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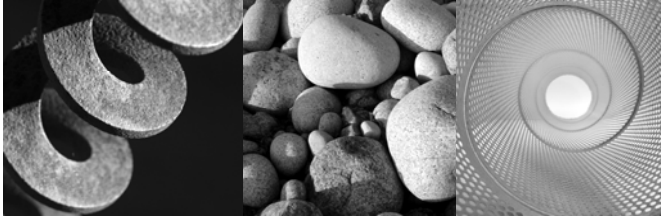

GEI Consultants

Geotechnical
Environmental and
Water Resources
Engineering

Draft - Specific Site Assessment for Coal Ash Impoundments at Arizona Public Service (APS) Four Corners Power Plant

Lined Ash Impoundment

Lined Decant Water Impoundment

Fruitland, New Mexico

Submitted to:
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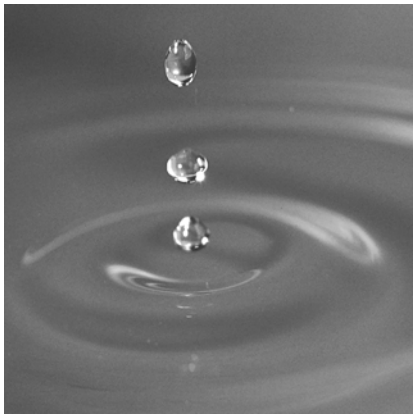
June 2009
Project 091330



Stephen G. Brown, P.E.
Senior Project Manager

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1.0 Introduction

1.1 Purpose

This report presents the results of a specific site assessment of the dam safety of Lined Ash Impoundment (LAI) embankment dam and Lined Decant Water Impoundment (LDWI) embankment dam at the Four Corners Power Plant in Fruitland, New Mexico.

1.2 Scope of Work

The scope of work between GEI and Lockheed-Martin Corporation for the site assessment is summarized in the following tasks:

1. Acquire and review existing reports and drawings relating to the safety of the project provided by the U. S. Environmental Protection Agency (EPA) and Owners.

2. Conduct detailed physical inspections of the project facilities. While on-site, fill out Field Assessment Check Lists provided by EPA for each management unit being assessed.

3. Review and evaluate stability analyses of the project's coal combustion waste impoundment structures.

4. Review the appropriateness of the inflow design flood (IDF), and adequacy of ability to store IDF, provision for any spillways, including considering the hazard potential in light of conditions observed during the inspections or to the downstream channel.

5. Review existing performance monitoring programs and recommend any additional monitoring required.

6. Review existing geologic assessments for the projects.

7. Submit draft and final reports.

1.3 Authorization

GEI Consultants, Inc., performed the coal combustion waste impoundment assessment for the EPA as a subcontractor to Lockheed Martin who is a contractor to the EPA. This work

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was authorized by the Lockheed-Martin under the P.O. No.: 7100052068; EAC #0-381 between Lockheed-Martin and GEI Consultants, Inc. (GEI), dated June 5, 2009.

1.4 Project Personnel

The scope of work for this task order was completed by the following personnel from GEI:

Stephen G. Brown, P.E.	Project Manager/Task Leader
Bryan Scott, P.E.	Project Geotechnical Engineer
Gillian Hinchliff	Staff Engineer

Program Manager for the EPA was Stephen Hoffman. Program Manager for Lockheed-Martin Corporation was Dennis Miller.

1.5 Limitation of Liability

This report summarizes the assessment of dam safety of the Lined Ash Impoundment and Lined Decant Water Impoundment coal combustion waste impoundments at Arizona Public Service, Four Corners, New Mexico. The purpose of each assessment is to determine the structural integrity of the impoundments and provide summaries and recommendations based the available information and on engineering judgment. GEI used a professional standard of practice to review, analyze, and apply pertinent data. No warrantees, express or implied, are provided by GEI. Reuse of this report for any other purpose, in part or in whole, is at the sole risk of the user.

1.6 Project Datum

All elevations in this report are New Mexico State Plane, Transverse Mercator-West Zone, NAD 1927 Horizontal, NAVD 1929 Vertical.

1.7 Prior Inspections

The LAI and LDWI embankment dams are inspected every 6 months by an APS Four Corners Plant Professional Engineer. The plant's Professional Engineers are registered with the State of New Mexico. The New Mexico Office of the State Engineer (OSE) Dam Safety Bureau last inspected the LAI and LDWI dams on October 4, 2007 and rated both of the impoundment dams as satisfactory.

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2.0 Description of Project Facilities

2.1 General

Four Corners Power Plant is a coal-fired power plant consisting of five units that generate about 2,060 megawatts (MW). The Four Corners Power Plant is located in Fruitland, San Juan County, New Mexico approximately 20 miles west of Farmington, New Mexico, and about 13 miles southeast of Shiprock, New Mexico, see the attached Figure 1. The power plant is located at the south side of Morgan Lake, and the Lined Ash Impoundment (LAI) and Lined Decant Water Impoundment (LDWI) are located just west of the power plant. The power plant is owned and operated by Arizona Public Service Company (APS) and the first unit went online in 1963.

2.2 Impoundment Dams and Reservoirs

LAI and LDWI embankments are classified by the New Mexico OSE Dam Safety Bureau as significant-hazard potential structures because of their intermediate heights, storage capacities, and economic risk to property and the environment. The LAI embankment dam crest is at El. 5248 for a total height of 83 feet; however, 43 feet of the height constitutes the underlying old ash impoundment #3 and #4. The LAI has a storage capacity of about 2,400 acre-feet. LAI has about 7 feet of freeboard at the time of this assessment and a design freeboard of 2.8 feet.

The LDWI dam crest is at El. 5216 for a total height of 90 feet; however, 80 feet of the height constitutes the underlying old ash impoundment #3. The LDWI has a storage capacity of about 435 acre-feet. LDWI currently has about 5 feet of freeboard and a design freeboard of 2.8 feet.

The LAI embankments have a 15-foot-wide zone of compacted clay on the upstream slopes with the remainder of the embankment constructed of bottom ash. The dam crest is 30 feet wide and both upstream and downstream slopes have an approximate 3H:1V slope. The LAI has a single HDPE lining and a clay lining on the upstream slope of the dam.

The LDWI embankments are constructed of compacted clay on the north, east, and south sides. The west embankment is constructed of a 15-foot-wide zone of compacted clay on the upstream slope with the remainder of the embankment constructed of bottom ash. The dam crest is 30 feet wide and both upstream and downstream slopes have an approximate 3H:1V slope. The LDWI has a dual HDPE liner with a leak detection system.

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Table 2.1: Impoundment Dam Parameters Summary

Parameter	Value	
Dam	LAI Dam	LDWI Dam
Height (ft)	40 ft (plus 43 ft are from old ash pond #3 and #4)	10 to 15 ft (plus 80 ft are from old ash pond #3)
Length (ft)	Approx 4,534	Approx. 3,094
Crest Width (ft)	30	30
Crest Elevation (ft)	El. 5248	El. 5216
Side Slopes (_H:1V)	3	3
Current Ash El. (ft)	El. 5241	El. 5211
Storage Capacity (ac-ft)	2,400	435
Surface Area (acres)	75	45

2.3 Spillways

The LAI dam and the LDWI dam do not have spillways.

2.4 Intakes and Outlet Works

The LAI dam has an 8-foot-diameter HDPE drop inlet decant structure. Two drainage pipes discharge decanted water from the LAI drop inlet structure to the LDWI; an 8-inch-diameter HDPE pipe at invert El. 5213.5 and a 16-inch-diameter HDPE at invert El. 5220. Both pipes exit the LAI at a 1 percent slope. The 16-inch-diameter pipe discharges by gravity over the top of the east embankment of the LDWI. The 8-inch-diameter HDPE pipe has a reverse slope where it is brought up and over the east embankment of the LDWI such that water remains in the pipe and flow does not occur until the height of water in the LAI exceeds the elevation of the intervening embankment (approx. El. 5216). A third pipe, an 8 inch diameter perforated HDPE drainage pipe, also discharges into the LDWI from the LAI. A perforated length of this 8-inch pipe is located on the pond bottom in the southwest corner of the LAI. Water collected by the 8-inch perforated pipe flows by gravity to a downstream pump station where it is lifted into the LDWI.

The LDWI dam has no decant pipe or drop inlet. Water impounded by the LDWI is pumped to the power plant.

2.5 Vicinity Map

Four Corners Power Plant is located in Fruitland, New Mexico in San Juan County approximately 20 miles west of Farmington, as shown on Figure 1. The station is located at the south end of Morgan Lake, and the LAI and LDWI are located just west of the station.

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The nearest town downstream of the LAI and LDWI is Shiprock, New Mexico, which is located approximately 13 miles away.

2.6 Plan and Sectional Drawings

Engineering drawings for the LAI proposed 5258 Lift are drawings numbered FC-C-41-ADS-156687-1 through FC-C-39-ADS-156687-18 dated October 29, 2007 through March 11, 2008 prepared by APS. Drawings that are generally descriptive of the impoundment structures are included in this report as Exhibits, as follows:

Exhibit 1	LAI Site Plan
Exhibit 2	LAI Embankment Sections (1 of 3)
Exhibit 3	LAI Embankment Sections (2 of 3)
Exhibit 4	LAI Embankment Sections (3 of 3)
Exhibit 5	LAI Soil Boring Logs
Exhibit 6	LAI Decant Drop Inlet Structure
Exhibit 7	LAI Instrument Locations

2.7 Standard Operational Procedures

A draft Operations and Maintenance Manual has been prepared and submitted to the New Mexico OSE for review and was not available for this assessment. The facility is manned full-time (24 hours a day and 7 days a week) and personnel perform daily inspections of ash pond facilities. There have been no known spills or unpermitted releases for either the LAI or LDWI in the past 10 years.

The plant's ash disposal area consists of an the LAI, the LDWI, a Dry Fly Ash Disposal Unit, and six old ash impoundments that are no longer in service. Based on available piezometer information, the old ash impoundments #3 and #4 that underlie the LAI and LDWI are mostly unsaturated and are expected to have only localized zones of perched water or saturation in low areas of the buried natural ground surface. The old ash impoundments that the plant identifies as #3 and #6 are still inspected by the New Mexico OSE Dam Safety Bureau because APS has not yet submitted closure plans for those facilities.

The plant and ash processes are operated as a low volume water usage system. In the arid Four Corners climate, the annual pan evaporation exceeds precipitation by a factor of 5. The average annual precipitation is about 7.9 inches per year.

Wet bottom ash is removed from all five generating unit boilers and is slurried to collection bins for dewatering. The bottom ash is completely dewatered and then hauled by truck to the plant's ash disposal area. The majority of the generated bottom ash is used in the

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construction of site haul roads and embankments for future coal ash impoundments and expansions.

The fly ash from generating units 1, 2 and 3 is collected by venturi scrubbers (a wet particulate SO_2 removal system), slurried to thickener equipment for fly ash and FGD material concentration (water reduction), and then pumped to the plant's LAI for settling, dewatering, and storage. The fly ash slurry entering the LAI is about 35 percent solids. Water decanted from the LAI flows by gravity through a filter of bottom ash constructed around the perforated decant intake in the LAI, and then into the LDWI. Water is also decanted by an 8 inch diameter perforated HDPE pipe that lies on the bottom of the southwest corner of the LAI and that has continued to flow despite being buried by fly ash. This water flows by gravity to a downstream pump station where it is lifted into the LDWI.

The SO_2 from generating units 4 and 5 is removed from the flue gas by a wet spray tower scrubber system. The resulting FGD material is then pumped to thickener equipment, where it is concentrated before being pumped to the plant's LAI, where it is co-mingled with fly ash and FGD material from generating units 1, 2 and 3.

Water from the plant's low volume waste water system is pumped into a collection system sump from several sources within the plant. The water then flows out of the collection sump by gravity flows through the Low Volume Waste Water Decant Cells before flowing into the plant's Low Volume Waste Water Pond.

The performance of certain areas of the facility can be monitored by several instruments. The location and type of instrumentation is discussed in Section 5 of this report.

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3.0 Summary of Construction History and Operation

The first unit of Four Corners Power Plant went online in 1963. Today, the plant has five generating units. Six old ash ponds are no longer in service. Historically, old ash ponds #3 and #4 were constructed as independent, unlined cells, contained be perimeter embankments and separated by a common earth embankment designated 3-4. There are no construction and/or design documents for the embankments. Fly ash was deposited into ash pond #4 at the east end as a slurry. The old 3-4 embankment had not been raised and ash ponds #3 and #4 became one unit. The old 3-4 common embankment was buried under the fly ash at shallow depth.

The west embankment for the LDWI also was constructed over, and tied into the underlying pond 3-4 embankment. The north, east, and south LDWI embankments were constructed directly on the fly ash within pond #3. The embankment of the Lined Decant Water Impoundment was built to the full height of approximately 10 to 16 feet in a single phase and was completed in 2003.

Embankments for the LAI were constructed over, and tie into, the underlying pond 3-4 clay embankments, with the exception of the northwest corner where the Pond 3-4 clay embankment could not be located. In this area, a deeper cutoff trench was excavated and backfilled with compacted clay for a length of several hundred feet. The contents of the LAI overlie the fly ash contained within pond #4.

In 2003, the LAI was initially constructed to El. 5228. In 2007, the second raise was constructed to its current crest El. 5248. Each embankment raise or lift consists of a 15-foot-wide zone of compacted, relatively low-permeability clay on the upstream slope, a 30-foot-wide dam crest, and compacted bottom ash on the downstream slope. Both the upstream and downstream slopes have an approximate 3H:1V slope. Currently, construction has begun for the next proposed LAI raise to El. 5258. The embankment geometry will remain the same during the raise to El. 5258.

APS plans to continue to raise the LAI embankment in 10-foot-elevation construction phases until the total height of the LAI is 70 feet with a dam crest elevation of El. 5278 (for a total height of 113 feet including the underlying former ash pond 3-4 embankment). The 70-foot-high embankment will provide approximately 12 years of capacity for fly ash disposal in the LAI.

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4.0 Geologic and Seismic Considerations

The site is situated near the San Juan Basin of the Colorado Plateau Physiographic Province. The San Juan Basin which is a major source of oil, gas, coal and uranium in the state. The San Juan Basin formed during regional-scale compression during the Laramide Orogeny. Surficial geology at the site is composed of fine-grained deposits that are a residual soil of the weathered near-surface strata of the Cretaceous-age Lewis Shale. The impoundments area located about 8,500 feet east of the Hogback Monocline, which is the dominant tectonic feature in the area and constitutes the northwest margin of the San Juan Basin. The Hogback is a north-south trending monocline formed by steeply east-dipping Cliff House Sandstone.

No geologically young-aged faults have been mapped in the area, despite the evident bedrock deformations. The closest mapped faults to the site occur near Cortez, Colorado, approximately 35 miles north of the power plant, and approximately 50 miles to the southwest near the southern boundary of the Defiance Uplift.

A peak horizontal acceleration coefficient of 0.10g can be assigned to the site based on the 2008 United States Geological Survey (USGS) regional probabilistic seismic hazard map for 2 percent Probability of Exceedance within 50 years (recurrence interval of approximately 2500 years), which is a reasonable recurrence period for consideration of significant hazard impoundments.

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5.0 Instrumentation

5.1 Location and Type

LAI instrument are all located on the west dam embankment of the LAI, as shown on Exhibit 7. The LDWI instruments, consisting of standpipe observation wells, are located around the perimeter dams of the LDWI.

5.1.1 Lined Ash Impoundment

- Vibrating Wire Piezometers for monitoring water levels at various depths in the underlying fly ash that forms the foundation of the LAI dams
- Settlement Plates for monitoring settlement of the dam and the underlying fly ash relative to natural ground foundation.
- Survey Monuments (benchmarks) for surveying control of vertical and horizontal movement of the dam

5.1.2 Lined Decant Water Impoundment

- Standpipe Piezometers for monitoring water levels at various depths in the dam foundation
- Survey Monuments (benchmarks) for surveying control of vertical and horizontal movement of the dam

5.1.3 Summary of Observation Well Locations

Five vibrating wire piezometers were installed on the west embankment of the LAI at locations shown on Exhibit 7. The piezometers were installed in clusters of 3 piezometers, each at different depths. A settlement plate was also installed in conjunction with clusters number 7, 8, and 9. The piezometer numbers with measurement elevations are summarized in Table 2. These piezometers monitor water pressure head in the underlying Pond #4 fly ash that forms the foundation of the LAI west embankment.

Table 5.1: LAI Piezometer Information

Piezometer Number	Measurement Elevation (ft)
P-7.1	5196.9
P-7.2	5191.4
P-7.3	5184.8
P-8.1	5196.6

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Piezometer Number	Measurement Elevation (ft)
P-8.2	5182.1
P-8.3	5174.1
P-9.1	5196.9
P-9.2	5184.0
P-9.3	5170.9
P-10.1	5198.2
P-10.2	5184.2
P-10.3	5173.7
P-11.1	5200.7
P-11.2	5189.7
P-11.3	5174.7
P-12.1	5202.5
P-12.2	5186.5
P-12.3	5176.5

Five observation wells were installed on the perimeter embankment of the LDWI in December 2003. The well numbers with depths are summarized in Table 3. These observation wells are screened to monitor water levels in the underlying Pond #3 fly ash and dam that forms the foundation of the LDWI perimeter embankment.

Table 5.2: LDWI Standpipe Observation Well Information

Well Number	Standpipe Bottom Depth (ft)	Monitoring Well Depth (ft)	Screen Depth (ft)
P-18	67	65	10
P-19	86	86	10
P-20	89	87.5	10
P-21	86	83	10
P-22	67	65	10

5.2 Time Versus Reading Graphs of Data

5.2.1 Lined Decant Water Impoundment

LDWI observation well water levels have been recorded monthly and the data versus time is summarized for the period July to December 2009 on Figure A-1 in Appendix A.

5.2.2 Lined Ash Impoundment

LAI piezometers have been monitored since January 2008. The piezometer readings are typically recorded monthly. Piezometer readings are submitted every 6 months to the NM SEO. The piezometric level data versus time are plotted on Figures A-2 to A-7 in Appendix A. The vertical movement devices (settlement plates) at LAI have also been monitored since January 2008. The vertical measurement device elevation data versus time data are plotted on Figure A-8 in Appendix A.

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5.3 Evaluation of Instrument Data

5.3.1 Lined Ash Impoundment

The vibrating wire piezometers include a short length of porous tube and consequently represent a water pressure measurement at discrete depths. All LAI piezometer readings, except P-9.3 and P-12.3, indicate no saturation at the depth of the instrument. The deepest instrument is P-9.3, which is about 6 feet above the underlying weathered shale foundation material. The water pressure in P-9.3 has been steadily declining since January 2008 from about 4 feet of head to a January 2009 reading of 1 foot of head. Piezometer P-12.3 has risen steadily in 2008 from zero head to about 0.5 foot of head. Piezometers P-9.3 and P-12.3 may indicate localized perched saturation. Information on the potential for water in the lower 6 feet of the fly ash can be inferred from the nearby LDWI observation wells, which are screened at the bottom of the fly ash, or in the shale foundation. The LDWI observation wells are dry, indicating no saturation at those locations. The underlying fly ash foundation can be inferred to be generally free of saturation at the instrument locations based on this information. However, seepage noted at the downstream toe of the Pond #4 south embankment indicates the potential for localized saturation of the fly ash, likely to depths of a few feet or less. The overall information is consistent with the LAI that includes an HDPE lining, and the investigation information that represents the underlying Pond #4 fly ash as unsaturated.

Settlement plates were installed into the shale foundation material at three locations along the downstream toe of the west embankment and will primarily measure settlement in the old fly ash that forms the foundation of the embankment. Settlement is expected to be nearly immediate in the unsaturated and moderately permeable fly ash. Vertical movement device data obtained since January 2008 indicate that settlements ranging from 0 to 2.5 feet may have occurred during 2008. These settlements greatly exceed the expected 1 inch settlement at the downstream toe and may represent disturbance of the settlement plate instruments. These instruments are located at the downstream toe of the existing 5248 embankment height and will not be subject to substantial vertical load until the dam embankments are raised 20 or more feet in the final phases.

5.3.2 Lined Decant Water Impoundment

The LDWI observation wells are screened at the bottom of the fly ash, or in the shale foundation. The LDWI observation wells are dry, indicating no saturation at those locations. The underlying fly ash foundation can be inferred to be generally free of saturation at the instrument locations based on this information. The instrument readings are consistent with the LDWI that includes a dual HDPE lining with leak detection system, and the investigation information that represents the underlying Pond #3 fly ash as unsaturated.

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6.0 Field Assessment

6.1 General

Field observations of the Lined Ash Impoundment and Lined Decant Water Impoundment were made on May 20, 2009, by Messrs. Stephen G. Brown, P.E. and Bryan Scott, P.E., of GEI. The field assessment was attended by Mr. John Schofield of the EPA – Region 9 and Messrs. David Bloomfield, P.E., Byron Conrad, P.E., and Bruce Salisbury, P.E., of Arizona Public Service Company.

The weather during the field assessment was generally clear, windy, and temperatures were warm. The discussions below are organized to follow the project from upstream (Lined Ash Impoundment) to downstream (Lined Decant Water Impoundment).

A copy of the field checklists are provided in Appendix B and photographs are provided in Appendix C. Sections 6.2 and 6.3 describe observations made during the inspection relative to key project features. Section 6.4 presents specific observations.

6.2 Lined Ash Impoundment

The LAI is formed by a perimeter dam having a crest elevation of El. 5248. The dam is largely founded on the 40-foot-thick fly ash deposits in the underlying Pond No. 3, which is no longer in service. The dam section consists primarily of compacted bottom ash with a 15-foot-wide clay liner and 60-mil HDPE liner on the upstream slope. Construction activity has been initiated to raise the perimeter dam to El. 5258 in accordance with a design that has been reviewed by the New Mexico Dam Safety Division. At the time of the site visit the construction activity was limited to preparation of the dam crest and downstream slope area and initial placements of bottom ash fill on the dam crest. Field observations of the LAI included the dam crest and toe as well as observable features of the decant drop inlet and decant discharge pipes.

6.2.1 Dam Crest

The dam crest appears to be in good condition. We saw no obvious signs of settlement or displacement associated with the LAI.

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6.2.2 Upstream Slope

The upstream slope of the dam, which consists of a 15 foot wide clay zone, is protected with an HDPE lining (Photo 2 in Appendix C). The upstream slope is mostly obscured by the HDPE lining. There was no visual evidence of slumps or bulges beneath the lining that would be indicative of stability issues. On this basis, the upstream slope was observed to be in good condition.

6.2.3 Downstream Slope

The downstream slope of the dam, which consists of compacted bottom ash, does not have additional erosion protection. Ponded water was observed at the downstream toe of the south embankment of the underlying Pond 3 & 4 embankment (see Photo 33). The seep occurs at a low point in the foundation topography and has been active for many years without significant change. The seep runs clear at a slow rate and there is no evidence of internal erosion of dam materials. There is no toe drain to collect and convey the water away from the embankment. The seepage is expected to reduce as the available water in the Pond 3 & 4 impoundment slowly drains. The downstream slope was observed to be in generally good condition.

6.2.4 Emergency Spillway

There is no emergency spillway for the LAI.

6.2.5 Outlet Works

The main structure is the decant inlet, which consists of a eight-foot-diameter HDPE manhole (3.6 inch wall thickness) that has been perforated with approximately one thousand 1/2-inch-diameter holes to serve as a subsurface drain in addition to functioning as a drop inlet (Photos 16, 17, 18, and 21). The HDPE manhole is founded on a concrete slab that forms the bottom of the decant inlet, but the HDPE riser is not embedded into the slab or otherwise positively connected to the slab. The water level in the decant inlet was above the lower 8-inch-diameter non-slotted HDPE discharge pipe and below the 16-inch-diameter non-slotted HDPE discharge pipe. The decant inlet appeared to be functioning satisfactorily and APS did not report any problems with its function to date. A perforated 8-inch-diameter HDPE pipe located on the pond bottom in the southwest corner of the pond and that serves to drain excess water from the pond could not be observed except where the discharge pipe enters the LDWI.

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6.2.6 Internal Drains or Toe Drains

There are no internal or toe drains associated with the LAI.

6.2.7 Water Surface Elevations and Reservoir Discharge

The water surface in the LAI at the time of the site visit was at about El. 5241, which provides 7 feet of freeboard. The LAI was discharging minor decant water flows to the LAI at the time of the site visit.

6.3 Lined Decant Water Impoundment

The LDWI is formed by a perimeter dam, which has a homogenous section constructed of compacted clay. Reduction of seepage and leakage from the pond is addressed by a dual 60-mil HDPE lining with leak detection system. The perimeter dam is primarily founded on the 40-foot-thick fly ash of Pond #3, which is no longer in service. Field observations of the LDWI included the dam crest and downstream slope and toe of the dam.

6.3.1 Dam Crest

The dam crest was generally level with exception of two areas on the west dam where material had been lost up to 18 inches in depth due to erosion by high winds (see Photo 40). We saw no obvious signs of settlement or displacement associated with the LDWI.

6.3.2 Upstream Slope

The upstream slope of the dam, which consists of a clay embankment on three sides and a 15-foot-wide clay zone on the west side, is protected with a dual HDPE lining with leak detection system (Photo 37). The upstream slope is mostly obscured by the HDPE lining. There was no visual evidence of slumps or bulges beneath the lining that would be indicative of stability issues. On this basis, the upstream slope was observed to be in good condition.

6.3.3 Downstream Slope and Toe

The downstream slope of the dam, which consists of compacted bottom ash, does not have additional erosion protection. The downstream toe of the west side of the dam could not be easily accessed on foot because it forms a nearly continuous slope with the underlying Pond #3 perimeter dam slope. Therefore, observations were made at the downstream toe of the west Pond #3 dam. Several tamarisk trees have become established at the downstream toe on the west dam and are near the perimeter seepage conveyance ditch that serves the old, inactive, Pond #6. The tamarisk may be supported by water supply from the ditch or by

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seepage from the Pond #3 dam. These trees should be carefully removed and observations made frequently for potential seepage in this area. With exception of the trees, the downstream slope and toe was observed to be in generally good condition.

6.3.4 Emergency Spillway

There is no emergency spillway for the LDWI.

6.3.5 Outlet Works

Decant water flows by gravity into the LDWI from the LAI via 3 pipes. The LDWI does not have a gravity outlet from the pond. Water is pumped via pipes over the perimeter dam to return the water to the power plant for reuse.

6.3.6 Internal Drains or Toe Drains

There are no internal or toe drains associated with the LDWI.

6.3.7 Water Surface Elevations and Reservoir Discharge

The water surface in the LDWI was at El. 5211 at the time of the site visit, which provides 5 feet of freeboard. Reservoir discharges are by pumping and it was not evident that pumping was in progress at the time of the site visit.

6.4 Field Assessment Observations

6.4.1 Settlement

No evidence of significant settlement of LAI or LDWI embankments was observed. Settlement associated with construction of the LAI perimeter dam is expected to have primarily occurred soon following construction due to the free draining properties of the bottom ash used to construct the dam and the moderate permeability, but unsaturated condition, of the underlying fly ash. Settlement of the north, east, and south LDWI clay embankments is expected to be minimal due to the low height of the embankment (maximum 15 feet).

6.4.2 Movement

No evidence was observed to indicate differential movement of LAI or LDWI structures.

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6.4.3 Erosion

No significant erosion of the LAI dams or abutments, or LDWI dams, was observed.

6.4.4 Seepage

No evidence of significant seepage through the LAI or LDWI dam embankments. Evidence of seepage was observed at the downstream toe (old Pond #4) of the south embankment of the LAI. This has been an area of ongoing seepage according to APS and has not been associated with instability of the surrounding embankment. The seepage is thought to be drainage of localized saturated zones within the fly ash of old Pond #4. Tamarisk trees growing at the downstream toe (old Pond #3) of the south embankment of the LDWI may be indicative of local seepage, but may also be associated with water conveyed in the nearby Pond #6 seepage ditch.

6.4.5 Leakage

No water leaks were observed from the project piping or structures.

6.4.6 Cracking

No cracks were observed in the upstream or downstream slopes or the crests of the dams.

6.4.7 Deterioration

No significant deterioration of LAI or LDWI dams and structures was observed.

6.4.8 Geologic Conditions

The geology of the LAI and LDWI project features is consistent with descriptions in the available reports. There have been no studies or events (landslide, earthquake, etc.) that would result in changes to the description of local geologic conditions.

6.4.9 Foundation Deterioration

No signs of foundation deterioration were observed for the LAI and LDWI dams.

6.4.10 Condition of Spillway and Outlet Works

There is no spillway at the LAI or LDWI. The LAI outlet consists of a decant drop inlet and perforated drain pipe. No adverse conditions were observed for the decant drop inlet and the

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perforated drain pipe could only be observed where it discharges to the LDWI. There is no outlet at the LDWI – water is removed by pumping back to the power plant.

6.4.11 Observations of Operation of the Spillway and Outlet Works

There is no spillway at the LAI. Based on the drawings and observed conditions, gravity flow from the decant drop inlet is controlled to approximate El. 5216 where the two outlet pipes cross over the LDWI dam, with the 8 inch pipe being slightly lower than the 16 inch pipe. Therefore, decant water is charged in the low portion of the lower 8-inch-diameter outlet pipe at all times with a minimum of about 10 feet of head and would not flow until the decant water is a few inches below the upper 16-inch-diameter pipe. The lower 8 inch decant pipe conveys the majority of decant water flows, besides the 8 inch perforated collection pipe located at the bottom of the reservoir (southwest corner). The 16 inch pipe has rarely conveyed flows to date. The flowable backfill seepage control fill around the 8-inch pipe and the 16 inch pipe serves to address the potential reservoir head that could be applied to these locations should the LAI membrane lining be compromised.

6.5 Reservoir Rim Stability

There are no reservoir rim issues associated with perimeter dams such as LAI and LDWI.

6.5.1 Uplift Pressures on Structures, Foundations, and Abutments

There are no significant structures associated with the two impoundments. No evidence of uplift pressure issues was observed.

6.5.2 Other Significant Conditions

No other conditions were observed that would affect the safety of the project structures.

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7.0 Spillway Adequacy

7.1 Floods of Record

Floods of record have not been evaluated for LAI and LDWI Dams.

7.2 Inflow Design Floods

Currently, the LAI and LDWI Dams are classified as a significant hazard potential structure by the NM DWR. Federal guidelines indicate that significant hazard dams be able to pass a flood equivalent to 50 percent PMP with a minimum of three feet of freeboard.

The LAI is designed as a perimeter dam with potential to receive only minor surface water run-on. The inflow flood will be limited to precipitation that falls directly on the reservoir itself. GEI was provided with limited information on the precipitation events associated with the Four Corners area. Based on the provided drawings, the dam has a 2.8-foot-freeboard and is capable of storing a 72-hour precipitation event of 10.9 inches, which is assumed to be 100 percent of the PMP developed using Hydrometeorological Report No. 49. The LAI does not have an emergency spillway. The maximum discharge through the drop inlet decant structure during this event was estimated to be 50 cfs. The LAI has capacity to store the inflow design flood.

The LDWI is designed as a perimeter dam with no potential to receive surface water run-on. The inflow flood will be limited to precipitation that falls directly on the reservoir itself. Based on the provided drawings, the dam has a 2.8-foot-freeboard and is capable of storing a 72-hour precipitation event of 10.9 inches, which is assumed to be 100 percent of the PMP developed using Hydrometeorological Report No. 49. The LDWI does not have an emergency spillway or an ungated gravity outlet works. Water levels in the LDWI are controlled by pumped discharge from the power plant (as decant from the LAI, maximum 500 gpm) and pumped discharge from the LDWI back to the power plant (maximum 400 gpm capacity). The LDWI has capacity to store the inflow design flood.

7.2.1 Determination of the PMF

The PMP was developed using Hydrometeorological Report No. 49. The PMP is considered to fall directly on the reservoir because there is no contributing drainage area.

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7.2.2 Freeboard Adequacy

The planned operating freeboard of 2.8 feet at the LAI and 2.8 feet at the LDWI is adequate to store the full PMP based on incipient rainfall on the reservoirs and no contributing drainage area.

7.2.3 Dam Break Analysis

A dam break analysis and inundation mapping has been documented for the LAI Dam and is currently being reviewed by NM Office of the State Engineer (OSE). For purposes of this review, this analysis is also considered generally applicable to the LDWI. The inundation is mapped downstream to where it flows from the Chaco River drainage to the San Juan River. No habitable structures were recorded during development of the inundation mapping and the flood outflow passes beneath the Highway N36 bridge.

7.3 Spillway Rating Curves

There are no spillways for the LAI or LDWI.

7.4 Evaluation

The capacity of the LAI and LDWI to store the inflow flood, which is the full PMP, within the available operating freeboard is considered to exceed the regulatory requirements for significant hazard impoundments.

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8.0 Structural Stability

8.1 Visual Observations

The inspection team saw no visible signs of instability associated with the LAI and LDWI dams and dikes during the May 20, 2009, site assessment.

8.2 Field Investigations

A Geotechnical Analysis Report for the Lined Ash Impoundment Embankment was prepared (URS, 2003). An addendum was issued to address comments from the New Mexico OSE on the 2003 report (URS, 2008). Subsurface investigations performed at the site consist of:

- Eight test pits excavated by APS to investigate borrow sources for the clay liner system. Clay soil samples were obtained and laboratory testing consisting of gradation, Atterberg Limits, Standard Proctor, and direct shear tests.
- In 2002, AMEC drilled six soil borings to depths ranging from approximately 32 to 52 feet below grade in the fly ash. Standard Penetration Tests (SPT), vane shear tests, and one flexible-wall permeability test were performed as part of the investigation. Laboratory tests consisted of gradation and Atterberg Limits.
- ConeTec, Inc. performed 15 piezocone penetration tests for the proposed lined impoundment in 2002. Pore pressure dissipation tests were performed at selected depths at each location.

8.3 Methods of Analysis

The results of LAI slope stability analyses are reported in the 2003 and 2008 Geotechnical Analysis Reports (URS, 2003; 2008). The results of LDWI slope stability analyses are reported in the 2003 Geotechnical Analysis Report (URS, 2003).

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8.4 Discussion of Stability Analysis

8.4.1 Lined Ash Impoundment

The results of slope stability analyses are reported in the 2003 and 2008 Geotechnical Analysis Reports. The 2003 study was completed to evaluate the stability of the proposed LAI in several increments up to the full planned height of 70 feet, and the 2008 report was completed to document stability factors of safety for the proposed 50 foot height based on revised New Mexico dam safety rules. The height of the LAI at the time of our site assessment was 40 feet.

The stability analyses completed as part of the 2003 study were used to evaluate the Factor of Safety of several critical sections. Using GSLOPE, by Mitre Software Corporation, stability under steady state seepage conditions was evaluated using the Bishop Method and the Janbu Method. For the seismic case, a pseudostatic acceleration of 0.05g was applied to the embankment based on one-half of the United States Geological Survey ground motion for an approximate 2,500 year return interval.

The material properties used in the stability modeling were based on laboratory testing of site-specific materials. The geometries of the modeled sections were based on the design geometry.

The phreatic surface used in the models was based on seepage output from the SEEP/W software by Geo-Slope International. This phreatic surface was based on steady-state seepage, modeling the ash as water and ignoring the HDPE lining.

Additional stability analyses were completed for the 50-foot-height LAI as part of the 2008 study. The same material properties were used for the raise analyses as were used for the initial analyses, with the exception of the properties for the compacted bottom ash. Based on testing during the construction of the 40-foot height impoundment, higher unit weight and friction angle were realized. These higher values were used for the design of the raise.

8.4.2 Lined Decant Water Impoundment

Stability of the LDWI was addressed in the 2003 report. The stability input/output files for the 2003 design report were not provided for review. A discussion of the slope stability analyses completed for the design of the LDWI is included in the 2003 report. The stability modeling was completed in GSLOPE using the Bishop Method and the Janbu Method. Two cross sections were analyzed for Full Reservoir- steady state seepage and Full Reservoir with seismic loading.

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The factors of safety for the analyses were reported in the text; however the details of the analyses were not available. The material properties used in the stability modeling were the same as those used for the LAI.

Because the details of the analyses were not available, we have performed several stability analyses for the LDWI as part of the current review. The resulting factors of safety are discussed in the following section.

8.5 Factors of Safety

8.5.1 Lined Ash Impoundment

We reviewed the computed factors of safety for the embankment design up to El. 5258 contained in the 2003 and 2008 reports. The design for the 70 foot raise has not been completed and the results shown in the 2003 report are not considered valid based on changed stability requirements by the New Mexico OSE. These reports indicate the factors of safety for static steady-seepage, earthquake (pseudostatic), and end of construction loading conditions meet or exceed the required minimum factors of safety as defined by the FERC and the New Mexico OSE Dam Safety Bureau. The criteria are minimum factors of safety of 1.5 for steady-state seepage, 1.1 for pseudostatic seismic stability, and 1.1 for end of construction.

8.5.2 Lined Decant Water Impoundment

We reviewed the computed factors of safety for the LDWI embankment stability analysis contained in the 2003 report. Stability analyses for the LDWI were not addressed in the 2008 report. We compared the reported calculated factors of safety to minimum required factors of safety as currently required by the New Mexico OSE and the FERC. Because details of the specific analyses were not available for review, we performed stability analyses for a generalized geometry for the LDWI as part of our review. End of construction conditions were not analyzed for the LDWI in the 2003 report.

Table 8.1: Stability Factors of Safety for Lined Decant Water Impoundment and Guidance Values

Loading Condition	Min. Calculated FOS (2003 Report)	Min. Calculated FOS (GEI Review)	Min. Required FOS
Full Reservoir – Steady-state Seepage	1.37	1.38	1.50
Full Reservoir – SS with pseudostatic earthquake (0.05g)	1.16	1.21	1.10

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As indicated in Table 8.1, the calculated factor of safety for steady-state seepage is below the guidance value. Though the FOS does not meet criteria, a conservative assumption has been made. The analyses assume that fully saturated steady state conditions develop within the clay embankment and also the nearly 80 feet of underlying fly ash. This condition is unlikely to occur given that the Lined Decant Water Impoundment contains a dual HDPE liner with a leak detection system. It is reasonable to analyze the dam assuming full steady-state conditions in the clay embankment, but only partial depth saturation of the underlying fly ash. In this revised case, the factor of safety would be nearly 1.9 and would meet both the New Mexico OSE and FERC minimum factor of safety for static steady seepage of 1.5.

8.6 Seismic Stability - Liquefaction Potential

The liquefaction potential at the various project features was evaluated in the 2003 study using procedures developed by Seed et. al. (1985) and Youd & Idriss (2001). The liquefaction potential was assessed at each of the CPT locations. The factors of safety against liquefaction were generally above 2.0, and were always greater than 1.5 indicating the potential for liquefaction at this site is low.

8.7 Decant Drop Inlet Structure

The decant drop inlet structure in the LAI is constructed of an 8-foot diameter Class 315 HDPE manhole that is founded on a concrete slab. At full impoundment build-out the manhole will be 70 ft high. The manhole is the primary means of removing decant water to the LDWI and is the sole means of discharging floodwater from the impoundment.

The manhole was designed by an APS professional engineer using calculations based on ASTM F-1759 and a calculation analysis provided by Performance Pipe, which is a division of Chevron Phillips Chemical Company LP. A copy of the manhole calculation input parameters and output was provided for review. The calculation, which is based on a solid wall HDPE manhole, indicates a factor of safety for radial loads of 3.6 and that other minimum safety factors for ring compressive strain, radial buckling, bending and compression, and wall axial strains are met.

The sensitivity of the structural analysis to varying the input parameters has not been evaluated in the provided information. The calculation assumed the water depth inside the manhole would be 20 feet. The calculation did not address potential range of internal water load ranging from no water inside the manhole to full of water (assuming discharge pipes are plugged). The analysis did not appear to address the approximately 1,000 half-inch diameter holes and the 16 inch and 8 inch holes that penetrate the side of the manhole, though APS indicated their discussion with Performance Pipe indicated the contribution of the small holes could be neglected. The calculation did not address the potential consequences and

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vulnerability of the HDPE manhole not being embedded or otherwise positively connected to the concrete slab foundation and relies only on confinement provided by the surrounding fly ash. The upper part of the manhole is not protected from impacts from vehicles or large equipment that may be used to service the manhole.

8.8 Summary of Results

8.8.1 Lined Ash Impoundment

The stability analyses that have been performed for the LAI appear to adequately address the most critical sections. The analyses presented in the 2003 and 2008 reports addressing embankment heights up to El. 5258 all meet the minimum required factor of safety criteria according to New Mexico OSE and the FERC guidance. These analyses include use of appropriate material properties and loading conditions.

8.8.2 Lined Decant Water Pond

The analyses performed in 2003 for the LDWI were not available for review. However, the reported factors of safety for the static steady-seepage loading condition does not meet the minimum values required by the New Mexico OSE and the FERC. GEI performed check analyses that resulted in a factor of safety for static steady–seepage of 1.4, which is similar to that reported in the 2003 report.

The low factor of safety for static steady-seepage resulted from an analysis that assumed fully saturated conditions in the underlying fly ash, which may not be reasonable given the LDWI has a dual HDPE liner with a leak detection system and the unsaturated fly ash is nearly 80 feet deep. An analysis based on less depth of saturation in the fly ash was found to meet the required stability criteria.

8.8.3 Decant Drop Inlet Structure

The structural analysis of the HDPE decant drop inlet structure did not appear to address the sensitivity of the analysis to varying the input parameters including water depth and penetrations of the manhole sides by pipes and many small drilled holes. The HDPE manhole may be vulnerable to differential movement between the manhole riser and the foundation slab because the riser is not embedded or otherwise positively connected to the concrete slab foundation. In addition, the upper part of the manhole is not protected from impacts from vehicles or large equipment that may be used to service the manhole.

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9.0 Adequacy of Maintenance and Methods of Operation

9.1 Procedures

Arizona Public Service's experience with management of the coal combustion waste management system has resulted in the development of standard operational procedures to inspect, maintain, and operate the system. A draft Operation & Maintenance Manual is currently under review by the New Mexico Office of the State Engineer and was not available to the assessment team. Many of the plant engineers and operating personnel have been with the District for 10 or more years. The power plant is manned 24 hours a day, seven days a week. Daily inspection rounds are performed of the entire ash pond facilities by operations staff to observe the general condition of structures and embankments. Identified deficiencies are documented and repaired.

9.2 Maintenance of Impoundments

Maintenance of the two impoundments is performed by APS staff under the guidance of APS managers and engineers. Instrument readings are reported twice annually to the New Mexico Office of the State Engineer. Inspections are made every 6 months by APS engineers and on an irregular annual to multi-year schedule by New Mexico Office of the State Engineer personnel.

9.3 Surveillance

The entire project is patrolled daily by APS personnel. Plant personnel are available at the power plant and on 24-hour call for any emergencies that may arise. There are no automatic alarm systems at the impoundments.

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10.0 Emergency Action Plan

An Emergency Action Plan (EAP) has been recently developed (draft EAP is currently under review by the New Mexico Office of the State Engineer). The EAP addresses dambreak analysis and inundation mapping for the Lined Ash Impoundment and the Lined Decant Water Impoundment. The inundation map indicates outflows resulting from a dam failure will be conveyed down the Chaco River drainage about 11 miles to the confluence with the San Juan River. No habitable structures were identified during development of the inundation mapping and the flood outflow passes beneath the Highway N36 bridge. The town of Shiprock is located about 13 miles downstream from the confluence of the Chaco and San Juan Rivers.

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11.0 Conclusions

11.1 Assessment of Dams

11.1.1 Field Assessment

The LAI and LDWI dams were generally found to be in satisfactory condition. Issues of potential concern for the LAI and LDWI facilities were identified from our field assessment as follows.

- Seepage was observed at the downstream toe of the south embankment of the Pond 3 & 4 embankment, which underlies the LAI. The seepage is expected to reduce with time as the mostly unsaturated fly ash in the Pond 3 & 4 impoundment slowly drains. The seepage has been active for many years with no significant change.
- Uneven dam crest at two locations on the west dam of the LDWI where wind erosion has contributed to loss of up to 18 inches depth of embankment material.
- Mature tamarisk trees have become established at the downstream toe of the west dam of the LDWI. This location is also the toe of the old Pond #3. The trees may be supported by seepage or by water flowing in a nearby ditch.

11.1.2 Stability Analysis (Adequacy of Factors of Safety)

The stability analyses addressing LAI embankment heights up to El. 5258 all meet the minimum required factors of safety criteria according to New Mexico OSE and the FERC guidance. These analyses include use of appropriate material properties and loading conditions.

The analyses performed in 2003 for the LDWI report factors of safety for static steady-seepage and earthquake (pseudostatic) that do not meet minimum values required by the New Mexico OSE and the FERC. The low factor of safety for static steady-seepage resulted from an analysis that assumed fully saturated conditions in the underlying fly ash, which may not be reasonable given the LDWI has a dual HDPE liner with a leak detection system and the unsaturated fly ash is nearly 80 feet deep. An analysis based on less depth of saturation in the fly ash was found to meet the required stability criteria. The 2003 factors of safety for the LDWI should be re-evaluated and compared with current criteria. While the 2003 factors of safety for the LDWI are somewhat below the required minimum, they do not indicate impending failure of the structure.

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11.1.3 Stress Evaluation

A full review of the stress analysis of the decant drop inlet structure could not be performed because limited calculation information was provided. The provided structural analysis did not include a sensitivity analysis of the HDPE decant drop inlet structure to varying water depth and the influence of multiple penetrations of the manhole sides by pipes and many small drilled holes. The HDPE manhole was not evaluated for potential for differential movement between the manhole riser and the foundation slab, which lacks embedment or positive connection. The exposed part of the manhole is not protected from impacts from vehicles or large equipment that may be used to service the manhole.

11.1.4 Spillway Adequacy and Outlet Works

Both the LAI and LDWI do not have emergency spillways. However, they do have the capacity to store 100 percent of the PMP within the design freeboard, which is acceptable for these off-channel perimeter dam facilities that have no contributing drainage area and exceeds regulatory requirements for significant hazard impoundments.

The LAI has a decant drop inlet structure that serves as an outlet works. The decant drop inlet has a maximum capacity of 50 cfs assuming a flood surcharge of 3 feet. The LDWI does not have an outlet works. Water is recirculated back to the power plant from the LDWI by pumping. This method of water removal is considered adequate because both the addition of water (slurried fly ash) and removal of water from the LDWI are carefully monitored and controlled by pumps operated by the plant.

11.2 Adequacy of Instrumentation and Monitoring of Instrumentation

The frequency of monitoring is considered adequate. Instrumentation and monitoring programs are satisfactory except that special attention should be made to monitoring potential seepage under the dam at the northwest corner of the LAI and some settlement plates are not providing useful data. This is the area where the LAI embankment was not tied-in to the underlying Pond 3-4 embankment to provide continuity of seepage control. A deeper trench was installed and backfilled with clay. However, this cutoff trench location presents a potential seepage pathway should the HDPE lining fail. A potential seepage pathway would be at the base of the permeable bottom ash at the contact with the less permeable fly ash. Additional piezometers are recommended for this area and the dam safety inspections should include documentation of any evidence of seepage near the downstream toe of the dam in this area.

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Two of the three settlement plates do not appear to be providing useful information and may have been damaged during construction or maintenance activities. Additional effort should be made to establish monitoring of settlement prior to the dam raise construction.

11.3 Adequacy of Maintenance and Surveillance

Both the LAI and LDWI have satisfactory maintenance and surveillance programs.

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12.0 Recommendations

12.1 Corrective Measures for the Structures

12.1.1 Lined Decant Water Impoundment

1. The calculated factor of safety for static steady-seepage of 1.4 is somewhat below the state and federal guidance of 1.5. Re-evaluation of this loading condition should be documented and may need to consider less conservative assumptions regarding saturation of the underlying fly ash.

2. The uneven dam crest on the west embankment should be restored to full height with compacted fill. This maintenance should be performed within the next six months.

3. Tamarisk trees should be removed from the downstream toe of the west embankment (Pond #3 toe) and an evaluation for any potential seepage should be performed in that area.

12.1.2 Decant Drop Inlet Structure

1. Perform a structural analysis that includes a sensitivity analysis of the HDPE decant drop inlet structure to varying water depth and the influence of multiple penetrations of the manhole sides. Evaluate the decant structure for potential for differential movement between the manhole riser and the foundation slab. Provide protection for the exposed part of the manhole from impacts from vehicles or large equipment.

12.2 Corrective Measures Required for Maintenance and Surveillance Procedures

None.

12.3 Corrective Measures Required for the Methods of Operation of the Project Works

None.

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12.4 Any New or Additional Monitoring Instruments, Periodic Observations, or Other Methods of Monitoring Project Works or Conditions That May Be Required

Continue monitoring seepage at the downstream toe of the south embankment (Pond #4 toe) for any changes in seepage quantity and flow rate or evidence that the flow is carrying soil/ash particles from the embankment.

Expand program to include additional monitoring of potential seepage under the dam at the northwest corner of the LAI, where the LAI embankment was not tied-in to the underlying Pond 3-4 embankment to provide continuity of seepage control, and where a potential seepage pathway exists if the HDPE lining fails. Install additional piezometers to address this potential seepage pathway and expand documentation in APS dam safety inspections to note any evidence of seepage near the downstream toe of the dam in this area.

Repair or replace the two settlement plates that do not appear to be providing useful information and that may have been damaged during construction or maintenance activities.

12.5 Acknowledgement of Assessment

I acknowledge that the management unit(s) referenced herein was personally inspected by me and was found to be in the following condition **(select one only):**

SATISFACTORY

FAIR

POOR

UNSATISFACTORY

DEFINITIONS FOR ASSESSMENT

SATISFACTORY
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. Minor maintenance items may be required.

FAIR
Acceptable performance is expected under all required loading conditions (static, hydrologic, seismic) in accordance with the applicable safety regulatory criteria. Minor deficiencies may exist that require remedial action and/or secondary studies or investigations

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POOR
A management unit safety deficiency is recognized for any required loading condition (static, hydrologic, seismic) in accordance with the applicable dam safety regulatory criteria. Remedial action is necessary. POOR also applies when further critical studies or investigations are needed to identify any potential dam safety deficiencies.

UNSATISFACTORY
Considered unsafe. A dam safety deficiency is recognized that requires immediate or emergency remedial action for problem resolution. Reservoir restrictions may be necessary.

I acknowledge that the management unit referenced herein:

Has been assessed on May 20, 2009 (date)

Signature: _____

List of Participants:

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Carl Woolfolk	Arizona Public Service

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13.0 References

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URS Corporation (URS), 2008, *Revised Addendum No. 1 Geotechnical Analysis Report Lined Ash Impoundment*, Prepared for Arizona Public Service Company, August 12.

URS Corporation (URS), 2003, *Geotechnical Analysis Report Lined Ash Impoundment Embankment*, Prepared for Arizona Public Service Company, January 15.

Federal Emergency Management Agency (FEMA), 2004, Federal Guidelines for Dam Safety, April.

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Appendix A

Instrumentation

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Appendix B

Inspection Checklist

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Appendix C

Inspection Photographs

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Appendix D

Reply to Request for Information Under Section 104(e)

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