**Draft Report**

# Tanner's Creek Fly Ash PondAssessment Report

## Lockheed Martin

## June 2009

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## Lockheed Martin

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# 1. Introduction

## 1.1. General

In response to the coal combustion waste (CCW) impoundment failure at the TVA/Kingston coal-fired electric generating station in December of 2008, the Environmental Protection Agency has initiated a nationwide program of structural integrity and safety assessments of CCW impoundments or "management units". A CCW management unit is defined as a surface impoundment or similar diked or bermed management unit or management units designated as landfills that receive liquid-borne material and are 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. Management units also include inactive impoundments that have not been formally closed in compliance with applicable federal or state closure/reclamation regulations. The administration of this program is being supported by Lockheed Martin, who has authorized O'Brien & Gere to provide actual site specific impoundment assessments at selected facilities. This project is being conducted in accordance with the terms of Purchase Order No. 710051584, dated May 29, 2009.

## 1.1. Project Purpose and Scope

As stated in the Request for Proposal (RFP), the purpose of this work is to provide Dam Safety Assessments of CCW management units, including the following:

- Identify conditions that may adversely affect the structural stability and functionality of a management unit and its appurtenant structures
- Note the extent of deterioration, status of maintenance, and/or need for immediate repair
- Evaluate conformity with current design and construction practices
- Determine the hazard potential classification for units not currently classified by the management unit owner or by state or federal agencies

O'Brien & Gere's scope of services for this project includes performing a site specific dam safety assessment of select CCW management units at the subject facility. Specifically, the scope includes the following tasks:

- Perform a review of pertinent records (prior inspections, engineering reports, drawings, etc.) made available at the time of the site visit to review previously documented conditions and safety issues and gain an understanding of the original design and modifications of the facility.
- Perform a site visit and visual inspection of each CCW management unit and complete the visual inspection checklist to document conditions observed.
- Perform an evaluation of the adequacy of the outlet works, structural stability, quality and adequacy of the management unit's inspection, maintenance, and operations procedures.
- Identify critical infrastructure within 5 miles downgradient of management units.
- Evaluate the risks and effects of potential overtopping and evaluate effects of flood loading on the management units.
- Immediate notification of conditions requiring emergency or urgent corrective action.
- Identify environmental permits issued for the management units
- Identify leaks, spills, or releases of any kind from the management units within the last 5 years.
- Prepare a report summarizing the findings of the assessment, conclusions regarding the safety and structural integrity, recommendations for maintenance and corrective action, and other action items as appropriate.

This report addresses the above issues for the Fly Ash Pond management unit at Tanner's Creek Power Plant owned and operated by Indiana Michigan Power Company (IMPC). IMPC is a subsidiary of American Electric Power Company (AEP). As such, AEP regularly provides engineering assistance to the IMPC Tanners Creek Power Plant.

# 2. Project/Facility Description

The Tanner's Creek Power Plant is located in the City of Lawrenceburg, Dearborn County, Indiana. It is owned and operated by IMPC. The facility operates two surface impoundments for storing CCW: the Fly Ash Pond and the Bottom Ash Complex. The safety assessment summarized in this report details the June 2009 inspection of the Fly Ash Pond. The inspection of the Bottom Ash Complex is covered in a separate report.

A site location map is provided as Figure 1.

## 2.1. Management Unit Identification

For the purposes of this report, the impoundment will be referred to as the Fly Ash Pond. The Fly Ash Pond carries the following identification numbers:

- Indiana Department of Natural Resources (IDNR) state dam identification number 15-13 and permit number D4748.
- National Inventory of Dams #IN03383

A site layout map highlighting the location of the Fly Ash Pond is provided as Figure 2. Please note the direction of plant north as commonly used by plant personnel. Plant north is referenced to the location of the plant relative to the Fly Ash Pond and is not true north. Plant north will be used for compass reference of locations within this report.

## 2.2. Hazard Class

The definitions for the four hazard potentials (less than low, low, significant and high) are included in the US EPA CCW checklist found in Appendix A. Based on the checklist definitions and as a result of this assessment, the hazard potential rating assigned to the Fly Ash Pond is **SIGNIFICANT.** This rating was identified because failure of the embankments would result in an immediate release of ash slurry to adjacent properties and eventual release to the Ohio River. Potential damage from a failure of the Fly Ash Pond could be: environmental damage to the Ohio River and adjacent agricultural lands, economic damage to nearby railways, and economic damage to a nearby community water supply well.

For reference, it should be noted that the IDNR and AEP also have assigned ratings to the Fly Ash Pond. For IDNR, the 2006 inspection has listed the impoundment as a "low" hazard. For internal purposes, AEP refers to the impoundment as a "high" hazard structure.

## 2.3. Impounding Structure Details

The following sections summarize the structural components and basic operations of the Fly Ash Pond. A diagram of the Fly Ash Pond and its relevant features is provided as Figure 3. Additionally, photos taken during the visual inspection are incorporated in a Photographic Log provided as Appendix B.

### 2.3.1. Embankment Configuration

The Fly Ash Pond is a partially incised impoundment with four raised dike embankments. Currently, the impoundment has two distinct sections: the Upper Pond and the Clear Pond.

The original embankment was constructed in 1977 and 1978 to an initial crest elevation of approximately 495 feet using borrowed soil from the site. The Clear Pond portion of the impoundment exists today as it was part of the original construction. The Clear Pond operates at a water level elevation of 487 to 489 feet.

Beginning in 2002 and completed in 2007, a portion of the Fly Ash Pond was raised to create the Upper Pond. The Upper Pond has a crest elevation of 518 feet and was constructed using bottom ash as the core construction material. The Upper Pond is presently filled with Fly Ash to its typical maximum elevation of 515 feet.

Typical embankment cross sections are provided as Figures 4 and 5 and views of the embankment slopes can be seen in Photos 1 through 10 of Appendix B.

### 2.3.2. Type of Materials Impounded

The Fly Ash Pond is used to store fly ash. Under normal operations it provides primary settling in the Upper Pond and secondary settling of decanted water from the Upper Pond in the Clear Pond.

Photos of stored fly ash are provided as Photos 11 and 12 in Appendix B.

### 2.3.3. Stormwater Inflows

Stormwater inflows to the Fly Ash Pond are limited to direct precipitation. The original, lower embankments direct runoff away from the impoundment. Runoff from the new, upper embankments is collected in open channels (or a new gravel/slotted drain pipe system) where the toe of the upper embankment meets the crest of the lower embankment and is conveyed to the Clear Pond.

### 2.3.4. Outlet Works

The Upper Pond has two operable halves. Each half has a 3-foot by 4-foot open channel spillway with stop logs that are used to control the depth of water. These open channel spillways connect to 30-inch diameter high density polyethylene (HDPE) discharge pipes which discharge to the drainage ditch at the toe of the upper embankment. The drainage ditch conveys the Upper Pond effluent to the Clear Pond.

Under normal operations the effluent from the Clear Pond is pumped back to the Bottom Ash Complex via two 14-inch diameter fiber reinforced plastic (FRP) pipes prior to discharge to the Ohio River.

A concrete emergency spillway is located in the southeast corner of the Clear Pond. The spillway is rectangular with a 3-foot depth and a 4-foot width. The invert elevation of the emergency spillway is 491 feet. The emergency spillway discharges to a channel that parallels the toe of the south embankment. Ultimately, this channel joins natural drainage features flowing south and west and empties into the Ohio River.

Photos 13 through 16 in Appendix B show the various parts of the outlet works for the Fly Ash Pond.

### 2.3.5. Instrumentation

The following table is a summary of Fly Ash pond instrumentation monitored by IMPC:

**Table 1** *Summary of Fly Ash Pond Instrumentation*

| Instrument | Parameter | Quantity | Monitoring Frequency |
|---|---|---|---|
| Surface monitoring points | Deformation of original embankments | 21 | Quarterly |
| Slope indicators | Slope deformation of original embankments | 6 | Quarterly |
| Settlement Plates | Settlement of Upper Pond embankments | 8 | Quarterly |
| Piezometers | Phreatic water levels within Upper Pond embankments | 13 | Monthly |
| Site data logging system | Volume pumped out of Fly Ash Pond/pump runtime | 1 | As needed |

Source: O'Brien & Gere

Photos 17 through 19 in Appendix B depict examples of the various monitoring instrumentation found at the Fly Ash Pond.

# 3. Records Review

At the time of the site visit, Indiana Michigan Power Company provided historical Fly Ash Pond documents for review. O'Brien & Gere also contacted IDNR to obtain historical permits on file. The following table summarizes reviewed documentation.

**Table 2** *Summary of Fly Ash Pond Documents Reviewed*

| Document | Dates | By | Description |
|---|---|---|---|
| Investigations for Proposed Fly Ash Pond | 1976 | Casagrande Consultants | Boring logs, compression analysis, stability analysis for construction of original fly ash pond structure |
| Permit/Certificate of Approval | 1975-1977 | IDNR | Approval for construction in a floodplain. Contains various engineer reports and conditions for construction |
| Final Report of Geotechnical Consultation and Inspection Services | 1979 | Woodward-Clyde Consultants | Report summarizing and documenting the construction of the original fly ash pond |
| Design Drawings and Construction Specifications | 2002 | Barr Engineering and American Electric Power Company | Details of boring logs, seepage/stability analysis, design calculations, construction specifications and drawings to install a seepage collection drain in the south dike |
| Fly Ash Storage Pond Elevation 518' Raising Engineering Report | 2002 | American Electric Power Company – ProServ and Barr Engineering | Geotechnical and stability analysis, toe drain design, hydraulic and hydrologic analysis, spillway structure design, and construction specifications |
| IDNR Inspection Checklist | 2006 | IDNR | Basic checklist documenting most recent (September 2006) state inspection |
| Annual Inspection Report | 2008 | American Electric Power Company | Annual inspection report documenting inspection completed by corporate engineering staff. Includes deformation/settlement data and analysis of new Upper Pond structure |
| Site NPDES Permit | 2008 | Indiana Michigan Power Company | NPEDS Permit #IN0002160 detailing allowable discharge parameters from the Bottom Ash Complex (which receives water pumped from Fly Ash Pond) |
| Draft Emergency Action Plan | 2009 | Geo/Environmental Associates and American Electric Power Company | Draft action plan for use in the event of a failure of the Fly Ash Pond embankments |
| Deformation Review | 2009 | American Electric Power Company | Summary of deformation related measurements collected since raising embankments to 518' |
| Site Inspection and Observation Report | 2009 | Geo/Environmental Associates | Visual inspection, seepage and stability analysis |
| Monthly Inspection Logs | 2009 | Indiana Michigan Power Company | Recent monthly inspection checklists completed by Tanner's Creek personnel |

Source: O'Brien & Gere

## 3.1. Design Documents

### 3.1.1. Stability Analyses

Casagrande Consultants were engaged in 1975 to perform investigations and analyses to design the earth embankments of the original dikes. Their scope of work included: 1) soils investigations; 2) commenting upon the design of the proposed dikes; and 3) suggesting specifications for the compaction of soils selected for use in the embankments. The resulting 1976 report (see Table 2) included stability analyses demonstrating that adequate Factors of Safety would be achieved for normal, static loading conditions and for seismic loading. Woodward Clyde's 1979 Final Report on Geotechnical Consultation and Inspection Services documents that the Fly Ash Pond was constructed in accordance with the design intent.

Barr Engineering performed a scope of geotechnical analyses to support the design for the offset-upstream, bottom ash dike that was proposed for raising the Fly Ash Pond dikes and establish the upper pond. The results of Barr's investigations and design are presented in their January 2002 report (see Table 2). The Barr report summarizes geotechnical investigation and testing of the existing, original earth dikes, the fly ash upon which the bottom ash dike would be constructed and the bottom ash materials to be used in the new embankments. Deformation analyses were performed to predict the effects of new loadings on the existing earth dike and the fly ash in the basin. Stability analyses show that adequate factors of safety were predicted for the existing embankments, the proposed bottom ash embankments and the overall system for normal, static (filled pond) conditions and for an earthquake loading. Barr's 2002 report was incorporated in an October 2002 submission by AEP Pro Serv, Inc. to the Indiana Department of Natural Resources presenting the design for the Fly Ash Pond dam raising. A formal permit pertaining to the raising was not observed during this review.

Geo/Environmental Associates, Inc. performed visual inspection of the Fly Ash Pond in February 2009 and stability analyses of the bottom ash embankments that form the Upper Pond. The results of these stability analyses are presented in an April 21, 2009 report (see Table 2). The stability analyses were performed to examine the effects of a potential high ratio of horizontal to vertical permeability in the fly ash underlying the bottom ash embankments and to reflect the bottom ash embankment toe drain improvements proposed and under construction. The analyses predict minimum factors of safety greater than 1.5 after the completion of the proposed drainage improvements.

### 3.1.2. Modifications since Original Construction

The original dikes were constructed of soil borrowed from the site. The original impoundment also incorporated a 20-mil poly vinyl chloride (PVC) and a 2-foot thick clay layer as a lining. The following modifications have been made since initial construction.

- A new Upper Pond was constructed on top of stored fly ash and the interior portion of the original embankment beginning in 2002. The Upper Pond embankments were constructed using bottom ash excavated from the Bottom Ash Complex. The new Upper Pond embankments were designed with a toe drain collection system.
- Piezometers were installed upon completion of the upper dikes to monitor seepage.
- As part of the 2002 Upper Pond construction the rectangular concrete emergency spillway was added to the Clear Pond.
- The downstream slopes of the new Upper Pond were reinforced with riprap and vegetation in 2006.
- A gravel and slotted pipe toe drain collection system is under construction and will replace the open channel that currently conveys seepage from the Upper Pond embankment toe drain to the Clear Pond. South of the Splitter Dike, an additional rockfill toe berm was added to accommodate installation of the slotted pipe collection system (Appendix B – Photo 9).

### 3.1.3. Monitoring Instrumentation

Water levels in thirteen piezometers located around the perimeter of the Upper Pond are measured and recorded monthly by plant personnel. Records of these measurements are monitored by IMPC but were not provided at the time of the inspection.

Eight settlement plates located on the crest around the perimeter of the Upper Pond are surveyed quarterly. Measurements from the settlement plates indicated vertical displacements ranging from 0.11 feet to 0.30 feet since the completion of construction in 2007. Indiana Michigan Power Company reported that these settlement readings are likely exaggerated due to continuing heavy equipment traffic associated with excavating the stored fly ash from the Upper Pond.

Twenty-one surface monitoring points and six slope indicators are located on the slopes around the perimeter of the original impoundment. Quarterly measurements from the surface monitoring points indicated a maximum vertical displacement of 0.073 feet and a maximum horizontal displacement of 0.18 feet. Measurements reported from the slope indicators show a maximum displacement of 0.33 inches since 2003.

Facility personnel reported that pump runtime and volume pumped from the Fly Ash Pond is recorded in the facility's data logging system. No physical record of the discharge volumes was reviewed during the inspection.

## 3.2. Previous Inspections

The Fly Ash Pond is inspected monthly by facility personnel. Completed monthly inspection checklists were documented through May 2009.

A comprehensive annual inspection is performed by AEP corporate engineering staff. The 2008 inspection report was reviewed. In general, action items noted in the annual report have been carried out or are reported as scheduled for completion. Specifically, details for improvements of the Upper Pond toe drain collection system were documented as "in progress."

State inspections by the IDNR are also performed at unknown periodic intervals. The most recent inspection forms provided were completed in September 2006 and January 1995. Items noted in the

2006 inspection, such as bare areas on the new Upper Pond embankments and minor visible liner tears around the Clear Pond were addressed prior to this June 2009 inspection.

## 3.3. Facility Operator Interviews

Numerous facility and corporate owner personnel took part in the inspection proceedings. The following is a list of participants from the inspection of the Fly Ash Pond:

**Table 2** *List of Participants*

| Name | Affiliation | Title |
|---|---|---|
| Sharon McFarland | IMPC – Tanner's Creek | Plant Environmental Coordinator |
| Mitch Montgomery | IMPC – Tanner's Creek | Material Handling Supervisor |
| Paul Bischoff | IMPC – Tanner's Creek | Material Handling Process Owner |
| Jim Bockstiegel | IMPC – Tanner's Creek | Energy Production Superintendent |
| Pedro Amaya, PE | AEP – Corporate Engineering | Principal Engineer |
| Tim Howdyshell | AEP – Corporate Engineering | Principal Coordinator |
| Dana Sheets | AEP – Corporate Environmental | Principal Engineer |
| Craig Dufficy | US EPA | |
| Jana Englander | US EPA | |
| Gary Romesser | Indiana Department of Environmental Management | |
| Scott Cormier, PE | O'Brien & Gere | Vice President |
| Gary Emmanuel, PE | O'Brien & Gere | Project Manager |
| Jason Huber | O'Brien & Gere | Design Engineer |

Source: O'Brien & Gere

Facility personnel provided a good working knowledge of the Fly Ash Pond and provided necessary historical documentation. These personnel also accompanied O'Brien & Gere and EPA staff throughout the visual inspections to answer questions and provide additional information as needed in the field.

## 3.4. Site Geology Summary

The Tanner's Creek site is located in the Dearborn Upland (the eastern-most physiographic region in southern Indiana) and it is a dissected plateau underlain by limestone and shale of mostly Ordovician age (dating from 510 million to 439 million years ago). The project site has been documented by many borings related to the ash ponds' construction. These borings generally indicate that the site stratigraphy consists of a layer of clay from the ground surface at an approximate elevation of 437 feet to an elevation of 465 feet underlain by a layer of coarse-grained sand with gravel that extends to shale bedrock at an approximate elevation of 395 feet.

The site clay was selectively used to construct the original embankments. In one area, around the area of the Clear Pond, site sand and gravel was used to construct the freeboard portion of the embankment.

# 4. Visual Inspection

The following sections summarize the inspection of the Fly Ash Pond which occurred on June 2, 2009. At the time of the inspection, O'Brien & Gere completed a US EPA inspection checklist which was submitted electronically to US EPA June 5, 2009. A copy of the completed inspection checklist is included as Appendix A. At the time of the inspection, the Fly Ash Pond was not in service with excavation of the fly ash being performed along the east/northeast area of the Upper Pond.

## 4.1. Overview

The visual inspection consisted of a thorough site walk along the perimeter of the Fly Ash Pond. Two passes were made for the Fly Ash Pond, one around the perimeter of the original embankments, and one around the new Upper Pond embankments. O'Brien & Gere team members made observations at the toe, mid-slope and crest of the embankments and also observed inlet/outlet structures, monitoring instrumentation and current operation.

Photos were taken during the visual inspection. A photo log of relevant items is incorporated as Appendix B and locations of photos are noted within Figure 3.

## 4.2. Findings

The following is a summary of observations made during the visual inspection. Figure 3 depicts the locations of the observations listed below.

- Shrubbery and trees up to 4-inch diameter are located along the fence line at the toe of the west slope.
- Animal burrows were noted at various locations on the west and south slopes of the original embankment
- An isolated seep of clear water was observed on the north slope near the construction access road (Appendix B - Photo 20).
- Areas rutted by equipment and missing vegetative cover were observed at two locations on the east slope of the original embankments.
- Minor elevation differences were noted along the crest of the Upper Pond due to heavy equipment traffic.
- Excavation of deposited fly ash was observed at the Upper Pond (Appendix B – Photo 11).
- Installation of the new slotted seepage collection system was observed along the splitter dike (Appendix B – Photo 21).
- Minor scarps were observed along the top of the upstream side of the east and south embankment slopes of the Upper Pond. Scarps are typically three feet in height and are made more prominent by the addition of roadway aggregate on the embankment crest (Appendix B – Photo 22).

# 5. Conclusions

Based on the ratings defined in the RFP (satisfactory, fair, poor and unsatisfactory), the information reviewed and the visual inspection, the overall condition of the Fly Ash Pond appears to be **SATISFACTORY**. Based on planned upgrades to the Upper Pond seepage collection system, the condition of the Fly Ash Pond is likely to improve.

## 5.1. Stability

Documents were provided from the design and construction of the original earth embankment. The observed, as built conditions of the embankment appear consistent with the assumptions in the design stability analyses.

Design analyses were provided for the vertical expansion creating the Upper Pond and for the upgrade measures currently being installed. The observed, as-built conditions appear consistent with the assumptions in the design stability analyses. The addition of sand and rip rap on the lower portions of the embankment slopes appears to be effective in addressing the wet conditions reported to have existed in these areas. The addition of the slotted pipe drain system also appears to be effective in conveying water away from the toe drain.

Documentation was also provided of monitoring performed on the original and upper embankments during construction and filling of the Upper Pond. Measurement data from piezometers and settlement plates in the upper embankments and slope indicators and surface monitoring points on the original embankments indicate no abnormalities or other cause for concern regarding the stability of the Fly Ash Pond embankments.

## 5.2. Operations and Maintenance

Current operations and maintenance of the Fly Ash Pond appear to be satisfactory. The owner has implemented regular inspections and maintenance which enables the impoundment to be kept in a good working order.

# 6. Recommendations

## 6.1. Immediate/Urgent Repair Recommendations

No immediate or urgent repairs are recommended at this time.

## 6.2. Long Term Improvements

A slotted pipe toe drain system is currently being installed to replace the drainage ditch which currently collects seepage from the Upper Pond. The owner should continue as planned with this modification to improve the conveyance of water away from the toe.

Beyond completing the slotted pipe toe drain system, no other long term improvements are recommended at this time.

## 6.3. Monitoring and Future Inspection Recommendations

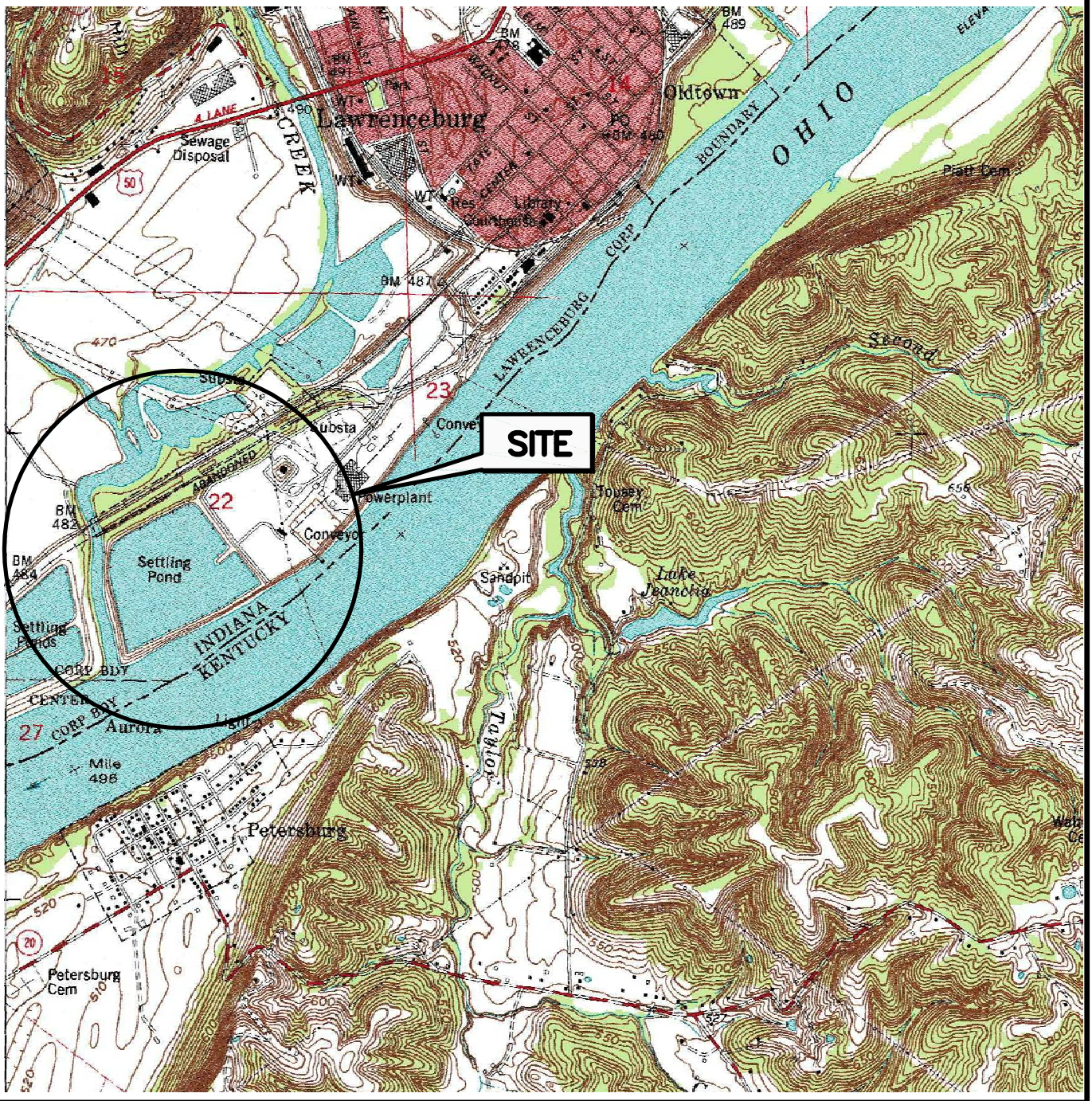
Monitoring and future inspections should continue on their current schedule. For future monthly inspections, additional detail regarding visual observations made at the time of inspection should be included.

Additionally, active maintenance of the vegetative growth around the Fly Ash Pond will need to continue along with regular filling of rodent burrows.

## 6.4. Time Frame for completion of Repairs/Improvements

The owner cited a 2009 completion date for the installation of the remainder of the slotted drain pipe system. The owner should continue toward completion of this project as planned.

FIGURE 1




ADAPTED FROM: LAWRENCEBURG QUADRANGLE, INDIANA U.S.G.S. 7.5 MIN. QUAD

QUADRANGLE LOCATION

# TANNER'S CREEK POWER PLANT
# LAWRENCEBURG, INDIANA

## SITE LOCATION MAP

1 0 1/2 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 5 0 1 KILOMETER

FILE NO. 5851.44642-001B.DWG SCALE: 1:24000

JULY 2009

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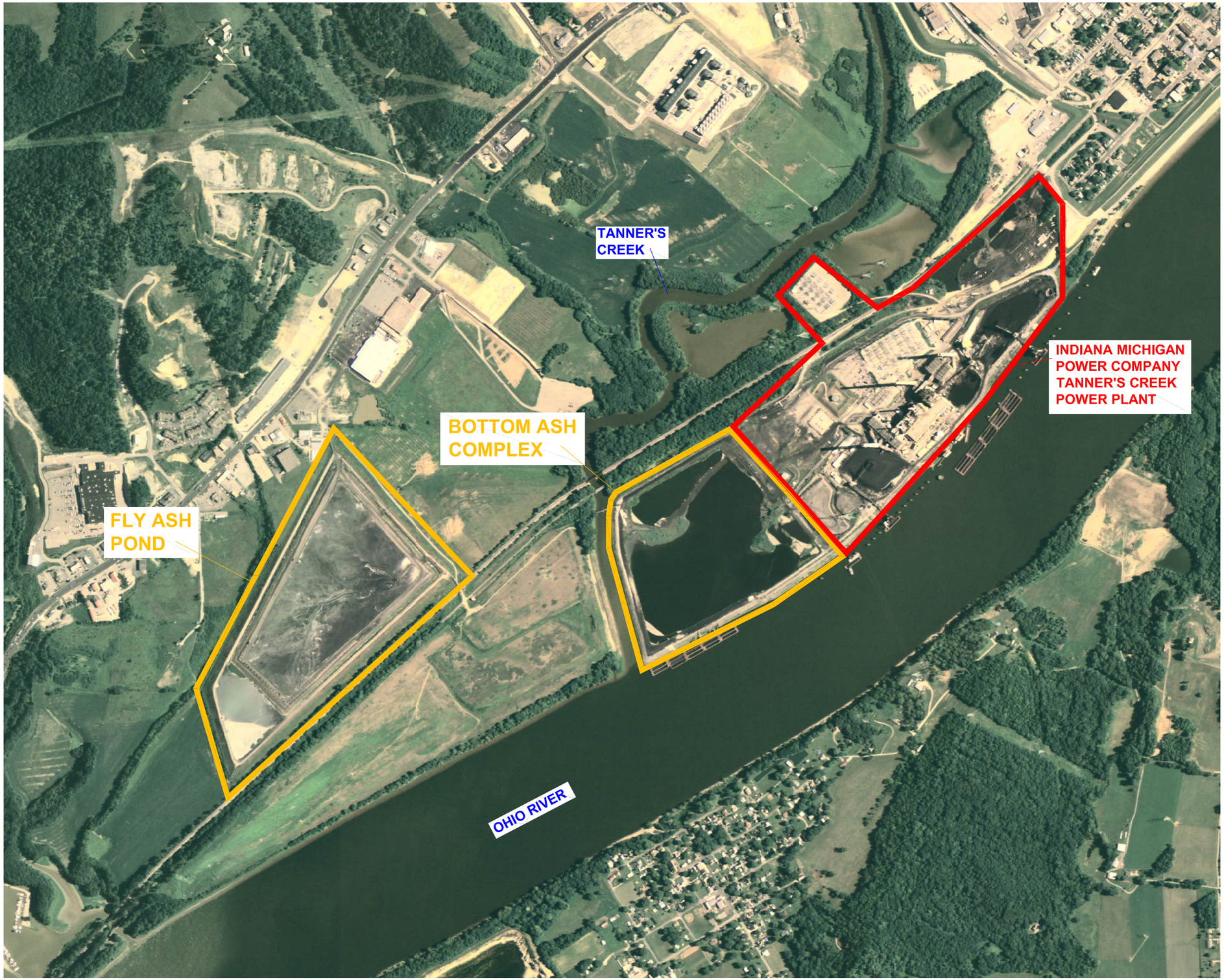


6/26/09 jph div078

FIGURE 2

TRUE NORTH

PLANT NORTH

US EPA &
LOCKHEED MARTIN
DAM SAFETY ASSESSMENT
OF CCW IMPOUNDMENTS

TANNER'S CREEK POWER PLANT
LAWRENCEBURG, IN

## SITE LAYOUT MAP

1000 0 1000

1"=1000'

FILE NO. 5851/44642-002
JUNE 2009

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2009 © O'Brien & Gere Engineers, Inc.

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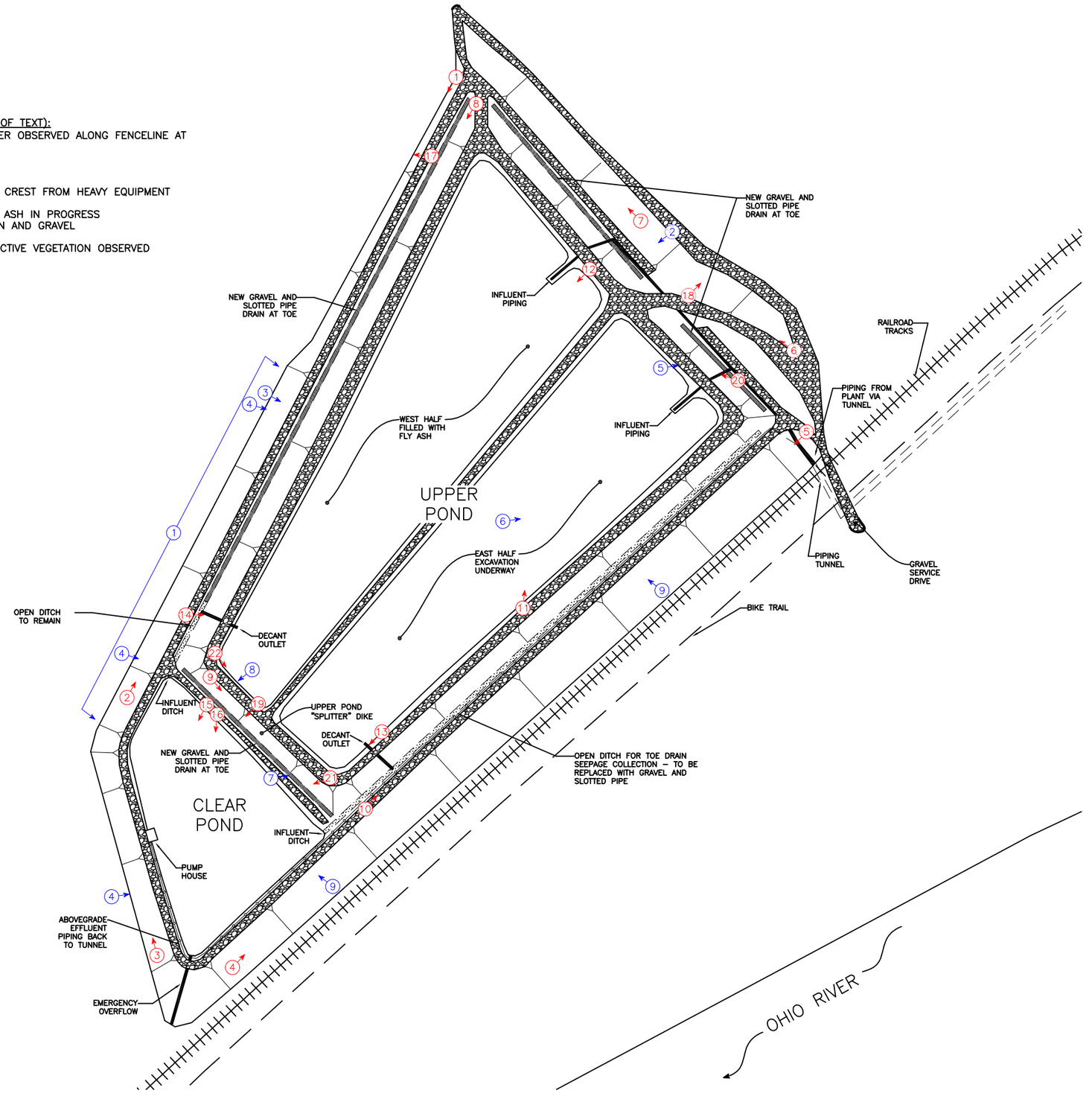
# FIGURE 3

OBSERVATION NOTES (ALSO SEE SECTION 4.2 OF TEXT):

1. SHRUBBERY AND TREES UP TO 4" DIAMETER OBSERVED ALONG FENCELINE AT TOE OF WEST EMBANKMENT
2. ISOLATED SEEP
3. MULTIPLE ANIMAL BURROWS
4. ANIMAL BURROW UNDER FENCE
5. ELEVATION DIFFERENCES OBSERVED ALONG CREST FROM HEAVY EQUIPMENT TRAFFIC
6. OBSERVED EXCAVATION OF DEPOSITED FLY ASH IN PROGRESS
7. OBSERVED INSTALLATION OF SLOTTED DRAIN AND GRAVEL
8. MINOR SCARPS OBSERVED
9. EQUIPMENT RUTS AND REMOVAL OF PROTECTIVE VEGETATION OBSERVED




TRUE NORTH

PLANT NORTH

## LEGEND

(#) APPENDIX B PHOTO REFERENCE – ARROW DEPICTS ORIENTATION OF PHOTO

(#) VISUAL INSPECTION OBSERVATION – ARROW DENOTES LOCATION OF OBSERVATION(S) – SEE INSET NOTES

US EPA &
LOCKHEED MARTIN
DAM SAFETY ASSESSMENT
OF CCW IMPOUNDMENTS

TANNER'S CREEK POWER PLANT
LAWRENCEBURG, IN

## FLY ASH POND PLAN DIAGRAM

1"=400' 400 0 400

FILE NO. 5851/44642-003B
JUNE 2009

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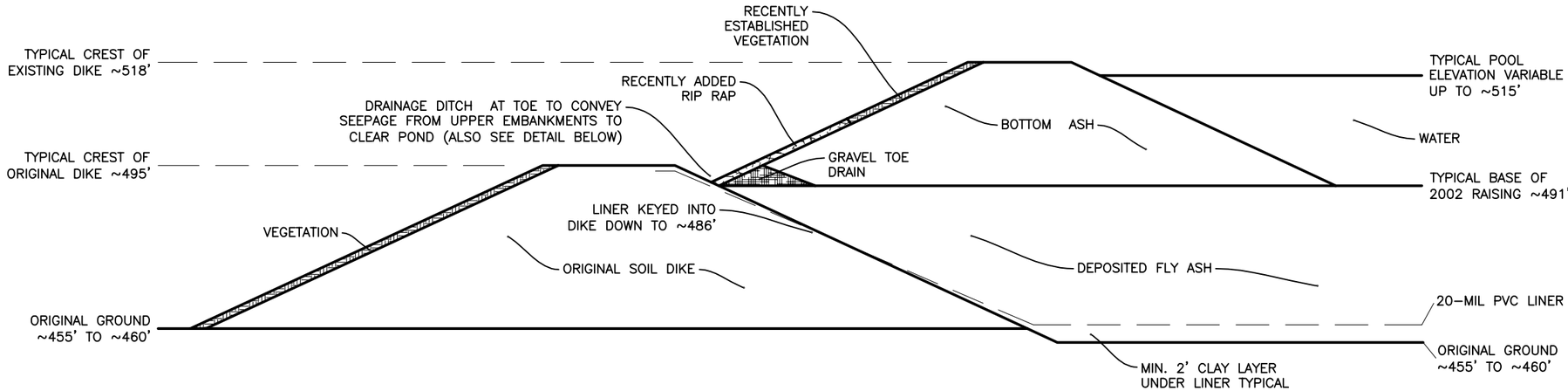
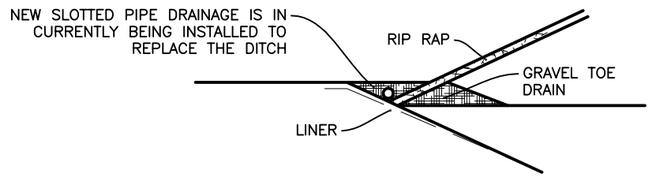
2009 © O'Brien & Gere Engineers, Inc.

6/28/09 jph div078

FIGURE 4




**NEW CONSTRUCTION DETAIL**
(INSTALLATION COMPLETE AROUND 65% OF UPPER EMBANKMENT PERIMETER)

US EPA &
LOCKHEED MARTIN
DAM SAFETY ASSESSMENT
OF CCW IMPOUNDMENTS

TANNER'S CREEK POWER PLANT
LAWRENCEBURG, IN

# FLY ASH POND
# TYPICAL SECTION

1"=30' 30 0 30
APPROXIMATE SCALE

FILE NO. 5851/44642-004B
JUNE 2009

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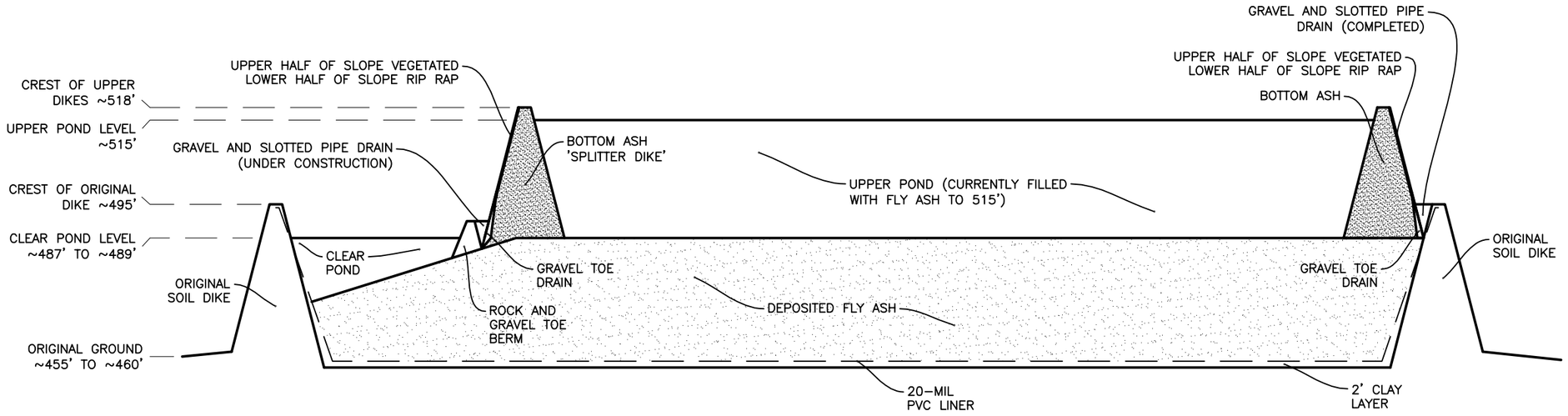
# FIGURE 5

PLANT NORTH

1"=30' 30 0 30
APPROXIMATE VERTICAL SCALE

1"=300' 300 0 300
APPROXIMATE HORIZONTAL SCALE

NOTE
1. SECTION VIEW IS CUT DOWN CENTER OF FLY ASH POND LOOKING 'PLANT WEST'




US EPA &
LOCKHEED MARTIN
DAM SAFETY ASSESSMENT
OF CCW IMPOUNDMENTS

TANNER'S CREEK POWER PLANT
LAWRENCEBURG, IN

## FLY ASH POND
## NORTH-SOUTH SECTION

FILE NO. 5851/44642-005B
JUNE 2009

O'BRIEN & GERE

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6/30/09 jph div078

# APPENDIX A

## Visual Inspection Checklist

Coal Combustion Dam Inspection Checklist Form

US Environmental Protection Agency

Site Name: Indiana Michigan Power - Tanner's Creek Plant Date: June 2, 2009

Unit Name: Fly Ash Pond - Upper Pond Operator's Name: Tim Kerns - Plant Manager

Unit I.D.: N/A Hazard Potential Classification: High (Significant) Low

Inspector's Name: Scott Cormier, PE & Gary Emmanuel, PE

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

| | Yes | No | | Yes | No |
|---|---|---|---|---|---|
| 1. Frequency of Company's Dam Inspections? | Multiple | | 18. Sloughing or bulging on slopes? | | X |
| 2. Pool elevation (operator records)? | 515' (max) | | 19. Major erosion or slope deterioration? | | X |
| 3. Decant inlet elevation (operator records)? | Variable | | 20. Decant Pipes: | | |
| 4. Open channel spillway elevation (operator records)? | None | | Is water entering inlet, but not exiting outlet? | | N/A |
| 5. Lowest dam crest elevation (operator records)? | 518' | | Is water exiting outlet, but not entering inlet? | | N/A |
| 6. If instrumentation is present, are readings recorded (operator records)? | X | | Is water exiting outlet flowing clear? | | N/A |
| 7. Is the embankment currently under construction? | X | | 21. Seepage (specify location, if seepage carries fines, and approximate seepage rate below): | | |
| 8. Foundation preparation (remove vegetation,stumps, topsoil in area where embankment fill will be placed)? | | N/A | From underdrain? | X | |
| 9. Trees growing on embankment? (If so, indicate largest diameter below) | | X | At isolated points on embankment slopes? | | X |
| 10. Cracks or scarps on crest? | | X | At natural hillside in the embankment area? | | X |
| 11. Is there significant settlement along the crest? | | X | Over widespread areas? | | X |
| 12. Are decant trashracks clear and in place? | | None | 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? | | N/A | 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? | | X |
| 17. Cracks or scarps on slopes? | X | | 24. Were Photos taken during the dam inspection? | X | |

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

Inspection Issue # Comments

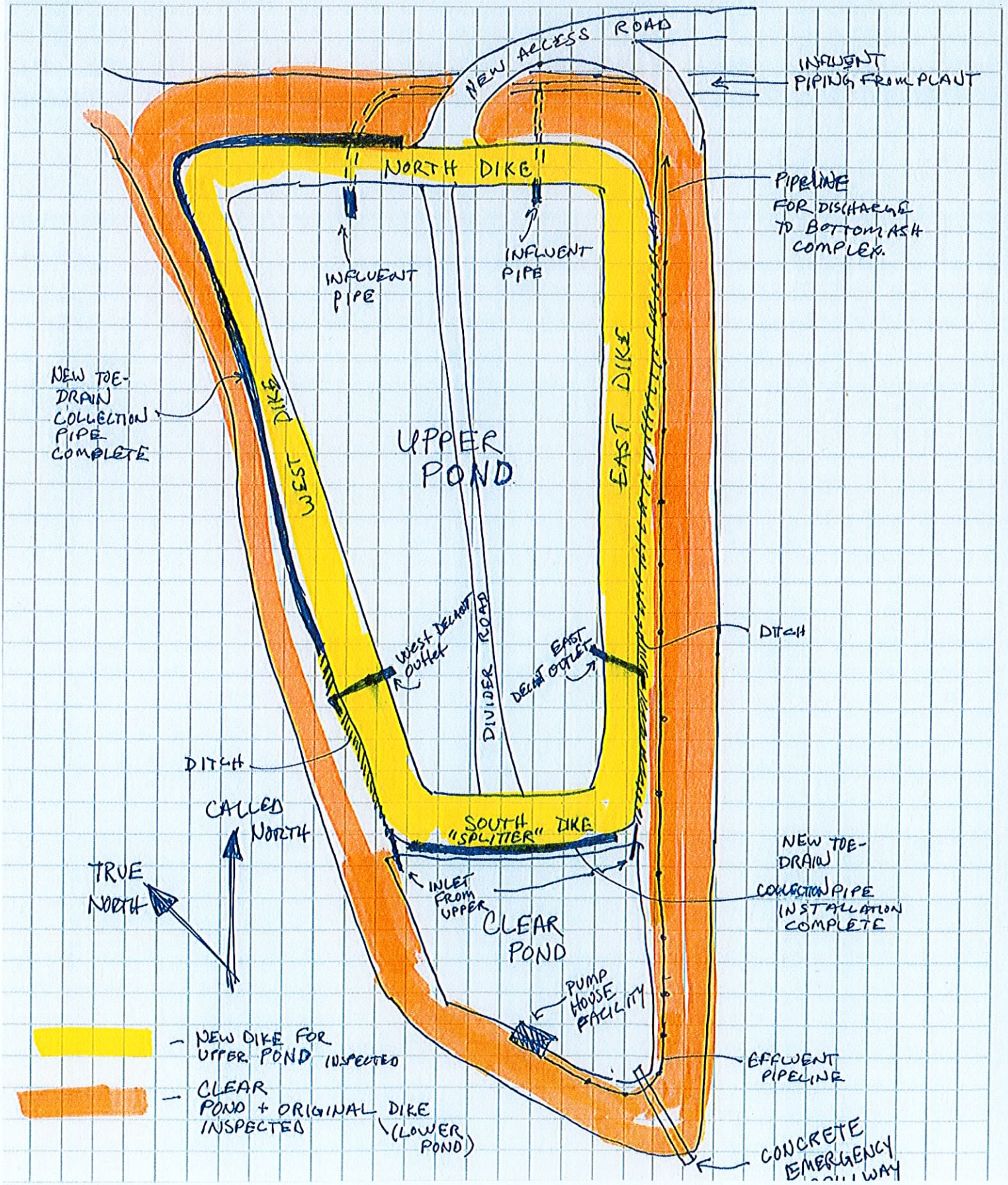
(Please refer to next page for list of comments - 2nd Page)

(Please refer to plan sketch for naming of features - 3rd Page)

| Inspection Issue # | Comments |
|---|---|
| 1 | Impoundment is inspected monthly by plant personnel and annually by a PE from corporate engineering staff |
| 3 | Outlet structures (2) have stop logs which can be added to the structures to raise decant elevation |
| 4 | No emergency spillway, only two decant outlets |
| 6 | 13 piezometers located around the impoundment are measured and recorded monthly. 8 settlement plates located along the impoundment crest are surveyed quarterly. |
| 8 | The dike forming the upper pond is constructed on top of the previous fly ash deposits. According to plant personnel, no vegetation was present at the time of construction. |
| 11 | Minor elevation differences were noted along the crest due to heavy equipment traffic from recent excavation of settled ash. The plant reported that the surface grade of the crest will be restored upon completion of excavation activities. |
| 12 | No trashracks exist for the decant outlet structures |
| 17 | Numerous minor scarps were observed along the top of the upstream side of the 'east' and 'south' embankment slopes. Scarps are typically 3' in height and are made more prominent by the addition of roadway aggregate on the embankment crest. |
| 20 | Fly Ash Pond not in operation at time of inspection |
| 21 | The base of the dike is constructed with a porous gravel toe drain that is designed to collect embankment seepage. A slotted drainpipe is currently being installed at downstream toe around perimeter of dike to replace the existing ditch which conveys the embankment seepage to the outlet. |
| 23 | During inspection, the upper pond was filled to capacity with fly ash and fully drained of free surface water. However, when receiving new fly ash, or in an extreme precipitation event, the level of the clear pond (lower pool) may be elevated and this water may rest against the toe of the 'south' (splitter) dike. |

O'BRIEN & GERE

| SUBJECT | SHEET | BY | DATE | JOB NO. |
|---|---|---|---|---|
| PLAN SKETCH - FLY ASH POND | 1 | JPH | 6/3/09 | 44642 |



U. S. Environmental Protection Agency

## Coal Combustion Waste (CCW)
## Impoundment Inspection

Impoundment NPDES Permit # IN0002160

INSPECTOR Scott Cormier, PE & Gary Emmanuel, PE

Date June 2, 2009

Impoundment Name Fly Ash Pond - Upper Pools

Impoundment Company Indiana Michigan Power

EPA Region V

State Agency (Field Office) Addresss N/A

Name of Impoundment Noted above

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

New _____ Update X

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

**IMPOUNDMENT FUNCTION:** Settling of Fly Ash

Nearest Downstream Town : Name Aurora, IN

Distance from the impoundment Approximately 1.75 Miles

Impoundment Location:

Longitude 39 Degrees 4 Minutes 36.90 Seconds

Latitude -84 Degrees 52 Minutes 48.49 Seconds

State Indiana County Dearborn

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

If So Which State Agency? IDNR - (Indiana Department of Natural Resources)

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

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

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

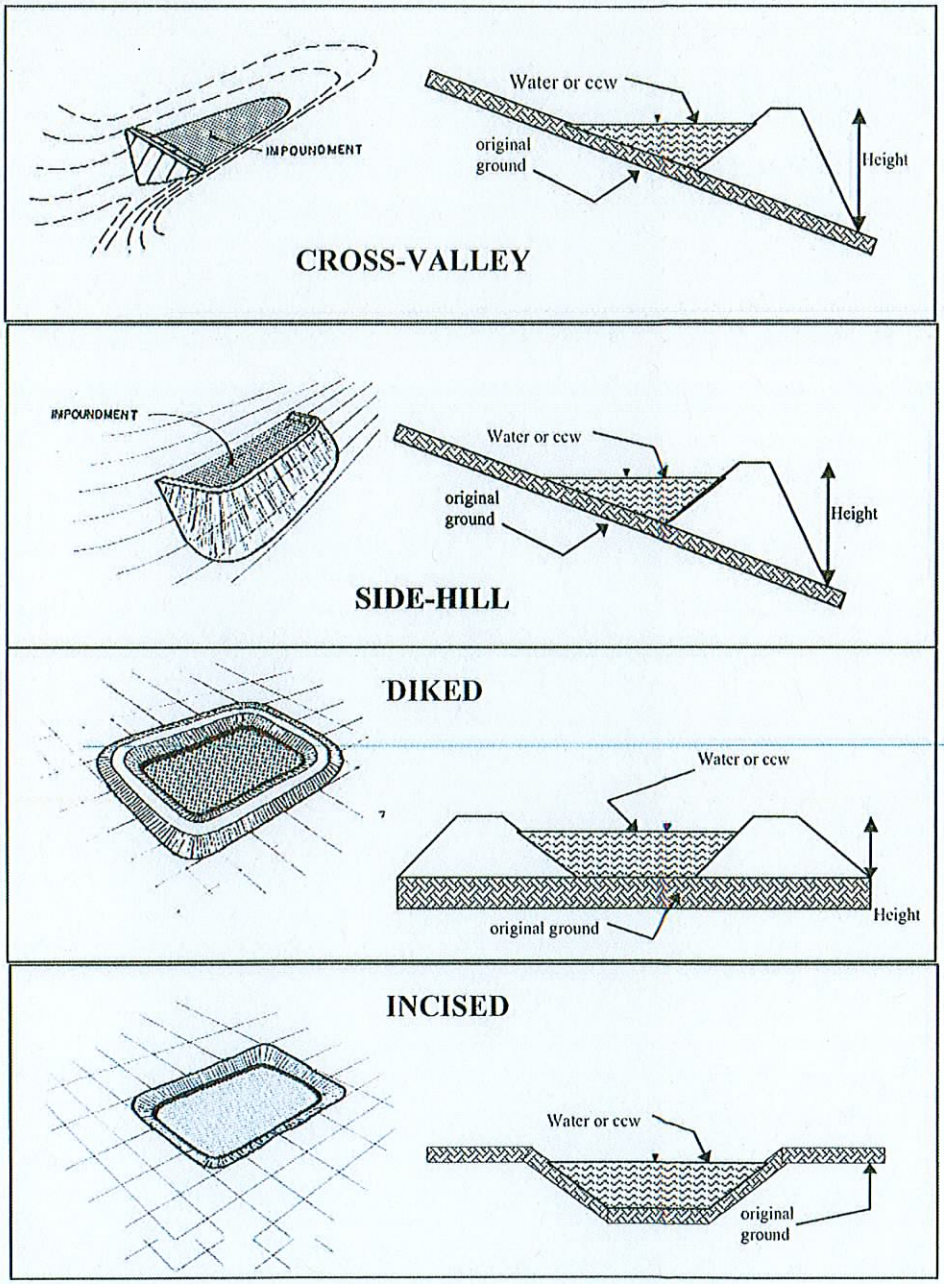
__X__ **SIGNIFICANT HAZARD POTENTIAL:** Dams assigned the significant hazard potential classification are those dams where failure or misoperation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or can impact other concerns.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

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

**DESCRIBE REASONING FOR HAZARD RATING CHOSEN:**

Failure of impoundment would result in immediate release to adjacent properties and eventual release to Ohio River. Additionally, potential exists for damage to nearby railway and community water supply well.

## CONFIGURATION:

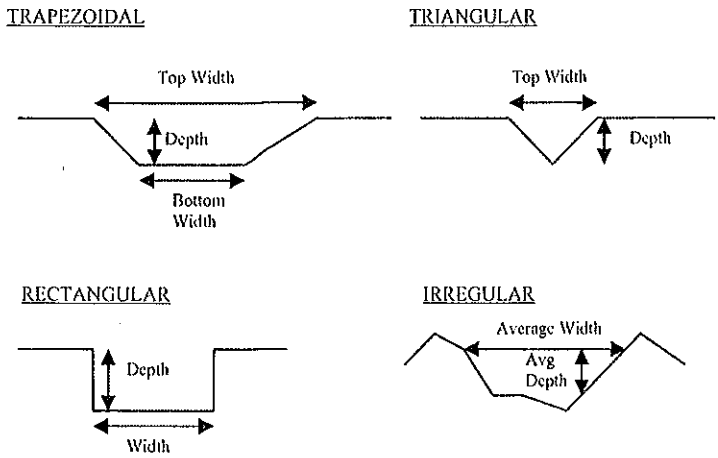



_____ Cross-Valley
_____ Side-Hill
X Diked
_____ Incised (form completion optional)
_____ Combination Incised/Diked

Embankment Height Approx 28 feet
Pool Area Approx 47.7 (@ El. 515') acres
Current Freeboard 3 feet

Embankment Material Gravel toe drain, bottom ash core, sand/soil & rip-rap cover
Liner none
Liner Permeability n/a

**TYPE OF OUTLET** (Mark all that apply)

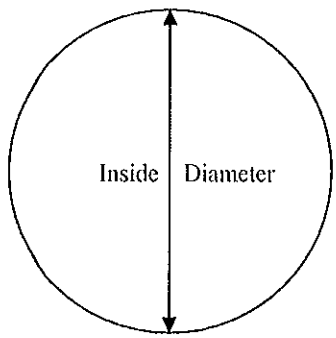



_____ **Open Channel Spillway**
_____ Trapezoidal
_____ Triangular
X Rectangular
_____ Irregular

3' depth
4' bottom (or average) width
_____ top width

X **Outlet**

30" inside diameter




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

Is water flowing through the outlet? YES _____ NO X

_____ **No Outlet**

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

The Impoundment was Designed By Barr Engineering with oversight by Indiana Michigan Power

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

If So When? _____

If So Please Describe : _____

Has there ever been significant seepages at this site? YES _____ NO X (see note)

If So When? _____

IF So Please Describe: _____

NOTE:
The downstream toe of the dike has been designed to collect embankment seepage such that the seepage does not affect the structural integrity of the embankment. Normal seepage and operation of the collection system was observed during the inspection.

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

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

If so Please Describe :

Note:
Thirteen piezometers were installed as part of the construction of the dike which contains the upper pools. They are used to monitor the water levels within the dike and are measured monthly.

Coal Combustion Dam Inspection Checklist Form

US Environmental Protection Agency

Site Name: Indiana Michigan Power - Tanner's Creek Plant Date: June 2, 2009

Unit Name: Fly Ash Pond - Clear Pond & Original (Lower Pond) Dike Operator's Name: Tim Kerns - Plant Manager

Unit I.D.: N/A Hazard Potential Classification: High (Significant) Low

Inspector's Name: Scott Cormier, PE & Gary Emmanuel, PE

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

| | Yes | No | | Yes | No |
|---|---|---|---|---|---|
| 1. Frequency of Company's Dam Inspections? | Multiple | | 18. Sloughing or bulging on slopes? | | X |
| 2. Pool elevation (operator records)? | 487' - 489' | | 19. Major erosion or slope deterioration? | | X |
| 3. Decant Inlet elevation (operator records)? | Pumped | | 20. Decant Pipes: | | |
| 4. Open channel spillway elevation (operator records)? | 491 | | Is water entering inlet, but not exiting outlet? | | N/A |
| 5. Lowest dam crest elevation (operator records)? | 495 | | Is water exiting outlet, but not entering inlet? | | N/A |
| 6. If instrumentation is present, are readings recorded (operator records)? | X | | Is water exiting outlet flowing clear? | | N/A |
| 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)? | X | | From underdrain? | | X |
| 9. Trees growing on embankment? (If so, indicate largest diameter below) | X | | At isolated points on embankment slopes? | X | |
| 10. Cracks or scarps on crest? | | X | At natural hillside in the embankment area? | | X |
| 11. Is there significant settlement along the crest? | | X | Over widespread areas? | | X |
| 12. Are decant trashracks clear and in place? | X | | From downstream foundation area? | | X |
| 13. Depressions or sinkholes in tailings surface or whirlpool in the pool area? | | X | "Boils" beneath stream or ponded water? | | X |
| 14. Clogged spillways, groin or diversion ditches? | | X | Around the outside of the decant pipe? | | 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? | | X |
| 17. Cracks or scarps on slopes? | | X | 24. Were Photos taken during the dam inspection? | X | |

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

Inspection Issue # Comments

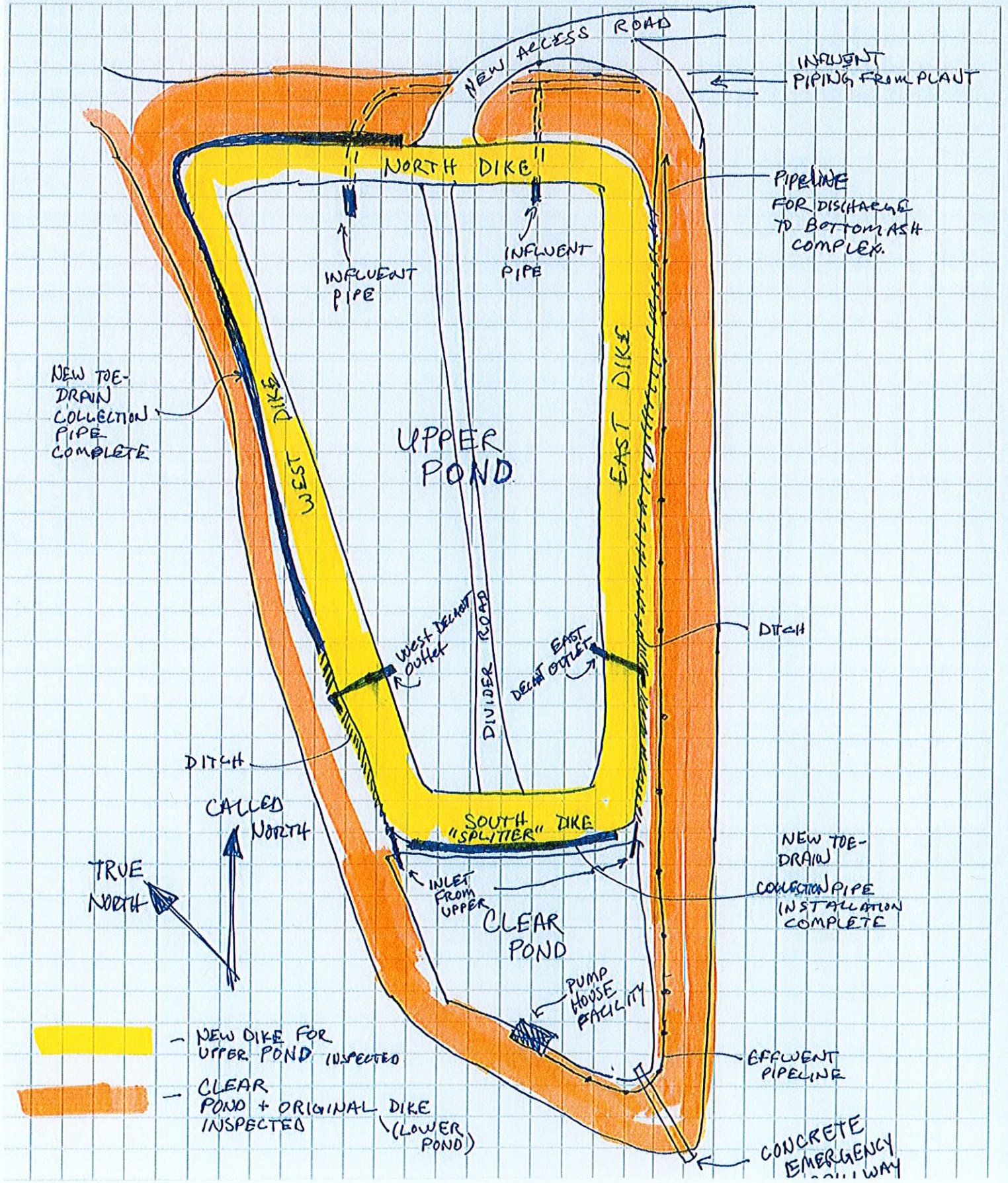
(Please refer to next page for list of comments - 2nd Page)

(Please refer to plan sketch for naming of features - 3rd Page)

| Inspection Issue # | Comments |
|---|---|
| 1 | Impoundment is inspected monthly by plant personnel and annually by a PE from corporate engineering staff |
| 6 | 21 surface monitoring points located along the impoundment slopes and six slope indicators are surveyed quarterly. Additionally, the flow from the pumping operation is recorded in the plant's electronic records system. |
| 8 | A summary of 1970's construction reports indicated that the area was cleared to construct the original dike. |
| 9 | Shrubery with diameters up to approximately 4" are located along the fenceline at the toe of the west slope. |
| 12 | The pump inlets are protected and maintained to prevent blockage |
| 20 | Fly Ash Pond not in operation at time of inspection |
| 21 | An isolated minor seep of clearwater was observed on the north slope near the new construction access road. |

O'BRIEN & GERE

| SUBJECT | SHEET | BY | DATE | JOB NO. |
|---|---|---|---|---|
| PLAN SKETCH – FLY ASH POND | 1 | JPH | 6/3/09 | 44642 |



U. S. Environmental Protection Agency

## Coal Combustion Waste (CCW)
## Impoundment Inspection

Impoundment NPDES Permit # IN0002160

INSPECTOR Scott Cormier, PE & Gary Emmanuel, PE

Date June 2, 2009

Impoundment Name Fly Ash Pond - Clear (Lower Pond) Dike

Impoundment Company Indiana Michigan Power

EPA Region V

State Agency (Field Office) Addresss N/A

Name of Impoundment Noted above

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

New _____ Update X

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

**IMPOUNDMENT FUNCTION:** Additional settling of Fly Ash beyond the settling achieved by the upper pond

Nearest Downstream Town : Name Aurora, IN

Distance from the impoundment Approximately 1.75 Miles

Impoundment Location:

Longitude 39 Degrees 4 Minutes 36.90 Seconds

Latitude -84 Degrees 52 Minutes 48.49 Seconds

State Indiana County Dearborn

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

If So Which State Agency? IDNR - (Indiana Department of Natural Resources)

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

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

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

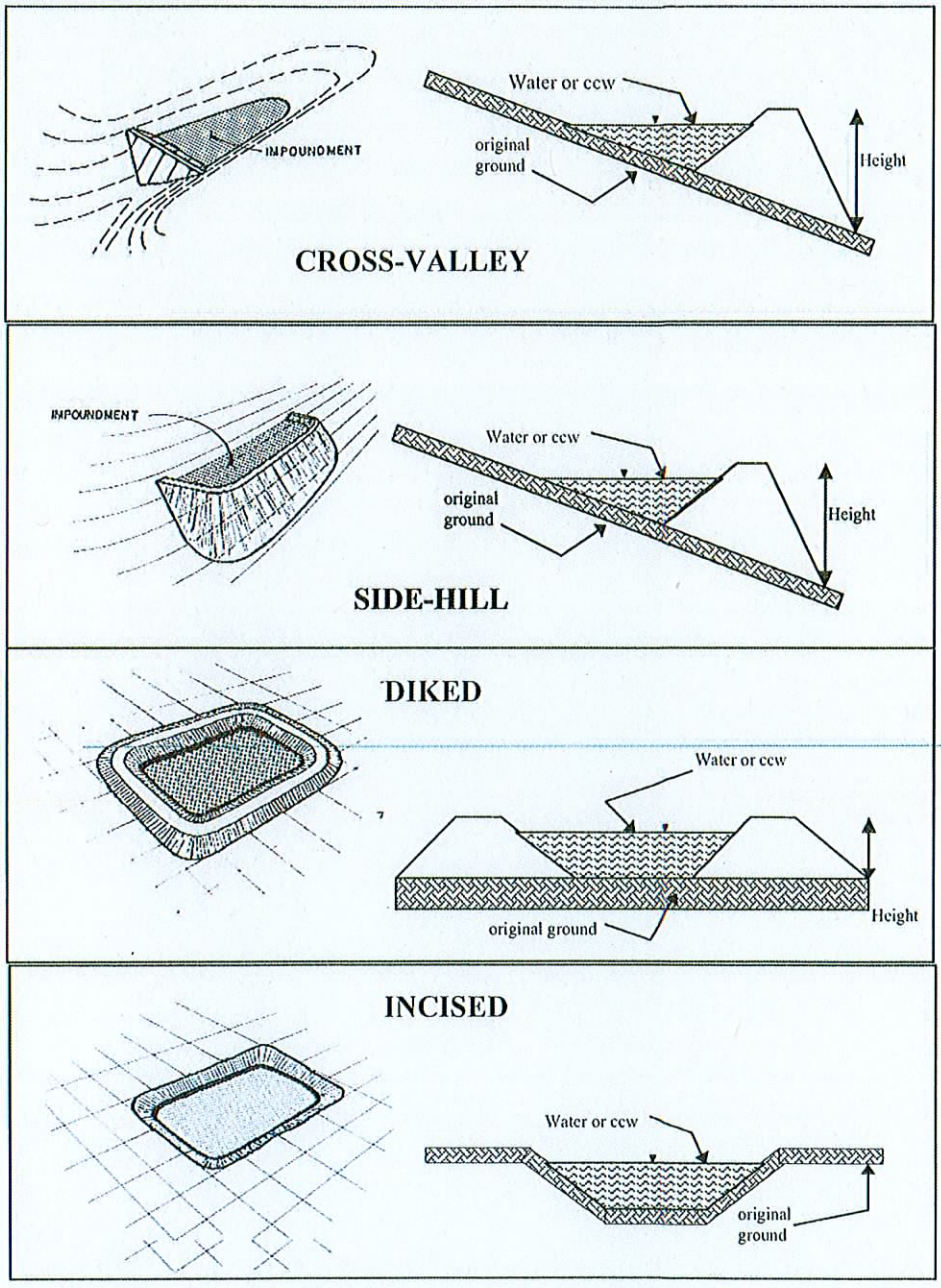
__X__ **SIGNIFICANT HAZARD POTENTIAL:** Dams assigned the significant hazard potential classification are those dams where failure or misoperation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or can impact other concerns.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

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

**DESCRIBE REASONING FOR HAZARD RATING CHOSEN:**

Failure of impoundment would result in immediate release to adjacent properties and eventual release to Ohio River. Additionally, potential exists for damage to nearby railway and community water supply well.

## CONFIGURATION:




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

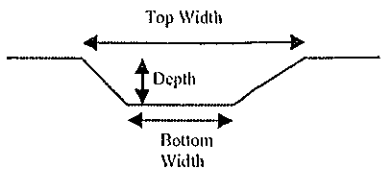
Embankment Height Approx 33 feet
Pool Area Approx 12 acres
Current Freeboard 9 feet

Embankment Material Mostly clay base with some granular soil core material in freeboard portion of dike
Liner PVC/Clay
Liner Permeability Virtually none

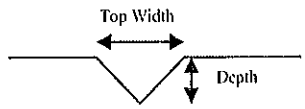
## TYPE OF OUTLET (Mark all that apply)

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

TRAPEZOIDAL



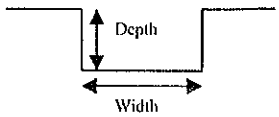

TRIANGULAR



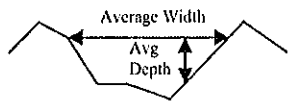

3' depth
4' bottom (or average) width
_____ top width

Note: The above is for the spillway only

RECTANGULAR

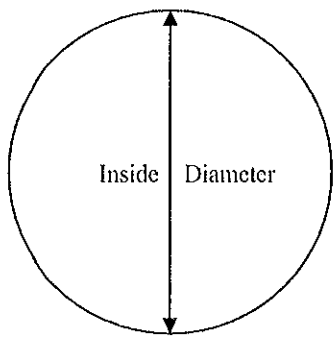



IRREGULAR




X **Outlet**

2 @ 14" inside diameter




Material
_____ corrugated metal
_____ welded steel
X concrete (Spillway)
X plastic (hdpe, pvc, etc.) (Pipeline from pumps)
_____ other (specify) _____

Is water flowing through the outlet? YES _____ NO X

_____ **No Outlet**

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

The Impoundment was Designed By Casagrande Consultants

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

If So When? _____

If So Please Describe : _____

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

If So When? _____

IF So Please Describe: _____

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

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

If so Please Describe : _____

# APPENDIX B

## Photographs

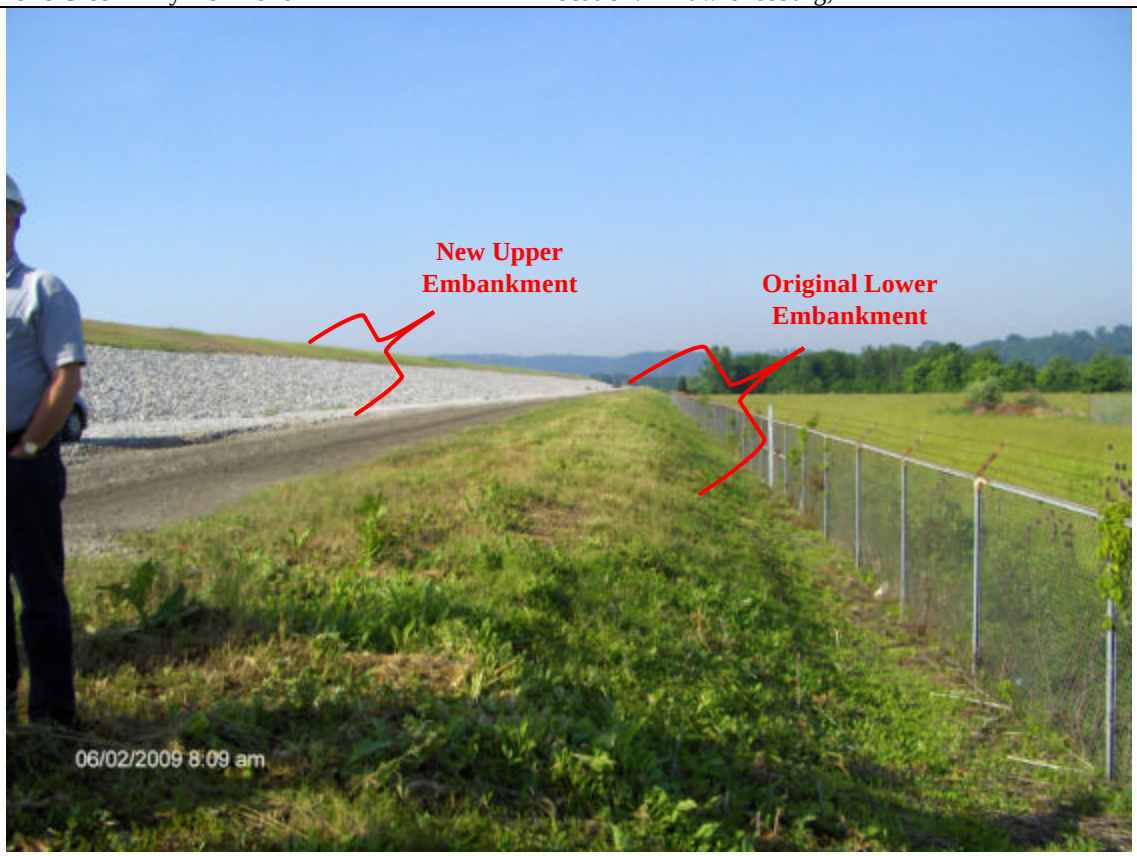
O'BRIEN & GERE

# PHOTOGRAPHIC LOG

| | |
|---|---|
| Client: US EPA / Lockheed Martin | Project Number: 5851/44642 |
| Site Name: Tanner's Creek - Fly Ash Pond | Location: Lawrenceburg, IN |

Orientation: South

Description: View along west embankment. Note original lower embankment and new upper embankment.




Date: 6/2/09

Photo Number: 1

Photographer: JPH

Orientation: North

Description: View along west side of original lower embankment.

Date: 6/2/09

Photo Number: 2

Photographer: JPH

O'BRIEN & GERE

# PHOTOGRAPHIC LOG

| | |
|---|---|
| Client: US EPA / Lockheed Martin | Project Number: 5851/44642 |
| Site Name: Tanner's Creek - Fly Ash Pond | Location: Lawrenceburg, IN |

| | |
|---|---|
| Orientation: West<br>Description: View along south embankment of original structure.<br>Date: 6/2/09<br>Photo Number: 3<br>Photographer: JPH | |
| Orientation: North<br>Description: View along east embankment of original structure. Note FRP piping along crest of original dike.<br>Date: 6/2/09<br>Photo Number: 4<br>Photographer: JPH | |

O'BRIEN & GERE

# PHOTOGRAPHIC LOG

| | |
|---|---|
| Client: US EPA / Lockheed Martin | Project Number: 5851/44642 |
| Site Name: Tanner's Creek - Fly Ash Pond | Location: Lawrenceburg, IN |

| | |
|---|---|
| Orientation: South<br>Description: View along east embankment of original structure. Note new access drive to road on crest of original dike and FRP discharge piping in foreground.<br>Date: 6/2/09<br>Photo Number: 5<br>Photographer: JPH | |
| Orientation: West<br>Description: View of north embankment and construction access road to Upper Pond for excavation work and transport of excavated fly ash.<br>Date: 6/2/09<br>Photo Number: 6<br>Photographer: JPH | |

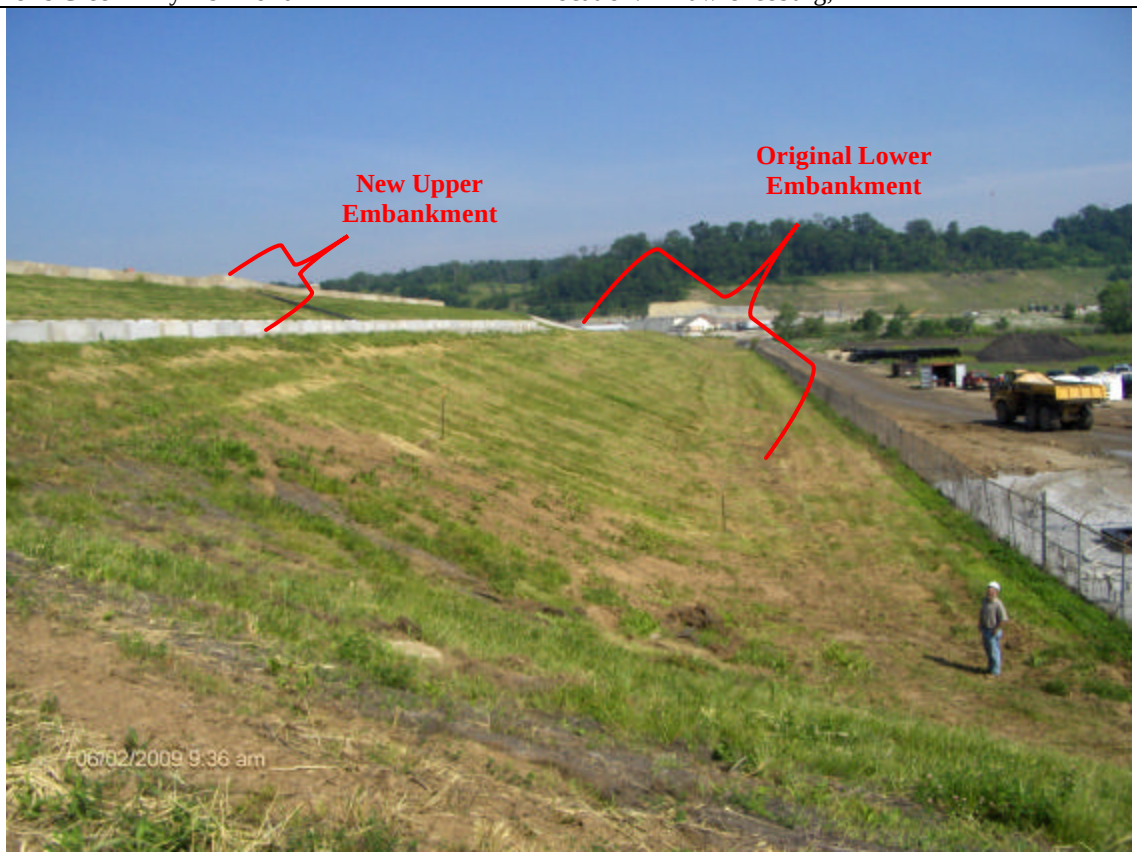
O'BRIEN & GERE

# PHOTOGRAPHIC LOG

| | |
|---|---|
| Client: US EPA / Lockheed Martin | Project Number: 5851/44642 |
| Site Name: Tanner's Creek - Fly Ash Pond | Location: Lawrenceburg, IN |

Orientation: West

Description: View of north embankment. Note original lower portion and new upper portion of embankment.




Date: 6/2/09

Photo Number: 7

Photographer: JPH

Orientation: South

Description: View along west embankment of Upper Pond. Note roadway at left leads up to crest of new upper embankment.

Date: 6/2/09

Photo Number: 8

Photographer: JPH

O'BRIEN & GERE

# PHOTOGRAPHIC LOG

| | |
|---|---|
| Client: US EPA / Lockheed Martin | Project Number: 5851/44642 |
| Site Name: Tanner's Creek - Fly Ash Pond | Location: Lawrenceburg, IN |

Orientation: East

Description: View along splitter dike of Upper Pond. Clear pond at right, Upper Pond at top left.

Date: 6/2/09

Photo Number: 9

Photographer: JPH

Orientation: North

Description: View along east embankment of Upper Pond. Discharge piping from Clear Pond shown in foreground.

Date: 6/2/09

Photo Number: 10

Photographer: JPH

O'BRIEN & GERE

# PHOTOGRAPHIC LOG

| | |
|---|---|
| Client: US EPA / Lockheed Martin | Project Number: 5851/44642 |
| Site Name: Tanner's Creek - Fly Ash Pond | Location: Lawrenceburg, IN |

| | |
|---|---|
| Orientation: North West<br>Description: Excavation of stored fly ash from east half of Upper Pond in progress. Excavated fly ash is destined for facility's new fly ash landfill.<br>Date: 6/2/09<br>Photo Number: 11<br>Photographer: JPH | |
| Orientation: South<br>Description: Stored ash in west half of Upper Pond. Inlet piping shown at right. Note sandbags placed on straw matting to control dust.<br>Date: 6/2/09<br>Photo Number: 12<br>Photographer: JPH | |

O'BRIEN & GERE

# PHOTOGRAPHIC LOG

| | |
|---|---|
| Client: US EPA / Lockheed Martin | Project Number: 5851/44642 |
| Site Name: Tanner's Creek - Fly Ash Pond | Location: Lawrenceburg, IN |

Orientation: South

Description: Inlet to Upper Pond decant structure. Note stop logs stored at left and stored ash in picture background.

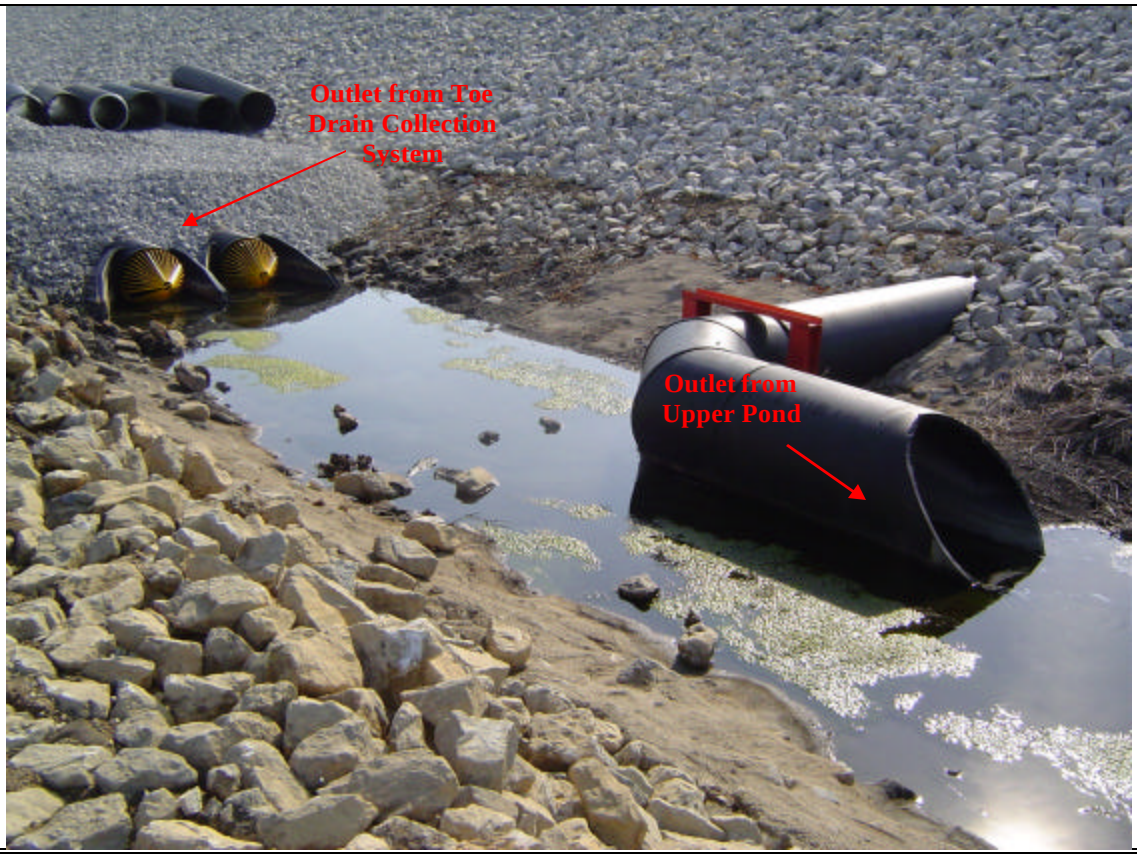
Date: 6/2/09

Photo Number: 13

Photographer: JPH

Orientation: Northeast

Description: Outlet from new slotted pipe toe drain collection system and outlet from Upper Pond into ditch.




Date: 6/2/09

Photo Number: 14

Photographer: JPH

O'BRIEN & GERE

# PHOTOGRAPHIC LOG

| | |
|---|---|
| Client: US EPA / Lockheed Martin | Project Number: 5851/44642 |
| Site Name: Tanner's Creek - Fly Ash Pond | Location: Lawrenceburg, IN |

| | |
|---|---|
| Orientation: South | |
| Description: Discharge pumping equipment in Clear Pond | |
| Date: 6/2/09 | |
| Photo Number: 15 | |
| Photographer: JPH | |
| Orientation: Southeast | |
| Description: Emergency overflow inlet at southeast corner of Clear Pond | |
| Date: 6/2/09 | |
| Photo Number: 16 | |
| Photographer: JPH | |

O'BRIEN & GERE

# PHOTOGRAPHIC LOG

| | |
|---|---|
| Client: US EPA / Lockheed Martin | Project Number: 5851/44642 |
| Site Name: Tanner's Creek - Fly Ash Pond | Location: Lawrenceburg, IN |

| | |
|---|---|
| Orientation: Southwest<br>Description: Surface monitoring point located on west embankment of original structure<br>Date: 6/2/09<br>Photo Number: 17<br>Photographer: JPH | |
| Orientation: North<br>Description: Slope indicator located near toe of slope on original North Embankment. Monument is heavily protected by concrete bollards.<br>Date: 6/2/09<br>Photo Number: 18<br>Photographer: JPH | |

O'BRIEN & GERE

# PHOTOGRAPHIC LOG

| | |
|---|---|
| Client: US EPA / Lockheed Martin | Project Number: 5851/44642 |
| Site Name: Tanner's Creek - Fly Ash Pond | Location: Lawrenceburg, IN |

Orientation: South

Description: Vault for settlement plate on crest of the Upper Pond splitter dike.

Date: 6/2/09

Photo Number: 19

Photographer: JPH

Orientation: West

Description: Wetland type vegetation growing on north side of upper embankment near isolated seepage at the toe of the slope.

Date: 6/2/09

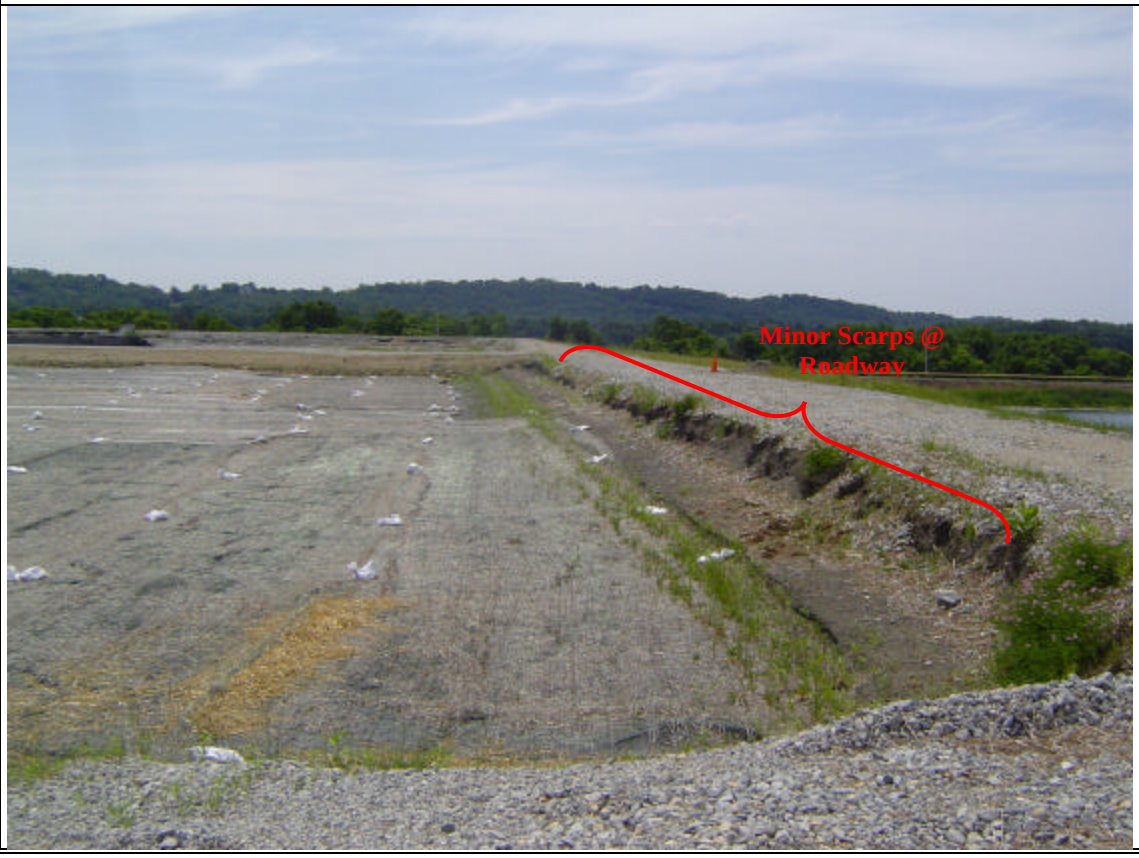
Photo Number: 20

Photographer: JPH

O'BRIEN & GERE

# PHOTOGRAPHIC LOG

| | |
|---|---|
| Client: US EPA / Lockheed Martin | Project Number: 5851/44642 |
| Site Name: Tanner's Creek - Fly Ash Pond | Location: Lawrenceburg, IN |

| | |
|---|---|
| Orientation: Southeast<br>Description: Installation of slotted pipe toe-drain collection system at toe of Upper Pond splitter dike.<br>Date: 6/2/09<br>Photo Number: 21<br>Photographer: JPH | |
| Orientation: East<br>Description: Minor scarps along roadway on upstream side of Upper Pond splitter dike.<br>Date: 6/2/09<br>Photo Number: 22<br>Photographer: JPH |  |