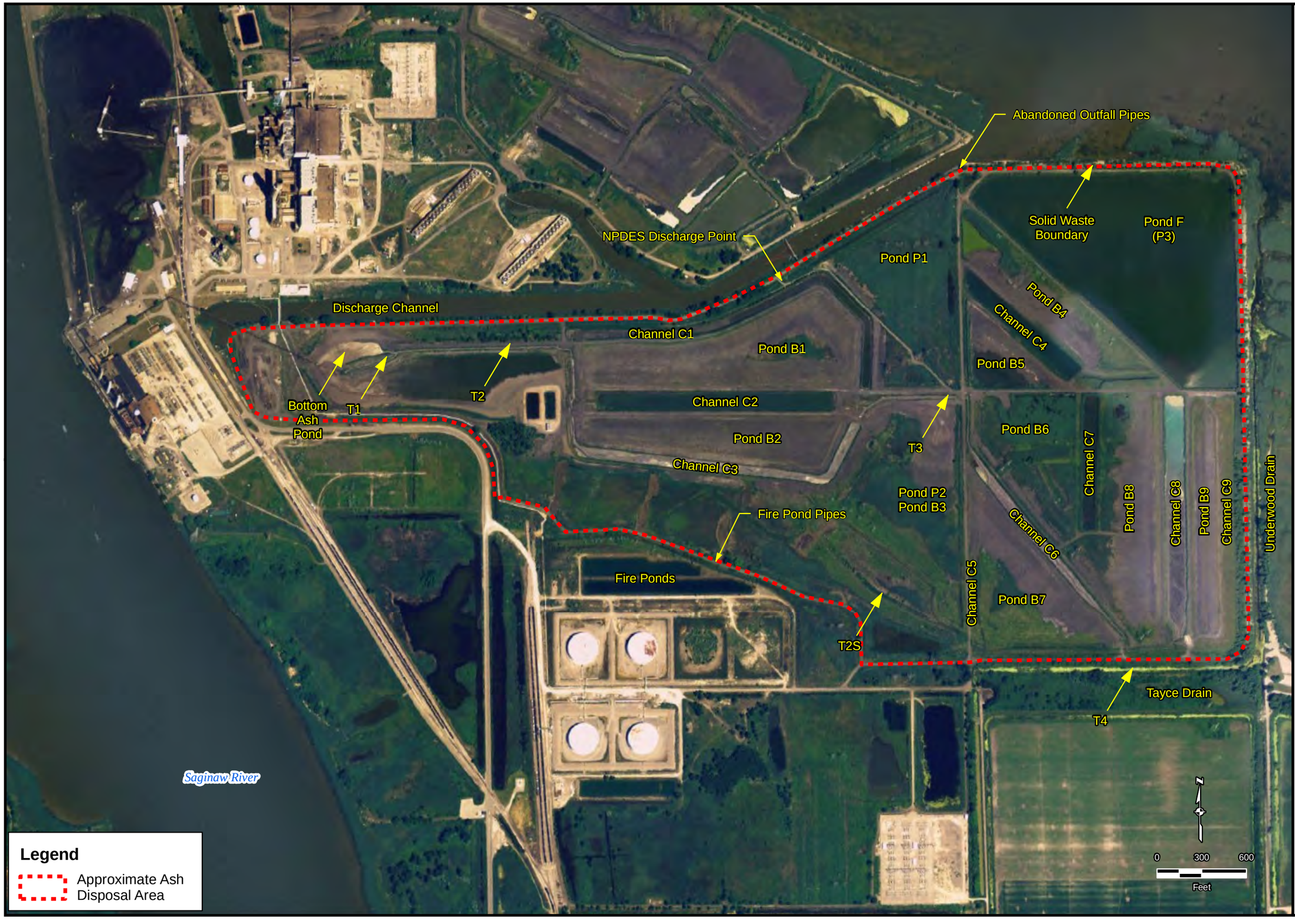
Feet

AECOM

www.aecom.com

D E KARN AND J C WEADOCK FACILITY MAP
CONSUMERS ENERGY COMPANY
ESSEXVILLE, MICHIGAN

Drawn:	JWW	9/17/2009
Approved:	MDC	9/17/2009
Scale:	1" = 1,000'	
PROJECT NUMBER	60100985	
FIGURE NUMBER	2	



Legend

Approximate Ash Disposal Area

AECOM

www.aecom.com

2005 NAIP AERIAL PHOTO
CONSUMERS ENERGY COMPANY
J C WEADOCK FACILITY
ESSEXVILLE, MICHIGAN

Drawn:	JWW	7/29/2009
Approved:	MDC	7/29/2009
Scale:	1" = 600'	
PROJECT NUMBER	60100985	
FIGURE NUMBER	3	

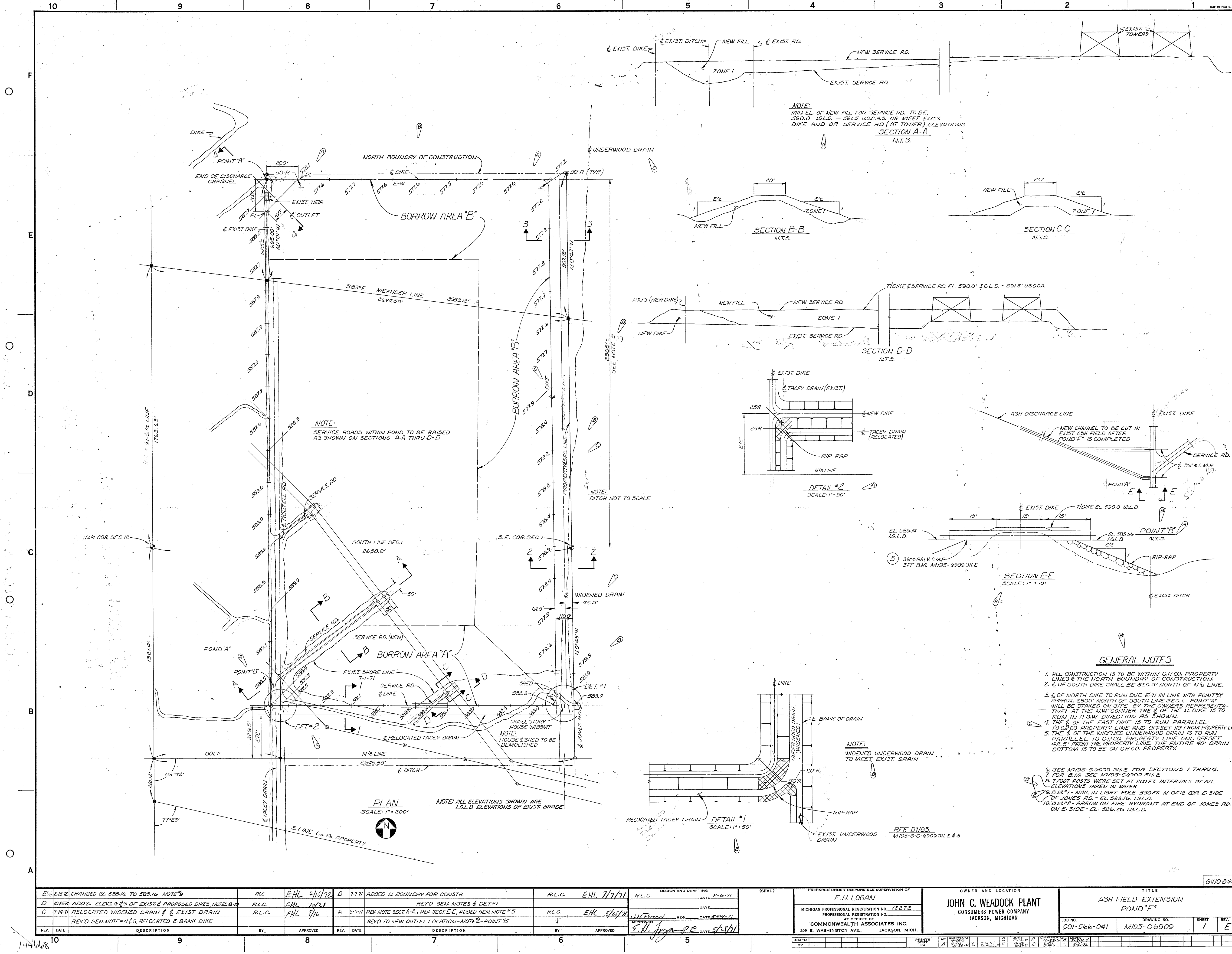
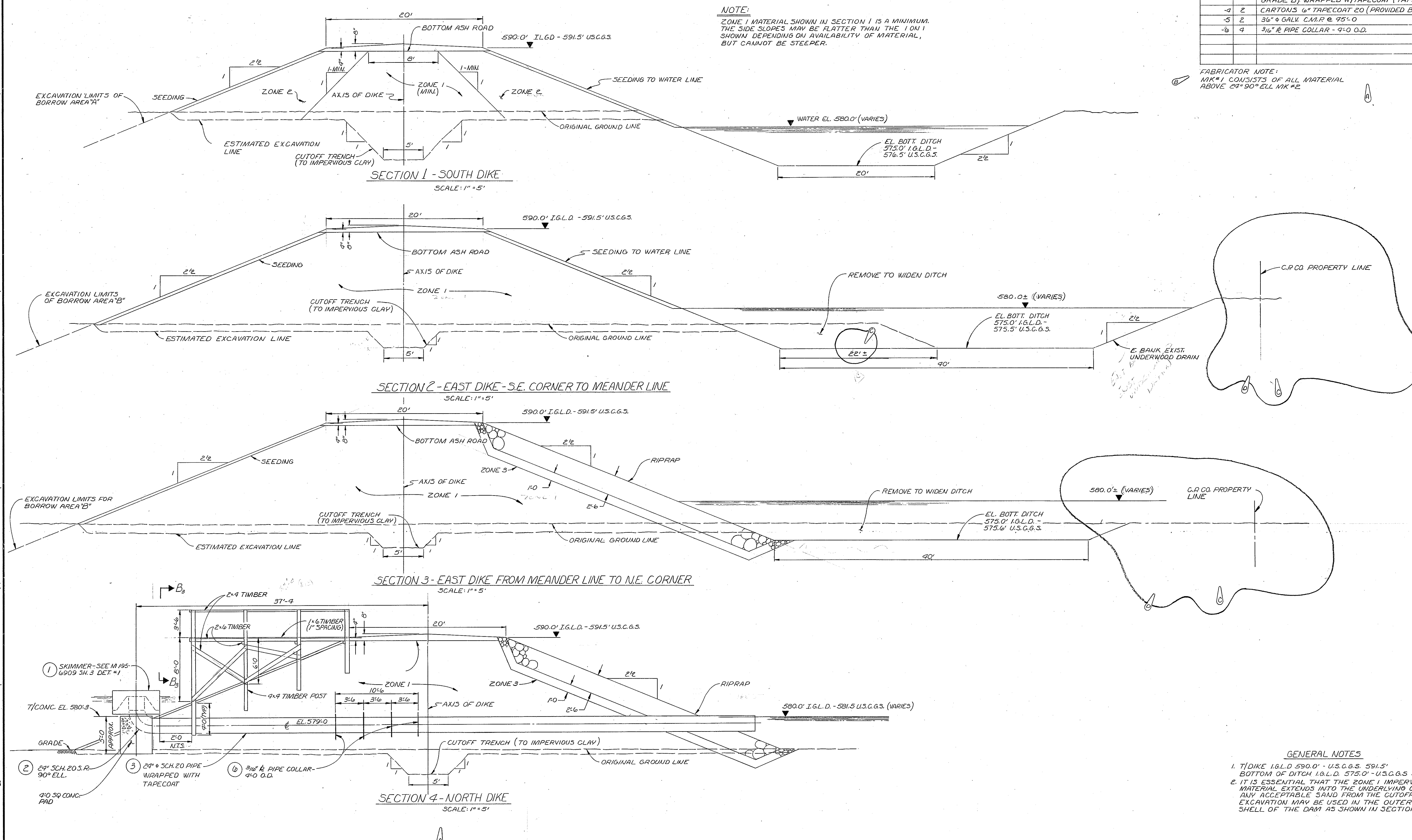


Figure 4



BILL OF MATERIAL

MARK NO.	QUAN.	DESCRIPTION	REQN.
240-6909-1	1	SKIMMER ASSY. (TO CONSIST OF PART NUMBERS A-D)	29020
-2	1	24" 90° SCH. 20 S.R. C.S. ELL (ASTM A53 OR A106 GRADE B) WRAPPED W/TAPECOAT (TAPECOAT 20)	29021
-3	80	LIN. FT. 24" ⌀ SCH. 20 C.S. PIPE (ASTM A53 OR A106 GRADE B) WRAPPED W/TAPECOAT (TAPECOAT 20)	29021
-4	2	CARTONS 6" TAPECOAT 20 (PROVIDED BY CONTR.)	
-5	2	36" ⌀ GALV. C.M.P. @ 45'-0	29021
-6	4	3/16" PL PIPE COLLAR - 4'-0 O.D.	29020

FABRICATOR NOTE:
MK#1 CONSISTS OF ALL MATERIAL ABOVE 24" 90° ELL MK #2

GENERAL NOTES

1. T/DIKE I.G.L.D 590.0' - U.S.C.G.S. 591.5'
   BOTTOM OF DITCH I.G.L.D. 575.0' - U.S.C.G.S. 576.5'
2. IT IS ESSENTIAL THAT THE ZONE 1 IMPERVIOUS MATERIAL EXTENDS INTO THE UNDERLYING CLAY. ANY ACCEPTABLE SAND FROM THE CUTOFF EXCAVATION MAY BE USED IN THE OUTER SHELL OF THE DAM AS SHOWN IN SECTION 1.

REF. DWGS.
M195-G6909-SH.1 & 3

GWO 8444

REV.	DATE	DESCRIPTION	BY	APPROVED
D	7-14-71	DELETED NOTES RE PROPERTY LINE SECTS. 2 & 3	R.L.C.	EHL 7/14/71
C	7-7-71	REV'D SECT. 2 & SECT. 3	R.L.C.	EHL 7/7/71
B	5-27-71	ADDED FABRICATOR NOTE	R.L.C.	
A	5-19-71	ADDED SKIMMER & PLATFORM, ALSO B.M.	R.L.C.	EHL 5/25/71

DESIGN AND DRAFTING: R.L.C. DATE 2-8-71
J.H. Pressel REG. DATE 5-24-71
APPROVED: E.H. Logan P.E. DATE 5/25/71

(SEAL)

PREPARED UNDER RESPONSIBLE SUPERVISION OF E.H. LOGAN
MICHIGAN PROFESSIONAL REGISTRATION NO. 12272
PROFESSIONAL REGISTRATION NO.
AT OFFICES OF COMMONWEALTH ASSOCIATES INC.
209 E. WASHINGTON AVE., JACKSON, MICH.

OWNER AND LOCATION
JOHN C. WEADOCK PLANT
CONSUMERS POWER COMPANY
JACKSON, MICHIGAN

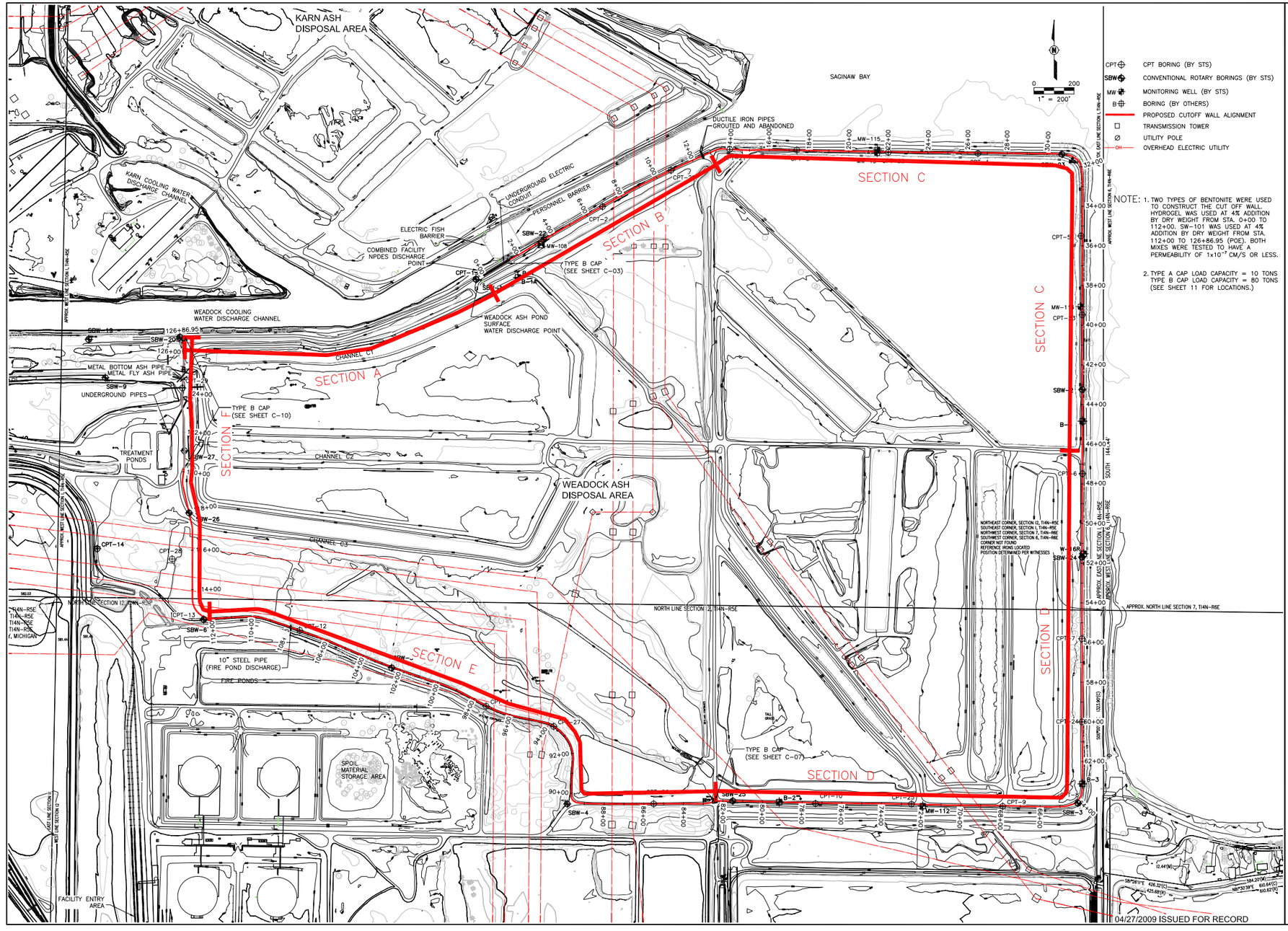
TITLE
ASH FIELD EXTENSION - POND "F"
SECTIONS & DETAILS

JOB NO.	DRAWING NO.	SHEET	REV.
001-566-041	M195-G6909	2	D

K&E 19 1253 4-70

144669

Figure 5



CPT — CPT BORING (BY STS)
SBW — CONVENTIONAL ROTARY BORINGS (BY STS)
MW — MONITORING WELL (BY STS)
B — BORING (BY OTHERS)
PROPOSED CUTOFF WALL ALIGNMENT
TRANSMISSION TOWER
UTILITY POLE
OH — OVERHEAD ELECTRIC UTILITY

NOTE:
1. TWO TYPES OF BENTONITE WERE USED TO CONSTRUCT THE CUT OFF WALL. HYDROGEL WAS USED AT 4% ADDITION BY DRY WEIGHT FROM STA. 0+00 TO 112+00. SW-101 WAS USED AT 4% ADDITION BY DRY WEIGHT FROM STA. 112+00 TO 126+86.95 (POE). BOTH MIXES WERE TESTED TO HAVE A PERMEABILITY OF $1x10^{-7}$ CM/S OR LESS.
2. TYPE A CAP LOAD CAPACITY = 10 TONS
TYPE B CAP LOAD CAPACITY = 80 TONS
(SEE SHEET 11 FOR LOCATIONS.)

STS | AECOM
3839 East Parts Ave.
Grand Rapids, MI 49512
616-940-3077
www.stsconsultants.com

SOIL - BENTONITE CUTOFF WALL RECORD DRAWINGS
2008 PROPOSED ADDITIONAL BORINGS
CONSUMERS ENERGY CO.
D.E.KARN AND J.C. WEADOCK GENERATING FACILITIES
ESSEXVILLE, MICHIGAN

Issued

Rev	Date	Description
ISSUED RECORD	04/27/2009	

Designed:	CF	10/03/2007
Drawn:	DAS	01/22/2009
Checked:	CF	01/22/2009
Approved:	JAT	01/22/2009

PROJECT NUMBER
200703855

SHEET REFERENCE NUMBER
C-02

04/27/2009 ISSUED FOR RECORD

X:\Projects\60109865\05-6909-24-REV-4.dwg, 10/1/2009 1:47:33 PM, FITZGERALD, CARLIN

Reference 195-6909-33 for cap designs

REV.	DATE	DESCRIPTION	BY	APP
A	04/27/2009	GWO 1547 Weadock Slurry Wall Project – Submitted for Record	DAS	EHW

DR. DAS DATE 04/27/2009
CK.
APP. SECTION HEAD
APP. DIVISION HEAD
APP. DEPARTMENT HEAD

Consumers Energy
JC WEADOCK PLANT

FLY ASH SLURRY WALL LAYOUT
WITH WEIGHT RESTRICTIONS

SCALE
JOB
DRAWING NO. 195-6909
SHEET SH24
REV. A

Figure 6

SAGINAW BAY
NOMINAL WATER LEVEL
580.7' (±)

SOLID WASTE BOUNDARY

AREA P3 IS FILLED WITH CONDITIONED ASH IN PHASE IV

VALLEY IN PHASE III IS FILLED WITH CONDITIONED ASH PHASE IV

BOTTOM ASH POND

T1 (BOTTOM ASH TRANSPORT WATER DITCH)

T2 (FLY ASH TRANSPORT DITCH)

T2N

T2S

T3

T4 (TRANSPORT DITCH)

P1

P2

C1

C3

C5

C6

C8

D

E

NOTE:
SECTIONS A-A, B-B, AND C-C ARE THE SAME AS SHOWN FOR "END OF ULTIMATE BERM DEVELOPMENT (HYDRAULICALLY TRANSPORTED ASH) PHASE III"

NOTE:
THIS DRAWING DEPICTS THE CONCEPTUAL DEVELOPMENT OF THE SITE AS DESCRIBED IN DIVISION II, ASH PLACEMENT. ACTUAL HORIZONTAL AND VERTICAL DIMENSIONS OF SURFACE FEATURES WILL APPROXIMATE THOSE INDICATED, DEPENDENT ON OPERATIONAL CONDITIONS AND RECYCLING OPPORTUNITIES.

ALL ELEVATIONS SHOWN ON THIS DRAWING ARE TO U.S.G.S. DATUM. TO CONVERT TO U.S.L.S. ELEVATION ADD 0.30'. TO CONVERT TO I.G.L.D. ELEVATION SUBTRACT 1.45'.

REV	DATE	DESCRIPTION	GWQ FC*	BY	CK	APP
0	12 23 91	ISSUED FOR PERMIT APPLICATION (SOLID WASTE MANAGEMENT ACT 641)	---	TLS		RJO

CONSUMERS POWER COMPANY
JACKSON, MICHIGAN

PREVIOUS RECORD ISSUE

MICHIGAN P.E. No.

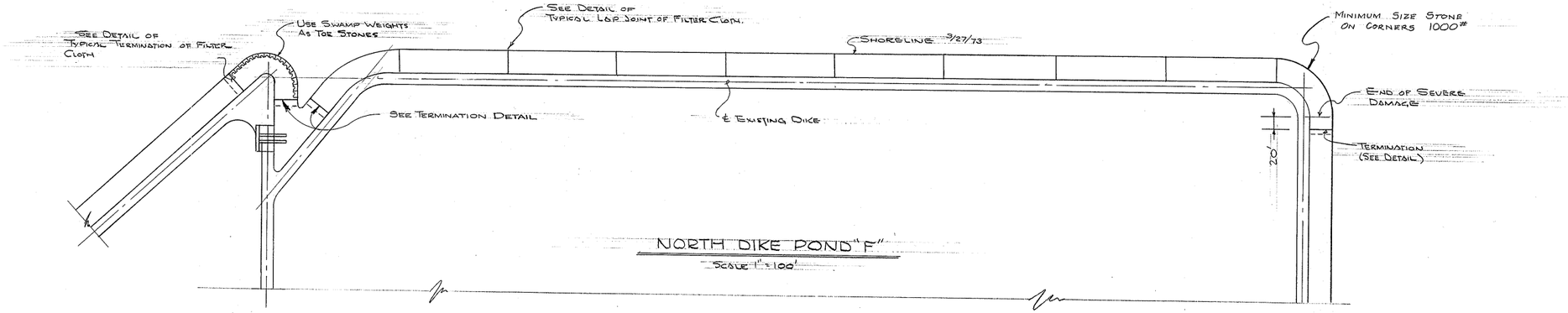
END OF ULTIMATE BERM DEVELOPMENT
(CONDITIONED ASH)
PHASE IV

0695LASH.RL0

UFI No.

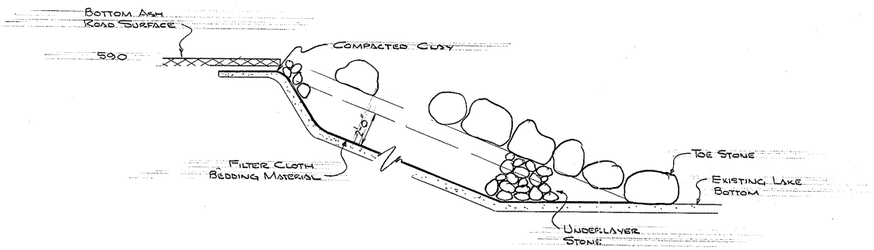
LOC	BASE	SHEET	REV
0195	G-6909	21	0

Figure 7

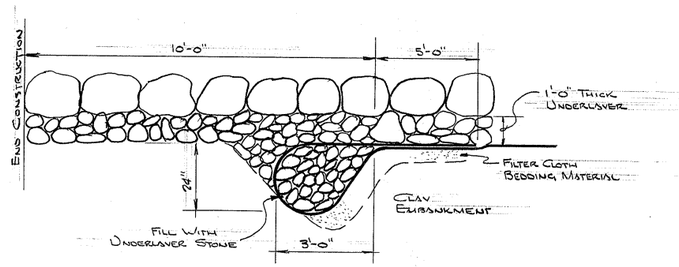


NORTH DIKE POND "F"

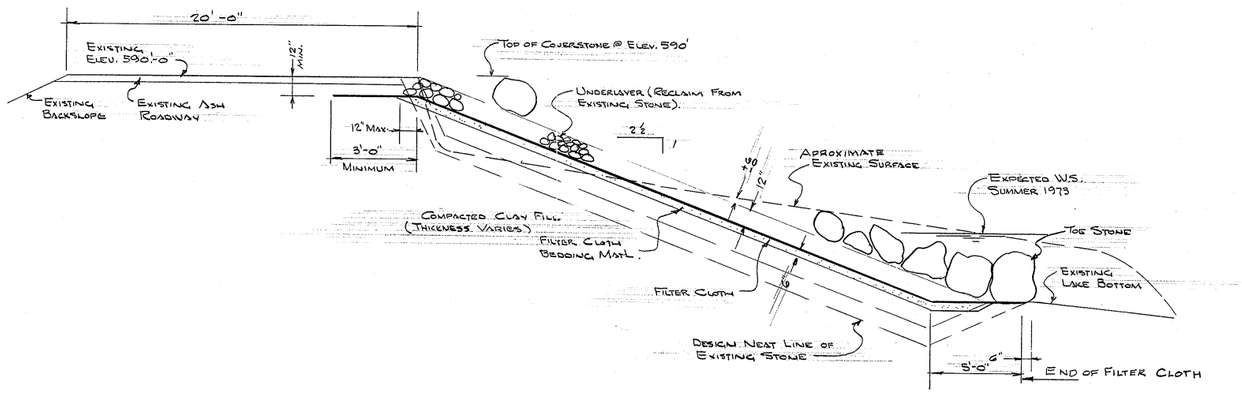
SCALE 1" = 100'



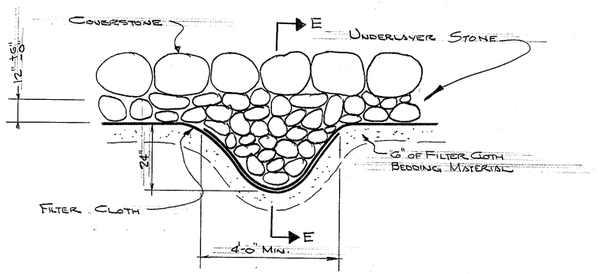
SECTION E-E



TERMINATION DETAIL FOR FILTER CLOTH



TYPICAL SECTION



LAP DETAIL FOR FILTER CLOTH

Figure 8

REV.	DATE	DESCRIPTION	BY	APP.	REV.	DATE	DESCRIPTION	BY	APP.

DR. Monte Curl 4/16/73
CK. R A Dirksen 4/30/73
APP. J E Emerson 4/73

FARGO ENGINEERING COMPANY
Consulting Engineers
120 W. MICHIGAN IN JACKSON, MICHIGAN

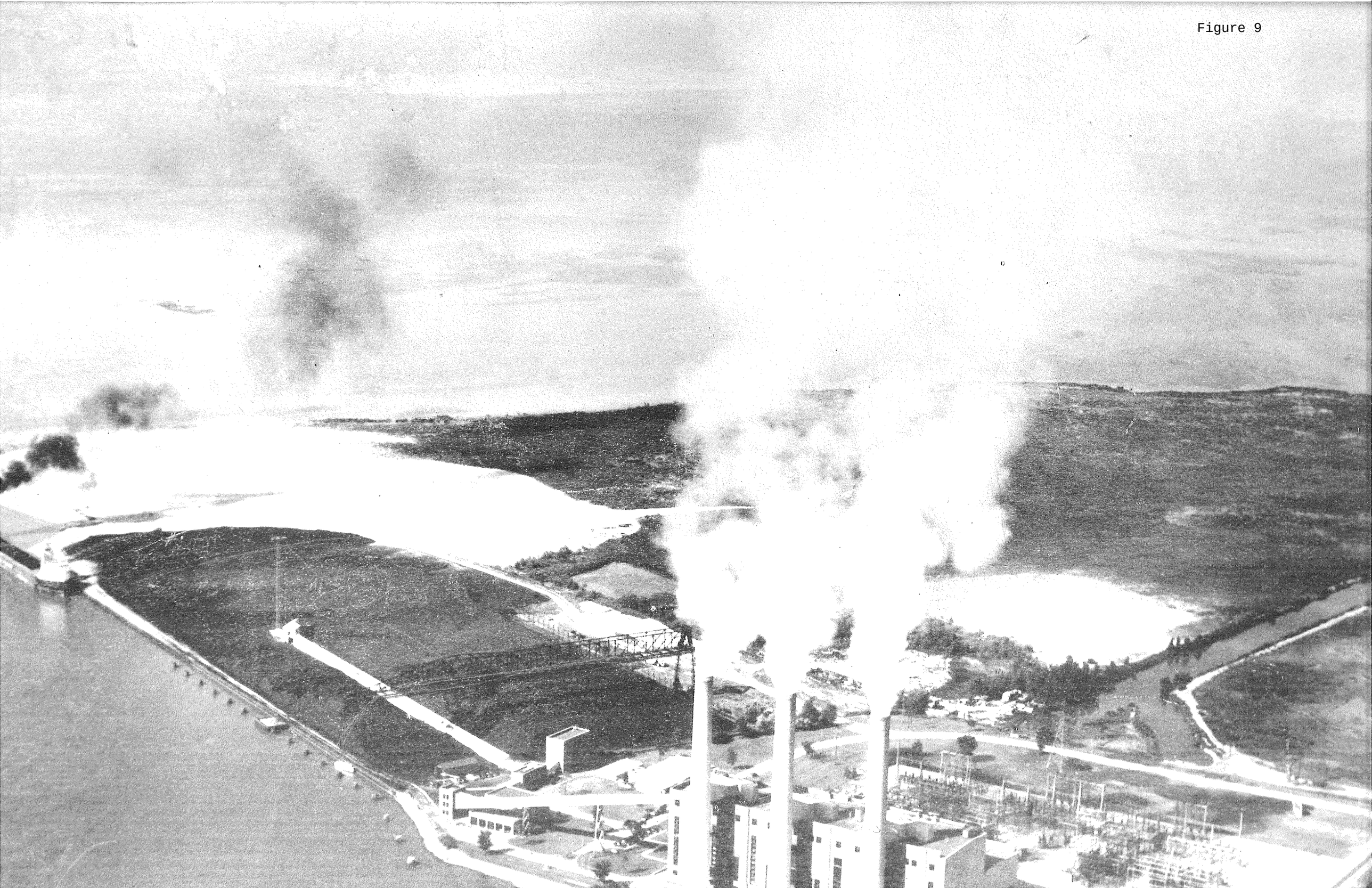
JOHN C. WEADOCK PLANT
CONSUMERS POWER COMPANY
STONE PROTECTION - POND "F"

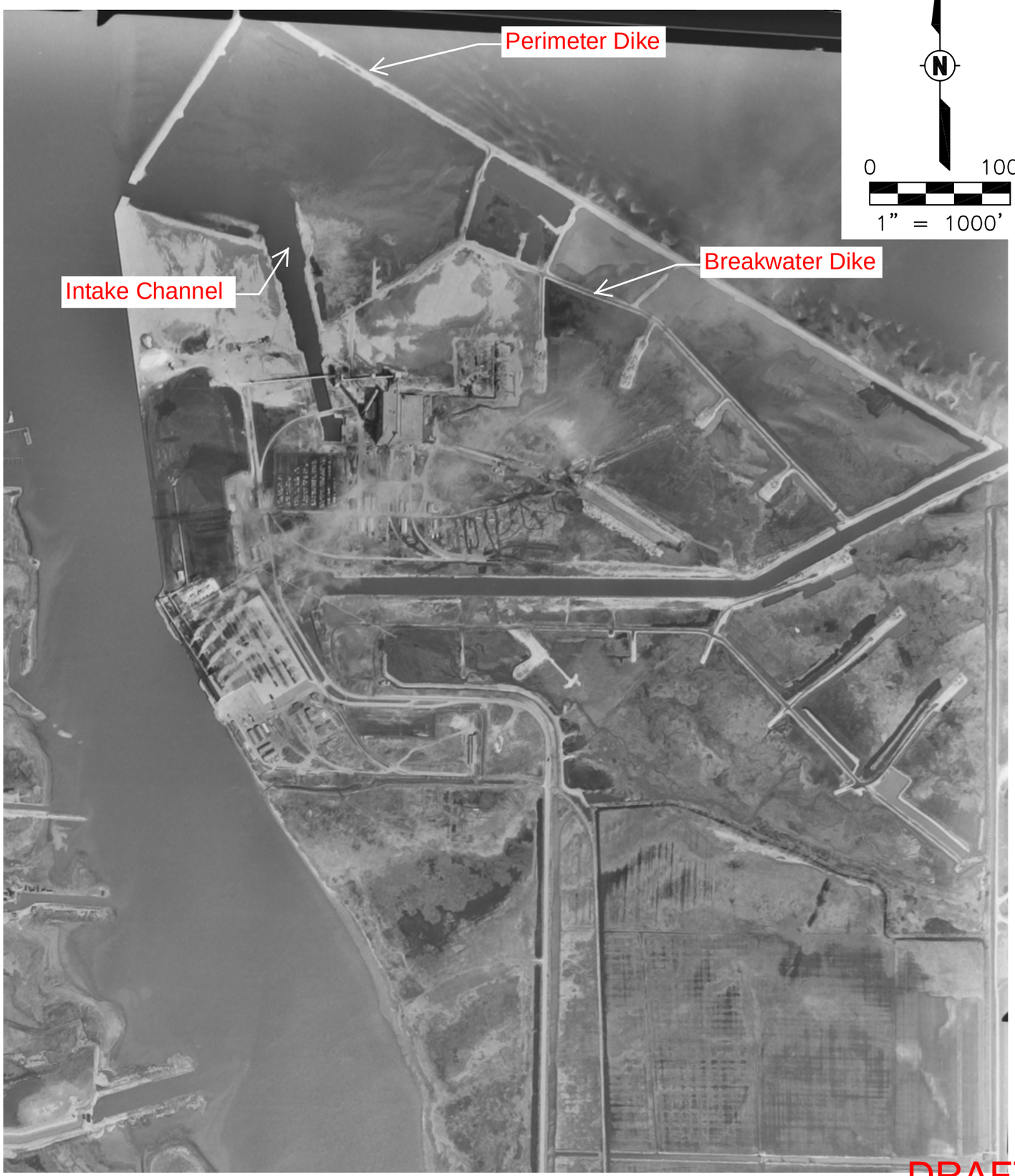
SCALE As Noted | JOB 88-0091 | DRAWING NO. M195-F6909 | SHEET 4 | REV.

O. K. TO FILE

6647 77

Figure 9





NOTE: Historic 04/16/1959 aerial photograph provided by client.

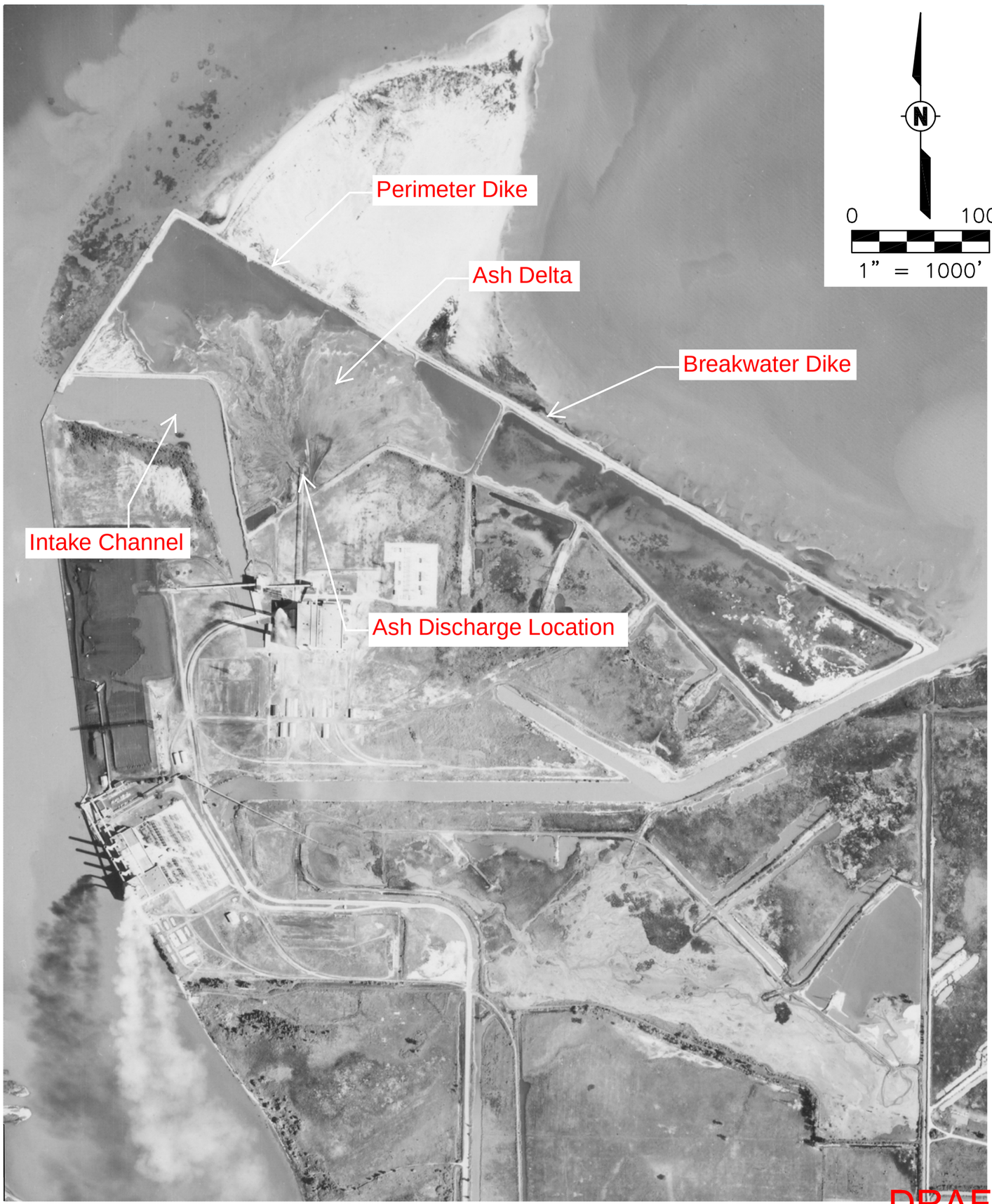
DRAFT

AECOM

HISTORIC AERIAL PHOTOGRAPH - 1959
ASH DIKE RISK ASSESSMENT
CONSUMERS ENERGY COMPANY
D.E. KARN GENERATING FACILITY
ESSEXVILLE, MICHIGAN

Drawn :	CJD	09/02/2009
Checked:	MFP	09/02/2009
Approved:	JSM	
PROJECT NUMBER	60100985	
FIGURE NUMBER	10	

X:\PROJECTS\60101367\60101367-004.dwg; 9/2/2009 3:13:18 PM; DOYLE, CONAN; STS.stb



NOTE: Historic 1963 aerial photograph provided by client.

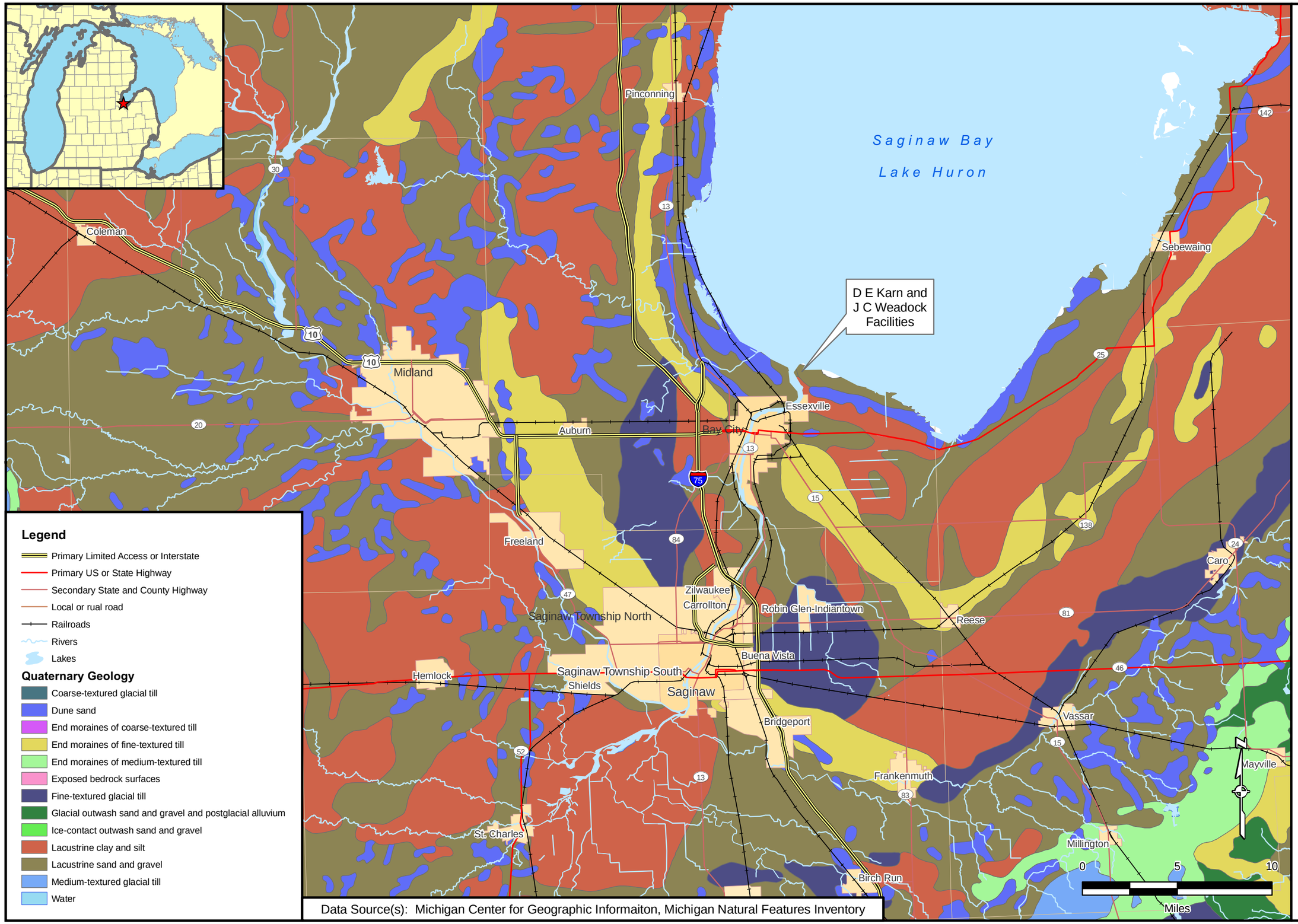
DRAFT

AECOM

HISTORIC AERIAL PHOTOGRAPH - 1963
ASH DIKE RISK ASSESSMENT
CONSUMERS ENERGY COMPANY
D.E. KARN GENERATING FACILITY
ESSEXVILLE, MICHIGAN

Drawn :	CJD	09/01/2009
Checked:	MFP	09/01/2009
Approved:	JSM	
PROJECT NUMBER	60100985	
FIGURE NUMBER	11	

X:\PROJECTS\60101367\60101367-005.dwg; 9/2/2009 3:15:18 PM; DOYLE, CONAN; STS.stb



Legend

- Primary Limited Access or Interstate
- Primary US or State Highway
- Secondary State and County Highway
- Local or rual road
- Railroads
- Rivers
- Lakes

Quaternary Geology

- Coarse-textured glacial till
- Dune sand
- End moraines of coarse-textured till
- End moraines of fine-textured till
- End moraines of medium-textured till
- Exposed bedrock surfaces
- Fine-textured glacial till
- Glacial outwash sand and gravel and postglacial alluvium
- Ice-contact outwash sand and gravel
- Lacustrine clay and silt
- Lacustrine sand and gravel
- Medium-textured glacial till
- Water

Data Source(s): Michigan Center for Geographic Informaiton, Michigan Natural Features Inventory

AECOM

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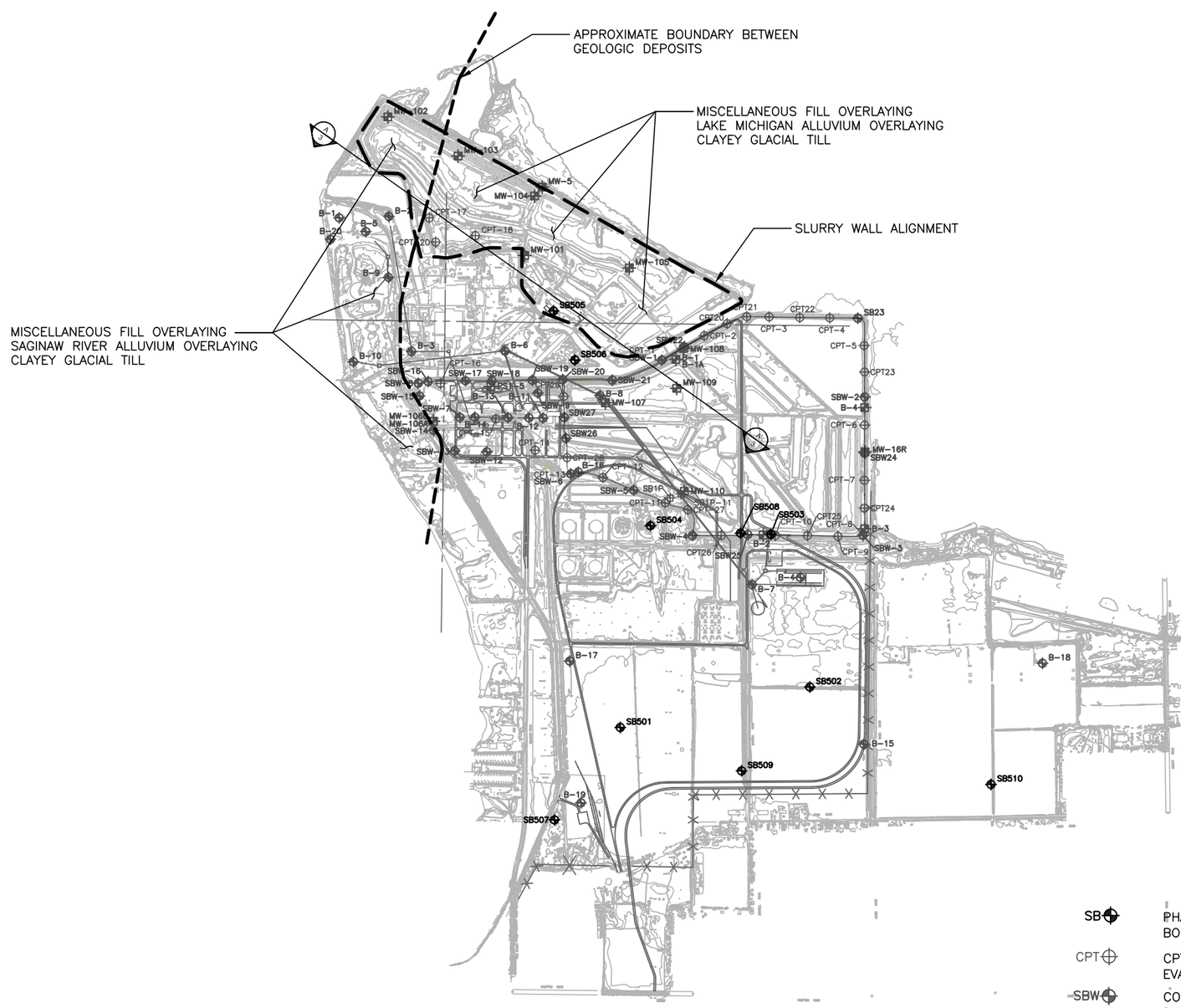
QUATERNARY GEOLOGY
CONSUMERS ENERGY COMPANY
D E KARN AND J C WEADOCK FACILITIES
ESSEXVILLE, MICHIGAN

Drawn:	JWW	7/29/2009
Approved:	MDC	7/29/2009
Scale:	AS SHOWN	
PROJECT NUMBER	60100985	
FIGURE NUMBER	12	



NOTE: Base map information from STS January, 2008 Geotechnical Evaluation Report.

LEGEND

SB	PHASE II GEOTECHNICAL EVALUATION SOIL BORING (BY STS)
CPT	CPT BORING (PERFORMED DURING PREVIOUS EVALUATIONS BY STS)
SBW	CONVENTIONAL ROTARY BORINGS (PERFORMED DURING PREVIOUS EVALUATIONS BY STS)
MW	MONITORING WELL (BY STS)
SB	BORING (BY OTHERS)
	PROPOSED CUTOFF WALL ALIGNMENT

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OVER ALL SITE PLAN
KARN ASH LANDFILL SLURRY WALL
FEASIBILITY STUDY
CONSUMERS ENERGY COMPANY
D.E. KARN AND J.C. WEADOCK GENERATING FACILITIES
ESSEXVILLE, MICHIGAN

Drawn :	LDJ	06/18/2009
Checked:	MFP	06/18/2009
Approved:		
PROJECT NUMBER		
FIGURE NUMBER	13	

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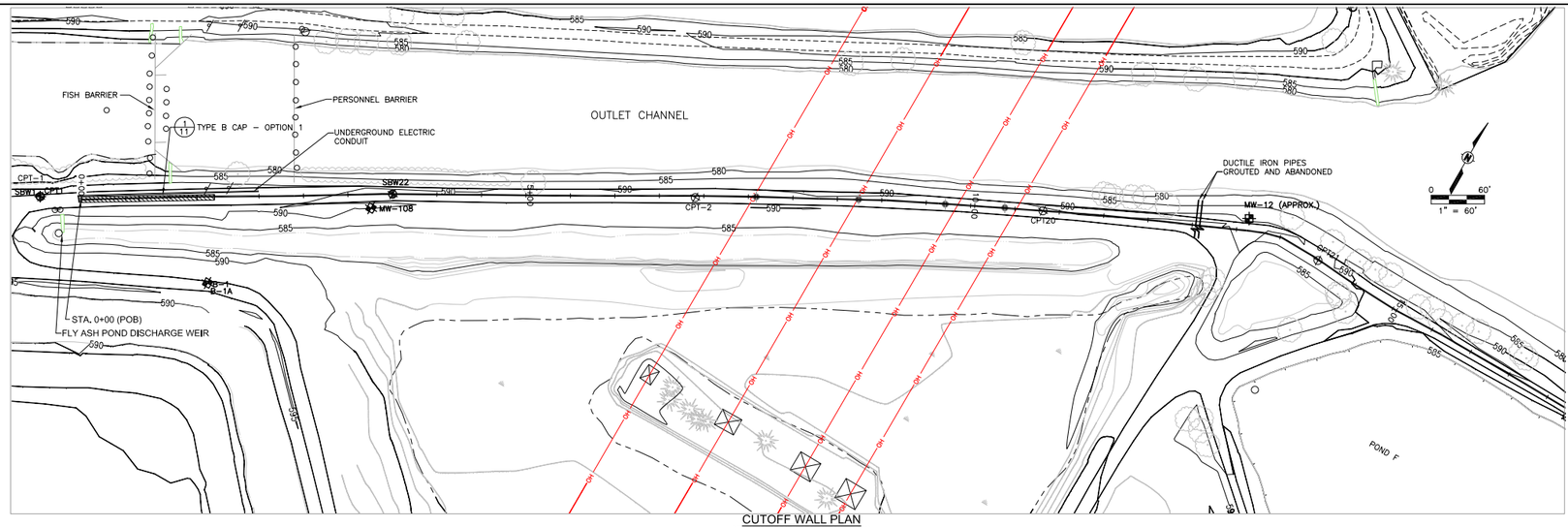
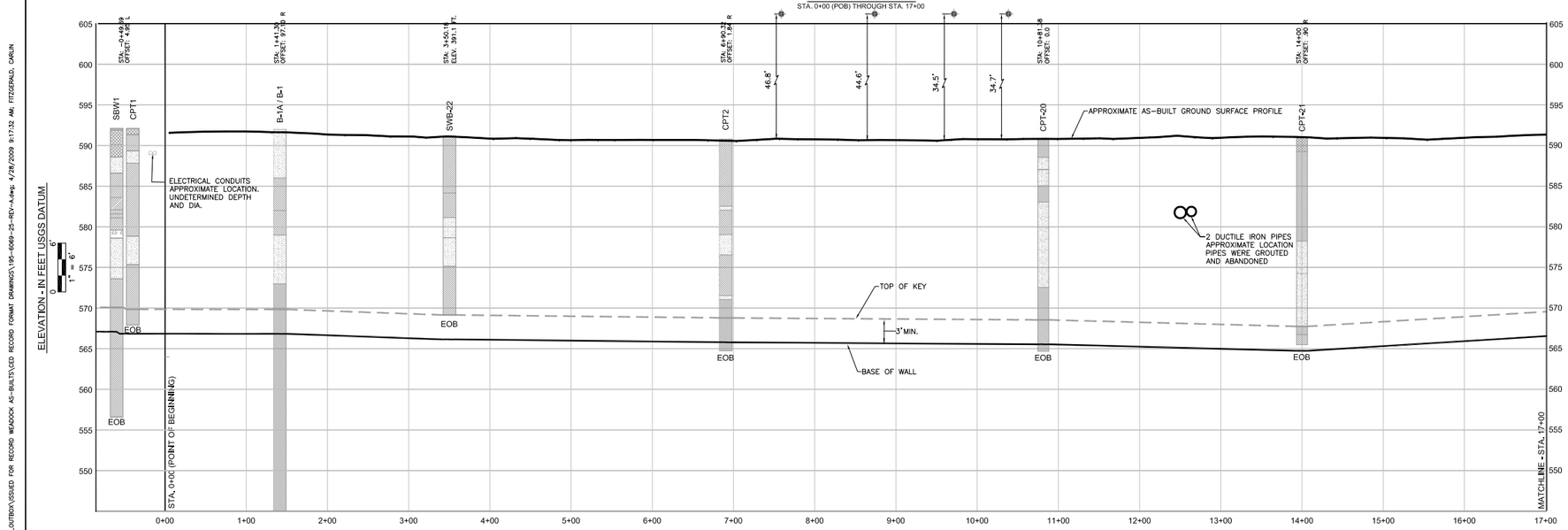


CUTOFF WALL PLAN
STA. 0+00 (POB) THROUGH STA. 17+00



LEGEND

- CLAY TILL
- ALLUVIAL CLAYEY SOILS
- SANDY SOILS
- ORGANIC
- FILL SOIL / BOTTOM ASH

- CPT — CPT BORING (BY STS)
- SBW — CONVENTIONAL ROTARY BORINGS (BY STS)
- MW — MONITORING WELL (BY STS)
- B — BORING (BY OTHERS)
- OVERHEAD ELECTRICAL LINE (CROSSING WORK AREA) LOCATION
- OH — OVERHEAD ELECTRIC LINE (MAY NOT REPRESENT ALL LINES)
- WOODEN UTILITY POLE LOCATION
- TRANSMISSION TOWER LOCATION
- SOIL– BENTONITE CUTOFF WALL

CUTOFF WALL PROFILE
STA. 0+00 (POB) THROUGH STA. 17+00
0 60'
1" = 60'

NOTES:
1. BORINGS PROJECTED IN PROFILE AND NOT NECESSARILY ON WALL ALIGNMENT.
2. ELEVATIONS ARE REPORTED IN NAVD 88 DATUM IN FEET.
3. TOPOGRAPHY BY ROWE INC. FROM AERIAL PHOTOGRAPHY FLOWN 04/16/2007.
4. IN CASE OF MULTIPLE OVERHEAD LINES. SURVEY LINE IS LOWEST OF GROUP.

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SOIL - BENTONITE CUTOFF WALL - RECORD DRAWINGS
WEADOCK FLY ASH DISPOSAL AREA - STA. 0+00 (POB) - STA.17+00
CONSUMERS ENERGY COMPANY
D.E. KARN AND J.C. WEADOCK GENERATING FACILITIES
ESSEXVILLE, MICHIGAN

Issued

Rev	Date	Description
ISSUED RECORD	04/27/2009	

Designed:	CF	10/03/2007
Drawn:	DAS	01/22/2009
Checked:	CF	01/22/2009
Approved:	JAT	01/26/2009

PROJECT NUMBER
200703855

SHEET REFERENCE NUMBER
C-03

X:\Projects\200703855\DATA_OUTBOX\ISSUED FOR RECORD WEADOCK AS-BUILTS\CED RECORD FORMAT DRAWINGS\195-6069-25-REV-A.dwg, 4/28/2009 9:17:32 AM, FITZGERALD, CARLIN

Reference 195-6909-24
Reference 195-6909-33

REV.	DATE	DESCRIPTION	BY	APP
A	04/27/2009	GWO 1547 Weadock Slurry Wall Project – Submitted for Record	DAS	EHW

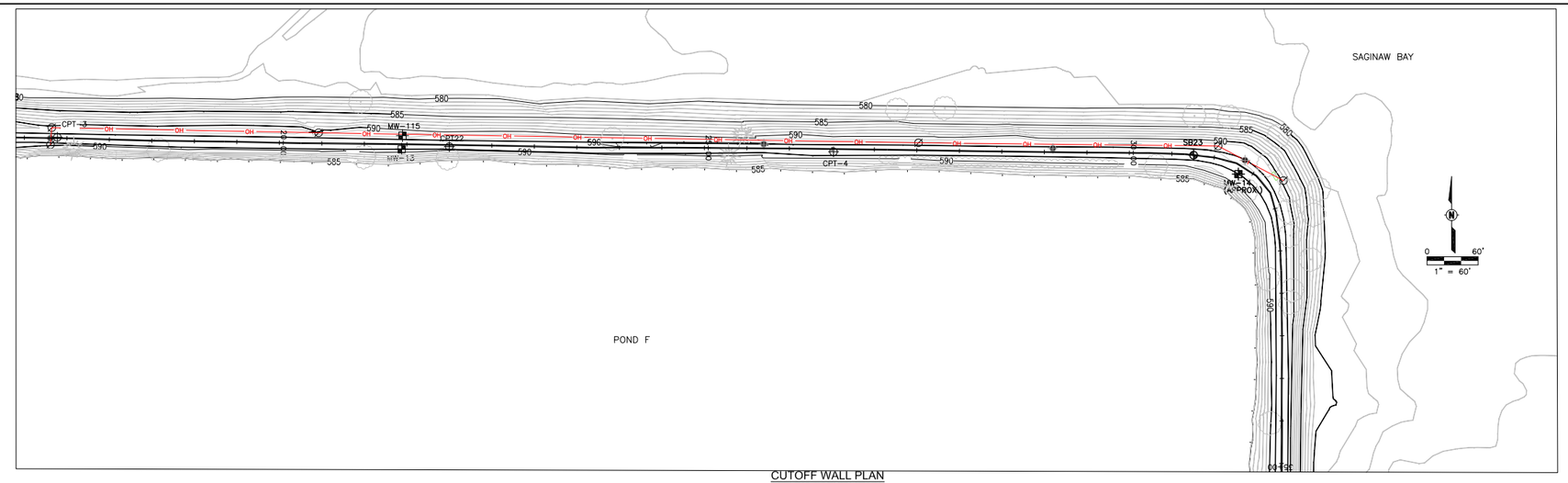
DR. DAS 04/27/2009
CK.
APP. SECTION HEAD
APP. DIVISION HEAD
APP. DEPARTMENT HEAD

Consumers Energy
JC WEADOCK PLANT

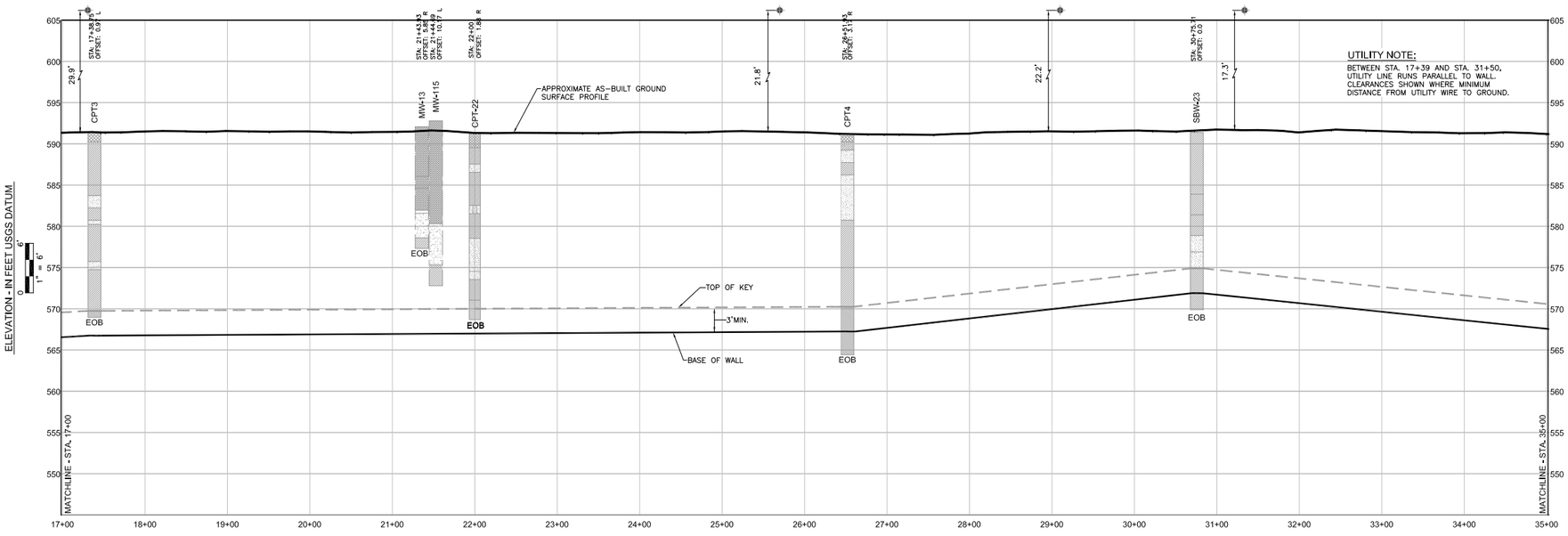
FLY ASH SLURRY WALL
STA 0+00 TO STA 17+00
WITH BORING DATA

SCALE	DRAWING NO.	SHEET	REV.
JOB	195-6909	SH25	A

Figure 14



CUTOFF WALL PLAN
STA. 17+00 THROUGH STA. 35+00



LEGEND

- CLAY TILL
- ALLUVIAL CLAYEY SOILS
- SANDY SOILS
- ORGANIC
- FILL SOIL / BOTTOM ASH

- CPT — CPT BORING (BY STS)
- SBW — CONVENTIONAL ROTARY BORINGS (BY STS)
- MW — MONITORING WELL (BY STS)
- B — BORING (BY OTHERS)
- OVERHEAD ELECTRICAL LINE (CROSSING WORK AREA) LOCATION
- OH — OVERHEAD ELECTRIC LINE (MAY NOT REPRESENT ALL LINES)
- WOODEN UTILITY POLE LOCATION
- TRANSMISSION TOWER LOCATION
- SOIL– BENTONITE CUTOFF WALL

CUTOFF WALL PROFILE
STA. 17+00 THROUGH STA. 35+00
0 60'
1" = 60'

NOTES:
1. BORINGS PROJECTED IN PROFILE AND NOT NECESSARILY ON WALL ALIGNMENT.
2. ELEVATIONS ARE REPORTED IN NAVD 88 DATUM IN FEET.
3. TOPOGRAPHY BY ROWE INC. FROM AERIAL PHOTOGRAPHY FLOWN 04/16/2007.
4. IN CASE OF MULTIPLE OVERHEAD LINES. SURVEY LINE IS LOWEST OF GROUP.

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ESSEXVILLE, MICHIGAN

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Rev	Date	Description
ISSUED FOR RECORD	04/27/2009	

Designed:	CF	10/03/2007
Drawn:	DAS	01/22/2009
Checked:	CF	01/22/2009
Approved:	JAT	01/26/2009

PROJECT NUMBER
200703855

SHEET REFERENCE NUMBER
C-04

REV.	DATE	DESCRIPTION	BY	APP
A	04/27/2009	GWO 1547 Weadock Slurry Wall Project – Submitted for Record	DAS	EHW

DR. DAS 04/27/2009
CK.
APP. SECTION HEAD
APP. DIVISION HEAD
APP. DEPARTMENT HEAD

Consumers Energy
JC WEADOCK PLANT

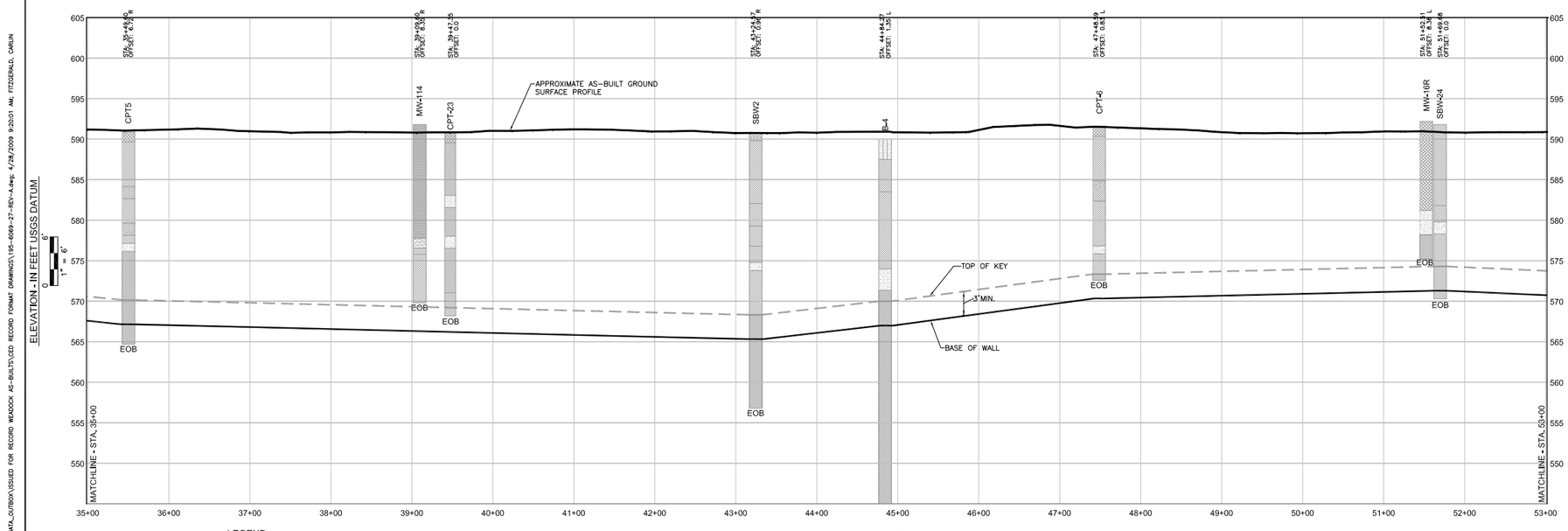
FLY ASH SLURRY WALL
STA 17+00 TO STA 35+00
WITH BORING DATA

SCALE
JOB
DRAWING NO. 195-6909
SHEET SH26
REV. A

Reference 195-6909-24
Reference 195-6909-33

Figure 15

CUTOFF WALL PLAN
STA. 35+00 THROUGH STA. 53+00



LEGEND

- CLAY TILL
- ALLUVIAL CLAYEY SOILS
- SANDY SOILS
- ORGANIC
- FILL SOIL / BOTTOM ASH
- CPT — CPT BORING (BY STS)
- SBW — CONVENTIONAL ROTARY BORINGS (BY STS)
- MW — MONITORING WELL (BY STS)
- B — BORING (BY OTHERS)
- OVERHEAD ELECTRICAL LINE (CROSSING WORK AREA) LOCATION
- OH — OVERHEAD ELECTRIC LINE (MAY NOT REPRESENT ALL LINES)
- WOODEN UTILITY POLE LOCATION
- TRANSMISSION TOWER LOCATION
- SOIL- BENTONITE CUTOFF WALL

CUTOFF WALL PROFILE
STA. 35+00 THROUGH STA. 53+00
0 60'
1" = 60'

NOTES:
1. BORINGS PROJECTED IN PROFILE AND NOT NECESSARILY ON WALL ALIGNMENT.
2. ELEVATIONS ARE REPORTED IN NAVD 88 DATUM IN FEET.
3. TOPOGRAPHY BY ROWE INC. FROM AERIAL PHOTOGRAPHY FLOWN 04/16/2007.
4. IN CASE OF MULTIPLE OVERHEAD LINES, SURVEY LINE IS LOWEST OF GROUP.

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D.E. KARN AND J.C. WEADOCK GENERATING FACILITIES
ESSEXVILLE, MICHIGAN

Issued

Rev	Date	Description
ISSUED FOR RECORD	04/27/2009	

Designed:	CF	10/03/2007
Drawn:	DAS	01/22/2009
Checked:	CF	01/22/2009
Approved:	JAT	01/26/2009

PROJECT NUMBER
200703855

SHEET REFERENCE NUMBER
C-05

Reference 195-6909-24
Reference 195-6909-33

REV.	DATE	DESCRIPTION	BY	APP
A	04/27/2009	GWO 1547 Weadock Slurry Wall Project – Submitted for Record	DAS	EHW

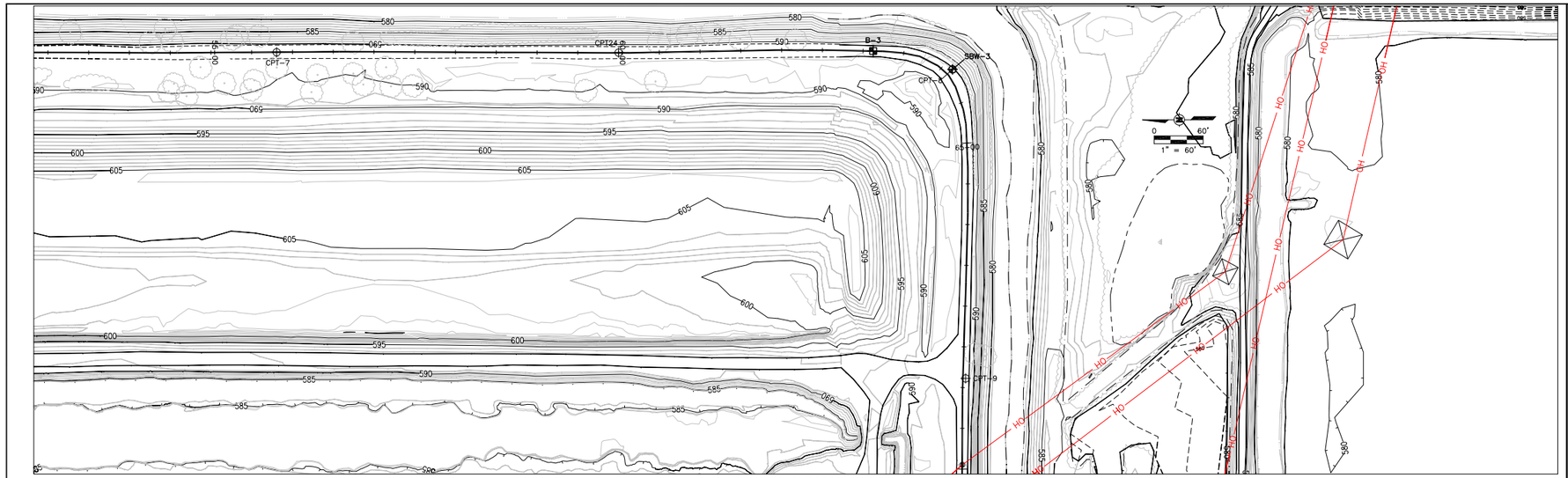
DR. DAS DATE 04/27/2009
CK.
APP. SECTION HEAD
APP. DIVISION HEAD
APP. DEPARTMENT HEAD

Consumers Energy
JC WEADOCK PLANT

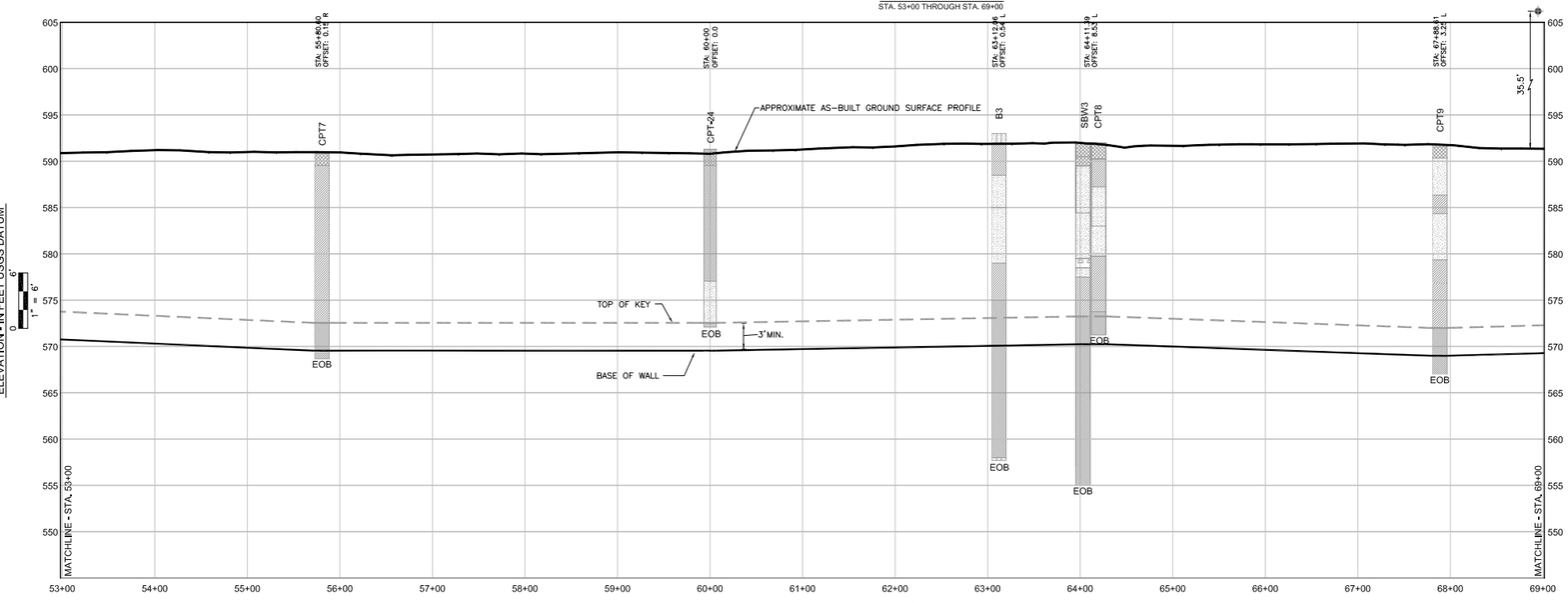
FLY ASH SLURRY WALL
STA 35+00 TO STA 53+00
WITH BORING DATA

SCALE	DRAWING NO.	SHEET	REV.
JOB	195-6909	SH27	A

Figure 16



CUTOFF WALL PLAN
STA. 53+00 THROUGH STA. 69+00



LEGEND

CLAY TILL	CPT	CPT BORING (BY STS)
ALLUVIAL CLAYEY SOILS	SBW	CONVENTIONAL ROTARY BORINGS (BY STS)
SANDY SOILS	MW	MONITORING WELL (BY STS)
ORGANIC	B	BORING (BY OTHERS)
FILL SOIL / BOTTOM ASH		OVERHEAD ELECTRICAL LINE (CROSSING WORK AREA) LOCATION
	OH	OVERHEAD ELECTRIC LINE (MAY NOT REPRESENT ALL LINES)
	∅	WOODEN UTILITY POLE LOCATION
		TRANSMISSION TOWER LOCATION
		SOIL- BENTONITE CUTOFF WALL

CUTOFF WALL PROFILE
STA. 53+00 THROUGH STA. 69+00
0 60'
1" = 60'

NOTES:
1. BORINGS PROJECTED IN PROFILE AND NOT NECESSARILY ON WALL ALIGNMENT.
2. ELEVATIONS ARE REPORTED IN NAVD 88 DATUM IN FEET.
3. TOPOGRAPHY BY ROWE INC. FROM AERIAL PHOTOGRAPHY FLOWN 04/16/2007.
4. IN CASE OF MULTIPLE OVERHEAD LINES. SURVEY LINE IS LOWEST OF GROUP.

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WEADOCK FLY ASH DISPOSAL AREA - STA. 53+00 THROUGH STA. 69+00
CONSUMERS ENERGY COMPANY
D.E. KARN AND J.C. WEADOCK GENERATING FACILITIES
ESSEXVILLE, MICHIGAN

Issued

Rev	Date	Description
ISSUED FOR RECORD	04/27/2009	

Designed:	CF	10/03/2007
Drawn:	DAS	01/22/2009
Checked:	CF	01/22/2009
Approved:	JAT	01/26/2009

PROJECT NUMBER
200703855

SHEET REFERENCE NUMBER
C-06

Reference 195-6909-24
Reference 195-6909-33

REV.	DATE	DESCRIPTION	BY	APP
A	04/27/2009	GWO 1547 Weadock Slurry Wall Project – Submitted for Record	DAS	EHW

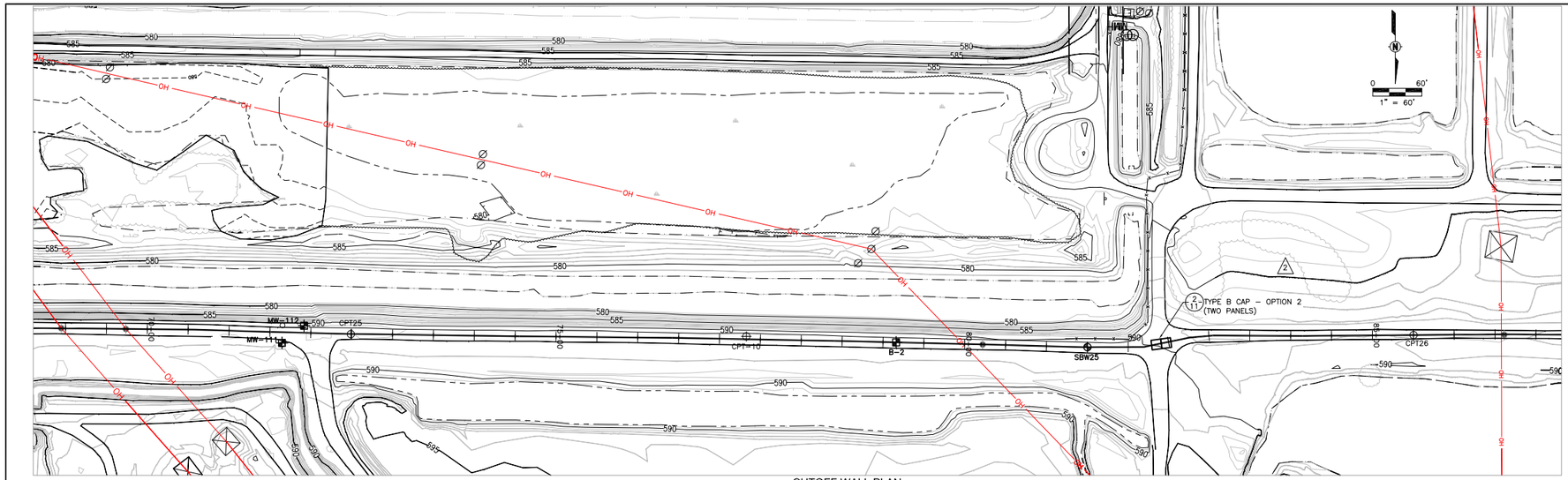
DR. DAS DATE 04/27/2009
CK.
APP. SECTION HEAD
APP. DIVISION HEAD
APP. DEPARTMENT HEAD

Consumers Energy
JC WEADOCK PLANT

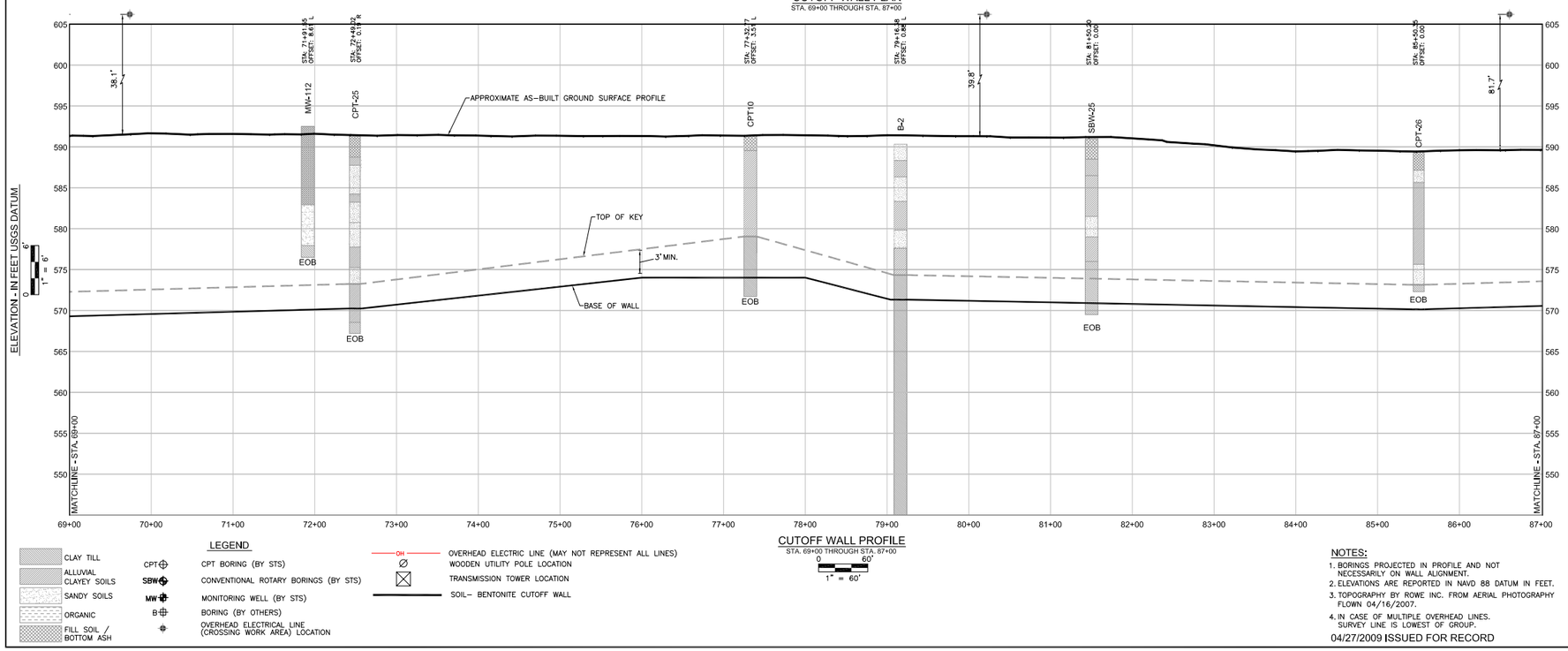
FLY ASH SLURRY WALL
STA 53+00 TO STA 69+00
WITH BORING DATA

SCALE	DRAWING NO.	SHEET	REV.
JOB	195-6909	SH28	A

Figure 17



CUTOFF WALL PLAN
STA. 69+00 THROUGH STA. 87+00



LEGEND

- CLAY TILL
- ALLUVIAL CLAYEY SOILS
- SANDY SOILS
- ORGANIC
- FILL SOIL / BOTTOM ASH
- CPT — CPT BORING (BY STS)
- SBW — CONVENTIONAL ROTARY BORINGS (BY STS)
- MW — MONITORING WELL (BY STS)
- B — BORING (BY OTHERS)
- OVERHEAD ELECTRICAL LINE (CROSSING WORK AREA) LOCATION
- OH — OVERHEAD ELECTRIC LINE (MAY NOT REPRESENT ALL LINES)
- ∅ — WOODEN UTILITY POLE LOCATION
- TRANSMISSION TOWER LOCATION
- SOIL– BENTONITE CUTOFF WALL

CUTOFF WALL PROFILE
STA. 69+00 THROUGH STA. 87+00
0 60'
1" = 60'

NOTES:
1. BORINGS PROJECTED IN PROFILE AND NOT NECESSARILY ON WALL ALIGNMENT.
2. ELEVATIONS ARE REPORTED IN NAVD 88 DATUM IN FEET.
3. TOPOGRAPHY BY ROWE INC. FROM AERIAL PHOTOGRAPHY FLOWN 04/16/2007.
4. IN CASE OF MULTIPLE OVERHEAD LINES, SURVEY LINE IS LOWEST OF GROUP.

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CONSUMERS ENERGY COMPANY
D.E. KARN AND J.C. WEADOCK GENERATING FACILITIES
ESSEXVILLE, MICHIGAN

Issued

Rev	Date	Description
ISSUED FOR RECORD	04/27/2009	

Designed: CF 10/03/2007
Drawn: DAS 01/22/2009
Checked: CF 01/22/2009
Approved: JAT 01/26/2009

PROJECT NUMBER
200703855

SHEET REFERENCE NUMBER
C-07

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Reference 195-6909-24
Reference 195-6909-33

REV.	DATE	DESCRIPTION	BY	APP
A	04/27/2009	GWO 1547 Weadock Slurry Wall Project – Submitted for Record	DAS	EHW

DR. DAS DATE 04/27/2009
CK.
APP. SECTION HEAD
APP. DIVISION HEAD
APP. DEPARTMENT HEAD

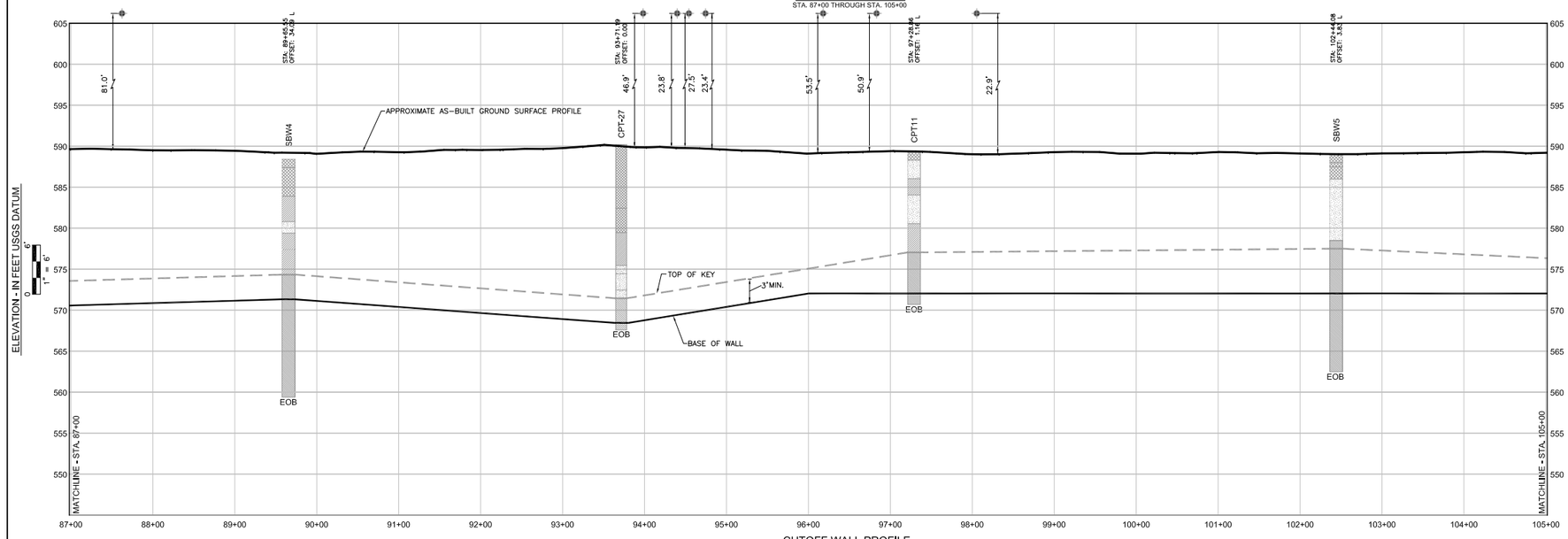
Consumers Energy
JC WEADOCK PLANT

FLY ASH SLURRY WALL
STA 69+00 TO STA 87+00
WITH BORING DATA

SCALE	DRAWING NO.	SHEET	REV.
JOB	195-6909	SH29	A

Figure 18

CUTOFF WALL PLAN
STA. 87+00 THROUGH STA. 105+00



CUTOFF WALL PROFILE
STA. 87+00 THROUGH STA. 105+00
0 60'
1" = 60'

LEGEND

- CLAY TILL
- ALLUVIAL CLAYEY SOILS
- SANDY SOILS
- ORGANIC
- FILL SOIL / BOTTOM ASH
- CPT — CPT BORING (BY STS)
- SBW — CONVENTIONAL ROTARY BORINGS (BY STS)
- MW — MONITORING WELL (BY STS)
- B — BORING (BY OTHERS)
- OVERHEAD ELECTRICAL LINE (CROSSING WORK AREA) LOCATION
- OH — OVERHEAD ELECTRIC LINE (MAY NOT REPRESENT ALL LINES)
- WOODEN UTILITY POLE LOCATION
- TRANSMISSION TOWER LOCATION
- SOIL- BENTONITE CUTOFF WALL

NOTES:

1. BORINGS PROJECTED IN PROFILE AND NOT NECESSARILY ON WALL ALIGNMENT.
2. ELEVATIONS ARE REPORTED IN NAVD 88 DATUM IN FEET.
3. TOPOGRAPHY BY ROWE INC. FROM AERIAL PHOTOGRAPHY FLOWN 04/16/2007.
4. IN CASE OF MULTIPLE OVERHEAD LINES. SURVEY LINE IS LOWEST OF GROUP.

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SOIL - BENTONITE CUTOFF WALL - RECORD DRAWINGS
WEADOCK FLY ASH DISPOSAL AREA - STA. 87+00 THROUGH STA. 105+00
CONSUMERS ENERGY COMPANY
D.E. KARN AND J.C. WEADOCK GENERATING FACILITIES
ESSEXVILLE, MICHIGAN

Issued

Rev	Date	Description
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Checked:	CF	01/22/2009	
Approved:	JAT	01/26/2009	

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SHEET REFERENCE NUMBER
C-08

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Reference 195-6909-24
Reference 195-6909-33

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A	04/27/2009	GWO 1547 Weadock Slurry Wall Project – Submitted for Record	DAS	EHW

DR. DAS DATE 04/27/2009
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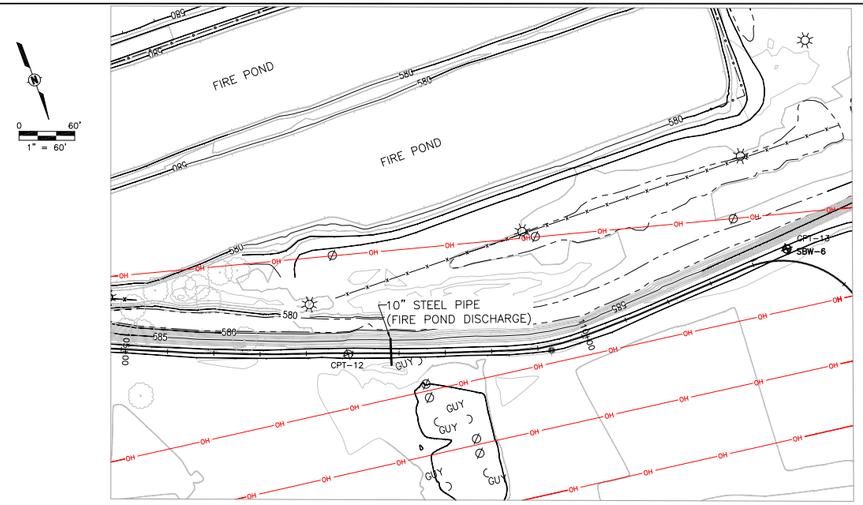
APP. SECTION HEAD
APP. DIVISION HEAD
APP. DEPARTMENT HEAD

Consumers Energy
JC WEADOCK PLANT

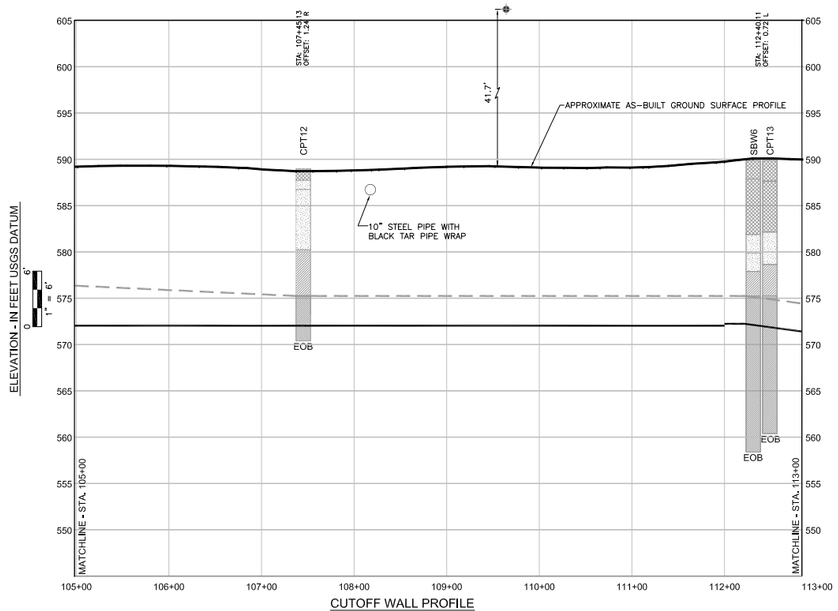
FLY ASH SLURRY WALL
STA 87+00 TO STA 105+00
WITH BORING DATA

SCALE	DRAWING NO.	SHEET	REV.
JOB	195-6909	SH30	A

Figure 19



CUTOFF WALL PLAN
STA. 105+00 THROUGH STA. 113+00



CUTOFF WALL PROFILE
STA. 105+00 THROUGH STA. 113+00
0 60'
1" = 60'

LEGEND

- CLAY TILL
- ALLUVIAL CLAYEY SOILS
- SANDY SOILS
- ORGANIC
- FILL SOIL / BOTTOM ASH

- CPT — CPT BORING (BY STS)
- SBW — CONVENTIONAL ROTARY BORINGS (BY STS)
- MW — MONITORING WELL (BY STS)
- B — BORING (BY OTHERS)
- OVERHEAD ELECTRICAL LINE (CROSSING WORK AREA) LOCATION
- OH — OVERHEAD ELECTRIC LINE (MAY NOT REPRESENT ALL LINES)
- WOODEN UTILITY POLE LOCATION
- TRANSMISSION TOWER LOCATION
- SOIL- BENTONITE CUTOFF WALL

NOTES:
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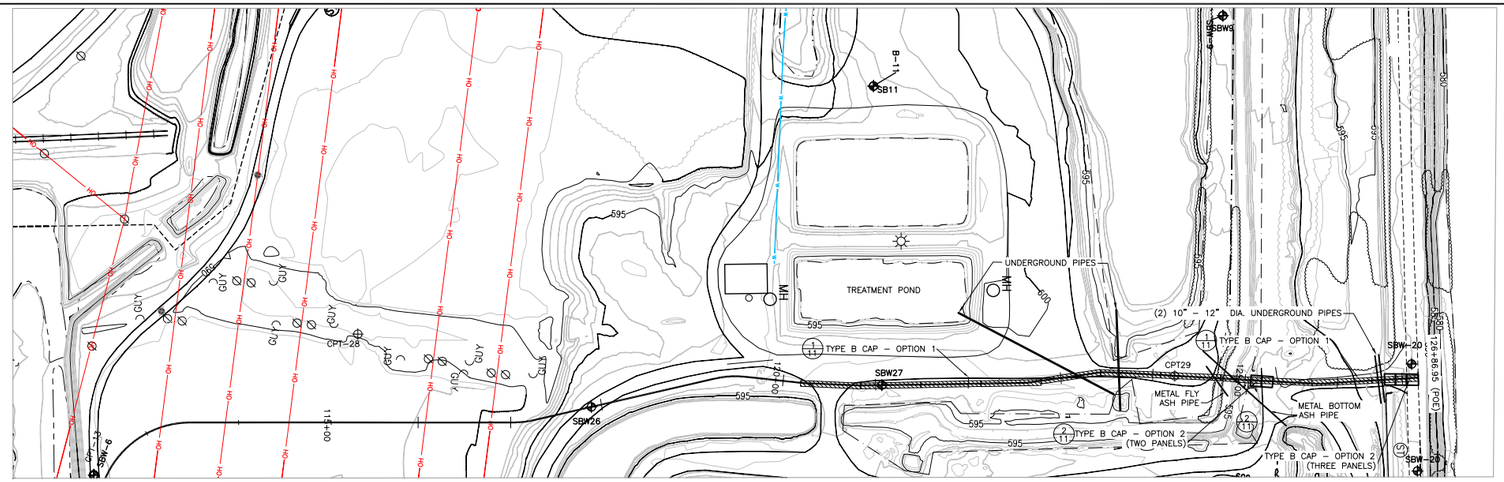
Consumers Energy
JC WEADOCK PLANT

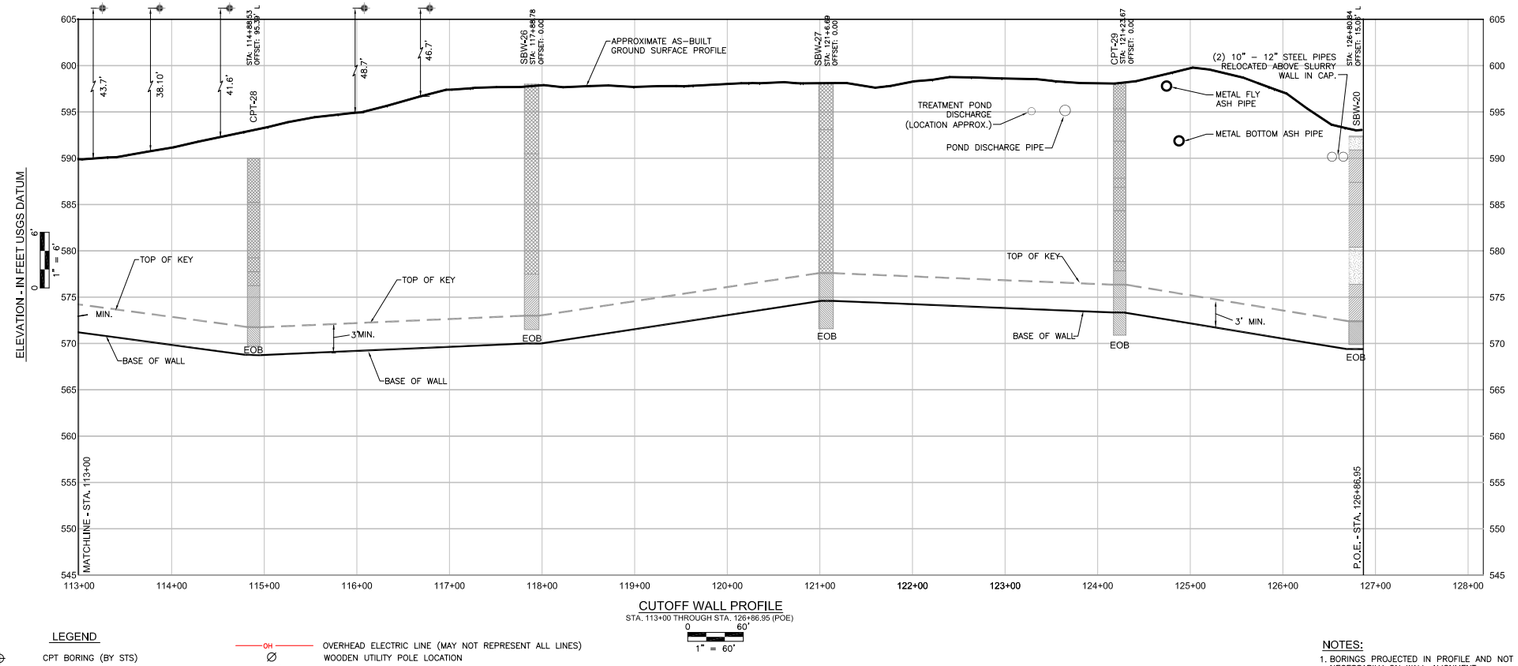
FLY ASH SLURRY WALL
STA 105+00 TO STA 113+00
WITH BORING DATA

SCALE	DRAWING NO.	SHEET	REV.
JOB	195-6909	SH31	A

Figure 20



CUTOFF WALL PLAN
STA. 113+00 THROUGH STA. 126+86.95 (POE)



CUTOFF WALL PROFILE
STA. 113+00 THROUGH STA. 126+86.95 (POE)
0 60'
1" = 60'

LEGEND

CLAY TILL	CPT	CPT BORING (BY STS)
ALLUVIAL CLAYEY SOILS	SBW	CONVENTIONAL ROTARY BORINGS (BY STS)
SANDY SOILS	MW	MONITORING WELL (BY STS)
ORGANIC	B	BORING (BY OTHERS)
FILL SOIL / BOTTOM ASH		OVERHEAD ELECTRICAL LINE (CROSSING WORK AREA) LOCATION
	OH	OVERHEAD ELECTRIC LINE (MAY NOT REPRESENT ALL LINES)
		WOODEN UTILITY POLE LOCATION
		TRANSMISSION TOWER LOCATION
		SOIL– BENTONITE CUTOFF WALL

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PROJECT NUMBER
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SHEET REFERENCE NUMBER
C-10

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Reference 195-6909-24
Reference 195-6909-33

REV.	DATE	DESCRIPTION	BY	APP
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DR. DAS DATE 04/27/2009
CK.
APP. SECTION HEAD
APP. DIVISION HEAD
APP. DEPARTMENT HEAD

Consumers Energy
JC WEADOCK PLANT

FLY ASH SLURRY WALL
STA 113+00 TO STA 126+86.95
WITH BORING DATA

SCALE	DRAWING NO.	SHEET	REV.
JOB	195-6909	SH32	A

Figure 21

Inspection Report
J.C. Weadock Generating Facility
Ash Dike Risk Assessment
Essexville, Michigan

Consumers Energy Company
Essexville, Michigan
AECOM Project No. 60100985
November 6, 2009

Prepared by:
AECOM
Carlin Fitzgerald, E.I.T.
Assistant Project Engineer
616.940.3077

Table of Contents

Table of Contents

1.0 Executive Summary

1.1 Findings

AECOM completed a site walkover and visual inspection of the J.C. Weadock Disposal Facility on Monday, August 17, 2009. Overall, the disposal facility appears to be in satisfactory condition; however, most containment dike slopes were covered in heavy vegetation and could not be inspected.

1.1.1 Summary Field Inspection Findings

In general, the field inspection found the J.C. Weadock Disposal Facility to have no visible distress or visible signs of movement. However, the following conditions were identified during the inspection:

- Heavy vegetation including large trees, shrubs, and tall grasses (phragmites) are growing on the slopes. Trees pose a minor threat to the stability of the slopes should the trees topple. Due to the heavy vegetal cover, an adequate visual inspection of the surface and toe of the slopes could not be performed.
- One area of surface erosion was noted on the exterior slope of the perimeter dike bordering the fire ponds. This erosion was probably a remnant of the 2009 overtopping when the fire ponds were pumped down and the perimeter ditch was plugged causing water in the perimeter ditch to back up resulting in erosion across the dike road.
- Perimeter ditches designed to convey storm water runoff inboard of the containment dike or access road are present around the site but are typically chocked with tall grasses. The outlets of these ditches are assumed to discharge to internal ponds but outlets could not be visually identified due to the heavy vegetation.
- Visual inspections indicated that there is little to no riprap present on the outboard slope of the perimeter dike along portions of the discharge channel upstream from the electric fish barrier. The design drawings indicate that this slope should be protected with riprap.

1.1.2 Summary of Surveillance and Monitoring Plan (SMP) and Operation and Maintenance (O&M) Status

The project does not have a formalized written Surveillance and Monitoring Plan (SMP). A typical SMP includes details such as types of instruments, recorded instrument readings, reading procedures, surveillance plans and procedures for visual inspection and data processing and evaluation methods that is specifically tailored for project performance (safety) from a structural, geotechnical and hydraulic standpoint, rather than environmental compliance. Generally it was found that instrumentation, such as observation wells, was in place but was not being monitored on a regular basis. Two observation wells at Weadock are monitored quarterly to semi-annually for groundwater elevation and environmental compliance purposes. Written procedures exist according to plant personnel; however, the written procedures were not available for review during the inspection. We understand the

current plan was developed for environmental compliance and not with consideration of the safety of the containment structures.

In general, the current operation and maintenance (O&M) of the disposal area is adequate to minimize the risk of the potential failure modes identified in the PFMA Report (AECOM, 2009b). However, there is little or no maintenance of vegetation on the containment dike slopes or perimeter storm water collection ditches. Trees, shrubs, and tall grasses choke the storm water ditches and obscure the dike slopes, which prevents adequate drainage and visual inspection, respectively.

1.2 Conclusions and Recommendations

Those areas of the facility that could be readily observed are generally in satisfactory condition and no major deficiencies were identified which could immediately jeopardize continued safe and reliable operation of the project structures. However, visual inspection of the dike slopes and toe areas were difficult due to the heavy vegetation present.

1.2.1 Field Inspection

In general, the field inspection found the J.C. Weadock Disposal Facility to have no imminent threat to the safety of the facility. With reference to Section 1.1.1, we recommend the following improvements be implemented to improve the safety of the project:

- Remove the trees (including roots) and shrubs on the downstream slopes of the perimeter dikes. In addition, the tall grass should be cut at least once per year to facilitate adequate visual inspection of the slopes. Stump holes should be backfilled with compacted granular fill.
- Clean the perimeter storm water ditches and culverts on the inboard side of the perimeter dike to promote positive storm water and discharged fire pond water drainage towards an internal cell. This will require the removal of some trees and mowing of the tall grass.
- Repair or install riprap along the exterior perimeter dike at the discharge channel where needed.

1.2.2 Surveillance and Monitoring Plan (SMP) and Operation and Maintenance (O&M) Plan

Although the facility currently does not have a formal written SMP in place, the current informal surveillance and monitoring program is adequate. The facility has several informal surveillance and monitoring measures in place that could form the basis of a formal SMP. We recommend developing a formal written SMP that includes the requirements of the current informal program and the following additional items:

- Monitor the NPDES outfall and all other internal drop structures daily

- Inspect the internal condition of the buried NPDES outfall pipe
- Measure and record water levels in all perimeter monitoring wells
- Monitor and document the downstream slopes of the perimeter dikes for instability problems

Current operations of the facility are adequate to reduce the risk to project safety; however, we recommend the following steps be taken to improve safety assessments:

- Maintain the internal drop structures and NPDES outfall to prevent obstructions
- Maintain the downstream slopes of the perimeter dikes to be free of trees and shrubs
- Maintain the perimeter storm water ditches to ensure adequate drainage for a design rain event

1.3 Certification

The undersigned, a registered Professional Engineer in Michigan, does hereby certify and state that he is an employee of AECOM; that he has been designated as being in responsible charge of the inspection of the J.C. Weadock Disposal Area; that the inspection work was done by him or under his direct supervision; that he approved this 2009 Inspection Report; and that the conclusions and recommendations herein are based on his independent opinion and are made independently of the Owner, its employees, and its representatives.

Field inspection participants:
Michael D. Carpenter, P.E.
Carlin Fitzgerald, E.I.T.

Sincerely,
AECOM

Michael D. Carpenter, P.E.
Senior Project Engineer

2.0 Project Description

2.1 Brief Project Description

The D.E. Karn and J.C. Weadock Generating Facilities consist of two separate power generating plants located in Essexville, Michigan on a peninsula bounded by the mouth of the Saginaw River to the west and Saginaw Bay to the east and is located on the western shore of Lake Huron. The J.C. Weadock plant was the first to generate power in 1940 and eventually consisted of six coal burning units, Units 1 to 6, which were retired in 1980. Two additional units, Units 7 and 8, were added in 1955 and 1958 and continue to operate. Aerial views showing the Karn and Weadock site layout and location of the ash disposal facilities can be seen on Figure 1.

The J.C. Weadock Ash Disposal Facility is located east of the Weadock plant. According to the 1992 permit application, the landfill covers an area of approximately 292 acres and has a perimeter of approximately 4.85 miles. The majority of the perimeter consists of ash containment dikes separating the landfill from the Saginaw Bay, the discharge channel, and Tacey and Underwood Drains (CPC, 1992a), which make up the bordering "Waters of the State". The remainder of the perimeter consists of dikes or upland areas with an unknown construction history. The dikes generally have a 20-foot wide crest and a typical crest elevation of 590 feet IGLD85. The containment dike is used as a perimeter access road upon which light utility trucks, large snowplows, and 80-ton haul trucks can be driven. However, heavy traffic is limited on portions of the perimeter access roads due to the presence of the slurry wall. The facility has been expanded and modified from its original layout in the 1940's to the current layout. Process water currently enters the facility at the west end of the site from the bottom ash sluice water discharge. Storm water and ground water make up the remaining portion of water within the facility. As of February 2009, the facility no longer receives sluiced fly ash. Process water from the sluiced fly ash was previously combined with the bottom ash sluice water, storm water, and ground water. Bottom ash sluice water and storm water exit the facility at a NPDES discharge point. Figure 2 in Appendix A is an aerial view of the Weadock Ash Disposal Facility site showing the location of various components.

The development of the facility is described in the 1992 permit application report prepared by Consumers Power Company (CPC). Currently, the facility is partially filled with ash and has remaining available airspace. The remaining life, in years, of the facility is unknown due to recent operational changes related to fly ash disposal. Fly ash from the Karn plant is now disposed of in the Weadock disposal area, which approximately doubles the disposal rate into the Weadock facility.

2.2 Hazard Potential Classification

A Potential Failure Mode Analysis (PFMA) session was conducted on August 13 and 14, 2009 for the J.C. Weadock Ash Disposal Facility. During the PFMA session, the Core Team discussed and assigned a hazard classification to the facility. It was determined that the Weadock facility was classified as having a low hazard

potential. This classification is based on the potential for loss of human life and impacts to economic, environmental, and lifeline facilities, should an uncontrolled failure occur. At the project site there is no probable risk of loss of human life and a low economic and environmental loss potential. There are no nearby public facilities other than a boat launch site located near the southeast corner of the facility. Also, should a failure occur, environmental or economic losses would be generally limited to the Owner.

2.3 Summary of Historic Stability Analyses

The stability of the ash dike structures has been previously evaluated by Materials Testing Consultants (MTC), titled *"Report of Slope Stability Evaluation J.C. Weadock Ashpond Vertical Expansion Project"* (MTC, 1991b). The stability of the dike structures was analyzed for stability with a slurry wall by AECOM in a report titled *"Weadock Coal Ash Berm Stability Analysis"* (AECOM, 2009a). The MTC report is included in Appendix A of the solid waste permit application (CPC, 1992a). Material properties used in the MTC report were determined in a separate report by MTC *titled "Report of Geotechnical Field Investigation and Laboratory Testing for Slope Stability Study, Vertical Expansion of Ashponds Project, J.C. Weadock Generating Complex"*, (MTC, 1991a).

The PFMA separated the perimeter dike into six (6) sections based on portions of the perimeter dike that have similar subsurface conditions, dike geometry, and adjacent ash filling plan. Figure 3 shows the separate sections considered. The MTC and AECOM analyses evaluated the slopes for Sections A, C, and D. Sections B, E, and F have not been evaluated. The status of each section related to slope stability is summarized as follows:

- Section A – As described by MTC, factors of safety ranged from 1.42 to 2.0. The minimum FS that could result in a loss of ash containment was reported to be 1.42. This FS is slightly less than the typically accepted value of 1.5. The analysis did not consider fully drained conditions or undrained conditions specifically within the wet ash.
- Section B – This section has not been specifically considered in previous stability analyses. Since it is similar to Section A in geometry and ash is not proposed to be stacked in the adjacent Pond P1, this dike is considered stable, provided adequate freeboard is maintained.
- Section C – As described by AECOM, factors of safety ranged from 2.1 to 4.2. The minimum FS that could result in a loss of ash containment was reported to be 2.1. This FS is greater than the typically accepted value of 1.5. These analyses considered the effect of interior ground water levels on FS. It was concluded that higher interior water levels did not greatly affect the overall stability of the structure. The analyses assumed that the wet loose ash in Pond F would be replaced with compacted ash.
- Section D – As described by MTC, factors of safety ranged from 1.35 to 3.91. The minimum FS that would potentially result in a loss of ash containment was reported to be 1.35. This FS is lower than the typically accepted value of 1.5. The analysis did not consider fully drained conditions or undrained conditions specifically within the wet ash.

- Section E – No stability analyses have been conducted on this section. Section E has remained stable and will not have any additional ash placed adjacent to it, according to the proposed closure plan. Therefore, Section E is considered stable based on its performance history.
- Section F – No stability analyses have been conducted on this section. Ash filling activities are planned adjacent to this section and known wet loose ash is present at this location.

2.4 Summary of Operations and Maintenance (O&M) Procedures

We are aware that the facility has a number of procedures related to standard and emergency operational requirements for the facility. The emergency procedures are contained in the "Spill Control Plan Procedure" which can be found on site in the results lab at both Karn and Weadock. Standard operations include daily inspections of the NPDES outlet. In addition, regular general site inspections of the Weadock ash disposal facility are made by security staff. Periodically Operators observe the degree of siltation in the intake and discharge channels and if needed, dredging is completed to maintain those channels. Ash filling operations are limited to 12 feet per year with lifts not thicker than 3 feet per site development specifications included in Appendix B of the solid waste permit (CPC, 1992a).

Currently there is no standard operating procedure to maintain a specific elevation in the ditches or internal ponds. Rather, sluice water is allowed to travel by gravity from the discharge point; down ditches, through drop structures, and culverts between internal ponds; and eventually to Pond F, and ultimately to the NPDES outlet structure into the plant discharge channel. The ground surface elevation at the discharge pipe in the bottom ash pond (see Photo 1 in Appendix B) is approximately 595 feet. The NPDES outfall weir is at a fixed elevation of 581.45 feet (see Photos 7 and 8 in Appendix B). Assuming a dike crest elevation of 590 feet, the freeboard at the downstream end of the flow path is approximately 8 feet.

The outfall has sufficient capacity to accommodate fly ash and bottom ash sluice water and a 25-year rain event (CPC, 1992b). Now that the facility has converted to dry disposal methods and fly ash sluice water no longer enters the system, it can be concluded that the facility has sufficient discharge and storage capacity while maintaining minimum freeboard. In addition, plant personnel noted that a large storm event was experienced by the outfall structure in the summer of 1994 and was contained with no noted overtopping of the perimeter dike or loss of containment.

2.5 Summary of Surveillance and Monitoring Program

The Weadock ash disposal facility does not currently have a SMP specifically for safety of the containment structures. Currently the environmental staff monitors two of the existing wells for environmental compliance and static water level. However, the facility does not review this data with regards to safety of the project structures related to a breach or loss of containment.

3.0 Discussion of Potential Failure Modes Analysis Report

3.1 General

The PFMA Session for the J.C. Weadock Disposal Facility was conducted on August 13 and 14, 2009 at the Karn-Weadock Generating Plants in Essexville, Michigan. The results of the PFMA session were documented in a PFMA report prepared by AECOM and dated November 6, 2009. The Core Team attending the PFMA session included the following people:

Bill Walton – AECOM	JR Register - CEC
Rick Anderson – AECOM	Marianne Walter – CEC
Jamie Matus – AECOM	Rick Hall - CEC
Mike Carpenter – AECOM	Jon Carpenter - CEC
Carlin Fitzgerald – AECOM	Roberto Falco - CEC

The purpose of the PFMA session was to identify potential failure modes at the project and classify each as fitting into one of the categories listed in Table 3-1.

Table 3-1 - Potential Failure Mode Categories

Category	Description
I. Highlighted Potential Failure Modes	Those potential failure modes of greatest significance considering need for awareness, potential for occurrence, magnitude of consequence and likelihood of adverse response (physical possibility is evident, fundamental flaw or weakness is identified and conditions and events leading to failure seemed reasonable and credible) are highlighted.
II. Potential Failure Modes Considered But Not Highlighted	These are judged to be of lesser significance and likelihood. Note that even though these potential failure modes are considered less significant than Category I they are all also described and included with reasons for and against the occurrence of the potential failure mode. The reason for the lesser significance is noted and summarized in the documentation report or notes.
III. More Information or Analyses Needed in Order to Classify	These potential failure modes to some degree lacked information to allow a confident judgment of significance and thus a dam safety investigative action or analyses can be recommended. Because action is required before resolution the need for this action may also be highlighted.
IV. Other Consideration (Potential Failure Mode Ruled Out)	Potential failure modes may be ruled out because the physical possibility does not exist, information came to light which eliminated the concern that had generated the development of the potential failure mode, or the potential failure mode is clearly so remote as to be non-credible or not reasonable to postulate. Potential failure modes discussed which were not developed in detail were classified as Category IV-ND (not developed) generally because the PFMA team judged them to be too improbable to warrant an in-depth evaluation of adverse versus positive factors.

3.2 Assessment of Potential Failure Modes Analysis Report

3.2.1 General

In reference to AECOM's PFMA report, the Core Team identified a total of thirty-two (32) Potential Failure Modes (PFMs) during the PFMA session. Six (6) of these PFMs were classified as Category II, eleven (11) Category III,

fourteen (14) Category IV, and one (1) Category IV-ND. No Category I PFMs were identified. Only failure modes classified as II and III will be discussed in this report. Refer to the PFMA Report for a full description of failure modes. Table 3-2, in the following section includes a summary of Potential Failure Modes (PFMs).

3.2.2 Potential Failure Mode Scenarios

Each of the Category II and III PFMs is listed in Table 3-2.

Table 3-2 - Summary of Category II, and III Potential Failure Modes

PFM Number and Description	Loading Condition	Structure	Category
1 – Discharge Flume Fails Backing Up Process Water Leading to Breach in Dike Which Causes Loss of Containment.	Maintenance and Human Factors	Outfall	II
2 – A Large Rain Event Overwhelms the Outfall Which Leads to Filling Ponds and Overtopping the Perimeter Dike Causing Loss of Containment.	Flood	Outfall	II
3 – Buried Concrete Outfall Pipe Deteriorates, Leads to Ground Loss Then Breach of Surrounding Embankment.	Maintenance and Human Factors	Outfall	II
4 – Piping, Seepage, or Collapse of Conveyance Pipe Leads to Ground Loss and Breach of Perimeter Dike Causing Loss of Containment.	Maintenance and Human Factors	Outfall	II
6 – Outfall Pipes and/or Ditch Along the Interior Side of Section E Become Blocked, Leads to Overtopping and Ground Loss and Breach of Perimeter Dike Causing Loss of Containment.	Maintenance and Human Factors	Fire Water Pond Pump	II
10 – Static or Seismic Liquefaction of the Loose Wet Ash in the Foundation of the Ash Fill Leads to Slope Failure Which Leads to Loss of Containment.	Proposed – Staged Filling and Earthquake	Dike Section A	III
12 – Static or Seismic Liquefaction of the Loose Wet Ash in the Foundation of the Ash Fill Leads to Slope Failure Which Leads to Loss of Containment.	Proposed – Staged Filling and Earthquake	Dike Section C	III
13 – Static or Seismic Liquefaction of the Loose Wet Ash in the Foundation of the Ash Fill Leads to Slope Failure Which Leads to Loss of Containment.	Proposed – Staged Filling and Earthquake	Dike Section D	III
14 – Static or Seismic Liquefaction of the Loose Wet Ash in the Foundation of the Ash Fill Leads to Slope Failure Which Leads to Loss of Containment.	Proposed – Staged Filling and Earthquake	Dike Section E	III
15 – Static or Seismic Liquefaction of the Loose Wet Ash in the Foundation of the Ash Fill Leads to Slope Failure Which Leads to Loss of Containment.	Proposed – Staged Filling and Earthquake	Dike Section F	III
16 – Global Slope Instability Leads to Loss of Containment.	Normal Operations	Dike Section A	III
18 – Global Slope Instability Leads to Loss of Containment.	Normal Operations	Dike Section C	III
19 – Global Slope Instability Leads to Loss of Containment.	Normal Operations	Dike Section D	III
20 – Global Slope Instability Leads to Loss of Containment.	Normal Operations	Dike Section E	III
21 – Global Slope Instability Leads to Loss of Containment.	Normal Operations	Dike Section F	III
23 – Rapidly Raising Ash Causes an Undrained Condition in the Perimeter Dike Foundation Which Leads to Slope Failure and Loss of Containment.	Proposed – Staged Filling	Dike Sections A, D, E, and F	III
31 – Failure of Interior Dike Due to Overtopping or Instability Leads to Loss of Containment Along the South Side of the Containment Dike.	Normal Operations	Interior Dikes	III

3.2.3 Assessment of Risk Reduction Measures

The risk reduction measures (RRM) identified for the Category II or III potential failure modes were summarized in the PFMA report (AECOM, 2009). Our assessment of those RRMs is provided in Table 3-3.

Table 3-3 - Assessment of Risk Reduction Measures for Category II and III Failure Modes

Risk Reduction Measure	Associated Category II or III PFM Nos.	Assessment
Monitor piezometers to obtain static groundwater levels upstream and downstream of the perimeter dike and to monitor any slope movements.	16, 18, 19, 20 and 21	This RRM should be added as part of the SMP to monitor hydrologic and geotechnical conditions to ensure the safety of these structures.
Scheduled inspections for clogging, freezing, or reduced flow in outlet structures.	1 and 3	This RRM should be added as a part of the SMP to ensure the outlet is resistant to clogging and if it does become clogged, that the problem is identified and fixed prior to a failure and loss of containment.
Installation of emergency overflow devices at discharge locations where overflow is directed back into the containment area to be stored until the problem causing the overflow can be alleviated.	1 and 2	Provided the risk of a clogged outlet is mitigated by inspecting the inside of the outlet pipe and frequent surface inspections, this RRM is not needed.
Add high water level alarm to warn of overtopping at outlet structures.	1	Provided the risk of a clogged outlet is mitigated by inspecting the inside of the outlet pipe and frequent surface inspections, this RRM is not needed.
Raise freeboard at outlet structures.	1 and 2	Provided the risk of a clogged outlet is mitigated by inspecting the inside of the outlet pipe and frequent surface inspections, this RRM is not needed.
Scheduled visual inspections of the interior of the outlet pipes for deterioration or damage.	3 and 5	This RRM should be added as a part of the SMP to ensure the discharge structure is sound and not at risk of failure.
Improve strength in the perimeter dike with ground improvement methods such as soil mixing, wick drains, or stone columns.	10, 12, 13, 14, 15, 16, 18, 19, 20 and 21	This RRM is only needed if recommended by future studies.
Stability analyses should be completed to further identify any instability in the perimeter dike or foundation. Future stability analyses should also consider wedge block-failure surfaces, fully drained and undrained analysis, and unstable nature of the sluiced ash under rapid loading conditions, surcharge loading associated with ash haul trucks, where appropriate, and re-evaluated soil properties and hydrogeologic conditions. Section B is considered stable and Section C is considered stable, provided Pond F is cleaned of wet loose ash.	16, 18, 19, 20, 21, and 31	This RRM should be completed as an additional study.
Develop staged fill plan for stacking fly ash to limit rate of loading on soft clays and sluiced loose ash in the dike and fill area foundations.	10, 12, 13, 14, 15 and 23	This RRM should be completed as an additional study.
Develop storm water management plan including pond capacities for a design storm event.	2	This RRM is needed to document ditches are the correct freeboard and pitch to accommodate a design rain storm event.
The existing fire water ditch could be cleaned out and enlarged. Also, an alarm or other warning instrumentation could be installed to prevent overtopping.	6	This RRM should be implemented to minimize the risk of overtopping.
A plan for excavating and dewatering Pond F should be developed to ensure that new ash fill can be placed in the dry.	18	This RRM is needed prior to placing ash in Pond F.
Supplemental soil borings and instruments (pneumatic piezometers and inclinometers) are needed to obtain soil properties, monitor static groundwater levels upstream and downstream of the perimeter dike, and monitor for slope movements.	10, 12, 13, 14, 15, and 23	This RRM should be added as part of the SMP to monitor hydrologic and geotechnical conditions to ensure the safety of these structures.

Since the RRMs in Table 3-3 are related to Category II or III failure modes, they should be considered for implementation. Section 5.0 provides recommendations for modification of the SMP and O&M plan to accommodate the RRMs described above.

Although not related to Category II or III failure modes, there are some additional RRMs that should be considered for the facility that are considered typical for operation, maintenance, and monitoring of dike structures. Our assessment of these additional risk reduction measures and associated failure modes are summarized in Table 3-4. Section 5.0 provides a summary of recommended improvements to the SMP and O&M plan for the site related to these additional RRMs.

Table 3-4 - Assessment of Risk Reduction Measures for Category IV Failure Modes

Risk Reduction Measure	Associated Category IV PFM Nos.	Assessment
Monitor and record static groundwater levels from existing monitoring wells.	29 and 30	The perimeter dike stability analyses assume a groundwater flow condition. It is important to monitor for groundwater fluctuations to evaluate the stability of existing and future conditions. Regular monitoring and thresholds for the perimeter wells should be identified in a formal SMP.
Remove trees, shrubs, stumps, and mow tall grasses from perimeter dike slopes.	25, 29 and 30	This RRM should be added as a comprehensive vegetation maintenance plan. It is needed to allow adequate inspection of the perimeter dike slopes.
Remove trees, shrubs, and mow tall grasses from perimeter storm water collection ditch.	32	This RRM should be added as a comprehensive vegetation maintenance plan. It is needed to allow storm water drainage and prevent overtopping of the perimeter dikes for a design rain event.
Scheduled inspections for surface erosion, cracking, slumping, woody growth on the perimeter dike and ash fill slopes.	27	This RRM should be added as a part of the SMP to allow for adequate inspection of the dike slopes.
Grade perimeter roads inward or crown them to prevent loss of containment from surface water runoff.	32	This RRM is needed to minimize risk of loss of containment due to surface runoff
Inspect perimeter dike slopes after storms for ice or wave damage.	27	This RRM should be added as a part of the SMP to identify any damage as a result of a storm or ice event.
Develop a dredging plan for the intake and discharge channels that will prevent negative impacts to the perimeter dikes.	9	This RRM is needed if dredging of the discharge channels is needed.

4.0 Field Inspection

The project was inspected by Mike Carpenter, P.E. and Carlin Fitzgerald, E.I.T of AECOM on August 17, 2009 along with a representative of Consumers Energy Company, Marianne Walter. Visual observations of each of the main structures were made during the field inspection. Photographs were taken during the inspection. Representative photographs have been included with descriptive captions in Appendix B. In addition, a CD containing all of the photographs obtained during the inspection is included in Appendix B. Copies of the inspection checklist and field notes are included in Appendix C.

4.1 Field Inspection Observations

4.1.1 Perimeter Dike

The inspection team walked the crest and along the downstream and upstream slopes of the perimeter dike. Overall, the slopes that could be observed appeared to be in good condition and free of any erosion, cracking, or signs of movement (Photos 5, 9, 10, 11, 12, 16 and 19). The crest is generally uniform with no visible signs of vertical settlement, lateral moving, or cracking (Photo 2, 13, 15 and 22). Some erosion of the crest was noted near the fire ponds (Photos 23 and 24). The ash landfill slope was lightly vegetated (Photo 21). Trees were observed on the ash slope and within the storm water drainage ditch (Photos 5, 12, 15 and 16). The downstream slope of the perimeter dike ranges from an estimated 1.5H:1V to 4H:1V along the discharge channel, Saginaw Bay, and Tacey and Underwood Drains. The ground is generally flat along the southern and western perimeter of the project where there is no apparent dike (Photo 22). Trees were growing on a majority of the containment dike slopes along with very tall grasses (phragmites, see Photos 5, 9, 10, 11, 12, 13, 15, 16, 17, 18, 19, 20, 23 and 24). Due to the amount of heavy vegetation, a conclusive visual inspection of the dike slopes could not be performed. However, areas with thinner vegetation where the slope could be seen appeared to be in good condition. Varying amounts and sizes of riprap were noted on the slopes (Photos 5, 10, 12, 16 and 19). However, riprap was not observed along portions of the dike slope along the discharge channel.

4.1.2 Abandoned Outfall Structures

The abandoned outfall structure is located at the northwest corner of Pond F (Photos 12 and 14). The condition of the abandoned structure could not be determined, nor could the discharge pipes be located. Operation staff noted that the discharge pipes (the pipe discharging to the discharge channel) had been plugged with concrete but no plans were found to confirm this. The 2008 slurry wall construction documentation report provides a description of the abandonment methods.

4.1.3 Existing Outfall Structure and Interior Drop Structures

The existing outfall structure (Photo 7) is currently located upstream of the electric fish barrier (Photo 9) where water is released to the power plant discharge channel through a vertical reinforced concrete pipe (RCP) drop

structure connected to a horizontal RCP discharge pipe. This vertical riser consists of a 4.5-foot diameter vertical concrete pipe with a larger diameter (approximately 8-foot) metal ring mounted to the top. Water flows under the metal ring and over the top of the concrete pipe to reduce the amount of solids being discharged. The water level adjacent to the edge of the riser is monitored (Photo 8) to calculate discharge flow. The horizontal RCP discharges to the channel at least 1 foot below the water surface and is not visible.

The outfall structure appears to be functioning properly. However, it was noted that large amounts of vegetation were growing on the slopes of the channel banks (Photo 7) and could potentially become lodged in the outfall.

Interior drop structures and culverts are typically metal weirs and pipes (Photo 6) that discharge to the next sluice channel or pond and appeared to be functioning properly.

4.1.4 Interior Divider Dikes

The interior divider dikes had minimal vegetation growing on the slopes and appeared to be primarily made of bottom ash. These dikes did not show any significant cracking, lateral movement, or vertical settlement during the visual inspection (Photo 2).

4.2 Field Observations with Respect to Potential Failure Modes

The following comments are based on observations made during the field inspection with respect to Category II and III potential failure modes:

- The outlet structure was observed to be functioning properly with only approximately 1 to 2 inches flowing over the weir. There was no visible evidence on the top of the concrete pipe that deterioration of the pipe was occurring. However, no observations could be made of the inside of the pipe at the inlet or submerged discharge. These observations are related to PFM Nos. 1, 2, and 3.
- The inspection did not identify any evidence of global stability movements, seepage, or erosion of the perimeter dike. However, the presence of heavy vegetation on the perimeter dike slopes makes it difficult to impossible to observe the conditions that may suggest a problem exists. These observations are related to PFM Nos. 16, 18, 19, 20, and 21.

5.0 Conclusions and Recommendations

The areas of the facility that could be readily observed were found to be generally in satisfactory condition. The project appears to be operated safely and reliably. No major deficiencies were identified which could immediately jeopardize continued safe and reliable operation of the project structures. However, visual inspection of the dike slopes and toe areas were difficult due to the heavy vegetation present.

5.1 Recommended Corrective Measures

Based on the inspection, the project structures appear to be in satisfactory condition. However, visual inspection of the dike slope and toe is difficult due to the heavy vegetation present. Therefore, we recommend a vegetative maintenance program be implemented to reduce the visual impairment.

5.2 Surveillance and Monitoring Program (SMP) Recommendations

Operators are available at the Karn and Weadock facility at all times (24-hours a day, 7-days a week). The results lab technicians visually inspect the ash landfill perimeter and outfall structure at least once per day. The water levels within two monitoring wells (MW-19 and MW-20) are measured quarterly. The current surveillance and monitoring program is conducted generally for environmental reasons and not specifically for dike safety performance monitoring. There is no other known formal written surveillance or monitoring procedures related to structure safety conducted at this facility. The following written surveillance and monitoring procedures are recommended for monitoring the performance of the project structures for the Category II or III potential failure modes identified:

- Daily scheduled inspections for clogging, freezing, or reduced flow in outlet structures should be identified in a formal SMP to ensure the outlet is resistant to clogging and if it does become clogged, that the problem is identified and fixed prior to a failure and loss of containment.
- Scheduled visual inspections of the interior of the outfall pipe for deterioration or damage should be identified in a formal SMP to ensure the discharge structure is sound and not at risk of failure. The interior of the drop shaft and pipe should be periodically inspected.

In addition, we recommend the following surveillance and monitoring procedures be included, which are related to Category IV potential failure modes:

- Regular monitoring and thresholds for the perimeter wells should be identified in a formal SMP to monitor for groundwater fluctuations with respect to the perimeter dike stability for existing and future conditions. The monitoring should include regular monitoring of groundwater levels from existing monitoring wells.

- Scheduled inspections for surface erosion, cracking, slumping, woody growth on the perimeter dike and ash fill slopes should be identified in a formal SMP to allow for adequate inspection of the dike slopes.
- Inspection of the perimeter dike slopes after storms for ice or wave damage should be identified in a formal SMP to identify any damage as a result of a storm or ice event.

5.3 Operation and Maintenance (O&M) Program Recommendation

Operators are available at the Weadock facility at all times (24-hours a day, 7-days a week). The results lab technicians visually inspect the ash landfill perimeter and outfall structure at least once per day. Generally, the O&M programs for this facility are related to ash management and maintaining sluice water flow. The current O&M programs are not specifically related to the potential failure modes identified during the PFMA session. The following O&M procedures are recommended to ensure the safe performance of the project:

- Maintain the internal drop structures and NPDES outfall to prevent obstructions.
- Maintain the downstream slopes of the perimeter dikes to be free of trees, stumps, and shrubs.
- Maintain the perimeter storm water ditches to ensure adequate drainage for a design rain event.

5.4 Additional Stability Studies

As a result of PFM Nos. 16, 18, 19, 20 and 21, additional stability analyses were considered necessary to re-categorize these Category III PFMs. We recommend additional stability analyses be performed on the perimeter dikes (Sections A, D, E, and F) adjacent to the areas receiving stacked ash above elevation 590 feet and up to elevation 650 feet. The analyses should consider drained and undrained conditions, loose wet sluiced ash in the foundation of the ash fill, and actual ground water conditions. Should an analysis be completed with the above mentioned considerations; the recommendations provided within the stability analysis report should be implemented.

6.0 References

(MTC, 1991a) Materials Testing Consultants. *"Report of Geotechnical Field Investigation and Laboratory Testing For Slope Stability Study, Vertical Expansion of Ashponds Project, J.C. Weadock Generating Complex",* November 1991.

(MTC, 1991b) Materials Testing Consultants. *"Report of Slope Stability Evaluation J.C. Weadock Ashpond Vertical Expansion Project"*, November 1991.

(CPC, 1992a) Solid Waste Management Act – Act 641. *"Construction Permit Application and Support Documents J.C. Weadock Ash Disposal Area",* Consumers Power Company, Essexville, MI, January 1992.

(CPC, 1992b) Consumers Power Company, *"J.C. Weadock Solid Waste Disposal Area Construction Permit Application; Transmittal of Supplemental Information",* April 10, 1992.

(FERC, 2004) *Federal Energy Regulatory Commission. "Federal Guidelines for Dam Safety – Hazard Potential Classification System for Dams", April 2004.*

(FERC, 2005), Federal Energy Regulatory Commission. "Chapter 14 - *Dam Safety Performance Monitoring Program".* Revision 1, July 1, 2005.

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(USACE Website, 2009) www.erdc.usace.army.mil, August 2009.

(CEC Website, 2009) http://www.consumersenergy.com/welcome.htm, August, 2009.

(USEPA Website, 2009) http://www.epa.gov/epawaste/nonhaz/industrial/special/fossil/surveys2/index.htm, September 2009.

(NOAA Website, 2009) http://www.glerl.noaa.gov/pubs/brochures/lakelevels/lakelevels.pdf, September 2009.

(USGS, 2009) http://earthquake.usgs.gov/regional/states/events/1947_08_10.php, September 2009.

(CEC, 2009) Letter to Mr. Richard Kinch (USEPA) from Mr. Gary A. Dawson (CEC), *"EPA Request for Information Concerning Surface Impoundments"*, March 26, 2009.

(AECOM, 2009a) AECOM. *"Weadock Coal Ash Berm Stability Analysis",* February 2009.

(AECOM, 2009b) AECOM, *"Potential Failure Modes Analysis Report"*, J.C. WeadockAsh Disposal Area, November 6, 2009.

Appendices

Appendix A - Applicable Project Figures

Appendix B - Inspection Photographs

Appendix C - Field Inspection Results

Appendix A

Applicable Project Figures

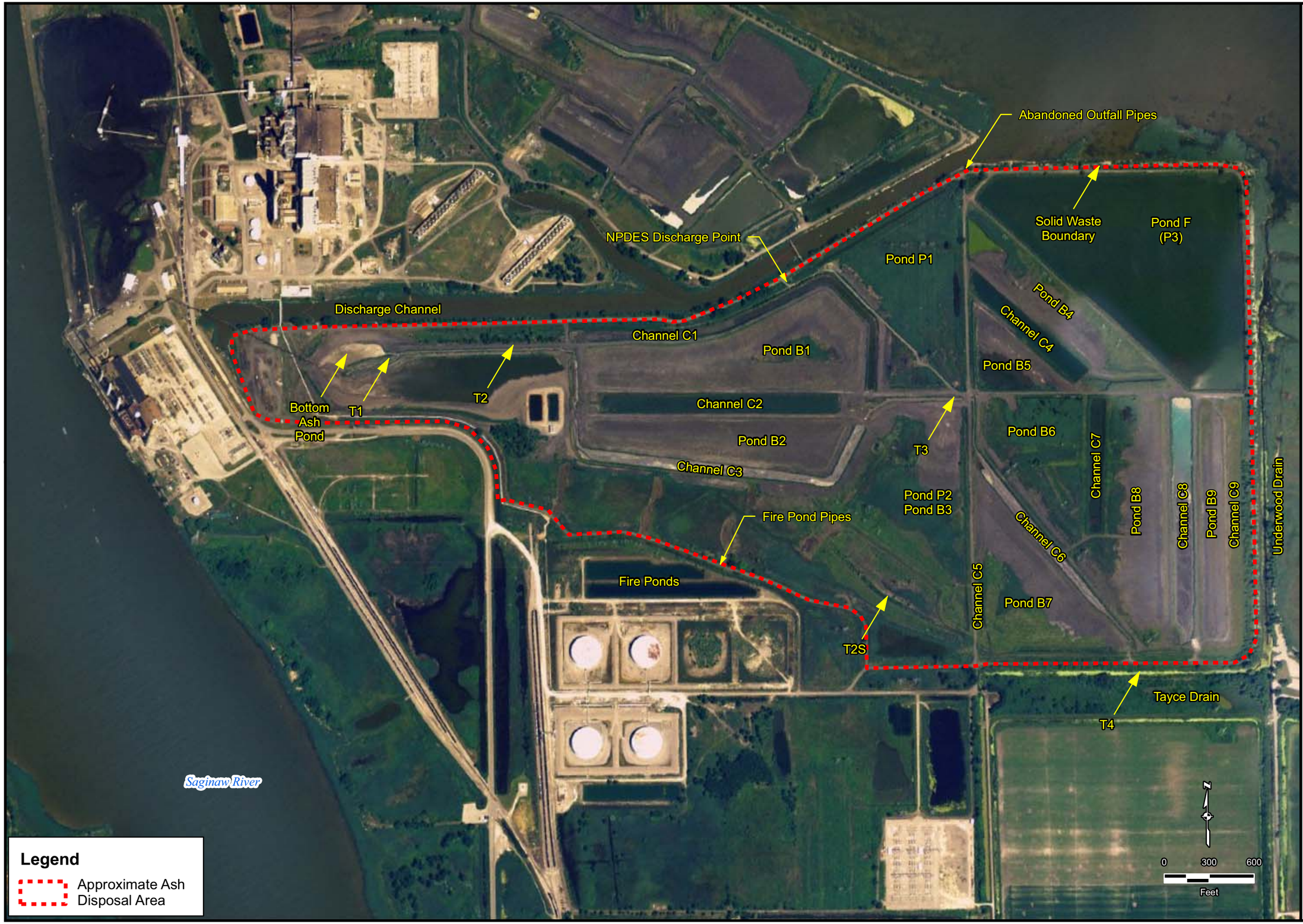
AERIAL PHOTO SOURCE: 2005 USDA NAIP

AECOM

www.aecom.com

D E KARN AND J C WEADOCK FACILITY MAP
CONSUMERS ENERGY COMPANY
ESSEXVILLE, MICHIGAN

Drawn:	JWW	9/17/2009
Approved:	MDC	9/17/2009
Scale:	1" = 1,000'	
PROJECT NUMBER	60100985	
FIGURE NUMBER	1	



Legend

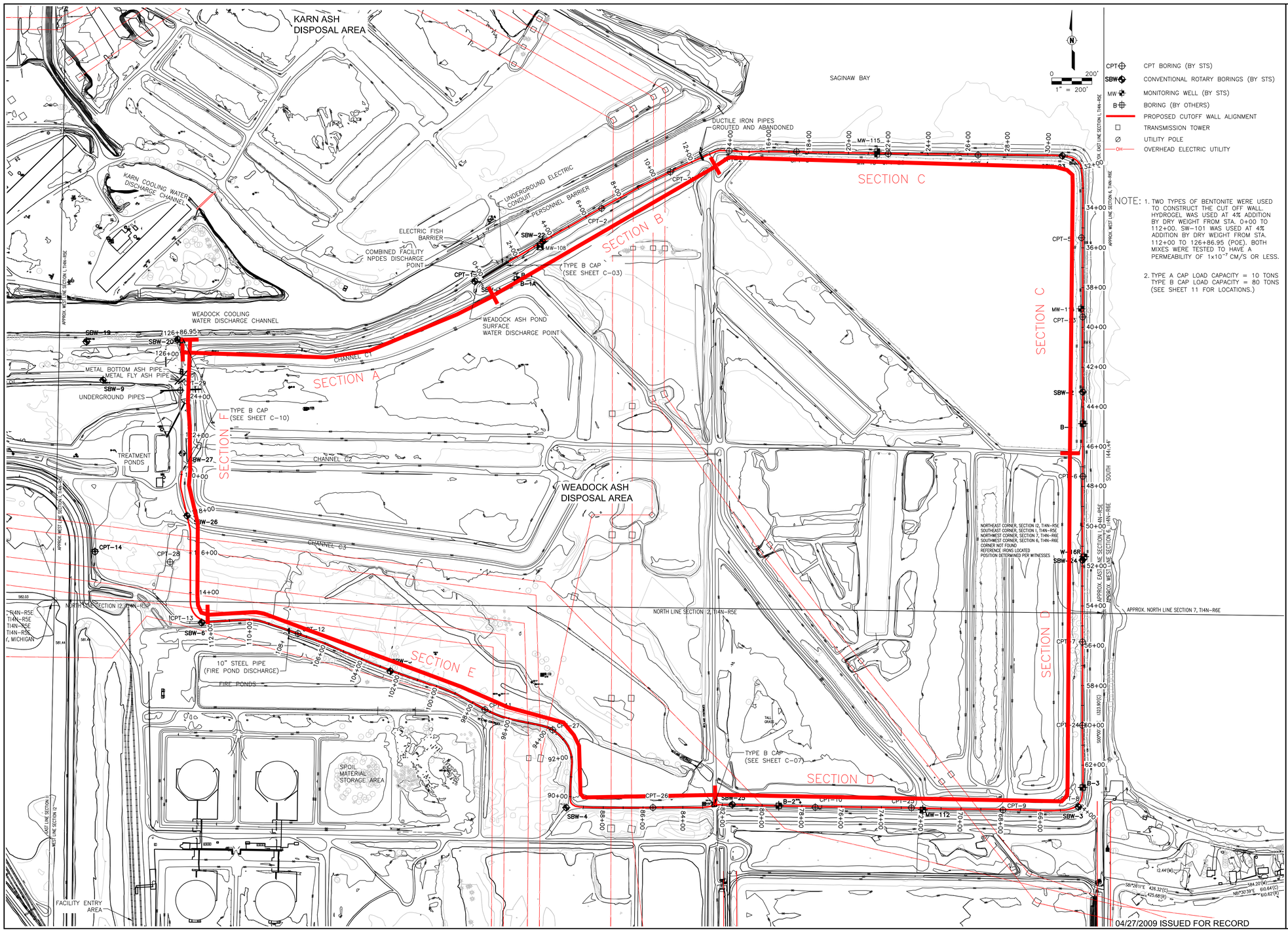
Approximate Ash Disposal Area

AECOM

www.aecom.com

2005 NAIP AERIAL PHOTO
CONSUMERS ENERGY COMPANY
J C WEADOCK FACILITY
ESSEXVILLE, MICHIGAN

Drawn:	JWW	7/29/2009
Approved:	MDC	7/29/2009
Scale:	1" = 600'	
PROJECT NUMBER	60100985	
FIGURE NUMBER	2	



STS | AECOM
3839 East Paris Ave.
Grand Rapids, MI 49512
616-940-3077
www.stsconsultants.com

SOIL - BENTONITE CUTOFF WALL RECORD DRAWINGS
2008 PROPOSED ADDITIONAL BORINGS
CONSUMERS ENERGY CO.
D.E.KARN AND J.C. WEADOCK GENERATING FACILITIES
ESSEXVILLE, MICHIGAN

Issued

Rev	Date	Description
ISSUED RECORD	04/27/2009	

Designed:	CF	10/03/2007
Drawn:	DAS	01/22/2009
Checked:	CF	01/22/2009
Approved:	JAT	01/22/2009

PROJECT NUMBER
200703855

SHEET REFERENCE NUMBER
C-02

X:\PROJECTS\MSC\Fitzgerald\195-6069-24-REV-A - Standard\195-6069-24-REV-A.dwg; 10/14/2009 4:50:23 PM; DOYLE, CONAN

Reference 195-6909-33 for cap designs

REV.	DATE	DESCRIPTION	BY	APP
A	04/27/2009	GWO 1547 Weadock Slurry Wall Project – Submitted for Record	DAS	EHW

DR. DAS 04/27/2009
CK.
APP. SECTION HEAD
APP. DIVISION HEAD
APP. DEPARTMENT HEAD

Consumers Energy
JC WEADOCK PLANT

FLY ASH SLURRY WALL LAYOUT
WITH WEIGHT RESTRICTIONS

SCALE	DRAWING NO.	SHEET	REV.
JOB	195-6909	SH24	A

Figure 6

Appendix B

Inspection Photographs

AECOM

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
Consumers Energy Company	**J.C. Weadock Ash Disposal Area**	60100985

Photo No.	Date:
1	8/17/09

Direction Photo Taken:

West

Description:

Bottom ash pond with view of Weadock plant (back center) and fly ash storage silo (back right).

Photo No.	Date:
2	8/17/09

Direction Photo Taken:

South

Description:

Interior dike with slurry wall to the east of the chemical treatment ponds.

AECOM

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
Consumers Energy Company	**J.C. Weadock Ash Disposal Area**	60100985

Photo No.	Date:
3	8/17/09

Direction Photo Taken:

West

Description:

Old fly ash transportation ditch.

Photo No.	Date:
4	8/17/09

Direction Photo Taken:

East

Description:

Interior sluice channel culvert between channels.

AECOM

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
Consumers Energy Company	**J.C. Weadock Ash Disposal Area**	60100985

Photo No.	Date:
5	8/17/09

Direction Photo Taken:

Northwest

Description:

View of perimeter dike exterior slope in the discharge channel upstream from the electric fish barrier.

Photo No.	Date:
6	8/17/09

Direction Photo Taken:

West

Description:

Typical drop structures and pipes between interior sluice channels.

AECOM

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
Consumers Energy Company	**J.C. Weadock Ash Disposal Area**	60100985

Photo No.	Date:
7	8/17/09

Direction Photo Taken:

South

Description:

NPDES discharge weir at the bottom right of staircase.

Photo No.	Date:
8	8/17/09

Direction Photo Taken:

West

Description:

Instrumentation for measuring flow over the discharge wier.

AECOM

PHOTOGRAPHIC LOG

Client Name: Consumers Energy Company	**Site Location:** **J.C. Weadock Ash Disposal Area**	**Project No.** 60100985

Photo No. 9	**Date:** 8/17/09

Direction Photo Taken:

Northwest

Description:

Discharge channel and electric fish barrier showing tall grasses on slope.

Photo No. 10	**Date:** 8/17/09

Direction Photo Taken:

Northeast

Description:

Physical barrier in discharge channel and heavy vegetation on perimeter dike.

AECOM

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
Consumers Energy Company	J.C. Weadock Ash Disposal Area	60100985

Photo No.	Date:
11	8/17/09

Direction Photo Taken:

South

Description:

Heavy vegetation and steep slope of perimeter dike along the discharge channel.

Photo No.	Date:
12	8/17/09

Direction Photo Taken:

North

Description:

Perimeter dike at outlet of discharge channel showing rip rap and heavy vegetation.

AECOM

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
Consumers Energy Company	**J.C. Weadock Ash Disposal Area**	60100985

Photo No.	Date:
13	8/17/09

Direction Photo Taken:

South

Description:

Pond F (background).

Photo No.	Date:
14	8/17/09

Direction Photo Taken:

South

Description:

Triangle pond at the northwest corner of Pond F.

AECOM

PHOTOGRAPHIC LOG

Client Name: Consumers Energy Company	**Site Location:** **J.C. Weadock Ash Disposal Area**	**Project No.** 60100985

Photo No. 15	**Date:**

Direction Photo Taken:

West

Description:

Perimeter dike along Saginaw Bay.

Photo No. 16	**Date:** 8/17/09

Direction Photo Taken:

Northwest

Description:

Exterior slope of perimeter dike along Saginaw Bay (4H:1V).

AECOM

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
Consumers Energy Company	**J.C. Weadock Ash Disposal Area**	60100985

Photo No.	Date:
17	8/17/09

Direction Photo Taken:

South

Description:

Heavy vegetation bordering the north side of Pond F.

Photo No.	Date:
18	8/17/09

Direction Photo Taken:

Southwest

Description:

View across Pond F from the perimeter dike along Saginaw Bay at the northeast corner of Pond F.

AECOM

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
Consumers Energy Company	**J.C. Weadock Ash Disposal Area**	60100985

Photo No.	Date:
19	8/17/09

Direction Photo Taken:

East

Description:

Perimeter dike slope bordering Underwood Drain (3V:1H).

Photo No.	Date:
20	8/17/09

Direction Photo Taken:

East

Description:

Perimeter dike slope bordering Underwood Drain (3V:1H).

AECOM

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
Consumers Energy Company	**J.C. Weadock Ash Disposal Area**	60100985

Photo No.	Date:
21	8/17/09

Direction Photo Taken:

North

Description:

View across Pond F from the top of current fly ash fill with light vegetative cover.

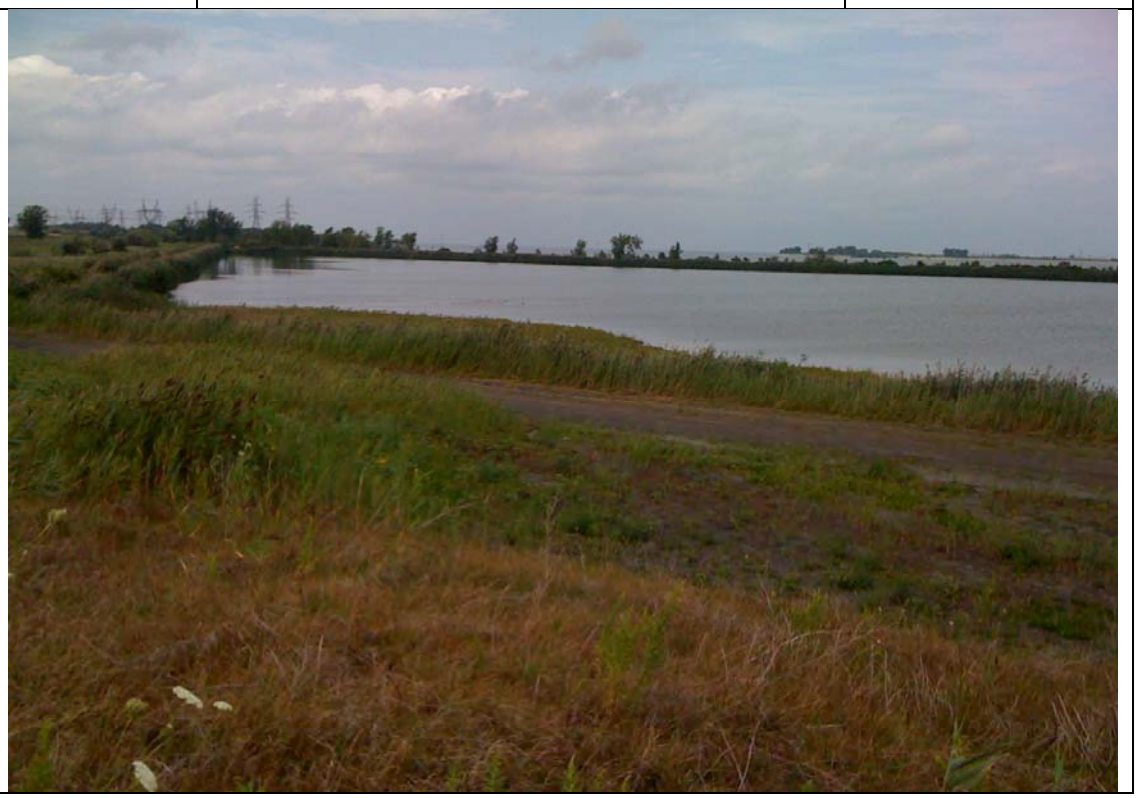


Photo No.	Date:
22	8/17/09

Direction Photo Taken:

West

Description:

View of perimeter dike (access road) in upland areas.

AECOM

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
Consumers Energy Company	**J.C. Weadock Ash Disposal Area**	60100985

Photo No.	Date:
23	8/17/09

Direction Photo Taken:

South

Description:

View of fire ponds and remaining erosion from the 2009 overtopping of the perimeter dike.

Photo No.	Date:
24	8/17/09

Direction Photo Taken:

South

Description:

Remaining erosion from 2009 dike overtopping near fire ponds.

AECOM

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
Consumers Energy Company	**J.C. Weadock Ash Disposal Area**	60100985

Photo No.	Date:
25	8/17/09

Direction Photo Taken:

East

Description:

View of interior perimeter ditch used to discharge fire pond water.

Appendix C

Field Inspection Results

VISUAL INSPECTION CHECKLIST

Sheet 1 of 4

Owner: Consumers Energy Company
Name of Ash Pond: J.C. Weadock Ash Disposal Area
Hazard Category: Low
Max Embankment Height: 912
Impoundment Area/Size:
Weather: Sunny 80

Date Inspected: 8-17-09
Pool Elevation: 583
Normal Freeboard: 7'
Design Crest Elevation: 590
Primary Outlet ~~Invert~~ weir Elevation: ?

Directions: Mark an "X" in the "YES" or "NO" / column.
If item does not apply, write "N/A" in "REMARKS" columns.
Use "OTHER COMMENTS" space to amplify "REMARKS"

ITEM	YES	NO	REMARKS
Is the impoundment currently being constructed or expanded?	X		
Is the impoundment actively being filled/used?	X		
a. Method of filling			
b. Type of waste being deposited		→	Compacted conditioned ash
c. Rate of filling			fly ash & bottom ash
Type of Impoundment:			37 truckloads per day (Bottom [illegible])
a. Incised, (Dike), Cross Valley, Side Hill,			
and/or Upstream/Downstream Expansions			
b. Is the impoundment Lined? If so, with what?			
		X	Perimeter slurry wall & underlying clay layer
DOWNSTREAM FLOODPLAIN			
a. Occupied Housing?			
b. Farming?		X	
c. Recreation Areas?	X		to the South
d. Changed Hazard Potential?	X		boat launch in [illegible]
e. New Development?		X	
f. Nearest Downstream Town?		X	
	X		Bay City
INSTRUMENTATION			
1. Are there			
a. Piezometers?			
b. Weirs?	X		
c. Settlement Pins?	X		NPDES outfall
d. Observation Wells?		X	
e. Other?	X		
2. Are readings			
a. Available?			
b. Plotted?	X		See excel sheet
c. Taken Periodically?	X		2 observation wells
	X		quarterly & historically

Comments:

ITEM	YES	NO	REMARKS
HISTORY			
1. MODIFICATIONS CONDUCTED FOR PROJECT SAFETY?			
a. Any New Modifications			
b. Status of Recommended Corrective Measures		X	
c. Other?		—	
		—	
2. FLOOD HISTORY			
a. Flood of Record			
b. Zero Freeboard Outlet Capacity?			
c. Peak Outlet discharge?	emergency spillway not allowed under permit		
d. Peak pond elevation?			
e. Is there an adjacent river that could impact the impoundment?			590'
	X		Saginaw River/very unlikely
OPERATIONS AND MAINTENANCE PROCEDURES			
1. COMMUNICATIONS/RESPONSE			
a. Communication System?			
b. Control System (manual, automated, other)? N/A	X		radios
c. Alarm System?			
d. Location of each system?		X	
d. Operators onsite (days, hours)?	X		outfall
e. Operator response time?	X		7 days/wk.
f. Access route? Is there redundency?			
g. Backup power/generator?	X		
	X		
2. ELECTRICAL MECHANICAL SYSTEMS N/A			
a. Gate hoists (number, type, location, etc.)?			
b. Gate and Valve Operaton (manual, remote, automatic)?			
c. Ice protection (heated, aggitated, bubblers, reservoir restrictions)?			
d. Standby and Backup power/generator?			
3. HUMAN FACTORS			
a. O&M Manual available? Location?			
b. Adequate Staff for Emergeny Response?	X		Results differ
c. Reliable Access Routes	X		
d. Electricians, Mechanics, Laborors (onsite, on call)?	X		
e. Adequate Response Time?	X		
f. Call out Systems?			
		X	
Comments:			

ITEM	YES	NO	REMARKS
OUTLETS/DECANT STRUCTURES			TYPE: Vertical drop inlet Manhole to horizontal pipe
1. CREST			TYPE: none / N/A
a. Any Settlements?		X	
b. Any Misalignments?		X	
c. Any Cracking?		X	
d. Any Deterioration?		X	
e. Exposed Reinforcement?		X	
f. Erosion?		X	
g. Silt Deposit Upstream?		X	
2. CONTROL STRUCTURES N/A			TYPE:
a. Mechanical Equipment Operable?			
b. Are Gates Maintained?			
c. Will Flashboards Trip Automatically?			
d. Are Stanchions Trippable?			
e. Are Gates Remotely Controlled?			
3. STILLING BASIN N/A			TYPE:
a. Any Cracking?			
b. Any Deterioration			
c. Erosion?			
d. Exposed Reinforcement?			
e. Seepage at Lift Lines or Joints?			
4. ENERGY DISSIPATORS N/A			TYPE:
a. Any Deterioration			
b. Erosion?			
c. Exposed Reinforcement?			
5. METAL APPURTENANCES N/A			
a. Corrosion?			
b. Breakage?			
c. Secure Anchorages?			
6. EMERGENCY SPILLWAY N/A			TYPE:
a. Adequate Grass Cover?			
b. Clear Approach Channel?			
c. Erodible Downstream Channel?			
d. Erodible Fuse Plug?			
e. Stable Side Slope?			
7. DEICING MEASURES N/A			

Comments: Double ring steel weir w/ concrete structure

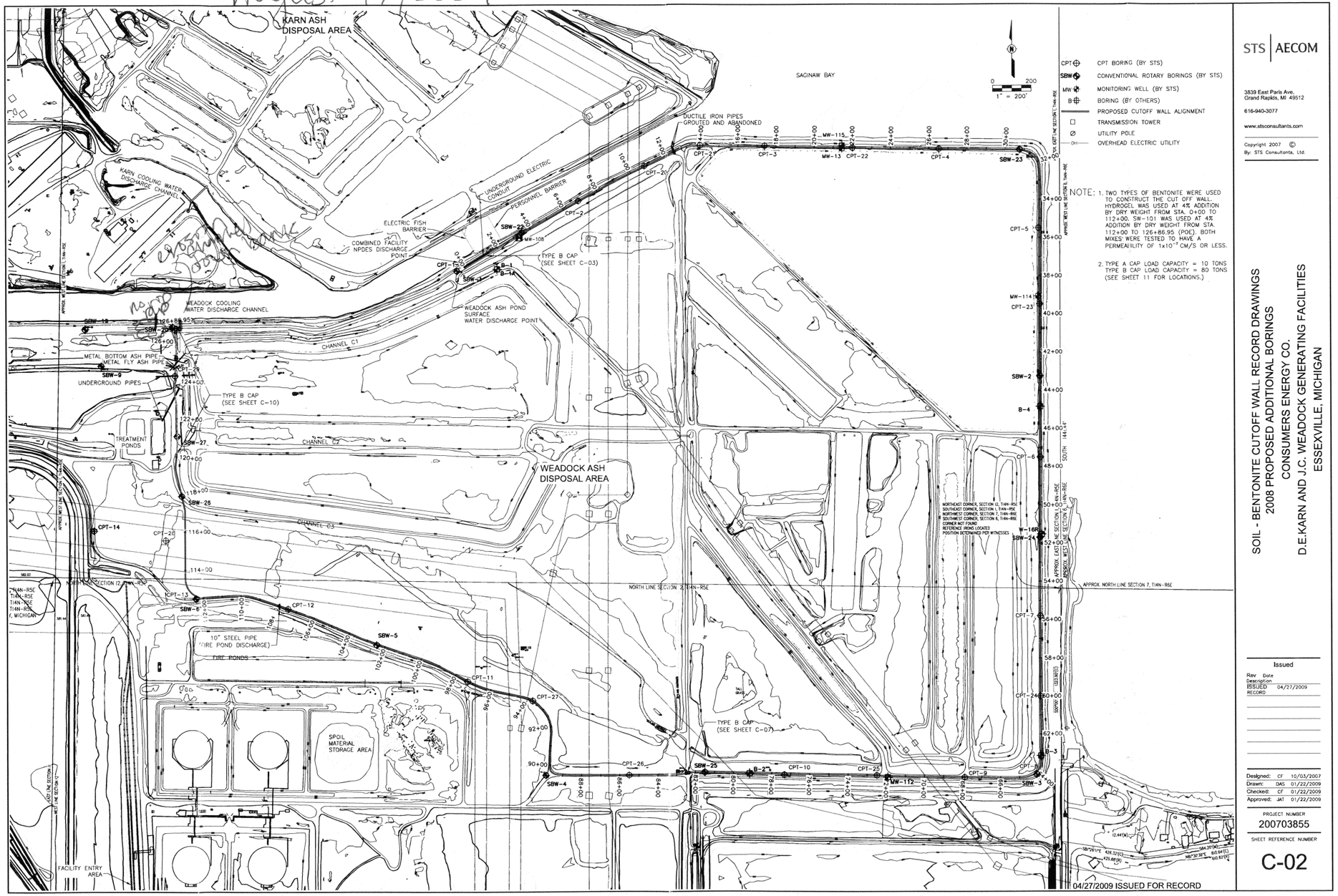
Sheet 4 of 9

ITEM	YES	NO	REMARKS
EARTH FILL DAMS			TYPE: Embankment
1. CREST			Inventory No.
a. Any Settlement?		X	
b. Any Misalignment?		X	
c. Any Cracking?		X	
d. Adequate Freeboard?	(4'-6")		Fetch: > 100 MILES
2. UPSTREAM SLOPE			
a. Adequate Slope Protection?	X		Type: no rip rap (only on P3)
b. Any Erosion or Beaching?	X		localized - minor
c. Trees Growing on Slope?	X		large vegetation
d. Deteriorating Slope Protection?		X	
e. Visual Settlements?		X	
f. Any Sinkholes?		X	
3. DOWNSTREAM SLOPE			
a. Adequate Slope Protection?	X		Type: rip rap
b. Any Erosion?	X		along north embankment toe
c. Trees Growing on Slope?	X		large vegetation
d. Animal Burrows?		X	none visible
e. Sinkholes?		X	"
f. Visual Settlement?		X	"
g. Surface Seepage?		X	"
h. Toe Drains Dry? N/A			
i. Relief Wells Flowing? N/A			
j. Slides or Slumps		X	"
4. ABUTMENT CONTACTS N/A			
a. Any Erosion?			
b. Seepage Present?			
c. Boils or Springs Downstream?			
5. FOUNDATION N/A			
a. If Embankment Founded on Bedrock N/A			Type:
(1) Is Bedrock adversely bedded?			
(2) Does Bedrock contain Gypsum?			
(3) Weak Strength Beds?			
b. If Embankment Founded on Overburden			Type: clay / sand
(1) Pipable?	X		
(2) Compressive?	X		
(3) Low Shear Strength?		X	
6. DRAINS N/A			Type:
a. Are there any internal drains?			
b. Are they flowing/working?			

Comments:

no rip rap was identified on the downstream slope upstream from the toe barrier along the discharge channel

August 17, 2009



STS | AECOM

3839 East Paris Ave.
Grand Rapids, MI 49512
616-940-3077
www.stsconsultants.com

SOIL - BENTONITE CUTOFF WALL RECORD DRAWINGS
2008 PROPOSED ADDITIONAL BORINGS
CONSUMERS ENERGY CO.
D.E.KARN AND J.C. WEADOCK GENERATING FACILITIES
ESSEXVILLE, MICHIGAN

Issued

Rev	Date	Description
ISSUED RECORD	04/27/2009	

Designed:	CF	10/03/2007
Drawn:	DAS	01/22/2009
Checked:	CF	01/22/2009
Approved:	JAT	01/22/2009

PROJECT NUMBER
200703855

SHEET REFERENCE NUMBER
C-02

Reference 195-6909-33 for cap designs

REV.	DATE	DESCRIPTION	BY	APP'D
A	04/27/2009	GWO 1547 Weadock Slurry Wall Project – Submitted for Record	DAS	EHW

DR. DAS DATE 04/27/2009
CK.
APP. SECTION HEAD
APP. DIVISION HEAD
APP. DEPARTMENT HEAD

Consumers Energy
JC WEADOCK PLANT

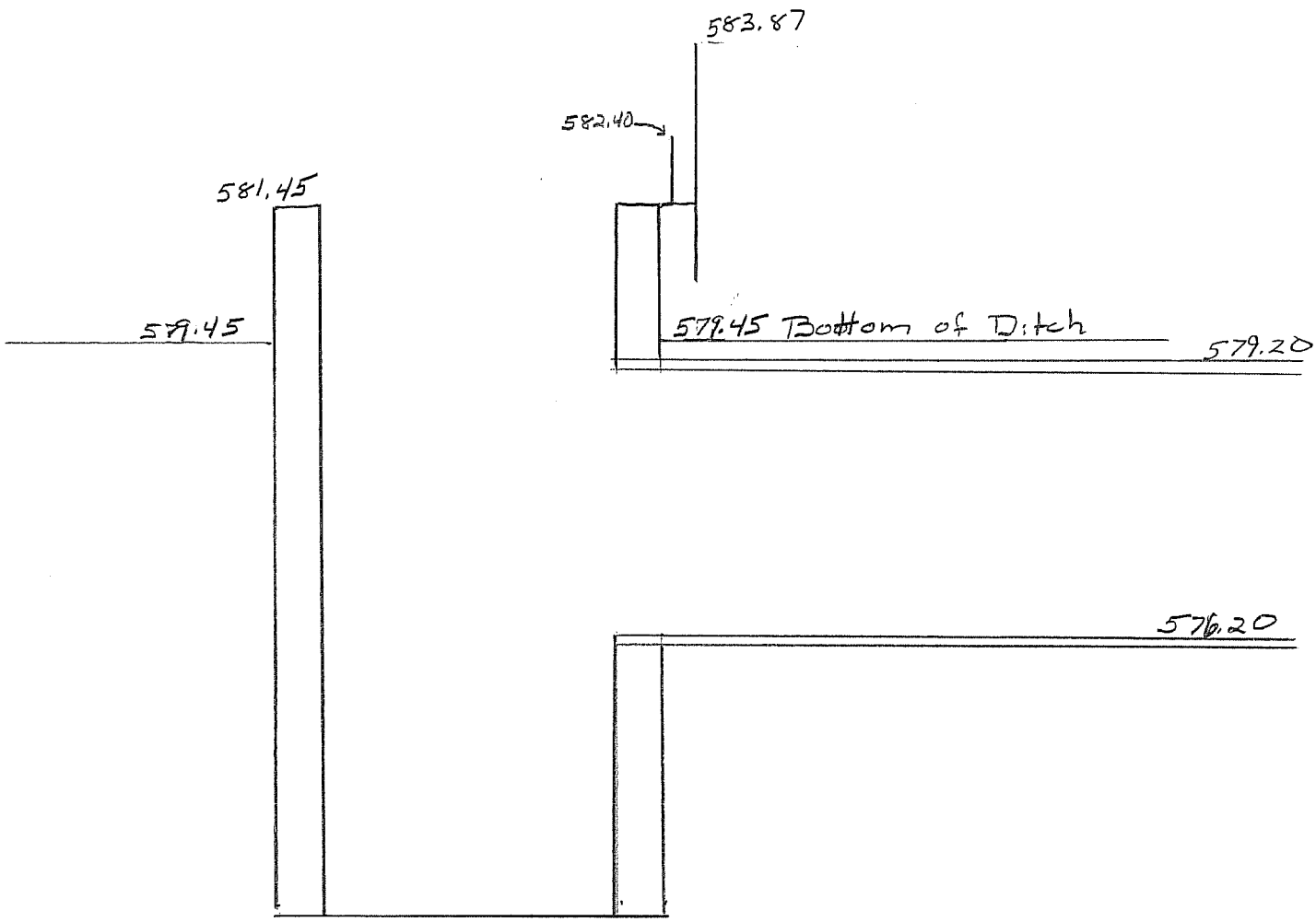
FLY ASH SLURRY WALL LAYOUT
WITH WEIGHT RESTRICTIONS

SCALE	DRAWING NO.	SHEET	REV.
JOB	195-6909	SH24	A

FIG 12

Weadock

3/8" = 1'-0"



4' Dia Galvanized environmental ditch 585.85
42" RCP P Pond 581.60 (leads to outflow ditch)

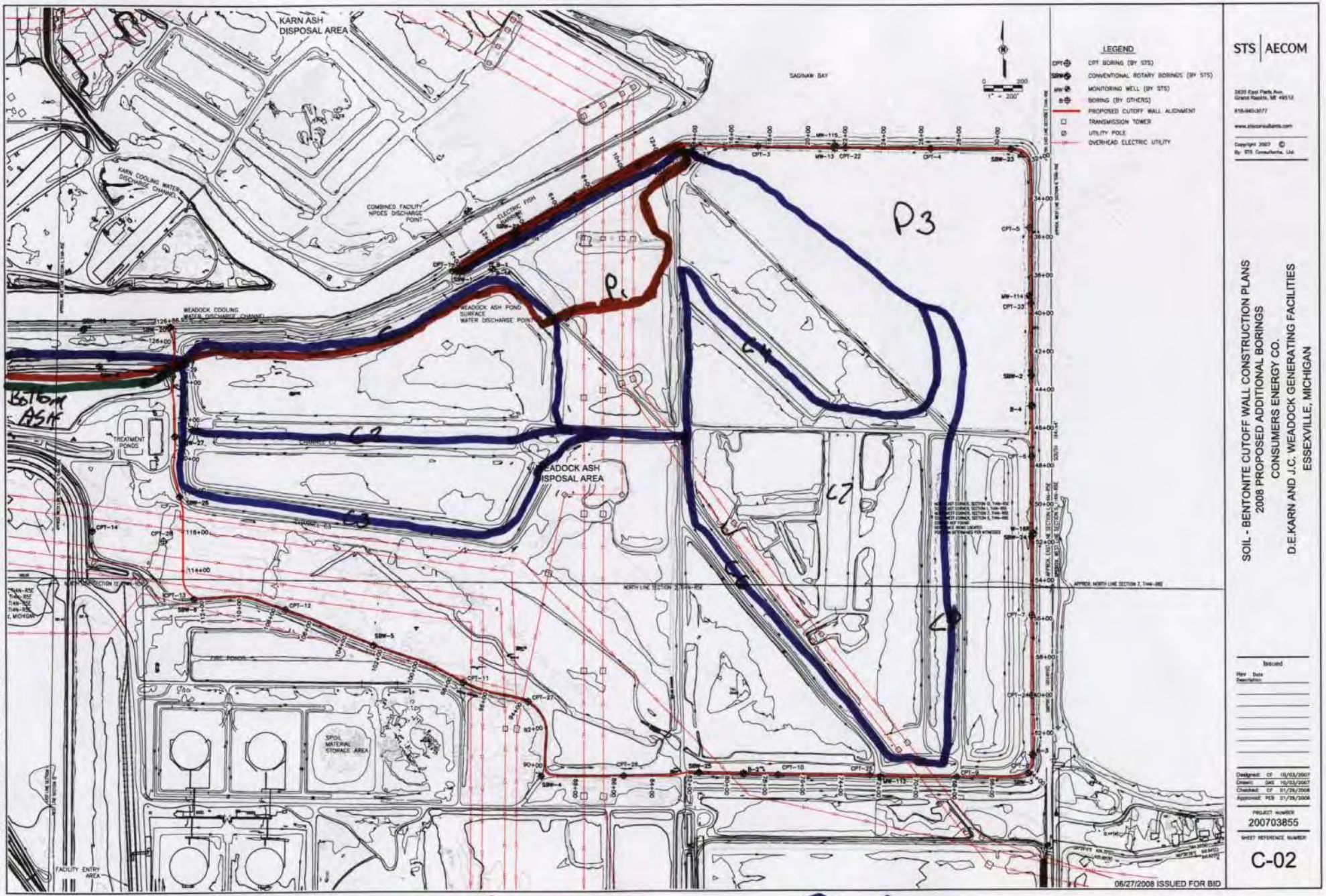
Elevation at JCW

591.10

589.25

588.31

Seperation Dike in old C1 channel



STS | AECOM

2639 East Paris Ave.
Grand Rapids, MI 49512
616-940-0677
www.stsconsultants.com

SOIL - BENTONITE CUTOFF WALL CONSTRUCTION PLANS
2008 PROPOSED ADDITIONAL BORINGS
CONSUMERS ENERGY CO.
D.E.KARN AND J.C. WEADOCK GENERATING FACILITIES
ESSEXVILLE, MICHIGAN

Issued

Rev	Date	Description

Designed: CF 10/03/2007
Drawn: DMS 10/03/2007
Checked: CF 01/29/2008
Approved: PCS 01/29/2008

PROJECT NUMBER
200703855

SHEET REFERENCE NUMBER
C-02

Bottom Ash Now

Fly Ash
Bottom Ash

STATE OF MICHIGAN
DEPARTMENT OF ENVIRONMENTAL QUALITY
LANSING

JENNIFER M. GRANHOLM
GOVERNOR

STEVEN E. CHESTER
DIRECTOR

October 15, 2009

Jon W. Carpenter
Consumers Energy Company
2742 North Weadock Highway
Essexville, Michigan 48732

Dear Dr. Carpenter:

SUBJECT: Application for Solid Waste Disposal Area Operating License; JC Weadock Solid Waste Disposal Area; Waste Data System Number 395457; License Number 9233

Staff of the Department of Environmental Quality (DEQ) has reviewed your application for a Type III low hazard industrial landfill, known as JC Weadock Solid Waste Disposal Area, located in Hampton Charter Township, Bay County, Michigan. This review was conducted under the provisions of Part 115, Solid Waste Management, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended.

Based upon our review of your application, your operating license is hereby granted. Enclosed is your license with operating stipulations.

If you have any questions, please contact Mr. Terry Walkington, Saginaw Bay District Supervisor, Waste and Hazardous Materials Division, at 989-686-8025, Extension 8200.

Sincerely,

Steven R. Sliver, Chief
Storage Tank and Solid Waste Section
Waste and Hazardous Materials Division
517-373-1976

Enclosure
cc: Bay County Health Department
Hampton Charter Township Clerk
Mr. Terry Walkington/Mr. Thomas Fox, DEQ – Saginaw Bay
Facility File

DEQ

Michigan Department of Environmental Quality
Waste and Hazardous Materials Division

SOLID WASTE DISPOSAL AREA OPERATING LICENSE

This license is issued under the provisions of Part 115, Solid Waste Management, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended, MCL 324.11501 et seq., and authorizes the operation of this solid waste disposal area (Facility) in the state of Michigan. This license does not obviate the need to obtain other authorizations as may be required by state law.

FACILITY NAME: JC Weadock Solid Waste Disposal Area

LICENSEE/OPERATOR: Consumers Energy Company

FACILITY OWNER: Consumers Energy Company

PROPERTY OWNER: Consumers Energy Company

FACILITY TYPE(S): Type III Low Hazard Industrial Landfill

FACILITY ID NUMBER: 395457

COUNTY: Bay

LICENSE NUMBER: 9233

ISSUE DATE: October 15, 2009

EXPIRATION DATE: October 15, 2014

FACILITY DESCRIPTION: The JC Weadock Solid Waste Disposal Area, a Type III low hazard industrial landfill, consists of 292 acres located in the S 1/2 of Section 1, the SE 1/4 of Section 2, and the N 1/2 of Section 12, T14N, R5E, Hampton Charter Township, Bay County, Michigan, as identified in Attachment A and fully described in this license.

AREA AUTHORIZED FOR DISPOSAL OF SOLID WASTE: Areas A, B, C, D, E, and F, which include the bottom ash settling area and the ash transport ditch.

RESPONSIBLE PARTY: Jon W. Carpenter
Consumers Energy Company
2742 North Weadock Highway
Essexville, MI 48732
989-891-2982

RENEWAL OPERATING LICENSE: This License Number 9233 supersedes and replaces Solid Waste Disposal Area Operating License Number 9022 issued to Consumers Energy Company on June 3, 2004.

This license is subject to revocation by the Director of the Michigan Department of Environmental Quality if the Director finds that this Facility is not being constructed or operated in accordance with the approved plans, the conditions of a permit or license, Part 115, or the rules promulgated under Part 115. Failure to comply with the terms and provisions of this license may result in legal action leading to civil and/or criminal penalties pursuant to Part 115. This license shall be available through the licensee during its term and remains the property of the Director.

THIS LICENSE IS NOT TRANSFERABLE.

Steven R. Sliver, Chief, Storage Tank and Solid Waste Section
Waste and Hazardous Materials Division

The licensee shall comply with all terms of this license and the provisions of Part 115 and the administrative rules implementing Part 115 (Part 115 Rules). This license includes the license application and any attachments to this license.

1. The licensee shall operate the Facility in a manner that will prevent violations of any state or federal law.

2. The following portions of the Facility are authorized to receive solid waste by this license:

   ACTIVE PORTIONS NOT AT FINAL GRADE: The area(s) identified as Areas A, B, C, D, E, and F (Area F includes the bottom ash settling area and the ash transport ditch) were authorized to receive waste by the previous license. This area's total acreage is 292 acres.

3. The following portions of the Facility **WILL BE** authorized to receive solid waste by this license following approval by the Michigan Department of Environmental Quality (MDEQ) of construction certification: None.

4. The following portions of the Facility are **NOT** authorized to receive solid waste by this license: None.

5. The attached map (Attachment A) shows the Facility, the area permitted for construction, monitoring points, leachate storage units, site roads, other disposal areas, and related appurtenances.

6. Issuance of this license is conditioned on the accuracy of the information submitted by the Applicant in the Application for License to Operate a Solid Waste Disposal Area (Application) received by the MDEQ on June 2, 2009, and any subsequent amendments. Any material or intentional inaccuracies found in that information is grounds for the revocation or modification of this license and may be grounds for enforcement action. The licensee shall inform the MDEQ's Waste and Hazardous Materials Division (WHMD), Saginaw Bay District Supervisor, of any inaccuracies in the information in the Application upon discovery.

7. This license is issued based on the MDEQ's review of the Application, submitted by Harold D. Register, Jr., for the Consumers Energy Company, dated May 28, 2009, and revised June 29, 2009. The Application consists of the following:

   a. Application Form EQP 5507.

   b. Application fee in the amount of $2,500.00.

   c. Certification of construction by NA.

   d. Waste Characterization: N/A.

   e. Restrictive Covenant:

      The June 1, 2000, restrictive covenant on 302 acres is on file at the Bay County Register of Deeds recorded on September 15, 2000, as Liber 1706 pages 416-420. A copy is on file with the MDEQ.

   f. Perpetual Care Fund Agreement, established as a trust account, signed by Mr. Robert A. Fenech, Senior Vice President, Nuclear, Fossil, & Hydro Operations of Consumers Energy Company on August 14, 1997, was executed by the MDEQ on September 23, 1997.

   g. Financial Assurance.

      i. Financial Assurance Required:

         The amount of financial assurance required for this Facility was calculated based on the calculation worksheet form EQP 5507A entitled, "Form A, Financial Assurance Required," and includes a Surety Bond of $20,000.00 per acre of licensed landfill, and the Perpetual Care Fund requirement.

         The Facility has provided financial assurance totaling $1,131,897.77, based on the requirements of Section 11523 of Part 115, consisting of a combination of the Perpetual Care Fund established under

Section 11525 of Part 115, and the bonding requirements of Section 11523 (1)(a) of Part 115. The financial assurance mechanisms used by the Facility are summarized below in Items ii and iii, respectively.

ii. Financial Assurance Provided Via a Perpetual Care Fund:

The Perpetual Care Fund Agreement statement showed a balance of $131,897.11 in the Facility's Perpetual Care Fund as of February 28, 2009.

iii. Financial Assurance Provided Via Bond:

The following financial assurance has been received from the Applicant to meet the amount of financial assurance required:

Irrevocable Letter of Credit	$1,000,000.00
Total Amount Received:	$1,000,000.00

8. The following documents approved with Construction Permit Number(s) 0260 issued to Consumers Power Company on April 21, 1992, are incorporated in this license by reference:

   a. Hydrogeological Study, prepared by Keck Consulting Services, Inc., dated 1980.
   b. Groundwater Permit Exemption Number GWE-005, dated August 21, 1986.
   c. Construction Permit Application and Support Documents, prepared by Consumers Power Company, dated December 1991.

9. The following additional documents, approved since the issuance of the construction permit(s) referenced in Item 8, are incorporated in this license by reference:

   a. Alternate Water Quality Monitoring Plan, prepared by Consumers Power Company, dated October 21, 1992.
   b. Construction Verification by Mr. Stephen J. Engers, Consumers Power Company, dated January 14, 1993.
   c. Alternate Groundwater Quality Monitoring Plan, prepared by Consumers Power Company, dated August 22, 1995.
   d. Groundwater Authorization to Discharge, GWE-0005, dated February 1, 2001.
   e. Phase II Workplan for Karn and Weadock, prepared by Natural Resource Technology, dated September 10, 2003.
   f. Request to construct ash silos titled, "Request for Approval under Restrictive Covenant: Construction of Fly Ash Storage Silos, Ash Conditioning and Truck Loading Facility, JC Weadock Solid Waste Disposal Area," dated June 23, 2006, and approved on July 14, 2006.
   g. Construction report titled, "JC Weadock Fly Ash disposal Area, Soil-Bentonite Cutoff Wall Design Report," dated March 3, 2008, revisions dated June 12, 2008, and received on March 5, 2008, and June 16, 2008, respectively.
   h. Construction revisions titled, "Revision to Wall Cap Detail, JC Weadock Fly Ash Disposal Area Slurry Wall Construction," dated September 30, 2008, received on October 23, 2008, and approved on November 5, 2008.
   i. Construction Drawings titled, "Soil-Bentonite Cutoff Wall-Construction Plans," including (Sheets C-07, C-10, and C-11) prepared by STS/AECOM, dated October 3, 2008, received on October 31, 2008, and approved on November 5, 2008.
   j. Construction Certification titled, "Construction Certification, Soil-Bentonite Cutoff Wall" dated April 24, 2009, received on May 1, 2009, and approved on June 24, 2009.

10. Consent Order/Judgment Number: N/A.

11. The licensee shall repair any portion of the certified liner or leachate collection system that is found to be deficient or damaged during the term of this license unless determined otherwise by the MDEQ.

12. The licensee shall have repairs to any portion of the certified liner or leachate collection system recertified by a registered professional engineer in accordance with R 299.4921 of the Part 115 Rules and approved by the MDEQ before receiving waste in that portion of the certified liner or leachate collection system. The licensee shall submit the recertification to the MDEQ's WHMD, Saginaw Bay District Supervisor, for review and approval.

13. The licensee shall conduct hydrogeological monitoring in accordance with the approved hydrogeological monitoring plan, dated August 22, 1995, and approved December 6, 1995. A revised hydrogeological monitoring plan is required by special conditions, including a submittal and approval schedule. The sampling analytical results shall be submitted to the MDEQ's WHMD, Saginaw Bay District Office.

14. Modifications to the approved hydrogeological monitoring plan referenced in Item 13 may be approved, in writing, by the WHMD, Saginaw Bay District Supervisor. Proposed revisions must be submitted in a format specified by the MDEQ.

15. Leachate may be recirculated if a leachate recirculation plan has been approved, in writing, by the Waste and Hazardous Materials Division, Saginaw Bay District Supervisor.

16. Modifications to approved engineering plans that constitute an upgrading, as defined in R 299.4106a(l) of the Part 115 Rules, may be approved, in writing, by the WHMD, Saginaw Bay District Supervisor.

17. Requests for alternate daily cover may be approved, in writing, by the Waste and Hazardous Materials Division, Saginaw Bay District Supervisor.

18. Leakage Control Criteria:

    This Type III Facility is a monitorable unit and, therefore, does not need to be in compliance with the leakage control criteria of R 299.4422 of the Part 115 Rules.

19. **VARIANCES**: The licensee is granted the following variance(s) from Part 115 and/or the Part 115 Rules:

    The Facility is granted the variances identified in Section C of the construction permit conditions listed in Construction Permit Number 0260, issued to Consumers Power Company on April 21, 1992. The variances were issued pursuant to the administrative rules for the Solid Waste Management Act, 1978 PA 641, as amended, that were in effect when the construction permit was issued. The administrative rules in effect at that time had an effective date of January 6, 1982.

20. **SPECIAL CONDITIONS**:

    a. On August 26, 2009, the MDEQ provided Consumers Energy (CE) with revised and confirmed Groundwater Surface Water Interface (GSI) Mixing Zone Compliance Criteria prepared by the MDEQ, Water Bureau. These criteria are referenced as an attachment to this license and shall be used to design facility improvements, demonstrate performance, and to evaluate compliance at the GSI.

    b. On September 11, 2009, CE submitted by email transmittal to the MDEQ, Waste and Hazardous Materials Division (WHMD), for review and approval, a revised Hydrogeological Monitoring Plan (HMP) for the Weadock Disposal Area. The HMP once approved shall include a GSI Compliance Monitoring Program for continued applicable Part 31 Water Resources Act monitoring and for applicable Part 115 compliance monitoring under the Natural Resources and Environmental Protection Act (NREPA), 1994 PA 451, as amended. The GSI Compliance Monitoring Program shall define: landfill leachate quality, coal ash leach potential characterization, landfill hydraulic head information, slurry wall (or comparable) system performance, groundwater quality along landfill boundaries, groundwater quality at the GSI, and groundwater quality step-out monitoring if any points at the GSI appear to exceed criteria. The revised HMP for the Weadock Disposal Area is not yet approved and shall be further revised and resubmitted for review, and to request approval by the MDEQ, WHMD within 60 days (on or before November 23, 2009) of CE receiving the Final Review Comments Letter dated September 23, 2009, from MDEQ, WHMD, regarding the Weadock Disposal Area HMP that was submitted on September 11, 2009. If a second round of Final Review Comments and revisions are necessary, then CE must obtain approval by the MDEQ, WHMD by December 23, 2009, in order to remain in compliance with this license. The approved Weadock Disposal Area HMP shall become an enforceable component of this license. Thereafter, CE shall continue to monitor in accordance with the approved Weadock Disposal Area HMP until a subsequently revised HMP may be approved by the MDEQ under this condition.

    The approved HMP for this facility, including the GSI Compliance Monitoring Program and any subsequent approved revision thereto, is enforceable under this license. CE may request that the MDEQ, WHMD, consider a

revision to the HMP and the GSI Compliance Monitoring Program by submitting a request for a revision that provides sufficient detail as to the modifications requested, including any proposed modifications to the monitoring parameters, methods, locations, frequencies, and modeling or statistical analyses used, and provides justification for the modifications to the MDEQ for review and approval. CE may request a recalculation of the GSI Mixing Zone Compliance Criteria for this facility based on the NREPA's amendments and rules in effect at the time of the request.

c. A Weadock Slurry Wall System was constructed and completed on or before December 31, 2008, and certified by a professional engineer licensed in the state of Michigan. A revised and updated Weadock Disposal Area HMP Compliance Monitoring Plan shall take effect on or before January 1, 2010. The modified HMP shall evaluate the slurry wall system and determine whether the wall or system performs as designed.

d. On or before December 31, 2011, CE shall submit to the MDEQ, WHMD, for review and approval, a revised closure plan for the Weadock Disposal Area, "Weadock Revised Closure Plan." The Weadock Revised Closure Plan shall include a description of any modifications or improvements that are related to and necessitated by the construction of structures or utilities on the Weadock Disposal Area property. The Closure Plan shall be subject to change if required or necessitated by a third power plant construction planned on or near the site, or as otherwise agreed by CE and the MDEQ. The Closure Plan shall include evaluations of the potential benefits of improving the Final Cover design to an impermeable cover over the ash landfill cells, to reduce precipitation infiltration, and pollutant source minimization and migration to leachates, groundwaters, and surface waters.

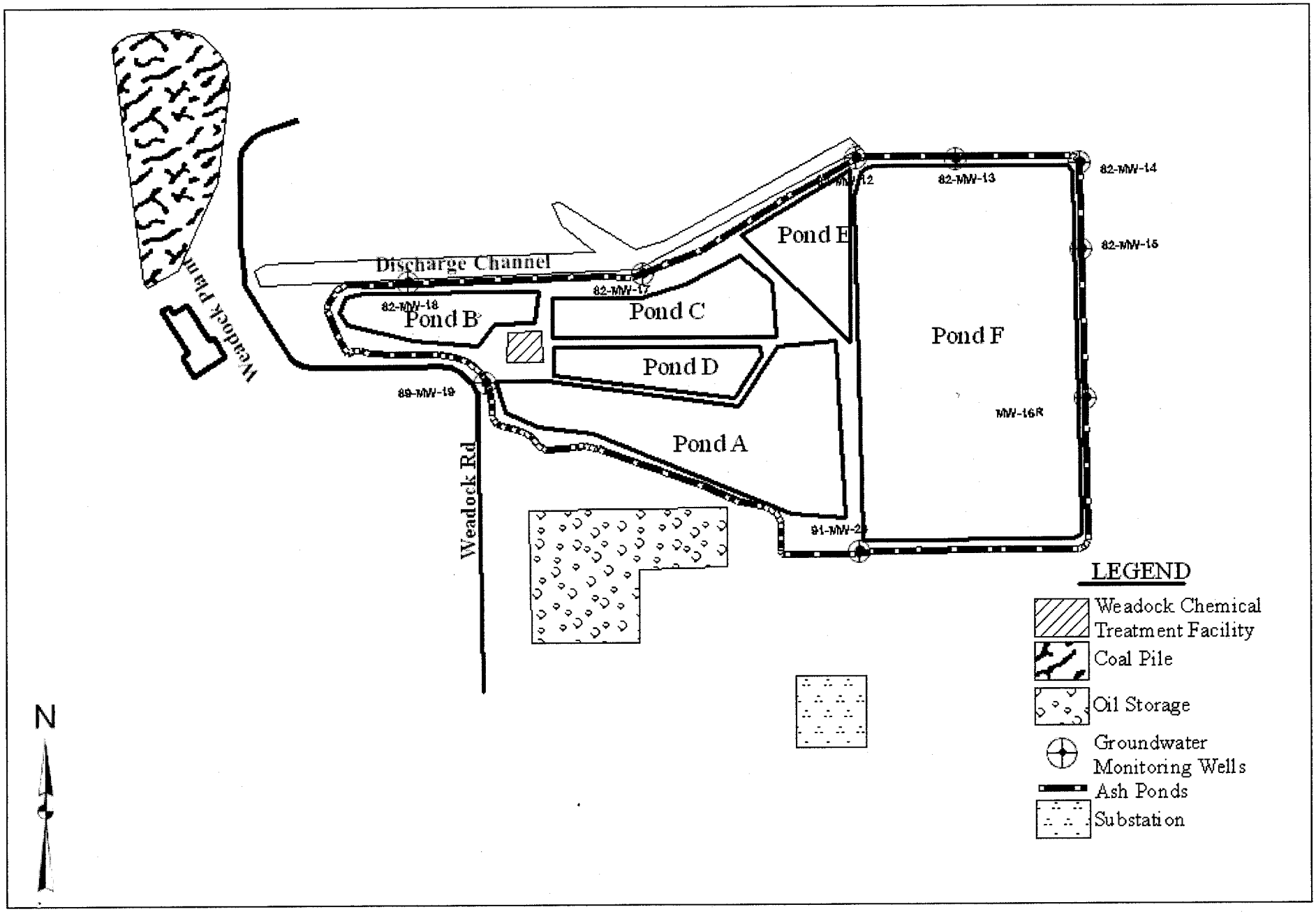
e. It is agreed and understood that if monitoring data exceed applicable compliance criteria, then the MDEQ may require further assessments, evaluations, controls, or remedial plans to be developed and implemented.

f. On or before December 31, 2009, CE shall submit for review and acceptance, a structural analysis of the dike stability and toe slope stability for the landfill's external dikes, including consideration of the slurry wall placement within the permitted solid waste Weadock Disposal Area. This analysis shall consider the permitted future maximum waste heights, a reasonable estimate of the maximum potential hydrostatic head within the landfills, predicted low water levels for the Saginaw River and Saginaw Bay potential influence of erosional effects, improvements provided by riprap and other engineered armoring, and any other significant factors. These factors shall be used in the analysis to determine if strength of the existing or future dikes and slopes will provide sufficient stability for the worst-case scenario with sufficient factors of safety. The acceptance by the MDEQ of the structural analysis of the dike stability and toe slope stability shall not constitute an approval of such and shall not be construed to mean that the MDEQ concurs with any of the conclusions, methods, or statements in the structural analysis or warrants that the structural analysis comports with the law.

21. **TERM**: This license shall remain in effect until its expiration date, unless revoked or continued in effect, as provided by, the Administrative Procedures Act, 1969 PA 306, as amended, or unless superseded by the issuance of a subsequent license.

END OF LICENSE

Attachment A



1 inch = 1,082 feet

Consumers Energy
JC Weadock Plant- Ash Disposal
9/28/09 LAJ

Consumers Energy Environmental Manual	Subject # : **LM-100** Subject Topic: **Revision Summary** Procedure # : **LM-100** Procedure Title: **Solid Waste Requirements** Issue Date: **03/26/2009**

Location(s): Weadock JC

ISSUE DATE	EFFECTIVE DATE	REVISION DESCRIPTION
12/30/82	12/30/82	Original Document
07/15/83	07/15/83	Controlled document format
03/05/85	03/05/85	Changed ash disposal area dike elevation limits to conform with current limits set in the 1983 relicensure.
07/31/86	07/31/86	Sample collection requirements for groundwater parameters have been revised (pages 1 & 2).
06/01/87	06/01/87	Added annual leachate testing requirement for bottom ash use/marketing; reinstated groundwater monitoring requirement for 82 MW-17; transferred PTS responsibility to TSS.
08/24/92	08/24/92	This revision revises the groundwater monitoring program and waste characterization program to meet license requirement; references the solid waste facility Engineering Plan as the basis for those activities carried on primarily by Plant personnel and provides for implementation of that plan; and provides a procedure for implementing the Perpetual Care Trust Fund Program.
09/30/93	09/30/93	Incorporates requirements of Solid Waste Disposal Area License 8038, and Bottom Ash Inert Designation dated 2/19/93 (92-I-020).
12/15/93	12/15/93	R3(a) revised basis for fly ash leachate testing to R299.4311(2)(3); revised fly ash and bottom ash leachate methods to provide flexibility in available test methods and reporting. R3(b) revised basis to include R299.4309(5)(6) which require the maintenance of freeboard in ash ponds and weekly monitoring to assure freeboard and external dike integrity. Added to both monitoring and documentation requirements.

08/01/96	08/01/96	Reformatted, revised procedure number; deleted fly ash leachate testing per License No 8277; revised groundwater monitoring program per 11/01/95 amendment to License No 8277; revised "no change of discharge" certification date per 10/04/95 letter; incorporated engineering plan by reference as a separate, auditable document.
11/15/96	N/A	Added new procedures on Waste Receipt Report **(LM-115)** and MDEQ Administration Fee **(LM-116)**, put HOLD ON ACTION on Inert Designation Testing **(LM-111)**, attached permits/approvals **(LM-150)**.
5/12/98	N/A	Editorial changes: organization name updates; Consumers Energy; E&TS-C&CS; minor clarity changes. Added requirement and reference to **AV-100** for notification of agency visit. Added OL 8481 (09/27/97 issue) - no changes. Added records retention for GWQMP reports. Added basis for flow estimate in groundwater permit exemption. Added Coal Ash Coordination Report. Deleted reference to ponds (new areas) A-F. Added reference to **AQ-100** for coal ash fugitive dust. Revised **LM-114.**
9/16/98	N/A	Revised **LM-113** reference to **AQ-100**.
3/1/00	12/16/99	Revised to incorporate License No. 8670, revised method detection limits in **LM-112-3** to show appropriate significant digits, and deleted **LM-111** Bottom Ash Inertness Designation Testing, which is no longer applicable.
6/01	6/01	Complete revision. Divided Registered Professional Engineer (RPE) responsibility between responsible individual (RI) and RPE, reserving those RPE responsibilities required by rule; clarified the role of the Results Lab (RL) in monitoring, documentation, and as keeper of the required files for the solid waste disposal areas' engineering and operating record;modified groundwater discharge permit exemption (**LM-112-6**; **LM-150-B**) to reflect issuance of 02/01/2001 groundwater discharge authorization by MDEQ.
6/2002	6/2002	Revised **LM-101, LM-105** and **LM-150-A** to incorporate solid waste Operating License No 8850.
03/2005	03/2005	Updated per operating license No. 9022. Changed MDEQ responsible division to Waste and Hazardous Materials Division, WHMD, updated **LM-115** Waste Receipt Report due to changes in law; revised **LM-116** Solid Waste Administration Fee to Solid Waste Surcharge due to changes in law.
12/2005	12/2005	Revised **LM-112-3** to add EPA method 6020, Inductively-coupled plasma (ICP), an alternate method accepted by MDEQ since its inception. The three (3) year review of this entire procedure was also conducted.

2/2007	2/2007	Revise **LM-112-5** reporting requirements.
03/2009	*03/2009*	*Three-year review completed by sponsor with **no revisions needed**.*

Consumers Energy Environmental Manual	Subject # : **LM-101** Subject Topic: **Contents** Procedure # : **LM-100** Procedure Title: **Solid Waste Requirements** Issue Date: **03/26/2009**

Location(s): Weadock JC

Location(s): Weadock JC

H - O

P

Q - R

S

T - Z

Consumers Energy Environmental Manual	Subject # : **LM-103** Subject Topic: **Abbreviations** Procedure # : **LM-100** Procedure Title: **Solid Waste Requirements** Issue Date: **03/26/2009**

Location(s): Weadock JC

Abbreviation	Meaning
AUS	Ash Utilization Supervisor
E&LS-AQ	Environmental & Laboratory Services Department - Air Quality Section
E&LS-CS	Environmental & Laboratory Services Department - Chemistry Section
E&LS-LWM	Environmental & Laboratory Services Department - Land & Water Management Section
GWQMP	Groundwater Quality Monitoring Program
MDEQ-WHMD	Michigan Department of Environmental Quality - Waste and Hazardous Materials Division (formerly Michigan Department of Natural Resources)
MDNR	Michigan Department of Natural Resources
mgd	million gallons per day
MWRC	Michigan Water Resources Commission
NPDES	National Pollutant Discharge Elimination System
NREPA	Natural Resources and Environmental Protection Act 451, PA 1994
OL	Operating License
PA	Public Act
RI	The individual responsible for day to day operations of the ash landfill according to the operating parameters established in the engineering plan and these procedures and the keeper of the solid waste operating record for the JC Weadock Solid Waste Landfill.

RL	Results Lab-responsible for certain operational monitoring and documentation functions and the keeper of the solid waste operating record for the JC Weadock Solid Waste Landfill.
RPE	Registered Professional Engineer (Michigan) at Weadock 7 & 8 responsible for ash area construction and certification purposes
US EPA	United States Environmental Protection Agency
USLS	United States Lake Survey

Location(s): Weadock JC

Consumers Power Company	Prior to 01/01/97 the name of Consumers Energy Company.
Groundwater Monitoring	Measurement and sampling of groundwater wells around the Solid Waste Disposal Area.
Solid Waste Disposal Area	The ash slurry lagoon system with provision for vertical expansion as a structural fill licensed as a Type III landfill for coal ash.

Consumers Energy Environmental Manual	Subject # : **LM-105** Subject Topic: **References** Procedure # : **LM-100** Procedure Title: **Solid Waste Requirements** Issue Date: **03/26/2009**

Location(s): Weadock JC

DOCUMENT BASIS

NATURAL RESOURCES AND ENVIRONMENTAL PROTECTION ACT 451, PA 1994, as amended

Part 31 - Water Quality and promulgated rules, including R323.2209
Part 115 - Solid Waste Management and promulgated rules, applicable to inert materials, Type III industrial wastes, and Type III landfills.

OPERATING LICENSE NO 9022

- Michigan Department of Environmental Quality
  - issued 6/3/04; - expires 6/3/09.

SOLID WASTE DISPOSAL AREA CONSTRUCTION PERMIT NO 0260 —

- Michigan Department of Natural Resources
  - issued 04/21/92.
- **Engineering Plan** dated 12/31/91; submitted as part of application; authorized by Permit.

APPROVAL OF ALTERNATE US EPA ANALYTICAL METHODS

- MDNR letter 02/24/93

MICHIGAN WATER RESOURCES COMMISSION EXEMPTION NO GWE-0005 (Groundwater Discharge Permit Exemption)

- Issued 08/21/86
- Superseded by Groundwater Discharge Authorization GWE-0005 issued February 1, 2001 by the Michigan Department of Environmental Quality.

APPROVAL OF ALTERNATE GWQMP

- MDEQ-WMD letter (12/06/95): approves monitoring program under Part 312 rather than Part 115 of NREPA to verify compliance with groundwater discharge exemption

KARN-WEADOCK PLANT NPDES PERMIT NO MI0001678

- Michigan Department of Environmental Quality
  - issued 07/24/97; - expires 10/01/01

PERPETUAL CARE FUND TRUST AGREEMENT (10/30/90); revised 8/14/97)

SUPPORTING PUBLICATIONS - Refer to these publications prepared by the US EPA, Environmental Monitoring and Support Laboratory in Cincinnati, Ohio:

- US EPA, 1986, Methods for Chemical Analysis of Water and Wastes
- US EPA, 1983, Handbook for Analytical Quality Control in Water and Wastewater Laboratories
- **J C Weadock 7 & 8 - Environmental Manual -**
    - **AV-100** Agency Compliance Visit/Inspection: Internal Notification/Documentation
    - **AQ-100** Air Quality Requirements

Consumers Energy Environmental Manual	Subject # : **LM-112-1** Subject Topic: **Groundwater Quality Monitoring Program - Introduction** Procedure # : **LM-100** Procedure Title: **Solid Waste Requirements** Issue Date: **03/26/2009**

Location(s): Weadock JC

SUMMARY

Described are the general responsibilities for collection, analysis, quality assurance/quality control, scheduling and reporting of groundwater data from the Weadock 7 & 8 coal ash solid waste Disposal Area. Data are collected from monitoring wells in accordance with the GWQMP. This includes resolving accuracy and scheduling problems within the framework of report date commitments with the MDEQ-WMD.

REFERENCES

CONTROLLING DOCUMENTS —

- Part 115 (Solid Waste Management) of NREPA and Rules R299.4306 and 4318.
- Operating License No 8670, issued 12/16/99, Stipulation 10. This OL incorporates by reference:
  - Alternate Water Quality Monitoring Plan, dated 10/21/92 (previously approved 12/06/95).
- Michigan Water Resources Commission Exemption No GWE-0005 (groundwater discharge permit exemption) issued 08/21/86.
- Part 31 (Water Quality) of NREPA
- MDNR letter (02/24/93) approving alternate US EPA analytical methods.

Supporting Publications — Refer to these publications prepared by the US EPA, Environmental Monitoring and Support Laboratory in Cincinnati, Ohio:

- US EPA, 1986, Methods for Chemical Analysis of Water and Wastes
- US EPA, 1983, Handbook for Analytical Quality Control in Water and Wastewater Laboratories

RESPONSIBILITIES

TECHNICAL MANAGEMENT including agency reporting and revisions to this document is the responsibility of the **E&LS-LWM.**

SAMPLE MANAGEMENT, i.e. collection, analysis, quality assurance, quality assurance protocols according to E&LS-CS procedure **CHEM-1**, including chain-of-custody, report preparation and schedule requirements according to subjects **LM- 112-2** through **LM- 112-5,** is the responsibility of **E&LS-CS.** Special nonroutine samples can be collected by **Plant personnel** under the guidance of **E&LS-CS.**

WELL MONITORING AND SECURITY including ensuring that all wells are clearly labeled and visible throughout the year, are properly vented, and are capped and locked when not in use is the responsibility of the RL**.**

OBTAINING APPROVALS FOR WELL MAINTENANCE including replacement, plugging, abandonment or repair is the responsibility of the **E&LS-LWM** coordinating with the Chief of the MDEQ-WMD (or designee).

Consumers Energy Environmental Manual	Subject # : **LM-112-2** Subject Topic: **Groundwater Quality Monitoring Program - Samples** Procedure # : **LM-100** Procedure Title: **Solid Waste Requirements** Issue Date: **03/26/2009**

Location(s): Weadock JC

SUMMARY

Described are the **E&LS-CS** responsibilities for physical measurements, sampling, preparing and handling samples to determine groundwater quality in the 2 groundwater monitoring wells: 89-MW-19 and 91-MW-20 around the coal ash Solid Waste Disposal Area (see Figure 1, for well locations).

Note
Remaining wells 82-MW-12, 82-MW-13, 82-MW-14, 82-MW-15, 82-MW-16, 82-MW-17 and 82-MW-18 are locked and are not sampled.

MEASUREMENTS AND SAMPLE COLLECTION

E&LS-CS uses the following methods to obtain groundwater measurements and samples (also see subject **LM-112-3**):

Static Water Levels

Obtain immediately prior to purging. Measure from top of casing. Report results using USLS datum. Decontaminate tape with deionized water prior to each use.

pH Measurement

Use buffer solutions of pH 4, 7 and 10 in conjunction with pH meters.

Conductivity Measurement

Calibrate conductivity meters in the field using conductivity standards prior to sampling.

Sampling Order

Dedicated Sampling Equipment - Specific pumps and sampling equipment are currently used at each sample location (e.g. pneumatic bladder sampling pumps equipped with Teflon tubing and filters). When using this dedicated sampling equipment, collect samples in any order.

Non-dedicated Pumps or Sampling Equipment (if used) - To minimize the potential of cross-contamination, clean and thoroughly rinse each piece of equipment with distilled water before monitoring each well. Sample according to the following:

- If wells are not known to be contaminated - monitor from the upgradient to the downgradient well with order based on recent static water levels.

- If wells are known to be contaminated - monitor from least contaminated to most contaminated, based on recent monitoring data.

Representative Samples - Ensure samples are representative of the site's groundwater quality:

- Thoroughly decontaminate the purge pump or bailer with deionized water prior to each use.

- If available, purge water volume equal to or greater than 3 times the volume of the well casing, or until dry, before sampling.

- Sample wells (quarterly and semiannually) immediately after purging or when recovery rates allow (no later than 24 hours after purging). If wells are pumped dry, determine and record recovery rates..

- Field filter the samples for **dissolved metals** analysis.

Water Purged from Wells - Discharge using a method approved by the MDEQ-WMD.

TAKING, PREPARING AND HANDLING SAMPLES

SAMPLE SELECTION AND PREPARATION - Procure, prepare and handle sample volumes, containers and preservatives according to 40 CFR 136 and US EPA recommended practices (see subject **LM-112-1** Supporting Publications) for each parameter.

Prevent Contamination - Wear and discard disposable latex gloves at each monitoring well. Thoroughly clean and rinse (with deionized water) any sampling equipment used at more than one well prior to use at each monitoring well.

Equipment - Use a propane-powered air compressor equipped with an air controller to obtain samples through the **dedicated sampling equipment.** Further field filter the samples to be analyzed for **dissolved metals** using <0.45 micron filter prior to preservation.

Volume - Collect sufficient sample for initial analysis and to allow re-analysis if required.

Containers - Place samples in clean, plastic high density polyethylene containers or glass bottles with Teflon-lined caps, as appropriate.

Preservation

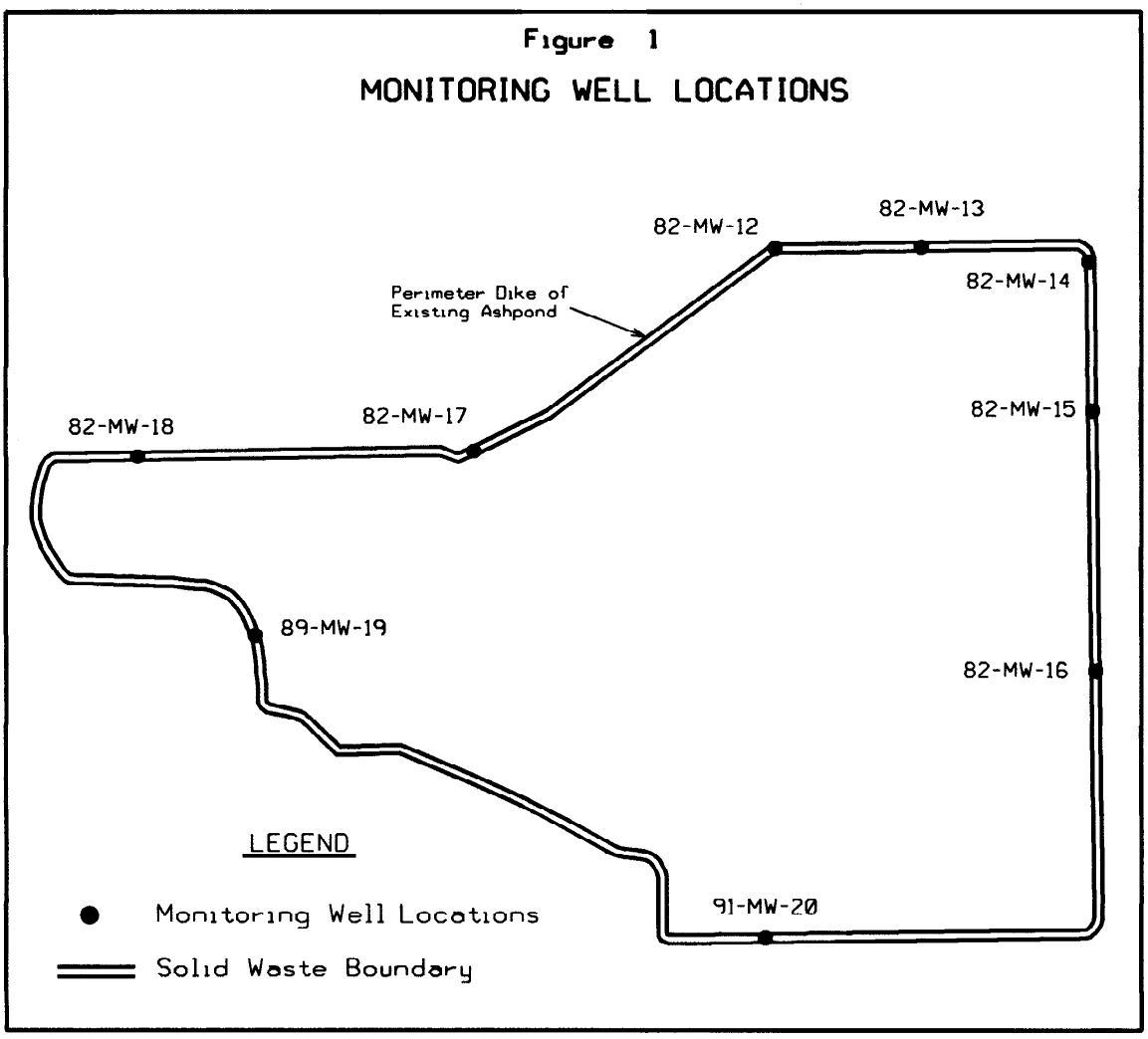
Place all field samples on ice in coolers for sample preservation. Ice or refrigerate samples in the laboratory until analyzed. For samples requiring additional preservation (e.g. metals), add concentrated acids or

other required preservatives at the required concentrations and volumes using pipettes with disposable tips to prevent contamination between or among samples.

Preserve samples on location unless quality control is sacrificed due to adverse climatic conditions (rain, dust, wind, etc. If adverse conditions exist, transport to a safe area and preserve as soon as possible.

Storage - Store preserved dissolved metal samples (properly labeled and cataloged) for a maximum of 3 months.

Chain-of-Custody - Follow the chain-of-custody procedures for both those samples analyzed by E&LS-CS and those samples that are collected by E&LS-CS, but shipped to another laboratory for analysis.



Monitoring Wells 89-MW-19 and 91-MW-20 are monitored. The remaining wells are locked and not sampled.

Consumers Energy Environmental Manual	Subject # : **LM-112-3** Subject Topic: **Groundwater Quality Monitoring Program - Measurement Parameters** Procedure # : **LM-100** Procedure Title: **Solid Waste Requirements** Issue Date: **03/26/2009**

Location(s): Weadock JC

SUMMARY Tabulated are specifications for **E&LS-CS** quarterly and semiannual groundwater sampling and analyses.

TEST	METHOD[1]	FREQUENCY[2]		METHOD DETECTION LIMIT[3] OR UNITS
		Quarterly	Semiannual	
Static Water Level[4]	Wetted Tape	x		1/8" or 0.01'
pH[4]	150.1	x		0.1 Standard Units
Specific Conductance[4]	120.1	x		10 µmho/cm
Antimony[5]	204.2 or 6020		x	2
Arsenic[5]	206.2 or 6020		x	1
Boron[5]	200.7 or 6020	x		20
Cadmium[5]	213.2 or 6020		x	0.2
Chromium[5]	218.2 or 6020		x	2
Cobalt[5]	219.2 or 6020		x	15
Magnesium[5]	242.1 or 6020	x		1000
Potassium[5]	258.1 or 6020	x		100
Selenium[5]	270.2 or 6020		x	2
Sodium[5]	273.1 or 6020	x		1000
Thallium[5]	279.2 or 6020		x	2
Vanadium[5]	286.2 or 6020		x	10

Notes
1 Source of method numbers, unless otherwise indicated, is US EPA, 1986, Methods for Chemical Analysis of Water and Wastes, US EPA Environmental Monitoring and Support Laboratory, Cincinnati, Ohio 2 Frequency: Quarterly: in all calendar quarters Semiannual: in second and fourth calendar quarters 3 Method detection limit in µg/l unless otherwise specified. 4 Field measurement 5 Sample and analyze for dissolved metals, field filter before preserving.

Consumers Energy Environmental Manual	Subject # : **LM-112-4** Subject Topic: **Groundwater Quality Monitoring Program - Analyses** Procedure # : **LM-100** Procedure Title: **Solid Waste Requirements** Issue Date: **03/26/2009**

Location(s): Weadock JC

SUMMARY

Described are **E&LS-CS** analytical methods requirements/ responsibilities for groundwater measurement parameters and quality control procedures.

REQUIREMENTS

METHODS - Use US EPA standards 40 CFR 136 and US EPA methods (subject **LM-112-1**, Supporting Publications).

Reporting Results - Ensure that the instruments and methods are capable of reporting concentrations according to subject **LM-112-3.**

If Using a Second or Contract Laboratory - Ensure that these procedures and requirements are used and that all results and procedures are properly documented.

QUALITY CONTROL - Maintain analytical consistency by ensuring the following are applied.

Methods - Adhere to US EPA standards and methods for all parameters and monitoring points (with particular emphasis on attention to interferences and sources of error).

Report methods used, exceptions to methods used, analytical results of calibration standards and when applicable, method “blank” concentrations.

Equipment - Ensure that field and laboratory services, glassware, reagents, solvents and gases meet US EPA standards. Selection, preparation and storage of field and laboratory equipment are controlled functions (US EPA, 1983).

Instrumentation - Maintain and calibrate field and laboratory equipment according to manufacturer’s recommendations and have backup equipment available. Instrument maintenance and calibration are controlled functions.

Field Blanks - Expose a reverse osmosis, deionized water field blank of the same lot at all monitoring points during each collection. Prepare and analyze with the other groundwater samples.

Replicates - Multiple measurements are required under specific conditions:

Duplicate Analyses - Required for analysis of dissolved metals in samples from monitoring wells. Report the mean value of the measurements.

Triplicate Analyses - Required if you feel instrument precision is inadequate. Report the mean value and standard deviation of the measurements.

Spiking - Spike and report recovery efficiencies (%) for all parameters for the groundwater sample having the highest specific conductance.

Method of Standard Additions - Use:

- In conjunction with atomic absorption spectrophotometric techniques when spike recovery efficiencies cannot be calculated.
- To quantitate sample concentrations when matrix interferences cannot be eliminated.

Certified Standards - Analyze certified standards and report results with the analyses and reporting for each applicable sample parameter during each collection.

Consumers Energy Environmental Manual	Subject # : **LM-112-5** Subject Topic: **Groundwater Quality Monitoring Program - Schedules and Reports** Procedure # : **LM-100** Procedure Title: **Solid Waste Requirements** Issue Date: **03/26/2009**

Location(s): Weadock JC

SUMMARY

Described are agency visit/inspection notification responsibilities for **all Company personnel, E&LS-CS** requirements for scheduling and reporting results of groundwater monitoring and **E&LS-LWM** responsibilities for preparing and submitting both quarterly reports and annual report.

MONITORING SCHEDULE

Note
If MDEQ-WHMD contacts **any Company personnel** to conduct a visit/inspection and/or to obtain samples immediately notify the Facility Contact or E&LS-LWM to implement **AV-100 Agency Compliance Visit/ Inspection: Internal Notification/Documentation.**

Responsibility	**ACTION**
E&LS-CS	**Conduct** sampling and analyses as indicated in subject **LM-112-3**. **Submit** prepared **collection schedules** to E&LS-LWM for approval by January of each year. **If Schedules Cannot be Met -** Notify E&LS-LWM (E&LS-LWM notifies the MDEQ-WHMD, if necessary) **If Schedules Met -** Notify E&LS-LWM in writing within 5 days of the collection date. Include: • Monitoring stations sampled. • Collection dates. • Potential problems related to collection, analysis, quality assurance or schedule compliance.

LABORATORY RESULTS

Responsibility	**ACTION**
E&LS-CS	**RESULTS OF MONITORING -** Furnish a complete report of the results to E&LS-LWM and to RL for review no later than the last day of the calendar quarter

If Revisions Required - Upon receipt of comments from E&LS-LWM (within 1 week of submission date), resolve and incorporate comments and submit a revised report to E&LS-LWM and RL within 1 week of the date you received the comments.

DATA ACCURACY - Ensure that:

- All parameters are analyzed consistent with recommended holding times.
- Parameter analytical results and quality control measures are reviewed.
- All test result anomalies are discussed with E&LS-LWM and RL to determine whether the data are reliable and accurate and if additional collections and testing are required.

If Additional Sampling Required - Try to collect samples within the original quarterly time frame and revise reporting schedule accordingly.

WRITTEN NOTIFICATION - If you find at any time that schedule and/or technical requirements cannot be met, give E&LS-LWM a written explanation of the circumstances.

REPORT INFORMATION - Ensure that reports contain:

Field Collection Notes - Collection date, collection equipment, stations sampled, field measurements such as pH, specific conductance and static water level and volume of groundwater purged and verification of field measurements. Include chain-of-custody information if samples are sent to an outside laboratory for analysis.

Sample Preparation and Handling Information - Sample volumes, containers, preservatives, actual holding times and handling procedures.

Methods and Instruments Used - Analytical methods, sensitivity limits and field and laboratory instrumentation.

Results - All sample analytical results.

Quality Control Measures - Analytical results for applicable test blanks and calibration standards, field blanks, replicates, spiking, method of standard additions and certified standards.

REPORTING

Responsibility	**ACTION**
E&LS-LWM	Prepare reports that include: • data for the quarterly or semiannual report, as applicable (for quarterly or semiannual submittal to MDEQ, for information purposes); and • a trend chart over time of the concentrations of all parameters for each well. Submit the report to MDEQ-WHMD by the 30th of the month following the calendar quarter (January 30, April 30, July 30 and October 30). Provide a copy

to RL and Legal Department.

RECORDS RETENTION

Responsibility	ACTION
RL	Retain GWQMP monitoring records for at least three (3) years.
E&LS-LWM	Maintain GWQMP monitoring records for the life of the facility.

Consumers Energy Environmental Manual	Subject # : **LM-112-6** Subject Topic: **Groundwater Quality Monitoring Program - Change in Discharge** Procedure # : **LM-100** Procedure Title: **Solid Waste Requirements** Issue Date: **03/26/2009**

Location(s): Weadock JC

SUMMARY Described is the process for (a) certifying no change and for (b) notification of proposed change of groundwater discharge to the MDEQ-WMD. The Weadock 7 & 8 Plant must certify periodically (at MDEQ-WMD discretion) no change in groundwater discharge and also must give 180 days advance notice of major proposed changes to releases to the coal ash Solid Waste Disposal Area that may change the groundwater discharge. For the purposes of this requirement, **major** means changes requiring amendment of the NPDES Permit.

Refer to:

- Groundwater Discharge Authorization issued 02/01/01 (see **LM-150-B**)
- Karn-Weadock Plant NPDES Permit No MI 0001678, reissued 07/24/97 by MDEQ.

CERTIFICATION OF NO CHANGE

Responsibility	ACTION
E&LS-LWM	1. On or before 07/01/05, review GWQMP data and NPDES Permit (amendments and reissuance , if any) and make written recommendation to RI regarding certification.

Note	
Groundwater discharge is estimated as 3% of surface water discharge flow through the ash ponds.	
Surface water	
Weadock ash ponds	7.197 mgd
Karn ash ponds	21.753 mgd
Total	28.950 mgd
Groundwater	
Total	0.8685 mgd

RL	2. On or before 07/15/05, provide comments or concurrence to E&LS-LWM.
E&LS-LWM	3. On or before 07/31/05, transmit the certification to MDEQ-WMD.

NOTIFICATION OF PROPOSED CHANGE IN DISCHARGE

Responsibility		ACTION
RL	1.	At least 210 days prior, notify E&LS-LWM of any **major** change in discharge that may affect the groundwater discharge permit exemption.
E&LS-LWM	2.	At least 180 days prior to the changed discharge, notify the Chief, MDEQ-WMD, Groundwater Programs Section.
	3.	Coordinate and support the proposed changed discharge with MDEQ-WMD.

Consumers Energy Environmental Manual	Subject # : **LM-113-1** Subject Topic: **Engineering Plan - Implementation, Operations and Records** Procedure # : **LM-100** Procedure Title: **Solid Waste Requirements** Issue Date: **03/26/2009**

Location(s): Karn DE 1&2

SUMMARY

Described are the **RI's and RL's** documentation and **the RPE's** certification responsibilities for implementing the Engineering Plan for the D E Karn coal ash Solid Waste Disposal Areas.

Note
IMPORTANT: The Engineering Plan is a separate auditable document establishing the engineering bases for construction and operation under the MDEQ-W*H* MD Construction Permit and associated Rules. Any change from the construction and operational requirements of the Engineering Plan requires review, approval and certification by a professional engineer registered in the State of Michigan and approval by MDEQ-WHMD. <u>All repair to original design, all new construction and all installation of final cover must be supervised and certified by a registered professional engineer licensed in the State of Michigan.</u>

OPERATIONS AND IMPLEMENTATION

Ensure that solid waste disposal area operations conform to Part 115 of the NREPA and its Rules. Refer to:

- Operating License No 8316, issued 10/24/95 by MDEQ.
- Engineering Plan dated 08/29/86, submitted with application and authorized by Solid Waste Disposal Area Construction Permit No 0195 issued 12/15/86.
- Michigan Administrative Code R299.4313 (licensing); 4315 (operating requirements); 4309(5) (freeboard); 4309(6) (weekly inspections).

RECORDS

FIELD NOTES - As a minimum, the RL shall maintain Engineering Plan implementation and operations records for possible reference at the time of relicensing (see R299.4922) or MDEQ-WMD inspection:

- G A Dawson letter 02/29/96 to Edwin Haapala, MDEQ-W*H* MD, detailing changes in site development plan and associated elevations.
- Construction Permit No 0195 issued 12/15/86.
- Copy of current operating license.
- Copy of Engineering Plan dated 08/29/86.

- Copy of Plant's requirements for implementing solid waste requirements **(LM-100's).**
- Copy of the annual survey of Solid Waste Disposal Area dikes and fill elevations.
- Log of weekly freeboard and dike integrity observations conducted by RL.
- Copy of the quarterly Coal Ash Coordination Report prepared by the AUS.
- Copy of the log of all equipment, with maintenance records, used in Solid Waste Disposal Area operations. See R299.4315(1).
- Documenting fugitive dust control activities. See R299.4315(5). See **LM-113-6** for details.

Note
Coal ash fugitive dust observation/recordkeeping/ notification responsibilities are also addressed by the Plant and E&LS-AQ in the D E Karn 1 & 2 **AQ-100** Air Quality Requirements. See **AQ-140 - Ash Storage and Handling**

- Documentation of any incidents where noise levels at the solid waste boundary exceeded standards. See R299.4315(14).
- Copy of all quarterly and semiannual groundwater monitoring results. See R299.4315(15) and 4318.
- Copy of "No Change in Discharge" certifications under exemption GWE-0005 or Groundwater Discharge Authorization GWE 0005..

CERTIFICATION

AT THE TIME OF RELICENSING - No later than **90** days prior to Operating License expiration, **RI** shall provide RL and E&LS-LWM with **RPE's** certification documents for any repair work to designed facilities, new construction design drawings or specifications that must be permitted, or final cover installation certifications. Ensure that these certifications or design documents are signed and sealed by an RPE. The RI shall also provide a copy of the RPE's field notes to RL for the Engineering Plan implementation and operating record.

- RL shall also **furnish copies of field notes,** as requested by E&LS-LWM.

Consumers Energy Environmental Manual	Subject # : **LM-113-2** Subject Topic: **Engineering Plan - General Management** Procedure # : **LM-100** Procedure Title: **Solid Waste Requirements** Issue Date: **03/26/2009**

Location(s): Karn DE 1&2

SUMMARY

Described are the RI's general management responsibilities for dike and fill measurements, dust control notification, changes in fill area, and limited disposal aspects of the Engineering Plan.

BASIS

Ensure that management commitments are met. Refer to:

- Solid Waste Disposal Area Construction Permit No 0195 issued 12/15/86.
- Drawing No 695-81906, sheet 19, Rev B, dated 9/13/00 and transmitted to Edwin Haapala, MDEQ-WMD, on 10/9/00 (**LM-150-D**).
- Engineering Plan dated 08/29/86 (Appendix E, Drawing No S-G 17054A).

MAXIMUM DIKE ELEVATIONS

Dike Elevations - RI shall provide for the measurement of the solid waste disposal areas annually where dike elevations were altered during the previous 12 months. The maximum dike elevation for a point on the dike is 591.75 USLS or the elevation given for that point in Drawing No S-G 17054A, Sheet 1, Revision C, whichever is greater.

Field Survey - Should be done once every 12 months to assure that Engineering Plan elevations and slope requirements are met. The RI shall establish survey data at his/her discretion. Survey and prepare written report listing the elevations for disposal areas altered during the past 12 months and submit to E&LS-LWM.

Survey Print - Within 4 weeks of survey completion, RI should transmit a survey print and written report to E&LS-LWM.

MAXIMUM FILL ELEVATIONS

Fill Elevations - Measure the solid waste disposal areas annually where the fill elevations were altered during the previous 12 months. Do not exceed the approved fill elevations: (See **LM-150-D** Drawing No 695-81906, Sh 19, Rev B, 9/13/00.)

Area	Agency Approved Fill Elevation (USLS)
A	641.75
B	594.00
C	594.00
D_1	610.3
D_2	604.3
D_3	591.75
E	591.75
F	591.75

Field Survey - Conduct at the end of the construction season (once every 12 months) on the structural fill or at the discretion of the RI.

Survey Print - Within 4 weeks of survey completion, the RI submits survey print to E&LS-LWM.

FILL VOLUME ASSESSMENT

Total Volume - RI will prepare written estimates of the coal ash volume placed in each solid waste disposal area since the last survey and estimates of each area's remaining capacity.

Methods - Estimate by field survey, visual inspection, Plant records and/or calculations. Total ash disposal tonnage which may be converted to volume can be calculated from coal ash coordinates' quarterly reports.

Fill Assessment - Within 4 weeks of completing the estimates, RI transmits a written report to E&LS-LWM and RL (can be part of the Dike and Fill Elevation Report). RI maintains a file on the dike and fill measurements and volume assessment to be used as "engineers field notes" to partially satisfy the requirements of R299.4313 of the Michigan Administrative Code necessary for biennial relicensing.

DUST CONTROL NOTIFICATION

Notification - RI shall verbally notify E&LS-AQ if:

- visible fugitive particulate emissions are considered to be causing a public nuisance, or
- a citizen complaint is received.

Notify on the same day if the observed exceedance occurs during normal working hours or in the morning of the next business day if the exceedance occurs outside of working hours. E&LS-AQ in turn notifies MDEQ (if determined necessary) and E&LS-LWM of the emission.

Fugitive Emissions - Control on-site dust at acceptable levels with the methods discussed in **LM-113-6**  . Fugitive dust emissions at the site boundary must not cause a public nuisance. RI verbally notifies E&LS-LWM if it appears that the on-site opacity level or emissions at the site boundary exceed the acceptable levels.

Note
Coal ash fugitive dust observation/recordkeeping/ notification responsibilities are also addressed by the Plant and E&LS-AQ in the D E Karn 1 & 2 AQ-100 Air Quality Requirements. See **AQ-140 - Ash Storage and Handling**

VERTICAL OR HORIZONTAL EXPANSIONS

Fill Area Changes - Vertical or horizontal expansions of the ash landfill beyond **permitted** limits are not allowed.

LIMITED DISPOSAL

Solid Waste Disposal under the existing operating license is limited to coal ash only (except waste streams permitted under Part 31 of NREPA and NPDES). RI shall ensure that solid wastes other than coal ash are not permitted within the boundaries of the licensed solid waste disposal area. Additionally, dike materials other than bottom ash, rock, broken concrete, or uncontaminated soil are not permitted.

Consumers Energy Environmental Manual	Subject # : **LM-113-3** Subject Topic: **Engineering Plan - Fill Parameters** Procedure # : **LM-100** Procedure Title: **Solid Waste Requirements** Issue Date: **03/26/2009**

Location(s): Karn DE 1&2

SUMMARY

Described are the fill parameters RI assures for ash placement and compaction in Areas A-F determined from an initial test fill of fly ash. If conditions warrant, another test fill will determine new fill parameters.

BASIS

- Engineering Plan dated 08/29/86 (Appendix C, Division II, Section 3.0, "Test Fill").
- J K Dunn, RPE, established initial fill parameters in his 06/29/87 letter to G A Dawson.

INITIAL TEST FILL

Results set the fill parameters at:

- **Optimal Ash Moisture Content -** 25 ± 6% assures eventual compaction of 75-80 pcf dry density.
- **Optimal Lift Thickness and Acceptable Variance -** 30 ± 6 in.
- **Equipment -** A Caterpillar D-6 with 22 in wide pads or its equivalent making a minimum of 6 passes over the subject area.
- **Dry Density -** If equipment cannot achieve 75-80 pcf, conduct additional testing and measurement to evaluate appropriate geofabric or specialized subgrade stabilization techniques to achieve it.
- RI files a copy of the fill parameters in the engineering record maintained by RL for agency inspection.

SUBSEQUENT TEST FILLS

Altered Conditions - RI confers with RPE and conducts another test fill to set new fill parameters if:

- New coal source changes ash characteristics
- Measurements indicate deviation from parameters of initial test fill:
  - Moisture Content - see above and subject **LM-113-4**
  - Lift Thickness - see above and subject **LM-113-4**
  - Equipment - see above
  - Dry Density - see above and subject **LM-113-4**

Consumers Energy Environmental Manual	Subject # : **LM-113-4** Subject Topic: **Engineering Plan - Fly Ash Placement and Testing** Procedure # : **LM-100** Procedure Title: **Solid Waste Requirements** Issue Date: **03/26/2009**

Location(s): Karn DE 1&2

SUMMARY Described are RI's testing responsibilities to assure compliance with the Engineering Plan and the parameters established by the test fill (subject **LM-113-3**) for fly ash placement and compaction, moisture content and density testing.

BASIS

- Part 115 of NREPA
- Engineering Plan dated 08/29/86 - (Appendix C, Division II, Section 3.0 “Test Fill”, and Division III, Section 3.0 “Field Testing”, Section 5.0 “Moisture Content Determination” and Section 7.0 “Test Frequency Alteration”)
- MDOT Procedure 8.01.03 Material Details
- Solid Waste Disposal Area License No 7558, issued 03/15/89 Stipulation No 2.

PLACEMENT AND COMPACTION RECORDS

Responsibility	ACTION
RI	1. Assure contractor places and compacts fly ash correctly and keeps appropriate records. Application Appendix C, Division II, contains additional (non-recordkeeping) requirements.
Contractor	2. Keep appropriate records and inform the RI of the location of soft spots and the thickness of bridging materials installed (limited to a 3-ft depth loose measure).
RI	3. Review record containing these data; take appropriate action, if required, and transmit record to RL for filing.
RL	4. Maintain records documenting the location of active work areas and their progression around the fill, including: a. Location b. Size (limited to 2-3 acres) c. Date of initiation d. Depth of individual lifts (maximum 3 ft) e. Angle of interior slopes of lift (limited to 1 on 4) f. Data on moisture content conducted by RL

g. Data on in-place density conducted by RL
h. Date and type of corrective measures taken to arrive at approved moisture/density figures
i. Maximum elevation (limited to 13 ft above previously finished grade)
j. Date of lift completion
k. Date of temporary cover installation
l. Date of final cover installation
m. Location and disposition of temporary roadways
n. The location and dimensions of runoff retention and diversion facilities such as ditches, culverts and tiles.

5. Maintain records throughout ash placement and compaction process for on-site inspection by MDEQ or Consumers Energy personnel.

RI

6. Provide copies of these records to E&LS-LWM at the same time as the ash area survey and volume calculations subject **(LM-113-2).**

MOISTURE CONTENT MEASUREMENT

RI - Assures that all measurements and reports on fly ash moisture content conform with this procedure and its basis requirements.

Measurements

- During ash placement activities
  - one sample for every 5000 cubic yards trucked from the silos for disposal
  - one sample for every 5000 cubic yards of stockpiled fly ash dredged from the lagoon.
  - Testing increments may be altered subject to Engineering Plan, Appendix C, Division III, Section 3.0.

- Samples
  - silo storage taken directly from the loaded truck
  - stockpiled fly ash from the core as well as the surface of the stockpile.

- Test per standards
  - ASTM D 2216-80, “Laboratory Determination of Water (Moisture) Content of Soil Rock, and Soil-Aggregate Mixtures”
  - MDOT “The Interim Method of Test for Determination of Moisture in Soils by Means of a Calcium Carbide Gas Pressure Meter (AASHO Designation T217-671).

RL - assures that the following records are kept:

Reports

- Annual log with separate testing data for
  - conditioned silo ash in 5000 cubic yard increments
  - stockpiled fly ash in 5000 cubic yard increments

- Records include
  - date of sampling
  - initials of person taking the sample
  - date of testing
  - initials of person performing the test

- method of testing
- moisture content and variance from the optimum water content as determined by the test fill

- If the moisture content exceeds the allowable variance from the optimum (25 ± 6%), note
  - the methods used to correct this apparent difference
  - the results of a satisfactory test to demonstrate compliance with the moisture parameter

- Provide log to E&LS-LWM with the dike and fill measurement survey and fill volume assessment (subject **LM-113-2**) according to the same timetable. Maintain a copy of this log for MDEQ review.

IN-PLACE DRY DENSITY TESTING

RI - assures:

- field testing for in-place density performed and reported per this procedure and its basis requirements

- field testing performed on a specified, incremental basis

- Consecutive tests average between 75-80 pcf, with no single test below 72 pcf.
  - averages greater than 80 pcf are permissible, but indicate unnecessary compaction.

Measurement

- During ash placement, test in-place fill with fill elevation and depth of sample recorded. Minimally obtain:
  - one in-place density test for every 5000 cubic yards of ash placed
  - one in-place density test for every 4 ft of fill, measured vertically.
  - If a single test fails acceptance criteria, take two additional tests in the immediate vicinity. If the two additional tests are acceptable, ignore but report the first test result.
  - Alter test frequency if experience indicates, under the criteria in Engineering Plan, Appendix C, Division III, Section 7.0.

- Use one of the following methods:
  - ASTM D 2922-81 (Method B) “Density of Soil and Soil-Aggregate in Place by Nuclear Method (shallow depth)”
  - ASTM D 2937-71 (1976) “Density of Soil in Place by the Drive-Cylinder Method”
  - ASTM D 2167-66 (1977) “Density of Soil in Place by the Rubber Balloon Method”
  - ASTM D 1556-64 (1974) “Density of Soil in Place by the Sand-Cone Method”

RL maintains the following records:

Reports

- An annual log detailing, in separate categories for 5000 cubic yard increments, and for lifts of 4 ft measured vertically:

- location of test samples
- elevation of fill surface
- depth of sample from fill surface
- moisture content
- dry density
- test method
- initials of person performing sampling and/or testing

- If a density test does not meet acceptance criteria, include:
  - results of additional tests
  - corrective action taken, if indicated

- Provide log to E&LS-LWM with the annual dike and fill survey fill volume assessment (subject **LM-113-2**). Maintain a copy of this log for MDEQ review.

Consumers Energy Environmental Manual	Subject # : **LM-113-5** Subject Topic: **Engineering Plan - Fly Ash Physical Characteristics** Procedure # : **LM-100** Procedure Title: **Solid Waste Requirements** Issue Date: **03/26/2009**

Location(s): Karn DE 1&2

SUMMARY

Described are RI responsibilities for scheduling testing and documentation, RL recordkeeping responsibilities, and RPE review responsibilities to assure fly ash physical parameters are consistent.

The intent is not to compare the test parameters against established acceptance criteria for the fill, but rather is an operational check on the efficiency of ash handling/processing equipment at the Plant which is responsible for the physical characteristics of ash. This is not a control procedure.

BASIS

Engineering Plan dated 08/29/86 (Appendix C, Division III, Section 4.0 "Laboratory Testing" and Section 7.0 "Test Frequency Alteration").

MEASUREMENTS

- Directly from the fly ash silo or hopper: RI schedules test
  - at least once per year
  - at least once for every 15 ft of fly ash over entire fill area
  - when there is a significant change in coal blending or supply as determined by the Plant
  - when there is a reason to suspect that fly ash characteristics are significantly different from those used in design
  - alter test frequency if experience indicates per Engineering Plan, (Appendix C, Division III, Section 7.0)
- Determine
  - Particle size of fly ash (ASTM D 422-63 [1972]), "Particle Size Analysis of Soils"
  - Specific gravity of fly ash (ASTM D 854-58 [1979]), "Specific Gravity of Soils"
  - Moisture-density relationship of fly ash (ASTM D 698-78, "Moisture-Density Relations in Soils and Soil-Aggregate Mixtures Using 5.5 lb Rammer and 12-in Drop")
  - Triaxial (CID) Test for fly ash (Bishop, AW, and Henkel, DJ, "Measurement of Soil Properties in the Triaxial Test," Part III, Section IV - Isotropically Consolidated Drained Triaxial (Shear [CID] Test, 1957, Edward Arnold Publisher Ltd, London). Conduct the triaxial test with an effective consolidation pressure of 1 tsf and a dry density of 72 pcf.

REPORTS

- RL maintains a copy of all test results; specifically:
  - particle size.
  - specific gravity moisture-density relationships
  - triaxial test results
  - date of sample

- initials of person taking the sample
- initials of person performing the analyses

- RL maintains a copy of all results, segregated on an annual basis, for MDEQ inspection. Submit a copy of annual results to E&LS-LWM together with and at the same time as annual fill and fill volume estimates (subject **LM-113-2**).

RPE REVIEW

RPE reviews the results of all tests to determine whether or not the tested parameters continue to fall within the ranges required by the design of the fly ash structural fill. The RPE may also order additional test fills to assure in-place density is maintained in circumstances where changes in fly ash quality are experienced or anticipated; eg, in a test burn involving changes in fuel and/or modified air pollution control equipment.

Consumers Energy Environmental Manual	Subject # : **LM-113-6** Subject Topic: **Engineering Plan - Fugitive Dust Control** Procedure # : **LM-100** Procedure Title: **Solid Waste Requirements** Issue Date: **03/26/2009**

Location(s): Karn DE 1&2

SUMMARY

Described are **RI** responsibilities to assure and document the implementation of fugitive dust control measures by the contractor and Plant personnel.

BASIS

Engineering Plan dated 08/29/86 (Appendix C, Division V "Fugitive Dust Control.") See this document for detailed procedures. This procedure (subject **LM-113-6**) addresses only those activities for which records must be kept.

Note
Coal ash fugitive dust observation/recordkeeping/ notification responsibilities are also addressed by the Plant and E&LS-AQ in the D E Karn 1 & 2 AQ-100 Air Quality Requirements. See **AQ-140 - Ash Storage and Handling**

ACTIVITIES

- Record indicated data for each activity:
  - Strategically install an agricultural irrigation system on active areas to prevent dusting as conditions require. Record location, date of installation, and date and time of use.
  - Install temporary and final cover to prevent fugitive dusting. Document location, date, etc.
  - Visually inspect twice daily for fugitive dust on active work areas within the solid waste disposal area. Document work area-location, date, time and initials of person performing inspection.
  - Document corrective action taken if fugitive dust formation occurs, including sprinkling, setting of wind screens, application of cover material, application of control chemicals, cessation of work and other methods and file this report as required under the "Report" section of this procedure below..
  - Document the availability of an on-site sprinkler truck. Keep a sprinkler truck on standby at all times.
  - Document the use of Coherex and other dust stabilizing chemicals on roads. Apply a minimum of every 6 months during the construction season at a rate of 1 gallon of 1:7 coherex/water per square yard.
  - Document cessation of dust generating activities when daily average wind speed exceeds 25 mph.
  - Document fugitive dust inspection by Plant personnel.
  - Contractor shall cease operations if generating fugitive dust.

REPORT

- Document the performance of fugitive dust control measures per occurrence by contractors or Plant personnel.
  - RL shall maintain report on-site for inspection by MDEQ or Consumers Energy personnel.

- Provide a copy of these records to E&LS-LWM annually, together with the ash area survey and volume calculations (subject **LM-113-2**).

Consumers Energy Environmental Manual	Subject # : **LM-113-7** Subject Topic: **Engineering Plan - Freeboard and Dike Monitoring** Procedure # : **LM-100** Procedure Title: **Solid Waste Requirements** Issue Date: **03/26/2009**

Location(s): Karn DE 1&2

SUMMARY

Described are **RI** responsibilities for ash pond dike inspections and for monitoring adequate freeboard.

BASIS

Freeboard - Part 115 NREPA, Rule R299.4309(5)

Dike Inspection - Part 115 NREPA, Rule R299.4309(6)

ADEQUATE FREEBOARD

- Maintain enough freeboard to prevent any overtopping of the dike by overfilling, wave action, or a storm, but not less than 2 ft at any time.
  - Monitor ash pond water level at least weekly to assure maintenance of required freeboard.
  - Monitor more frequently under unusual operating and/or meteorological conditions that may infringe on the required freeboard.
  - Assure that freeboard monitoring data are recorded in a log and maintained in the engineering record.

DIKE INSPECTION

- Maintain protective cover (grass or rock) on the earthen dike to minimize wind and water erosion and to preserve structural integrity.
  - Inspect ash pond dikes for protective cover at least weekly to detect deterioration or failure.
  - Assure all dike inspections are recorded in a log and maintained in the engineering record as part of RL files.

Consumers Energy Environmental Manual	Subject # : **LM-113-8** Subject Topic: **Engineering Plan - Final Cover Installation and Certification** Procedure # : **LM-100** Procedure Title: **Solid Waste Requirements** Issue Date: **03/26/2009**

Location(s): Karn DE 1&2

SUMMARY

Described are the responsibilities of the RPE and the RI, under the supervision of the RPE, to assure that final cover is placed and certified as required in the bases provided below.

BASIS

- approval of alternate final cover, D E Karn Operating License No 8088, issued 8/2/93, Condition J.1-5, Interim and Final Cover for Active Fill Areas.
- Requires placement of final cover as described in J C Weadock Construction Permit No 0260, Condition C.1.m, issued 4/21/92, which states:

  "m. R 299.4316(3) A conditional variance to the use of final cover materials described in R 299.4305(10) is granted. The permittee shall instead use a tiled bottom ash/topsoil as final cover, seeded and stabilized in accordance with R 299.4316(6). Final cover installation is detailed in J C Weadock Ash Disposal Area Construction Permit Application and Support Documents, Appendix B, Division IV, Temporary and Final Cover, Installation, Stabilization and Maintenance. Compaction would be limited to that which would occur during normal spreading and grading of the final cover material.

  This variance will remain in effect only so long as the groundwater monitoring required by Condition D of this permit and that required by Determination of Permit Exemption No. GWE-0005 issued by the Water Resources Commission on August 21, 1986 does not show a change in the discharge that will adversely impact on the quality of the groundwater or surface waters of the State."
- Requires certification of the final cover by a registered professional engineer.

PLACEMENT AND COMPACTION RECORDS

Responsibility	ACTION
RPE	1. Assure contractor installs the final cover in conformance with the J C Weadock Engineering Plan, Appendix B.
	2. Division IV - Temporary and Final Cover Installation, Stabilization and Maintenance (see **LM-150-C** of this procedure) and assure appropriate records are kept. Certify, under seal, drawings of those areas that have received final cover.

3. Maintain a record containing these data and certify those areas closed during the period of the operating license.

RPE and RI

4. Maintain records documenting the location of final cover areas and their progression around the fill, including:

    a. Location
    b. Size (drawing)
    c. Date of initiation
    d. Verification of 18" less than or equal to cover depth
    e. Angle of slope (to 1 on 4)
    f. Location of tile
    g. Verification of horizontal tile slope (1%)
    h. Location and view of typical tie-ins for vertical tile in "environmental ditch"
    i. Specification for seed, mulch, lime and fertilizer applied
    j. Irrigation record
        - Certification of fully vegetated final cover
        - Dates of maintenance fertilization and liming

5. Maintain final cover records throughout the life of the facility for on-site inspection by MDEQ or Consumers Energy personnel.

RPE

6. Provide copies of these records to the RL, and E&LS-LWM at the time of relicensing.

Consumers Energy Environmental Manual	Subject # : **LM-114** Subject Topic: **Perpetual Care Trust Agreement - Quarterly Deposits** Procedure # : **LM-100** Procedure Title: **Solid Waste Requirements** Issue Date: **03/26/2009**

Location(s): Weadock JC

SUMMARY Described are responsibilities for making quarterly deposits to the Perpetual Care Fund for closure, monitoring, maintenance or response activities of the ash disposal area.

BASIS Make deposits of 7.5 cents per ton of disposed coal ash.

REFERENCES

- Part 115 of NREPA, Section 11525(3)(a).
- The Perpetual Care Fund Trust Agreement (10/30/90; revised 8/14/97).

BUDGETING The **RI** budgets for funding the Perpetual Care Fund based on deposit history.

Responsibility	ACTION
AUS	1. Send a copy of the Quarterly Coal Ash Sales/Perpetual Care Fund Report to the E&LS-LWM within 15 days after the end of the calendar quarter.
E&LS-LWM	2. Send the Payment Request form to Treasury within 28 days after the end of the calendar quarter for First Trust National Association (successor trustee) for the amount calculated. The Payment Request form will require that the money be wired no later than 30 days after the end of the calendar quarter.
	3. Provide copies of the Payment Request form and the Quarterly Ash Sales/Perpetual Care Fund Report to the RI and RL and to E&LS-ED File P08.5.

Consumers Energy Environmental Manual	Subject # : **LM-116** Subject Topic: **Solid Waste Program - Surcharge** Procedure # : **LM-100** Procedure Title: **Solid Waste Requirements** Issue Date: **03/26/2009**

Location(s): Weadock JC

SUMMARY Described are responsibilities for providing the basis for the Plant's payment of the annual MDEQ Solid Waste Surcharge and paying the resultant surcharge .

BASIS The NREPA section referenced below requires an annual fee of $3,000 if more than 100,000 cubic yards are disposed of in a landfill, a fee of $2,500 for 75,000 to 100,000 cubic yards, $2,000 for 50,000 to 75,000 cubic yards, $1,000 for 25,000 to 50,000 yards, and $500 for less than 25,000 yards. The annual fee, while based on the volume of ash landfilled during the past state fiscal year, is actually a fee on anticipated ash to be disposed of in the next state fiscal year.

REFERENCE

- NREPA, Part 115, Section 11525a(6)(b)(i)-(iii)

BUDGETING RP budgets for payment of the Surcharge based on last year's surcharge adjusted, if necessary, for Plant planned outage projections.

Responsibility	ACTION
E&LS-LWMD	1. Use Ash Sales Report (AKA Coal Ash Coordination Report) to calculate tonnage of ash disposed in landfill during previous state of Michigan fiscal year (October 1-September 30). Convert to cubic yards by dividing by 0.972 conversion factor for Consumers fly ash. Complete and sign "Surcharge Worksheet for Captive Type III Facilities" and Transmit to RI no later than December 1.
RI	2. Assure the Plant pays the Surcharge to MDEQ-WHMD no later than January 31 of the next year. • Maintain a copy of worksheet and check in solid waste operating file. • Send copy of check to E&LS-LWMD for their file.

Location(s): Weadock JC

1. To view the Checklist, Microsoft Word must be installed on your computer. Double click on the icon, and then click on launch in the Properties for Attachment box.

2. To print the file, press Ctrl P and select OK.

3. To return to this procedure, exit Microsoft Word by clicking on the "X" in the upper right corner of the screen.

   a. Operating License No 9022

Operating_License_9022.d

Consumers Energy

A CMS Energy Company

Environmental & Laboratory Services

August 2, 2010

Mr. Thomas Fox
Waste and Hazardous Materials Division
Department of Natural Resources and Environment
Saginaw Bay District Office
401 Ketchum St, Suite B
Bay City, Michigan 48708

SUBJECT: Vegetation Management Plan
DE Karn Surface Impoundment Landfill/
JC Weadock Surface Impoundment Landfill
Bay County: WDS#392503

Dear Mr. Fox:

Please find the attached Interim Vegetation Management Plan for DE Karn and JC Weadock as requested in your June 30, 2010 letter and commensurate with our understanding for an acceptable plan documented in Consumers' July 15, 2010 letter. The attached plan for each facility addresses the agreed upon elements for the vegetation management plan and provides a schedule and map delineating areas to be addressed. In addition to the each plan, Consumers Energy is providing a clarification letter from AECOM that addresses recommendations for tree removal at the DE Karn and JC Weadock facilities.

If you have any questions regarding this plan, feel free to contact me by phone or email.

Sincerely,

Harold D. Register

Harold D. Register, Jr., P.E.
Sr. Engineer
Land and Water Management
Phone: (517) 788-2982
Email: hdregister@cmsenergy.com

cc: Richard G. Hall, CEC – DE Karn/JC Weadock

Interim Vegetation Management Plan for DE Karn Landfill
July 29, 2010

Site Description

The DE Karn Landfill is located north of the DE Karn Power Plant which consists of two coal burning units, Units 1&2, and two oil and gas co-fired units, Units 3&4. Units 1&2 were constructed in the late 1950's and were put into service in 1959 and 1961, respectively. The DE Karn Solid Waste Disposal Area covers approximately 174 acres, and has a perimeter of 3.1 miles that also serves as access roads. The solid waste disposal area is bordered by the intake channel to the southwest, the Saginaw River to the northwest, Saginaw Bay to the north and northeast, the discharge channel to the southeast and the remaining perimeter is bordered by CEC property. In 2009, sluicing of fly ash was ceased at the DE Karn facility. Fly ash is now disposed of in dry placement methods where ash is blown to a silo then conditioned to 15-25% moisture content to prevent fugitive dust and aid in the compaction. This mixture is finally trucked to an active fill area of the landfill.

Vegetation Management on the Landfill

This plan's intent is to develop a procedure for mowing, phragmites eradication, and small woody brush removal for the perimeter dikes, perimeter ditches, and the elevated slopes of fill. Perimeter ditches are the ditches running parallel with the dike road to allow for runoff conveyance. The elevated slopes of fill are the slopes of fill that are completed sections of fill with the approved alternative final cover in place.

1.0 Perimeter Dikes

Woody Growth Removal

According to the Potential Failure Modes Analysis Report dated October 30, 2009 the PFMs 12, 19, 28, 36, and 45: Existing Trees Growing on Perimeter Dike Falling or Rotting Leads to Slope Instability and Loss of Containment was deemed a Category IV by the Core Team. A Category IV failure mode is a mode/mechanism that is categorically ruled out because the physical possibility does not exist, information came to light which eliminated the concern that had generated the development of the potential failure mode, or the potential failure mode is clearly so remote as to be non-credible or not reasonable to postulate. However, removal of dense vegetation, such as phragmites and thick stands of trees, was a recommendation to allow for adequate inspection of the dike structure implemented through a vegetation management plan. This recommendation is further clarified by AECOM correspondence dated July 22, 2010 and appended to this report.

Small woody growth consisting of brush and small trees (4 inches in diameter and less) will be cut flush with the ground and will be treated with a waterproof preservative to prolong root ball and stump decay. This will be the approach for the first year; the successive year's specific removal specification will be developed and reported within the site's Vegetation Management Section of the Surveillance Monitoring Plan which will be completed by the end of Fourth Quarter of 2010.

Mowing or Mechanically Removed

Once the small woody growth on the perimeter dikes has been removed, the perimeter dike slopes without rip rap should be mowed twice a year with one mowing scheduled for spring after

initiation of new spring growth and the second mowing schedules for late fall shortly prior to the first killing frost or freeze. The spring mowing should be a very close cutting of all vegetation to allow maximum sunlight to penetrate to desirable grass cover species. The fall cutting should not be as close as the spring cutting to provide maximum resistance to surface runoff erosion and to provide cover for wildlife species. For perimeter dikes along the waterfront that are covered with riprap, removal of small woody growth will begin in 2010 and be completed no later than the end of 2014. Areas that have been previously cut and/or treated will be inspected annually and maintained as needed to control the growth of small woody vegetation and phragmites.

2.0 Perimeter Ditches

Inspection and Cleaning:

All perimeter ditches should be cleaned and cleared of undesirable vegetation in 2010. In subsequent years the perimeter ditches will be inspected and semiannually cleaned for unobstructed flow and/or cleared of woody growth and phragmites as necessary.

3.0 Elevated Slopes of Fill

Mowing:

All elevated slopes of fill should be mowed twice a year with one mowing scheduled for spring after initiation of new spring growth and the second mowing schedules for late fall shortly prior to the first killing frost or freeze. The spring mowing should be a very close cutting of all vegetation to allow maximum sunlight to penetrate to desirable grass cover species. The fall cutting should not be as close as the spring cutting to provide maximum resistance to surface runoff erosion and to provide cover for wildlife species.

Woody Growth Removal:

Any small woody growth on the elevated slopes of fill is undesirable because the growth is intersecting the final or temporary final cover of the landfill, and should be removed in a timely fashion. Small bushes and trees with diameters less than 4 inches should be removed including the root ball; the cavity should be backfilled with bottom ash and seeded with approved final or temporary cover seed mix.

4.0 Phragmites Control for Sections 1.0 – 3.0

Research:

Dikes infested with invasive phragmites which have stems that are tan, rough, dull and rigid opposed to the native phragmites which have reddish stems in the spring and summer which are shiny, flexible and smooth. Invasive phragmites can reach 15 feet in height and have green foliage during the growing season with purple-brown-silver seed head plumes that appear by late July. A mature plant can produce up to 2,000 seeds annually; therefore management will be a continuing effort due to the availability of seeds around the landfills.

Phragmites spread through rhizomes, horizontal stems growing underground, which can grow more than 6 feet per year and can penetrate to a depth of more than 6 feet. Thus with such an expansive root system, the use of an herbicide treatment is necessary.

Interim Vegetation Management Plan for DE Karn Landfill
July 29, 2010

The Michigan Department of Natural Resources and Environment (MDNRE) *A Guide the Control and Management of Invasive Phragmites* recommends using imazapyr or glyphosate for herbicide treatment, or a combination of the two. Typically imazapyr containing herbicide treatment is more effective during the months of June or July to allow for absorption during the primary growth period. Glyphosate is most effective while the phragmites are in full bloom in late August until the first frost. A combination of the two products may be used while the phragmites are full bloom in late August until the first frost; the combination of the two products allow for a cost effective application. Once the phragmites have been treated, it may take several weeks for any visual signs of absorbance to become apparent.

It is also recommended to mechanically control the growth of phragmites in parallel with herbicides. Due to the slow absorption of the herbicide by the phragmites it is recommended to allow for 2-3 weeks after application to mow the phragmites.

Please note that pesticide use certification is required prior to the use of imazapyr and recommended prior to the use of glyphosate; a pesticide use certification can be obtained through the Michigan Department of Agriculture. Permits are required in Michigan when applying herbicide to phragmites in standing water or below the ordinary high-water mark of the Great Lakes.

Implementation:
Short Term:
Before extensive herbicide treatment is implemented, test plots located on the elevated slopes of fill and perimeter ditches, as shown on the attached map, will be sprayed this fall while the phragmites are in full bloom. After ample time to allow for absorption has passed, mowing of the test plots will take place.

The one acre test plot will begin just past windy point along the northeastern side of Pond A extending along Pond B. The area shown on the map is an estimate, and the actual test plot will be located so mowing after treatment is possible.

Long Term:
Areas of dense phragmites stands will be mechanically removed or mowed once or twice a year along the perimeter dikes, perimeter ditches and elevated slopes of fill to allow for native vegetation to receive ample sunlight to compete against the remaining phragmites seeds. Areas of phragmites will be treated with herbicide in either the main growing season (June-July) or when the phragmites are in full bloom (late August to first frost).

Interim Vegetation Management Plan for DE Karn Landfill
July 29, 2010

Implementation Schedule

Elements of this plan implemented in calendar year 2010 are as follows:

INTERIM VEGETATION PLAN - CALENDAR YEAR 2010	Start Date
Manage grassy and small woody vegetation on elevated slopes of fill	Q3 2010
Manage grassy and small woody vegetation from perimeter ditches	Q3 2010
Manage small woody growth on perimeter dikes beginning in areas as indicated on the provided map.	Q3 2010
Implement phragmites test plot areas	Q3 2010
Submit supplemental plan addressing large trees	12/31/2010

Upon review and acceptance of the supplemental plan addressing large trees, Consumers Energy will proceed as follows:

Calendar Year 2011 – 2012: Remove some or all large trees per accepted supplemental plan on the dikes at JC Weadock starting with the area around Pond P3 (Pond F) then proceeding with dike slopes adjacent to the discharge channel or Saginaw Bay shoreline and the finally addressing the area along the Tacey and Underwood Drains.

Calendar Year 2013 – 2014: Remove some or all large trees per accepted supplemental plan on the dikes at DE Karn starting with the inlet channel and then working clockwise around the land disposal area along the Saginaw Bay shoreline to the discharge channel.

					DR. M. Walter	DATE 7/10
					CK.	
					APP. SECTION HEAD	
					APP. DIVISION HEAD	
	DATE	DESCRIPTION	BY	APP	APP. DEPARTMENT HEAD	

Consumers Energy

JACKSON, MICHIGAN

DE Karn Landfill

Interim Vegetation Management Plan Aerial Map

SCALE	DRAWING NO.	SHEET	REV.
JOB			

AECOM
1050 Wilson Street
Marquette, Michigan 49855

906.228.2333 tel
906.226.8371 fax

July 22, 2010

Mr. Harold Register, Jr., P.E.
Consumers Energy Company
1945 West Parnall Road
Jackson, Michigan 49201

Re: Clarification Letter, Tree Removal Recommendations, Karn and Weadock Ash Landfill Facilities, Essexville, Michigan

AECOM is providing this letter clarifying our recommendations related to the forthcoming vegetation management plan for the Karn and Weadock Ash Landfill facilities in Essexville, Michigan.

Background and Purpose

In 2009 AECOM performed Potential Failure Modes Analysis (PFMA) on both the Karn and Weadock facilities. The results of the PFMA were summarized in two reports dated October 30, 2009 for Karn and November 6, 2009 for Weadock. The PFMA process was successful in assessing the risks to the project relative to ash containment and identifying recommended actions to reduce those risks. One of the risk reduction recommendations was to develop a vegetation management plan as follows:

> "The presence of trees, shrubs and tall grasses are preventing adequate inspection of the perimeter dike slopes and functioning of the perimeter storm water ditch. We recommend a vegetation maintenance plan be developed to include the removal of trees, stumps and shrubs, and periodic mowing of grass on the downstream side of the perimeter dikes and within the perimeter storm water drainage ditch."

The PFMA report also identified the risk of a tree falling or rotting, which leads to a loss of ash containment, to be negligible or a Category IV failure mode. For these Category IV failure modes, the PFMA report indicated that, "although there are many trees growing on the slopes, it is unlikely that even a large tree uprooting would cause sufficient dike instability to cause a slope failure and loss of containment."

Since the publication of our report, Consumers Energy Company (CEC) has developed a draft vegetation management plan for review and comment from the Michigan Department of Natural Resources and Environment (MDNRE), which includes the possibility of maintaining some trees on the perimeter dike slopes. In the previous letter dated June 30, 2010, the MDNRE indicated "all trees, including large trees, should be removed at both the Weadock site and Karn site due to the recommendation in the [AECOM] inspection reports and the risks they pose to dike integrity." At the request of CEC, AECOM has prepared this letter clarifying the risks trees pose to perimeter dike stability and adequate dike observations and inspections.

Discussion

The recommendation contained within the AECOM PFMA regarding the removal of the trees is related to standard practice for dams (water retaining structure). Typically, a tree falling or rotting failure mode in a water-retaining embankment dam would be categorized as a Category I or II failure mode, which indicates the failure mode is credible. Since the bulk of the perimeter dikes at the Karn and Weadock facilities are historic dikes along the outer limits of the landfill, and are not water retaining dams, the risk of loss of ash containment related to falling or rotting trees was found to be

non-credible or a Category IV failure mode. Therefore, from the perspective of perimeter dike safety and ash containment, trees were found to not pose a threat to the Karn or Weadock facilities.

Although the trees were not found to pose a risk to dike integrity, the trees (along with other growth) were found to contribute to the inability to adequately inspect the dike slopes for signs of erosion, animal burrows, slumps, seeps, or other potential signs of dike degradation. Therefore, the recommendation contained within the AECOM reports to remove the trees was related to adequate inspection and not to the risk of loss of ash containment.

Conclusions

Provided the trees can be maintained to allow inspection of the dike slopes, it is our opinion that the majority of the trees on the perimeter dike slopes can remain in place for aesthetic or other purposes. In consideration of the facts discussed above, we recommend that the vegetation management plan include the following measures:

- Removal of trees and stumps from the perimeter dike slopes that can be considered to be the equivalent of dams or that retain standing water
- Removal of trees from perimeter storm water drainage ditches
- If CEC wishes to leave some trees in place in select locations, then any remaining trees should be pruned as needed to allow visual inspection of the perimeter dike slope around the tree trunk

We appreciate the opportunity to provide our engineering services for this project. Please contact Jamie Matus if you have any questions regarding the information contained within this letter.

Sincerely,

Carrie Grudzinski for

Michael D. Carpenter, P.E.
Senior Project Engineer

Jamie Matus, P.G.
Vice President

MDC/skd

Interim Vegetation Management Plan for JC Weadock Landfill
July 29, 2010

Site Description

The JC Weadock Landfill is located east of the JC Weadock Power Plant which consists of Units 1-8. The plant first generated power in 1940, and eventually consisted of six coal burning units, which were retired in 1980. Two additional units, Unit 7&8, were added in 1955 and 1958 and continue to operate. The JC Weadock Solid Waste Disposal Area covers approximately 292 acres, and has a perimeter of 4.85 miles that also serves as access roads. The solid waste disposal area is bordered by the discharge channel to the north, Saginaw Bay to the northeast, the Tacey and Underwood Drains to the southeast and east directions, and the remaining perimeter is bordered by CEC property. In 2008, a soil bentonite slurry wall was installed within the clay dike and keyed into the hydraulically confining glacial clay till layer to cut off groundwater flow through the perimeter dike. In 2009, sluicing of fly ash was ceased at the JC Weadock facility; fly ash is now disposed of in dry placement methods where ash is blown to a silo then conditioned to 15-25% moisture content to prevent fugitive dust and aid in the compaction. This mixture is finally trucked to an active fill area of the landfill.

Vegetation Management on the Landfill

This plan's intent is to develop a procedure for mowing, phragmites eradication, and small woody brush removal for the perimeter dikes, perimeter ditches, and the elevated slopes of fill. Perimeter ditches are the ditches running parallel with the dike road to allow for runoff conveyance. The elevated slopes of fill are the slopes of fill that are completed sections of fill with the approved alternative final cover in place.

1.0 Perimeter Dikes

Woody Growth Removal

According to the Potential Failure Modes Analysis Report dated November 6, 2009 the PFM 25 Existing Trees Growing on Perimeter Dike Falling or Rotting Leads to Slope Instability and Loss of Containment was deemed a Category IV failure mode by the Core Team. A Category IV failure mode is a mode/mechanism that is categorically ruled out because the physical possibility does not exist, information came to light which eliminated the concern that had generated the development of the potential failure mode, or the potential failure mode is clearly so remote as to be non-credible or not reasonable to postulate. However, removal of dense vegetation, such as phragmites and thick stands of trees, was a recommendation to allow for adequate inspection of the dike structure implemented through a vegetation management plan. This recommendation is further clarified by AECOM correspondence dated July 22, 2010 and appended to this report.

Small woody growth consisting of brush and small trees (4 inches in diameter and less) will be cut flush with the ground and will be treated with a waterproof preservative to prolong root ball and stump decay. This will be the approach for the first year; the successive year's specific removal specification will be developed and reported within the site's Vegetation Management Section of the Surveillance Monitoring Plan which will be completed by the end of Fourth Quarter of 2010.

Mowing or Mechanically Removed

Once the small woody growth on the perimeter dikes has been removed, the perimeter dike slopes without rip rap should be mowed twice a year with one mowing scheduled for spring after initiation of new spring growth and the second mowing schedules for late fall shortly prior to the first killing frost or freeze. The spring mowing should be a very close cutting of all vegetation to allow maximum sunlight to penetrate to desirable grass cover species. The fall cutting should not be as close as the spring cutting to provide maximum resistance to surface runoff erosion and to provide cover for wildlife species. For perimeter dikes along the waterfront that are covered with riprap, removal of small woody growth will begin in 2010 and be completed no later than the end of 2012. Areas that have been previously cut and/or treated will be inspected annually and maintained as needed to control the growth of small woody vegetation and phragmites.

2.0 Perimeter Ditches

Inspection and Cleaning:

All perimeter ditches should be cleaned and cleared of undesirable vegetation in 2010. In subsequent years the perimeter ditches will be inspected and semiannually cleaned for unobstructed flow and/or cleared of woody growth and phragmites as necessary.

3.0 Elevated Slopes of Fill

Mowing:

All elevated slopes of fill should be mowed twice a year with one mowing scheduled for spring after initiation of new spring growth and the second mowing schedules for late fall shortly prior to the first killing frost or freeze. The spring mowing should be a very close cutting of all vegetation to allow maximum sunlight to penetrate to desirable grass cover species. The fall cutting should not be as close as the spring cutting to provide maximum resistance to surface runoff erosion and to provide cover for wildlife species.

Woody Growth Removal:

Any small woody growth on the elevated slopes of fill is undesirable because the growth is intersecting the final or temporary final cover of the landfill, and should be removed in a timely fashion. Small bushes and trees with diameters less than 4 inches should be removed including the root ball; the cavity should be backfilled with bottom ash and seeded with approved final or temporary cover seed mix.

4.0 Phragmites Control for Sections 1.0-3.0

Research:

Dikes infested with invasive phragmites which have stems that are tan, rough, dull and rigid opposed to the native phragmites which have reddish stems in the spring and summer which are shiny, flexible and smooth. Invasive phragmites can reach 15 feet in height and have green foliage during the growing season with purple-brown-silver seed head plumes that appear by late July. A mature plant can produce up to 2,000 seeds annually; therefore management will be a continuing effort due to the availability of seeds around the landfills.

Phragmites spread through rhizomes, horizontal stems growing underground, which can grow more than 6 feet per year and can penetrate to a depth of more than 6 feet. Thus with such an expansive root system, the use of an herbicide treatment is necessary.

The Michigan Department of Natural Resources and Environment (MDNRE) *A Guide the Control and Management of Invasive Phragmites* recommends using imazapyr or glyphosate for herbicide treatment, or a combination of the two. Typically imazapyr containing herbicide treatment is more effective during the months of June or July to allow for absorption during the primary growth period. Glyphosate is most effective while the phragmites are in full bloom in late August until the first frost. A combination of the two products may be used while the phragmites are full bloom in late August until the first frost; the combination of the two products allow for a cost effective application. Once the phragmites have been treated, it may take several weeks for any visual signs of absorbance to become apparent.

It is also recommended to mechanically control the growth of phragmites in parallel with herbicides. Due to the slow absorption of the herbicide by the phragmites it is recommended to allow for 2-3 weeks after application to mow the phragmites.

Please note that pesticide use certification is required prior to the use of imazapyr and recommended prior to the use of glyphosate; a pesticide use certification can be obtained through the Michigan Department of Agriculture. Permits are required in Michigan when applying herbicide to phragmites in standing water or below the ordinary high-water mark of the Great Lakes.

Implementation:
Short Term:
Before extensive herbicide treatment is implemented, test plots located on the elevated slopes of fill and perimeter ditches, as shown on the attached map, will be sprayed this fall while the phragmites are in full bloom. After ample time to allow for absorption has passed, mowing of the test plots will take place.

The one acre test plot will begin just south of Pond F extending along the old Channel C9. The area shown on the map is an estimate, and the actual test plot will be located so mowing after treatment is possible.

Long Term:
Areas of dense phragmites stands will be mechanically removed or mowed once or twice a year along the perimeter dikes, perimeter ditches and elevated slopes of fill to allow for native vegetation to receive ample sunlight to compete against the remaining phragmites seeds. Areas of phragmites will be treated with herbicide in either the main growing season (June-July) or when the phragmites are in full bloom (late August to first frost).

Implementation Schedule

Interim Vegetation Management Plan for JC Weadock Landfill
July 29, 2010

Elements of this plan implemented in calendar year 2010 are as follows:

INTERIM VEGETATION PLAN - CALENDAR YEAR 2010	Start Date
Manage grassy and small woody vegetation on elevated slopes of fill	Q3 2010
Manage grassy and small woody vegetation from perimeter ditches	Q3 2010
Manage small woody growth on perimeter dikes beginning in areas as indicated on the provided map.	Q3 2010
Implement phragmites test plot areas	Q3 2010
Submit supplemental plan addressing large trees	12/31/2010

Upon review and acceptance of the supplemental plan addressing large trees, Consumers Energy will proceed as follows:

Calendar Year 2011 – 2012: Remove some or all large trees per accepted supplemental plan on the dikes at JC Weadock starting with the area around Pond P3 then proceeding with dike slopes adjacent to the discharge channel or Saginaw Bay shoreline and the finally addressing the area along the Tacey and Underwood Drains.

Calendar Year 2013 – 2014: Remove some or all large trees per accepted supplemental plan on the dikes at DE Karn starting with the inlet channel and then working clockwise around the land disposal area along the Saginaw Bay shoreline to the discharge channel.

Note: Base Image was retrieved from Google Maps

DATE	DESCRIPTION	BY	APP

DR. M. Walter DATE 7/10
CK.
APP. SECTION HEAD
APP. DIVISION HEAD
APP. DEPARTMENT HEAD

Consumers Energy
JACKSON, MICHIGAN

JC Weadock Landfill

Interim Vegetation Management Plan Aerial Map

SCALE	DRAWING NO.	SHEET	REV.
JOB			

AECOM
1050 Wilson Street
Marquette, Michigan 49855

906.228.2333 tel
906.226.8371 fax

July 22, 2010

Mr. Harold Register, Jr., P.E.
Consumers Energy Company
1945 West Parnall Road
Jackson, Michigan 49201

Re: Clarification Letter, Tree Removal Recommendations, Karn and Weadock Ash Landfill Facilities, Essexville, Michigan

AECOM is providing this letter clarifying our recommendations related to the forthcoming vegetation management plan for the Karn and Weadock Ash Landfill facilities in Essexville, Michigan.

Background and Purpose

In 2009 AECOM performed Potential Failure Modes Analysis (PFMA) on both the Karn and Weadock facilities. The results of the PFMA were summarized in two reports dated October 30, 2009 for Karn and November 6, 2009 for Weadock. The PFMA process was successful in assessing the risks to the project relative to ash containment and identifying recommended actions to reduce those risks. One of the risk reduction recommendations was to develop a vegetation management plan as follows:

> "The presence of trees, shrubs and tall grasses are preventing adequate inspection of the perimeter dike slopes and functioning of the perimeter storm water ditch. We recommend a vegetation maintenance plan be developed to include the removal of trees, stumps and shrubs, and periodic mowing of grass on the downstream side of the perimeter dikes and within the perimeter storm water drainage ditch."

The PFMA report also identified the risk of a tree falling or rotting, which leads to a loss of ash containment, to be negligible or a Category IV failure mode. For these Category IV failure modes, the PFMA report indicated that, "although there are many trees growing on the slopes, it is unlikely that even a large tree uprooting would cause sufficient dike instability to cause a slope failure and loss of containment."

Since the publication of our report, Consumers Energy Company (CEC) has developed a draft vegetation management plan for review and comment from the Michigan Department of Natural Resources and Environment (MDNRE), which includes the possibility of maintaining some trees on the perimeter dike slopes. In the previous letter dated June 30, 2010, the MDNRE indicated "all trees, including large trees, should be removed at both the Weadock site and Karn site due to the recommendation in the [AECOM] inspection reports and the risks they pose to dike integrity." At the request of CEC, AECOM has prepared this letter clarifying the risks trees pose to perimeter dike stability and adequate dike observations and inspections.

Discussion

The recommendation contained within the AECOM PFMA regarding the removal of the trees is related to standard practice for dams (water retaining structure). Typically, a tree falling or rotting failure mode in a water-retaining embankment dam would be categorized as a Category I or II failure mode, which indicates the failure mode is credible. Since the bulk of the perimeter dikes at the Karn and Weadock facilities are historic dikes along the outer limits of the landfill, and are not water retaining dams, the risk of loss of ash containment related to falling or rotting trees was found to be

non-credible or a Category IV failure mode. Therefore, from the perspective of perimeter dike safety and ash containment, trees were found to not pose a threat to the Karn or Weadock facilities.

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Conclusions

Provided the trees can be maintained to allow inspection of the dike slopes, it is our opinion that the majority of the trees on the perimeter dike slopes can remain in place for aesthetic or other purposes. In consideration of the facts discussed above, we recommend that the vegetation management plan include the following measures:

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We appreciate the opportunity to provide our engineering services for this project. Please contact Jamie Matus if you have any questions regarding the information contained within this letter.

Sincerely,

Carrie Grudzinski for

Michael D. Carpenter, P.E.
Senior Project Engineer

Jamie Matus, P.G.
Vice President

MDC/skd

Site Name:	**J.C. Weadock**	**Date:**	**9-21-2010**
Unit Name:	**J.C. Weadock Solid Waste Disposal Area**	**Operator's Name:**	**Consumers Energy**
Unit I.D.:	**N/A**	**Hazard Potential Classification:**	**High** ☐ **Significant** ☐ **Low** ☒
	Inspector's Name:	Cleighton D. Smith, P.E. and Scott C. Clarke, P.E.	

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

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

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

Issue #	Comments
1.	Visual inspections at least once weekly by plant personnel and at least once quarterly by MDEQ's personnel
2.	+/- 583.0 ft USLS
3.	+/- 592.7 ft USLS (inlet from incised bottom ash pond to ditch network)
4.	+/- 590.00 ft USLS along crest of Dike 'E'
5.	24" max
6.	Along toe of Dikes 'A' and 'B'

Coal Combustion Waste (CCW)

Impoundment Inspection

Impoundment NPDES Permit M10001678 **INSPECTOR** Jennifer Wegener

Date 9-21-2010
Impoundment Name J.C. Weadock Solid Waste Disposal Area

Impoundment Company Consumers Energy
EPA Region 5

State Agency (Field Office) Address Michigan DNR and Environment, 401 Ketchum St., Suite B, Bay City, MI 48708
Name of Impoundment J.C. Weadock Solid Waste Disposal Area

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

New ☒ **Update** ☐

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

IMPOUNDMENT FUNCTION: Solid Waste Landfill

Nearest Downstream Town Name: N/A – Along shoreline of Lake Huron

Distance from the impoundment: N/A – Along shoreline of Lake Huron

Location:

Latitude	43	Degrees	38	Minutes	23	Seconds	**N**
Longitude	-83	Degrees	49	Minutes	26	Seconds	**W**

State Michigan **County** Bay

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

If So Which State Agency? Michigan DNR and Environment

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.

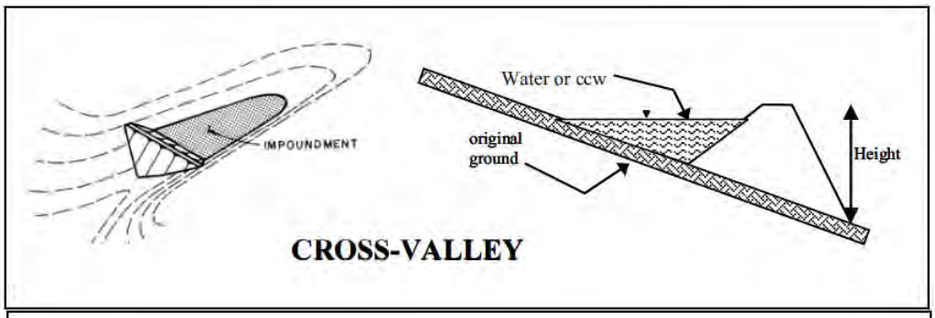
☐ **SIGNIFICANT HAZARD POTENTIAL:** Dams assigned the significant hazard potential classification are those dams where failure or misoperation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or can impact other concerns.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

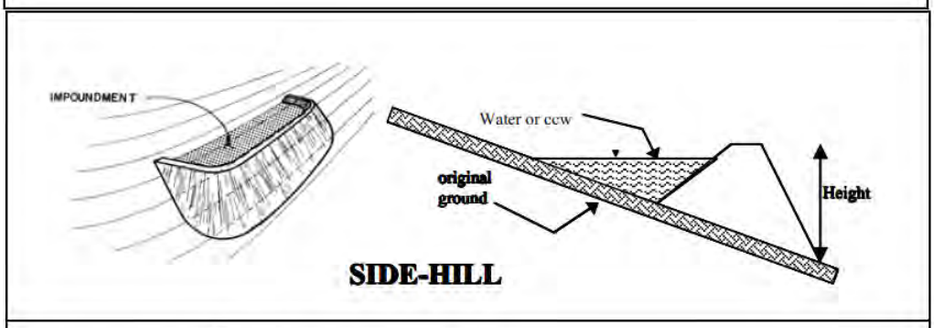
☐ **HIGH HAZARD POTENTIAL:** Dams assigned the high hazard potential classification are those where failure or misoperation will probably cause loss of human life.

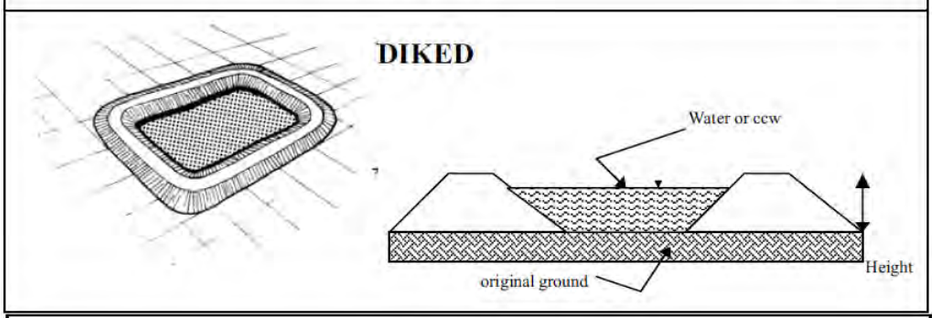
DESCRIBE REASONING FOR HAZARD RATING CHOSEN:

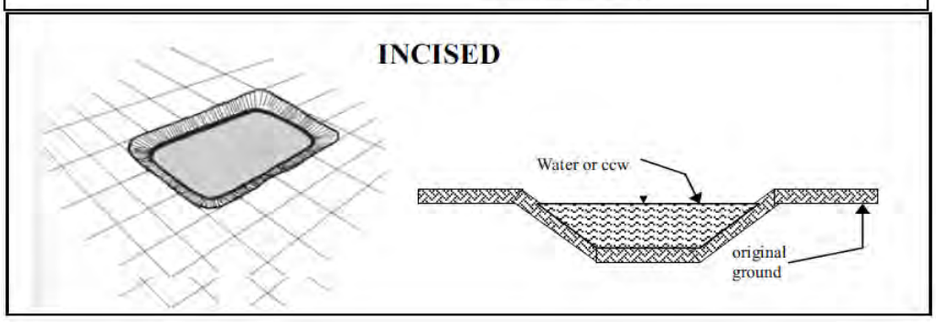
The facility is primarily a solid waste management unit and operated as such. A perimeter dike, which includes a recently installed bentonite cut-off wall, surrounds the 277 acre landfill which contains a network of drainage ditches that create the requisite residence time to settle particulates that enter the facility in accordance with the approved NPDES permit for the unit. With the exception of Pond F, which is currently being dewatered and transitioned into part of the landfill, there is very little wet volume behind the perimeter dikes that could cause a breach failure. Further, the facility is located on the shoreline of Lake Huron. Currently, there are no inhabited buildings, insurable buildings, or public parks between the perimeter dikes and Lake Huron that could be impacted due to a potential failure of the perimeter dikes.

CONFIGURATION:









☐ Cross-Valley ☐ Side-Hill ☒ Diked

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

Embankment Height (ft)	+/- 15 ft	**Embankment Material**	Compacted clay core and sandy silt
Pool Area (ac)	+/- 101.3 ac	**Liner**	Clay with perimeter Bentonite cut-off wall
Current Freeboard (ft)	+/- 8 to 10 ft	**Liner Permeability**	Clay 10^{-6} cms; Bentonite 10^{-8} cms

TYPE OF OUTLET (Mark all that apply)

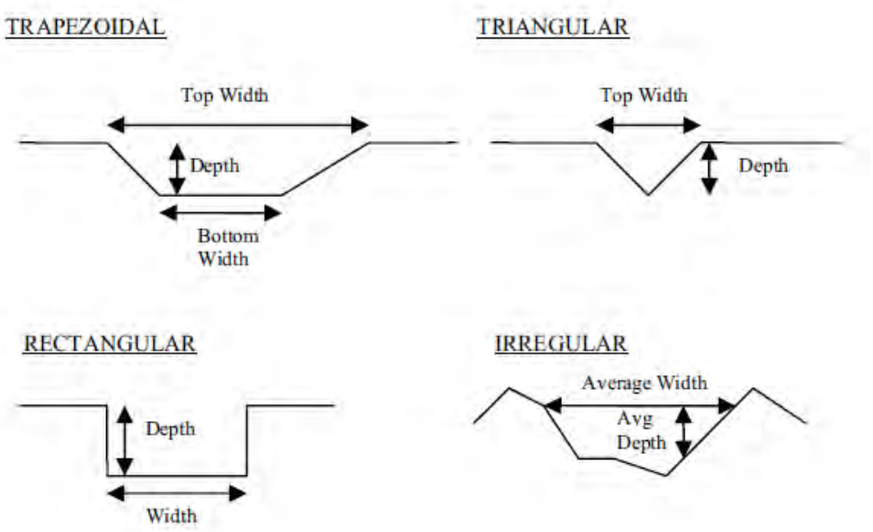
☐ **Open Channel Spillway**

- ☐ Trapezoidal
- ☐ Triangular
- ☐ Rectangular
- ☐ Irregular

depth (ft)

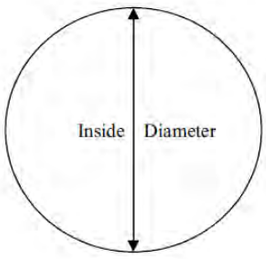
average bottom width (ft)

top width (ft)



☒ **Outlet**

72” drop inlet with 36” RCP outlet conduit



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 **Richard Oliver, P.E., Consumers Power**

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

If So When?

If So Please Describe :

	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, not to the best of our knowledge.

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

Yes, Consumers Energy provided documentation from the design Engineer-of-Record.

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

No, not to the best of our knowledge.