2017 ANNUAL DAM AND DIKE INSPECTION REPORT

Fly Ash Dams 1, 2
&
Bottom Ash Pond Complex

Cardinal PLANT

BRILLIANT, OHIO

November, 2017

Prepared for: Cardinal Operating Company
Brilliant, Ohio

Prepared by: American Electric Power Service Corporation
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AEP AMERICAN® ELECTRIC POWER

GERS-17-063

Dam & Dike Inspection Report
Fly Ash Dams 1, 2, and
Bottom Ash Pond Complex

GERS-17-063
Revision 0

CARDINAL PLANT

BRILLIANT, OHIO

INSPECTION DATE **November 8, 2017**

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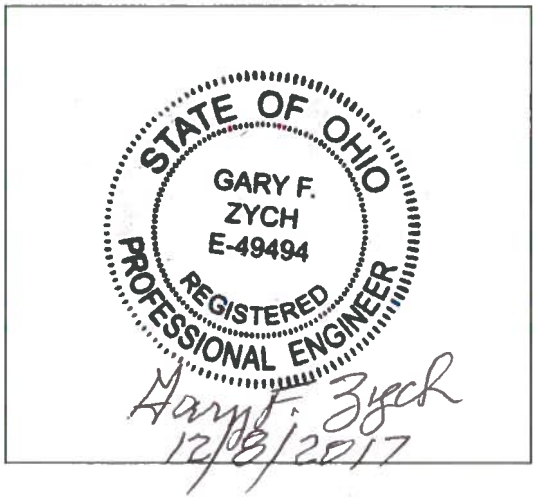

PROFESSIONAL ENGINEER SEAL & SIGNATURE

I certify to the best of my knowledge, information and belief the information contained in this report meets the requirements of 40 CFR § 257.83(b).

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LIST OF ATTACHMENTS

1.0 INTRODUCTION

This report was prepared by AEP- Geotechnical Engineering Services (GES) section, in part, to fulfill requirements of 40 CFR 257.83 and the Ohio Department of Natural Resource (ODNR), Division of Water and to provide Cardinal Operating Company and Cardinal plant with an evaluation of the facility.

The Cardinal Power Plant is located at 306 County Road 7 East, Brilliant, OH, 43913 County, near the town of Brilliant, Jefferson County, Ohio. It is owned by Buckeye Power and AEP Generation Resources (GENCO) and operated by Cardinal Operating Company. The facility operates the Fly Ash Dam 1 (FAD 1, ODNR# 0205-009, the Fly Ash Dam 2 (FAD 2), ODNR# 0205-010 and the Bottom Ash Pond (BAP) Complex dam, ODNR# 0105-004.

American Electric Power Service Corporation's Civil Engineering Division administers the Cardinal Plant's Dam Inspection and Maintenance Program (DIMP). As part of the DIMP, staff from the Geotechnical Engineering Services Section annually conducts dam and dike inspections. This report contains the inspection findings, observations, photographic descriptions, conclusions, and maintenance recommendations. This inspection report addresses the FAD 1, FAD 2, and the BAP Complex at the Cardinal plant.

Mr. Randy Sims, P.E., at the Cardinal Plant, was the project facility contact and accompanied Mr. Brett Dreger of GES throughout the inspection. The site inspection was performed on November 8, 2017. Weather conditions were very cool, but mostly sunny throughout the day. Temperatures reached a high of approximately 41°F. There was precipitation of 3.59 inches in the preceding 7 days prior to the November 8 inspection date.
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2.0 DESCRIPTIONS OF IMPOUNDMENTS

2.1 FLY ASH DAM 1

FAD 1 is the plant's original fly ash retention dam constructed in the early 1970's. The dam is an earth and rockfill dam having a final design crest elevation of 1001.5 ft. The dam has upstream (u/s) and downstream (d/s) slopes of approximately 2.5 Horizontal to 1 Vertical (2.5 H to 1 V). As ash placement behind FAD 1 reached its maximum allowed level, Cardinal FAD 2 was constructed and began operation in the late 1980's. FAD 1 is still listed with the ODNR as an active dam, however, its reservoir area has been repermitted by the Ohio EPA as a solid waste landfill (PTI permit # 06-07993, dated May 11, 2007) for the disposal of synthetic gypsum generated by the air pollution control equipment constructed at the Cardinal Plant that captures sulfur dioxide emissions (Figure 1).

2.2 FLY ASH DAM 2

The last raising of FAD 2 was completed in 2013 with a design crest elevation of 983 ft, a maximum reservoir operating elevation of 974 ft, and a dam height of approximately 250-ft. This raising of FAD 2 incorporated back to back Mechanically Stabilized Earth (MSE) walls with a cut off system consisting of a PVC sheetpile inserted into a trenched cement bentonite cutoff wall connected to the existing clay core. The emergency overflow spillway was raised using mass concrete to minimum elevation of 974.5. The MSE wall was supported by the existing RCC crest placed during the 1997 dam raising. Inspection location plans for FAD 2 are provided in Figure 2A. A general cross section of FAD 2 showing the final dam raising is presented in Figure 2B.

2.3 BOTTOM ASH POND COMPLEX

The Bottom Ash Complex at the Cardinal Plant consists of a Bottom Ash Pond (BAP) and a Recirculation Pond (RCP) located along the Ohio River. Flow from the Bottom Ash Pond is directed to the RCP. The exterior dike crest elevation is approximately 670 ft and an overflow conduit with an inlet elevation of approximately 665.5 ft. controls the maximum Recirculation Pond water level. The arrangement of BAP Complex is shown in Figure 3.

3.0 REVIEW OF AVAILABLE INFORMATION (257.83(b)(1)(i))

A review of available information regarding the status and condition of the FAD 1, FAD 2, and the BAP Complex, which include files available in the operating record, such as design and construction information, previous periodic structural stability assessments, previous 7 day inspection reports, and previous annual inspections has been conducted. Based on the review of the data there were no signs of actual or potential structural weakness or adverse conditions.

4.0 INSPECTION (257.83(b)(1)(ii))

4.1 DEFINITIONS OF VISUAL OBSERVATIONS AND DEFICIENCIES

This summary of the visual observations uses terms to describe the general appearance or condition of an observed item, activity or structure. The meaning of these terms is as follows:

Good: A condition or activity that is generally better or slightly better than what is minimally expected or anticipated from a design or maintenance point of view.

Fair/Satisfactory: A condition or activity that generally meets what is minimally expected or anticipated from a design or maintenance point of view.

Poor: A condition or activity that is generally below what is minimally expected or anticipated from a design or maintenance point of view.

Minor: A reference to an observed item (e.g., erosion, seepage, vegetation, etc.) where the current maintenance condition is below what is normal or desired, but which is not currently causing concern from a structure safety or stability point of view.

Significant: A reference to an observed item (e.g. erosion, seepage, vegetation, etc.) where the current maintenance program has neglected to improve the condition. Usually conditions that have been identified in the previous inspections, but have not been corrected.

Excessive: A reference to an observed item (e.g., erosion, seepage, vegetation, etc.) where the current maintenance condition is above or worse than what is normal or desired, and which may have affected the ability of the observer to properly evaluate the structure or particular area being observed or which may be a concern from a structure safety or stability point of view.

This document also uses the definition of a "deficiency" as referenced in the CCR rule section §257.83(b)(5) Inspection Requirements for CCR Surface Impoundments. This definition has been assembled using the CCR rule preamble as well as guidance from MSHA, "Qualifications for Impoundment Inspection" CI-31, 2004. These guidance documents further elaborate on the definition of deficiency. Items not defined by deficiency are considered maintenance or items to be monitored.

A "deficiency" is some evidence that a dam has developed a problem that could impact the structural integrity of the dam. There are four general categories of deficiencies. These four categories are described below:

1. Uncontrolled Seepage

   Uncontrolled seepage is seepage that is not behaving as the design engineer has intended. An example of uncontrolled seepage is seepage that comes through or around the embankment and is not picked up and safely carried off by a drain. Seepage that is collected by a drain can still be uncontrolled if it is not safely collected and transported. Seepage that is not clear and is turbid would also be considered as uncontrolled. Seepage that is unable to be measured and/or observe it is considered uncontrolled seepage.

   Note: Wet or soft areas are not considered as uncontrolled seepage, but can lead to this type of deficiency. These areas should be monitored more frequently.
2. Displacement of the Embankment

   Displacement of the embankment is large scale movement of part of the dam. Common signs of displacement are cracks, scraps, bulges, depressions, sinkholes and slides.
3. Blockage of Control Features

   Blockage of Control Features is the restriction of flow at spillways, decant or pipe spillways, or drains.
4. Erosion

   Erosion is the gradual movement of surface material by water, wind or ice. Erosion is considered a deficiency when it is more than a minor routine maintenance item.

4.2 FLY ASH DAM 1

4.2.1 CHANGES IN GEOMETRY SINCE LAST INSPECTION (257.83(b)(2)(i))

No modifications have been made to the geometry of the FAD 1 since the 2016 annual inspection. The geometry of the impoundment has remained essentially unchanged.

4.2.2 CHANGES THAT EFFECT STABILITY OR OPERATION (257.83(b)(2)(vii))

Based on interviews with plant personnel and field observations there were no changes to the FAD 1 since the last annual inspection that would affect the stability or operation of the impounding structure.

4.2.3 INSTRUMENTATION (257.83(b)(2)(ii))

No instrumentation data is provided for Fly Ash Dam I since the reservoir has been drained and the site is now under construction to receive synthetic gypsum. The permit application submitted to the Ohio EPA to license this area as a residual waste landfill was approved on May 11, 2007 (Ohio EPA PTI # 06-07993).

4.2.4 IMPOUNDMENT CHARACTERISTICS (257.83(b)(2)(iii, iv, v))

As ash placement behind FAD 1 reached its maximum allowed level in the late 1980's, FAD 2 was constructed and began operation soon thereafter. FAD 1 and its impoundment are not subject to CCR rules since they were close well before the CCR rules were promulgated.

4.2.5 VISUAL INSPECTION (257.83(b)(2)(i))

A visual inspection of the FAD 1 was conducted to identify any signs of distress or malfunction of the impoundment and appurtenant structures. Specific items inspected included all structural elements of the dam such as inboard and outboard slopes, crest, and toe.

Results of the visual inspection of the FAD 1 performed on November 8, 2017 are provided below (photos are presented in Attachment A):

1. The downstream slope of FAD 1 was well protected with rock fill. The presence of vegetative growth in the rocks was noticed (Photo Nos. 1 and 2). No significant erosion or slumping was observed.

2. Typical view of the right and left groin area of the downstream slope (Photographs No. 3 and 4). No significant erosion was observed along the groin areas, however there was some overgrown woody vegetation noticed just few feet away.

3. The crest areas of FAD 1 were in generally good condition with no significant signs of erosion, rutting or misalignment as shown in Photographs No. 5 and 6.

Overall the facility is in good condition. The impoundment is functioning as intended with no signs of potential structural weakness or conditions which are disrupting to the safe operation of the impoundment.

4.3 FLY ASH DAM 2

4.3.1 CHANGES IN GEOMETRY SINCE LAST INSPECTION (257.83(b)(2)(i))

No modifications have been made to the geometry of the FAD 2 since the 2016 annual inspection. The geometry of the impoundment has remained essentially unchanged.

4.3.2 CHANGES THAT EFFECT STABILITY OR OPERATION (257.83(b)(2)(vii))

Based on interviews with plant personnel and field observations there were no changes to the FAD 2 since the last annual inspection that would affect the stability or operation of the impounding structure.

4.3.3 INSTRUMENTATION (257.83(b)(2)(ii))

The location and type of instrumentation is shown on Figure 2A. The results of the measurements of various piezometers are shown in Figure 5b through 5n. The maximum recorded readings of each instrument since the previous annual inspection is shown in Table 1.

Table 1 FAD 2 Maximum recorded instruments reading since the previous annual inspection

INSTRUMENTATION DATA Fly Ash Dam 2			
Instrument	**Type**	**Maximum Reading since last annual inspection**	**Date of Reading**
P-1A	Piezometer	763.40	3/14/17
P-2A	Piezometer	782.30	2/14/17
P-3A	Piezometer	804.80	11/22/17
P-3B	Piezometer	784.30	9/02/17
P-1BE	Piezometer	731.70	11/22/17
P-1BW	Piezometer	738.40	3/14/17
P-2BE	Piezometer	761.10	9/02/17
P-2BW	Piezometer	733.90	9/02/17
P-2C	Piezometer	713.50	9/02/17
P-5A	Piezometer	903.00	1/17/17
P-8A	Piezometer	805.30	6/06/17
P-8B	Piezometer	779.70	9/02/17
P-9	Piezometer	786.70	11/22/17
P-10	Piezometer	776.90	2/14/17
P-11A	Piezometer	804.70	11/22/17
P-11B	Piezometer	798.80	8/25/17
MW-7	Piezometer	971.40	3/14/17

PIEZOMETERS

A total of Sixteen (16) pneumatic piezometers and one monitoring well were installed in the foundation and various zones of the dam to monitor total hydraulic head. The piezometers' locations are shown in plan view Figure 3A and in cross-sections (Drawing Nos. 13-30041 and 13-30042). Precipitation is measured at the plant and also continues to be within the normal ranges measured over the last five (5) years (Figure 4). Historical records of the piezometer and observation borehole water elevations are presented in a graphical form in Figure 5, Attachment F to this report.

- A composite of all the hydrographs (Figure 5a). All piezometer showed none or a minor increase in the measured pore water pressure as a result of the raising the pond level in October 5, 2016. Figure 5b provides a record of pond discharge as measured at its Parshall flume (Drain No.14) versus the pond stage.
- Water levels in the shallow, intermediate and deep foundation showed none or a minor increase corresponding to raising the pond stage that took place in October 2016 (Figures 5c &5d).
- Water levels along the centerline of the dam are shown in Figure 5e and are segregated into hydrographs for each clustered location (Figures 5f through 5i). Piezometer P-3B is showing some decrease in water level despite the increase in FAR 2's pool level. Water levels in the downstream shell (P-1A) and drain (P-1BW) showed none or a minor increase corresponding to raising the pond stage (Figure 5i).

- Piezometer P-2BE, installed within the drain, reflects a higher-pressure head (about 27ft) in comparison to the western (right) P-2BW. Most piezometers showed none or minor increase corresponding to raising the pond stage (Figure 5j, 5l and 5m).
- Piezometer P-2C, installed within the foundations of the dam show no increase corresponding to raising the pond stage (Figure 5k).
- Two standpipe type piezometers were installed in 2004 into the right bedrock abutment to monitor seepage (FA-7 & FA-8). Both of these piezometers are installed into the Morgantown Sandstone member, a well fractured and jointed, medium to coarse grained sandstone. Piezometer FA-7 also forms a clustered well site with M-11 (also screened within the Morgantown Sandstone) and S-9 (screened in the Connellsville Sandstone). M-10 is located away from the dam site but is also screened within the Morgantown Sandstone and is used to help illustrate the following trends (Figure 5n).
- Monitoring wells M-10 & M-11 showed an increase in static water levels coincident raising the pond level in October 5, 2016. Piezometer FA-7 monitors a 1 inch wide open joint (observed by a borehole camera survey prior to well installation) and reflects a steady decline that closely correlates with the declines observed in the drain piezometer P-1BW, M-10 and M-11 (Figure 5n). The long-term decline before the current pond stage raising is believed to result from the progradation of the fly ash delta forming a blanket deposit and acting as a hydraulic barrier that reduces seepage from the reservoir.
- The shallow monitoring well, S-9, is becoming more constant or slightly decreasing after raising the pond level in October 5, 2016 (Figure 5n). It is expected that S-9 will continue to decrease due to the deposition of fly ash around the abutment area. Monitoring well S-9 is screened from elevation 914 to 923 ft and the fly ash has been deposited to elevations ranging from 909 to 924 ft NGVD.
- One standpipe type piezometer (MW-7) was installed in 2014 into the left abutment to monitor potential seepage through the PVC sheet pile (Figure 5n). It appears that MW-7 readings are reflective of the water pressure in the rock at the left abutment and is currently at similar level of FAR II pool.

In general, a review of the data contained on the FAD 2 static water elevation plot showed that all piezometers exhibit consistent water elevations.

SEEPAGE COLLECTION DRAINS

A total of sixteen (16) drainage collection points were installed in various zones of the dam to monitor seepage. The discharge from the right abutment seepage as measured at the V– notched weir has risen to as high as 177 gpm and then has fallen to around 125 gpm.

The most recent flow volumes are presented in a tabular form in Attachment F and the locations of the various drains are also included in attachment F to this report

VERTICAL AND HORIZONTAL DEFORMATION MONUMENTS

The last AEP Civil Laboratory's Deformation Review Survey Report was prepared on August 21, 2017 for vertical and horizontal deformation monuments for FAD2. Starting October 2015, a monthly basis Survey Report is being prepared by DLZ. A brief discussion of the data is provided below.

33 top of dam monuments (29901 thru 29933) were covered due to the 2014 dam raising. Replacement top of dam deformation monuments (1401 thru 1433) were installed and a base measurement was

established. In addition, 12 tilt meters were installed at the MSW wall concrete panels with less than 0.5º tilt recorded to date (Figure 5o).

Vertical and horizontal deformation measurements for 33 top of dam monuments (i.e. 1401 thru 1433), 23 downstream dam face and berm monuments (i.e. 29936 thru 29958), 2 additional monuments located at the emergency spillway (i.e. 29934 and 29935) and 9 additional deformation monuments (i.e. 29959 to 29966 were made.

In general, all horizontal movement is towards a downstream direction. Review of top of dam horizontal movement plots provided in the report indicates small movements in a southerly direction (downslope), - southeast at the center of the dam; and southeast to east along the left abutment. Downstream face monuments show small movements generally in the downstream (south) direction. The least amount of movement is observed along the east end where the RCC is more fully supported by bedrock.

SLOPE INCLINOMETERS

Three slope inclinometers, SI-1, SI-2 and SI-3, were installed at the dam site as part of the 1998 dam raising project. The slope indicators are located near the alignment of the creek valley. SI-1 was installed in November 1997, and it is believed SI-2 and SI-3 were installed at a later date (date not reported in logs). Two additional slope indicators, SI-4 and SI-5, were installed in 2006 further down slope from SI-1. The latest slope indicator SI-8 was installed in June 2015 and is located to the right abutment close to the southwest corner MSE wall. Copies of the SI plots are provided in the Deformation Review Survey Report. Slope indicators measurements indicate movement generally towards the southwest with a good correlation with the surface deformation monuments.

BATHYMETRIC SURVEYS

AEP's Civil Engineering Lab performed the most recent bathymetric survey on September 12, 2017. These surveys show no unusual morphological features in the vicinity of the right abutment upstream of the dam. The ash delta is prograding into this area in a uniform manner. The depressions noted in previous surveys are no longer present. The deposition of fly ash within this portion of the reservoir has increased greatly due to the sluicing to the ash at the right abutment side of the pond that started in early 2014:

Survey Date	Ash Elev.	Thickness Increase	Comment
March 3, 2004	873.7		
December 9, 2004	889.3	15.6ft	from Mar 04 to Dec 04
March 29, 2005	891.8	2.5ft	from Dec. 04 to Mar. 05
October 19, 2005	898.1	6.3ft	from Mar. 05 to Oct. 05
October 3, 2006	906.0	7.9ft	from Oct 05 to Oct 06
September 13, 2007	907.5	1.5ft	from Oct 06 to Sept 07
September 3, 2008	907.4	-0.1ft	from Sept 07 to Sept 08
August 31, 2009	909.0	1.6ft	from Sept 08 to Aug 09
August 30, 2010	908.5	-0.5ft	from Aug 09 to Aug 10
September 6, 2011	909.0	0.5ft	from Aug 10 to Sept 11
October 22, 2013	908.4	-0.6 ft	from Sept 12 to Oct 13
September 3, 2014	918.2	9.8 ft	from Oct 13 to Sept 14
September 22, 2015	924.0	5.8 ft	from Sept 14 to Sept 15
September 20, 2016	929.0	5.0 ft	from Sept. 2015 to Sept. 2016
September 12, 2017	929.5	0.5 ft	from Sept. 2016 to Sept. 2017

Attachment D contains the most recent bathymetric survey. Fly ash deposition within the original (March 2004) mapped depression has increased over the last few years as a result of the sluicing ash close to the Dam's right abutment (Figure 6). Over this same time period, the hydraulic gradient has remained practically constant between the Pond's pool stage and ground water levels observed in M-11. Also, the direction of ground water flow in the upper portion of the bedrock has been reversed as noted by the gradient reversal between the pond stage and S-9 and M-11.

4.3.4 IMPOUNDMENT CHARACTERISTICS (257.83(b)(2)(iii, iv, v))

Table 2 is a summary of the minimum, maximum, and present depth and elevation of the impounded water & CCR since the previous annual inspection; the storage capacity of the impounding structure at the time of the inspection; and the approximate volume of the impounded water and CCR at the time of the inspection.

Table 2 Summary of Relevant Storage Information FAR 2

IMPOUNDMENT CHARACTERISTICS **Fly Ash Reservoir 2** (water pool elevation was approximately 968)	
Approximate **Minimum** depth (Elevation) of impounded water since last annual inspection	13 ft. (968) ft.
Approximate **Maximum** depth (Elevation) of impounded water since last annual inspection	13 ft. (968) ft.
Approximate **Present** depth (Elevation) of impounded water since last annual inspection	13 ft. (968) ft.
Approximate **Minimum** depth (Elevation) of CCR since last annual inspection	68 ft. (959) ft.
Approximate **Maximum** depth (Elevation) of CCR since last annual inspection (ft.)	70 ft. (961 ft.)
Approximate **Present** depth (Elevation) of CCR since last annual inspection	70 ft. (961 ft.)
Storage Capacity of impounding structure at the time of the inspection	12,000 ac-ft
Approximate volume of impounded water at the time of the inspection	2000 ac-ft.
Approximate volume of CCR at the time of the inspection	10000 ac-ft

4.3.5 VISUAL INSPECTION (257.83(b)(2)(i))

A visual inspection of the FAD 2 was conducted to identify any signs of distress or malfunction of the impoundment and appurtenant structures. The inspection also included hydraulic structures underlying the base of the dike. Specific items inspected included all structural elements of the dam such as inboard and outboard slopes, crest, and toe; as well as appurtenances such as the outlet structure at the FAD 2 and pipe discharge structure.

Results of the visual inspection of FAD 2 performed on November 8, 2017 are provided below (photos are presented in Attachment B):

1. The RCC crest surface is mostly covered by the new MSE Wall construction. The top surface of the MSE Wall is covered with a gravel road and appears to be in good conditions with no signs of major rutting or settlement (Photographs No. 1 and 2).

2. The discharge structure was inspected closely at the locations of the diagonal joint and diagonal crack in the RCC face, as shown in Photographs Nos. 3 – 5. There was no visual evidence of significant differential movement of the structure chute or steps. Visual portions of the structure's concrete, diagonal joint and steps appeared to be in good condition. The diagonal crack in the underlying RCC has weathered and infilled and is no longer visible. The overlying diagonal construction joint in the skimmer chute continues to exhibit no differential movement and was caulked and sealed in anticipation of it being inundated during the next pool raising.

3. The southeast corner of the MSE Wall where the wall panels meet the concrete coping, the corner piece is show signs of separation (Photograph No. 6).

4. The upstream RCC slope appeared to be stable with no significant wave cut erosion, slumping or cracking (Photographs Nos. 7 and 8).

5. The emergency spillway crest area consists of non-reinforced concrete material and appears to be in good shape (Photograph No. 9).

6. The emergency spillway channel is cut through natural high ground. The channel's left slope continues to have bank seepage that is conveyed to a shallow ditch along the toe of the slope with subsequent discharge through Drain No. 12 at the mouth of the emergency spillway channel. The channel abutment slopes and floor area appeared stable with no visible signs of slumping or significant erosion (Photograph No. 10 and 11).

7. The emergency spillway has a downstream slope channel constructed of RCC steps and berms between the concrete retaining walls. The concrete walls and concrete steps appeared to be in good condition while the spillway's 2-ft high RCC steps continue to weather (Photograph No. 12).

8. The downstream slope of the dam appeared to be in good condition with good vegetative growth as shown in Photograph Nos. 1 and 14. No significant signs erosion, sloughing or seepage was observed and the slopes appeared to be stable.

9. The downstream slope lower berm appeared to be in good condition with good vegetative growth (Photograph No. 15). There were signs of standing water on the bench of the lower berm indicating poor drainage from recent rains (Photograph No. 16).

10. The right downstream groin ditch was in good condition (Photographs No. 17 and 18). The rip rap is a hard limestone and showed minor weathering or deterioration. The discharges from several seepage drains were clear and no sediment deposits were observed in the pooling area. The groin appeared to be generally in good condition (Photograph No. 19).

11. The left groin ditches and discharge pipe were observed to be in good conditions. The vegetation was cut back to the left of the pipeline allowing excellent visual observation of the abutment. No significant uncontrolled seepage along this portion of the abutment or as the discharge pipe enters into the ground prior to its connection to the energy dissipater structure was observed. No

significant erosion, slumping or bulges were observed. Minor vegetation growth within the groin ditch needs to be eliminated using spry chemicals (Photograph No. 20).

12. The energy dissipater structure and downstream channel appeared to be in good condition (Photograph Nos. 21).

13. The dam's concrete flume (identified as Drain 14 (NPDES Permit Outfall # 019)) was observed to be in excellent condition and flow was unobstructed (Photograph No. 22).

Overall the facility is in good condition. The impoundment is functioning as intended with no signs of potential structural weakness or conditions which are disrupting to the safe operation of the impoundment. Additional pictures taken during the inspection can be made available upon request.

4.4 BOTTOM ASH POND COMPLEX

4.4.1 CHANGES IN GEOMETRY SINCE LAST INSPECTION (257.83(b)(2)(i))

No modifications have been made to the geometry of the BAP Complex since the 2016 annual inspection. The geometry of the impoundment has remained essentially unchanged.

4.4.2 CHANGES THAT EFFECT STABILITY OR OPERATION (257.83(b)(2)(vii))

Based on interviews with plant personnel and field observations there were no changes to the BAP Complex since the last annual inspection that would affect the stability or operation of the impounding structure.

4.4.3 INSTRUMENTATION (257.83(b)(2)(ii))

The location and type of instrumentation is shown on Figure 3. The results of the measurements of various piezometers since November 2016 are shown in Figure 5p. The maximum recorded readings of each instrument since the previous annual inspection is shown in Table 3.

Figure 5p presents the historical piezometric head elevations of all the piezometers along with the two pond's stages. The fluctuation of a few of the instruments could be directly correlated to the fluctuation in the pond stage.

A review of the data contained on the BAP Complex static water elevation plot showed that all piezometers exhibit consistent water elevations.

Table 3 BAP Complex Maximum recorded instruments reading since the previous annual inspection

INSTRUMENTATION DATA **Bottom Ash Pond Complex**			
Instrument	**Type**	**Maximum Reading since last annual inspection**	**Date of Reading**
2-N	Piezometer	664.43	7/03/17
3-S	Piezometer	660.17	7/03/17
B-0902	Piezometer	657.60	3/1317
B-0904	Piezometer	655.54	4/10/17
B-0905	Piezometer	646.02	3/13/17

4.4.4 IMPOUNDMENT CHARACTERISTICS (257.83(b)(2)(iii, iv, v))

Table 4 is a summary of the minimum, maximum, and present depth and elevation of the impounded water & CCR since the previous annual inspection; the storage capacity of the impounding structure at the time of the inspection; and the approximate volume of the impounded water and CCR at the time of the inspection.

Table 4 Summary of Relevant Storage Information BAP Complex

IMPOUNDMENT CHARACTERISTICS **Bottom Ash Pond Complex**	
Approximate **Minimum** depth (Elevation) of impounded water since last annual inspection	5 ft. (663) ft.
Approximate **Maximum** depth (Elevation) of impounded water since last annual inspection	10 ft. (665) ft.
Approximate **Present** depth (Elevation) of impounded water since last annual inspection	7.5 ft. (664) ft.
Approximate **Minimum** depth (Elevation) of CCR since last annual inspection	8 ft. (655) ft.
Approximate **Maximum** depth (Elevation) of CCR since last annual inspection (ft.)	11 ft. (658 ft.)
Approximate **Present** depth (Elevation) of CCR since last annual inspection	11 ft. (658ft.)
Storage Capacity of impounding structure at the time of the inspection	324 ac-ft
Approximate volume of impounded water at the time of the inspection	160 ac-ft.
Approximate volume of CCR at the time of the inspection	164 ac-ft.

4.4.5 VISUAL INSPECTION (257.83(b)(2)(i))

A visual inspection of the BAP Complex was conducted to identify any signs of distress or malfunction of the impoundment and appurtenant structures. The inspection also included hydraulic structures underlying the base of the dike. Specific items inspected included all structural elements of the dam such as inboard and outboard slopes, crest, and toe; as well as appurtenances such as the outlet structure at the BAP Complex, and pipe discharge structure.

Results of the visual inspection of the BAP Complex performed on November 8, 2017 are provided below (photos are presented in Attachment C):

1. The BAP downstream slope on the west side has two old seepage areas that have been repaired with an inverted riprap filter. These seepage areas appeared stable with grass growing in the immediate vicinity of the seepage. Photograph Nos. 1 through 4 show typical exterior slope conditions. The remainder of the BAP west side slope was well protected with bottom ash and slag.
2. The BAP and RCP downstream slope along the Ohio River was well protected with vegetation or riprap as typically shown in Photographs Nos. 5 through 9. The vegetation showed a good established growth and is maintained by periodic mowing (Photographs Nos. 7 and 8). The trees shown in the photographs along the riverbank are generally located below the toe of the slope and serve to protect the river bank from erosion. A few erosion rills have started to form where the

downstream slope and crest meet. These erosion rills are most likely caused by storm water run-off from the crest area (Photograph No. 9).

3. The crest areas of the BAP, splitter dike between the BAP and RCP and the Recirculation Pond were in generally good condition with no significant signs of erosion, rutting or misalignment as shown in Photograph Nos. 10 through 13.
4. The internal slopes of the BAP and RCP were in good condition with no significant signs of erosion, sloughing or deterioration as seen in Photograph Nos. 14 through 16. Minor erosion was noticed at the corners of the dike.
5. The BAP discharge structure concrete and steel platform were in good condition, as shown in Photograph No. 18. The railings are showing minor rust and the steel support members to the walkway are showing fair conditions with minor corrosion.
6. The RCP overflow pipe, concrete and riprap appeared in good condition as shown in Photograph No. 19. The upstream concrete inlet structure was also in satisfactory condition. The pond water level was well below the invert of the steel weir (Photograph No. 19).
7. Typical view of the bottom ash discharge pipes are show in Photograph no. 20. The ash pipe and support structure appeared to be in satisfactory and functioning condition.

Overall the facility is in good condition. The impoundment is functioning as intended with no signs of potential structural weakness or conditions which are disrupting to the safe operation of the impoundment.

5.0 SUMMARY OF FINDINGS

5.1 MAINTENANCE ITEMS

The following maintenance items were identified during the visual inspection:

Fly Ash Dam 1

- Vegetation control on the outboard slopes is to be kept under control by mowing or spraying.

Fly Ash Dam 2

- Vegetation control along the left and right groin areas is to be kept under control by mowing and spraying.

Bottom Ash Pond Complex

- The erosion rills located on the downstream slope of the eastern dike where the top of slope meets the crest needs to be repaired.

5.2 ITEMS TO MONITOR

Fly Ash Dam 1

- There are no items to monitor.

Fly Ash Dam 2

- Seepage in the rock in the left and right abutment areas should be monitored on weekly basis. Changes in the rate or the clarity of the seep should be reported to GES on the day of the inspection.

Bottom Ash Pond Complex

- Minor seepage along the downstream slope of the eastern dike should be monitored on weekly basis. Changes in the rate or the clarity of the seep should be reported to GES on the day of the inspection.

5.3 DEFICIENCIES (257.83(b)(2)(vi))

There were no deficiencies or signs of structural weakness or disruptive conditions that were observed at the time of the inspection that would require additional investigation or remedial action. There were no deficiencies noted during any of the periodic 7-day or 30-day inspections. If any of these conditions occur before the next annual inspection contact AEP Geotechnical Engineering immediately.

If you have any questions with regard to this report, please contact Brett Dreger at Audinet: 200-2258 or Gary Zych at Audinet: 200-2917.

ATTACHMENT A:
Photographs – Fly Ash Dam 1

Photo # 1 FAD 1 View of the downstream slope of the FAR 1 dam.	
Photo # 2 FAD 1 Typical view of the downstream slope of the FAR 1 dam.	
Photo # 3 FAD 1 Typical view of the right groin area of FAR 1 dam showing a damaged surface water pipe.	

Photo # 4 FAD 1 Typical view of the left groin area of the FAR 1 dam.	
Photo # 5 FAD 1 Typical view of the ash discharge pipes along crest area of FAR 1 dam looking west.	
Photo # 6 FAD 1 Typical view of the crest area of the FAR 1 dam looking east.	

ATTACHMENT B:
Photographs – Fly Ash Dam 2

November 8, 2017
Cardinal Plant
Dam and Dike Inspections

Photo # 1 FAD 2 Typical view of crest area looking west. Crest appeared in good condition with no indications of misalignment, rutting or erosion.	
Photo # 2 FAD 2 Typical view of crest area looking east. Crest appeared in good condition with no indications of misalignment, rutting or erosion.	
Photo # 3 FAD 2 Typical view of the west side of the decant structure. Skimmer and stair appeared in good condition.	

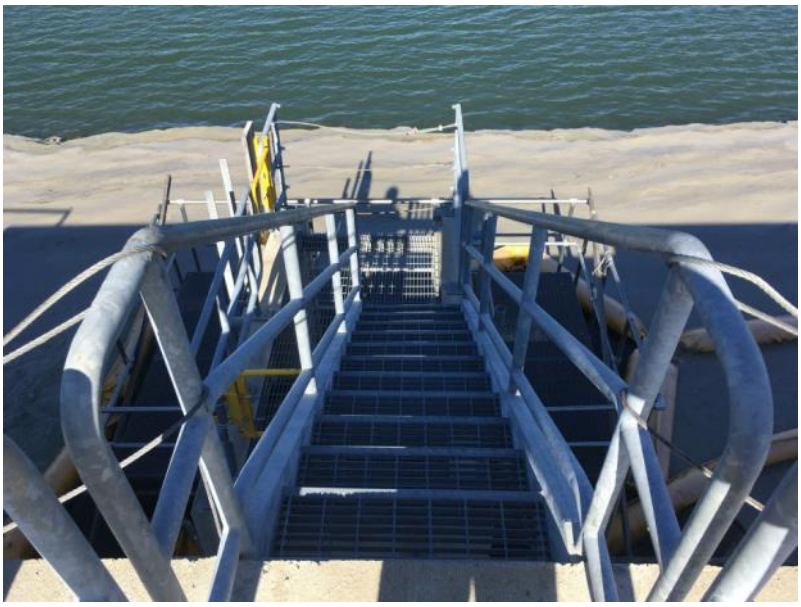
Photo # 4 FAD 2 Typical view looking down the access stair to the decant structure. Stairs, railings and platform appeared in good condition.	
Photo # 5 FAD 2 Typical view of the staff gauge on principal spillway.	
Photo # 6 FAD 2 Typical view of the east side of MSE Wall looking at downstream corner where the wall panel meets concrete coping. Notice the separation at the corner piece.	

Photo # 7 FAD 2 Typical view of the upstream MSE wall on the right side looking east.	
Photo # 8 FAD 2 Typical view of the upstream MSE Wall and Emergency Spillway Opening.	
Photo # 9 FAD 2 Typical view of the Emergency Spillway Crest Area.	

Photo # 10 FAD 2 Typical view of the emergency discharge channel showing good conditions. Vegetative control is well maintained. Historic seep from the rock slope at the left abutment has slightly increase in rate as a result of the increased upstream gradient as a result of rising the pool elevation by approximately 5 ft.	
Photo # 11 FAD 2 Typical view of the emergency spillway grass channel. Overall condition appeared to be satisfactory.	
Photo # 12 FAD 2 Typical view of the Concrete and RCC emergency spillway discharge channel “steps.” The RCC steps have experienced a moderate amount of differential erosion but appear to be in fair condition.	

Photo # 13 FAD 2 Typical view of the downstream slope showing good condition. Vegetative cover is well established and no significant erosion rills or gullies were observed.	
Photo # 14 FAD 2 Typical view of the downstream slope showing good conditions. Vegetative cover is well established and no significant erosion rills or gullies were observed.	
Photo # 15 FAD 2 Typical view of downstream slope lower berm. The vegetation was well maintained.	

Photo # 16 FAD 2 Typical view of downstream slope lower berm bench area showing standing water from recent rainfall.	
Photo # 17 FAD 2 Typical view of the right groin ditch. The woody shrub/small tree growth has been removed from the ditch per previous recommendations. Several seep drains that collect seepage from the hillside outlet into the pooling area shown.	
Photo # 18 FAD 2 Typical view of the right groin ditch. The rip rap is a hard limestone and showed no significant weathering or deterioration.	

Photo # 19 FAD 2 Typical view of Drain no. 2 that discharges from the right abutment drainage blanket. The discharge was visually clear but has increased. Flow measurements are taken of the seep drains that let down into the pooling area. A v-notch weir is used to measure flow.	
Photo # 20 FAD 2 Typical view of the left groin ditch. The rip rap is a hard limestone and showed no significant weathering or deterioration.	
Photo # 21 FAD 2 View of the energy dissipater showing good conditions of the concrete structure. No cracking, spalling was observed.	

Photo # 22 FAD 2	
View of the permit outfall for the main service spillway. The flow weir was un-obstructed and flowing freely with no signs of sediment buildup.	
Photo # 23 FAD 2	
Photo # 24 FAD 2	

ATTACHMENT C:
Photographs –Bottom Ash Pond Complex

Photo # 1 BAP	
Typical view showing satisfactory condition of exterior slope and some minor seepage / drainage along toe of the embankment. No significant signs of erosion, slumping or bulges were observed.	
Photo # 2 BAP	
Typical view showing satisfactory condition of exterior slope and access stair to the ash sluice lines along toe of the embankment. No significant signs of erosion, slumping or bulges were observed.	
Photo # 3 BAP	
Typical view showing satisfactory condition of exterior slope and some minor seepage / drainage along toe of the embankment. No significant signs of erosion, slumping or bulges were observed.	

Photo # 4 BAP Typical view showing good condition of the exterior slope along the toe of embankment.	
Photo # 5 BAP Typical view showing good condition of the rip rap. An inverted filter drain was extended in late 2009 through this area to control seepage emanating from the pond.	
Photo # 6 BAP Typical view showing good condition of the rip rap and downstream outlet of the RCP discharge pipe.	

Photo # 7 BAP Typical view of the exterior slope along the Ohio River and access stairs down to a monitoring well. The piezometer in the foreground is well protected and is currently being monitored by plant personnel.	
Photo # 8 BAP The embankment along the Ohio River showed a good growth of vegetative cover and is regularly controlled by mowing. There were no signs of slumping, or bulges observed. The trees are located along the Ohio River and are being left in place to protect the riverbank.	
Photo # 9 BAP View of the exterior slope along the Ohio River showing some erosion rills forming at the top of slope where water runs off of the crest area.	

Photo # 10 BAP	
Typical view of the crest area of the exterior slope long the Ohio River. There were no signs of rutting, pot holes or misalignment.	
Photo # 11 BAP	
Typical view showing good conditions of the splitter dike between the bottom ash pond and the RCP pond with minor erosion at the corners.	
Photo # 12 BAP	
Typical view of the crest area along the RCP, The crest conditions were good with no indications of misalignment, and minimal rutting or erosion.	

Photo # 13 BAP Typical view showing conditions of the splitter dike between the bottom ash pond and the RCP with minor erosion at the corners.	
Photo # 14 BAP Typical view showing good conditions of the interior slope areas of the bottom ash pond.	
Photo # 15 BAP Typical view showing good conditions of the interior slope areas of the bottom ash pond.	

Photo # 16 BAP Typical view showing good conditions of the interior slope areas of the bottom ash pond.	
Photo # 17 BAP Typical view of the pump house and intake structure at the RCP.	
Photo # 18 BAP Typical view of the BAP discharge structure. The concrete drop inlet structure was observed to be in good condition. The metal skimmer is significantly rusted and in poor condition.	

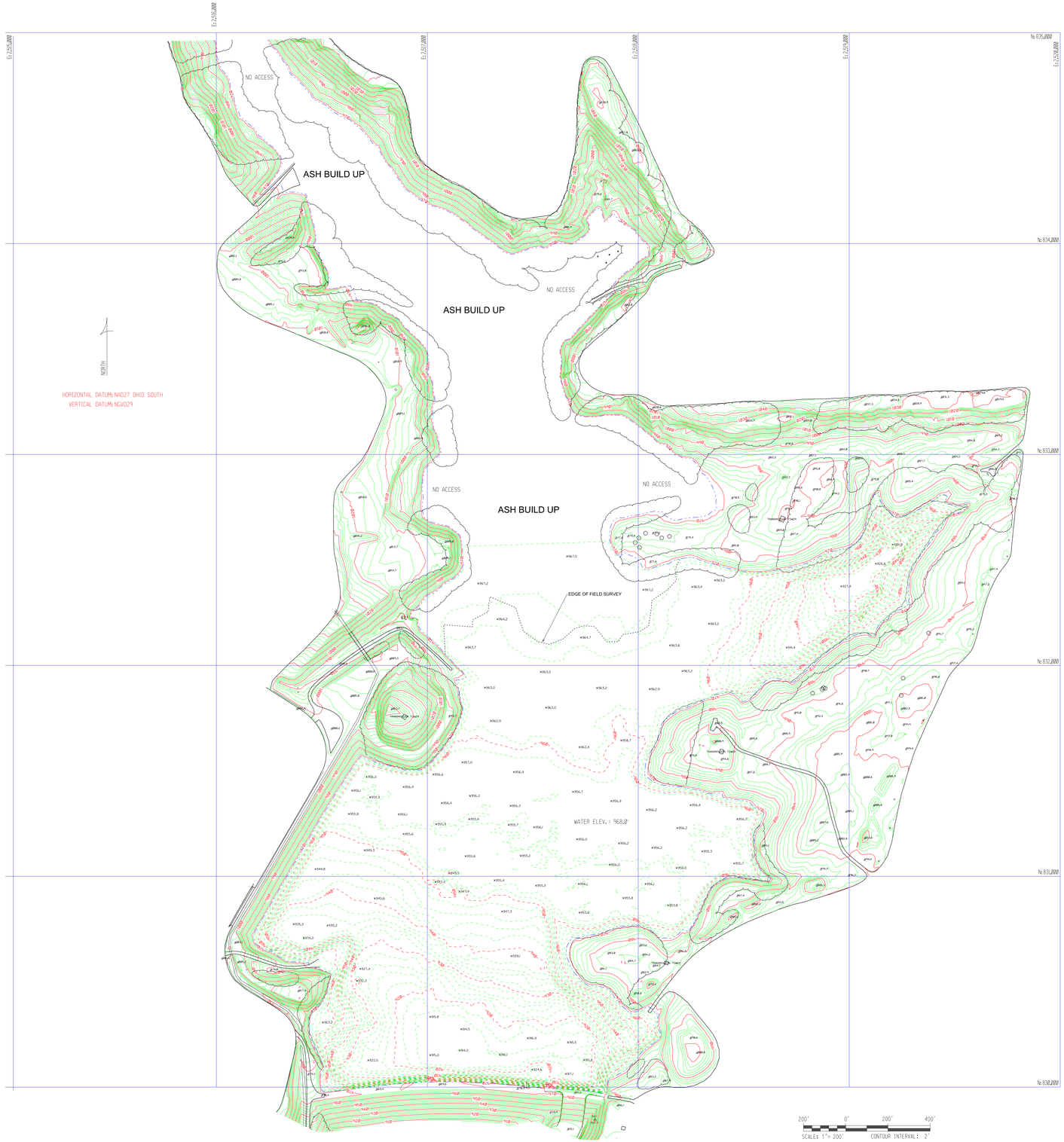
Photo # 19 BAP	
The RCP overflow structure appeared to be in good condition. No spalling or cracking of the concrete was observed. The RCP overflow structure has been retrofitted with a steel weir.	

Photo # 20 BAP	
Typical view showing good conditions of the bottom ash discharge pipes. Access to the discharge lines is being maintained, discharge into the channel and flow through the channel was unobstructed.	

Photo # 21 BAP	

ATTACHMENT D:
Bathymetric Surveys (September 12, 2017)

DWG. NO.



Triangle Volume Report

Volume Up To Water Elevation 968.0'

Original Surface: cdFARII 9-12-17_2729SF_field
Description: FAR **II** Hydrographic Survey 9-12-17 Field Data

Design Surface: cdFARII 9-12-17_2729SF_H2O
Description: FAR **II** Hydrographic Survey 9-12-17 Water Elevation 968.04

Cut Factor: 1.00
Fill Factor: 1.00

Cut: 0.0 cu ft
Fill: 74604155.4 cu ft
Net: -74604155.4 cu ft

Cut: 0.0 cu yd
Fill: 2763116.9 cu yd
Net: -2763116.9 cu yd

•NOTE: CONTOURS AND DTM DATA ABOVE THE WATER LEVEL ARE FROM AERIAL PHOTOS DATED 3/05-09.

DATE	NO.	DESCRIPTION	APPD.
		REVISIONS	

DIGITAL MAP FILES CDFARII 9-12-17_2729SF.DGN & .DTM

FAR II HYDROGRAPHIC SURVEY

CARDINAL PLANT

SURVEY DATE SEPTEMBER 12, 2017

DWG. NO. CD- 170912

SCALE=1" = 200'	CIVIL ENGINEERING DIVISION
DRW. W. FLYNN	
CHK.	
ENGR.	
PROJ. ENGR.	
DATE: 10/18/17	

APPROVED BY

AMERICAN ELECTRIC POWER
1 RIVERSIDE PLAZA
COLUMBUS, OH 43215

IGS1092

ATTACHMENT E:
Figures & Drawings 13-30040, 13-30041 & 13-30042

DRN BY:	CARDINAL POWER STATION	DWG NO: FIGURE 1
DATE:		AEP AMERICAN ELECTRIC POWER / AEP SERVICE CORP. 1 RIVERSIDE PLAZA COLUMBUS, OH 43215
SCALE: 1"=	FLY ASH DAM I	

DWG. NO. 13-30040

GENERAL NOTES

1. - EXCAVATE ROCK SURFACE TO ACHIEVE A RIGHT ANGLE CONTACT WITH THE RCC.
2. - THE SOIL OVERBURDEN ON BOTH THE RIGHT & LEFT ABUTMENTS SHALL BE STRIPPED. A 2' BOTTOM ASH DRAINAGE BLANKET SHALL BE PROVIDED OVER THE ENTIRE STRIPPED AREA. ANY SEEPAGE ZONES FOUND DURING STRIPPING SHALL BE DRAINED AS NECESSARY BY A FRENCH DRAIN DAYLIGHTING INTO GROIN DITCH.
3. - ADJUST LOCATION OF GROIN DITCH AS REQUIRED TO CLEAR PIPE SUPPORTS.

LEGEND - EXISTING

- SPOT ELEVATION
- INTERMEDIATE CONTOUR
- INDEX CONTOUR
- DEPRESSION CONTOUR
- TREES AND TREELINE
- STRUCTURE AND BUILDING
- FENCE
- POLE
- ROADS
- EDGE OF WATER
- MANHOLES / CATCH BASIN
- POWER POLE
- PIPES
- TOWER

LEGEND - PROPOSED

- +(970.0') FIN. GRADE SPOT ELEV.
- 920 FIN. GRADE CONTOUR
- DRAINAGE DITCH
- INCLINED BORE HOLES
- VERTICAL BORE HOLES
- PIEZOMETER

REFERENCE DRAWINGS

13-30041 - FLY ASH DAM II RAISING PROFILE & SECTION.

13-30042 - FLY ASH DAM II RAISING SECTIONS & DETAILS SHT.1.

13-30043 - FLY ASH DAM II RAISING SECTIONS & DETAILS SHT.2.

DATE	NO.	DESCRIPTION	APPD.
3/30/00	5	REVISED TO REFLECT AS-BUILT CONDITIONS. FINAL SUBMITTAL TO STATE	GTM/LK
5/24/99	4	AS-BUILT: REVISED TOPO, DRAIN PIPES , ADDED TABLES, PIEZOMETERS AND OPEN BORE HOLES. REMOVED MONITORING WELLS 4,3, 2D & 2S	LMH/ JC
8/22/98	3	REMOVED INTERMEDIATE CONTOURS. INDICATED CONCRETE TRAINING WALL & GEOTEXTILE FABRIC.	LMH/ RCD
5/20/98	2	DELETED DROP MANHOLE & REV. PIPE ALIGNMENT.	LMH/ RCD
8/25/97	1	REV. TOE OF DAM TO REFLECT SLIDE REPAIR. RELOCATED DROP MANHOLE & REV. PIPE BEND, 6°30' WAS 6°. ADDED UNDERDRAIN SYSTEM.	LMH/ RCD
4/2/97	0	ISSUED FOR CONSTRUCTION.	LMH/

REVISIONS

s:/cd/13/geo_hydro_site/30040.dgn

CARDINAL OPERATING COMPANY

CARDINAL PLANT

BRILLIANT OHIO

FLY ASH DAM II RAISING GRADING & DRAINAGE PLAN

DWG. NO. 13-30040-5

SCALE: 1"=50'

CIVIL ENGINEERING DIVISION

DRN: RCD
CHK: GTC
ENGR.: LMH
PROJ. ENGR.:
APPROVED BY: H. Joseph Bubac
DATE: 4/2/97

AEP AMERICAN ELECTRIC POWER — 1 RIVERSIDE PLAZA COLUMBUS, OH 43215

PTS No. 55689

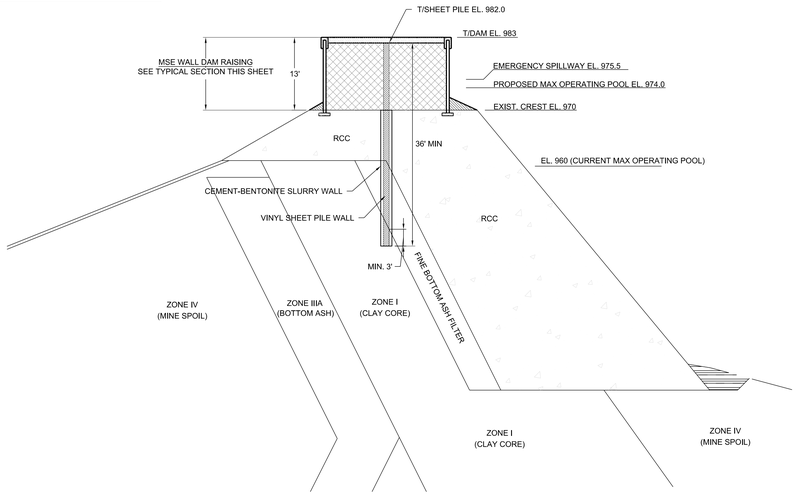
MONITORING WELLS	NORTH	EAST	TIP ELEV.
MW-1D	830,048.740	2,518081.850	654.5
MW-1S	830,048.780	2,518081.930	806.1
MW-5	830,072.415	2,516465.055	782.2
MW-6	830,072.415	2,516465.990	915.6
MW-7	829,942.57	2,517,824.47	972.50
PIEZOMETER No.	NORTH	EAST	TIP ELEV.
P8B	829,880.385	2,517,198.101	776.0
P8A	829,880.185	2,517,191.730	802.1
P2BE nested	829,893.405	2,517,001.135	730.0
P2C nested	829,893.405	2,517,001.135	711.0
P3B nested	829,965.095	2,516,994.335	772.3
P3A nested	829,965.095	2,516,994.335	802.3
P3C	829,947.865	2,516,994.545	712.3
P2BW	829,892.685	2,516,941.390	731.1
P2A	829,910.895	2,516,891.870	771.0
P11	829,874.275	2,516,805.610	802.6
P11B	829,887.670	2,516,773.430	789.1
P10	829,815.120	2,516,776.440	769.1
P9	829,757.800	2,517,221.000	771.2
P8E	829,687.855	2,516,999.390	728.0
P1A	829,692.010	2,516,965.335	752.3
P1C	829,692.010	2,516,965.335	714.4
PSBR-Orig.	829,851.135	2,517,269.030	725.0
PSBR-sl. doylite	829,705.160	2,517,222.820	CONNECTOR EL.807.0
P1BW	829,701.320	2,516,925.760	735.9
PRCC3	830,018.040	2,517,445.700	913.3
PRCC2	830,034.680	2,517,185.460	913.4
PRCC1	830,008.870	2,516,765.950	923.3
P4A	830,078.650	2,517,007.900	801.7
P5A	830,079.170	2,517,013.940	774.7

OPEN BOREHOLES	NORTH	EAST	GR. ELEV.	BOTT. ELEV.
OB-1	829,963.475	2,516,484.110	970.205	920.000
OB-2	829,976.090	2,516,583.770	970.015	920.000
OB-3	829,988.100	2,516,683.385	969.950	920.000
OB-4	830,000.125	2,516,781.285	969.915	920.000
OB-5	830,009.680	2,516,880.480	969.890	920.000
OB-6	830,016.215	2,516,980.785	969.885	920.000
OB-7	830,019.285	2,517,080.595	969.865	920.000
OB-8	830,017.820	2,517,180.080	969.880	920.000
OB-9	830,013.940	2,517,279.295	969.935	920.000
OB-10	830,006.100	2,517,378.760	970.015	920.000
OB-11	829,998.195	2,517,452.330	970.035	920.000
OB-12	829,987.550	2,517,642.140	961.965	910.000
OB-13	829,979.315	2,517,739.690	961.240	910.000

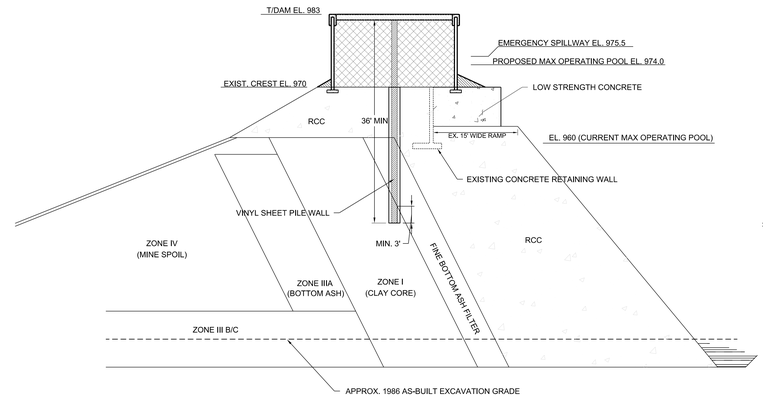
NOTE: ALL OB. HOLES ARE INCLINED 15° FROM VERTICAL

FIGURE 2A

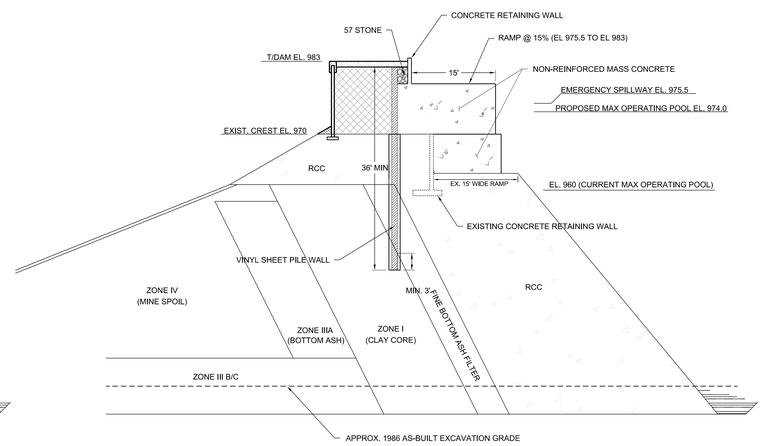
DWG. NO. 13-30087-A



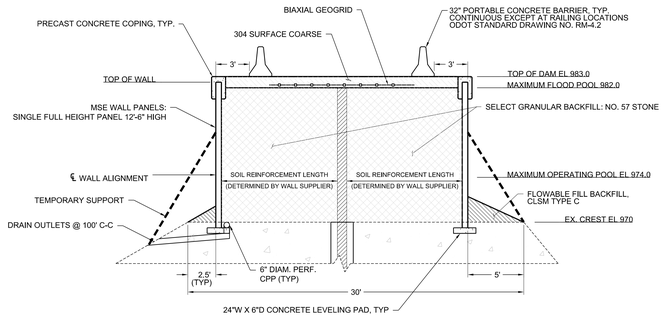
A TYPICAL SECTION - MAIN DAM
SCALE: 1" = 10'



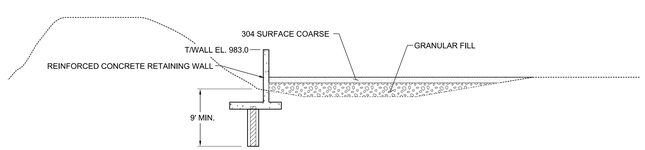
B1 SECTION THROUGH EXISTING EMERGENCY SPILLWAY RAMP
SCALE: 1" = 10'



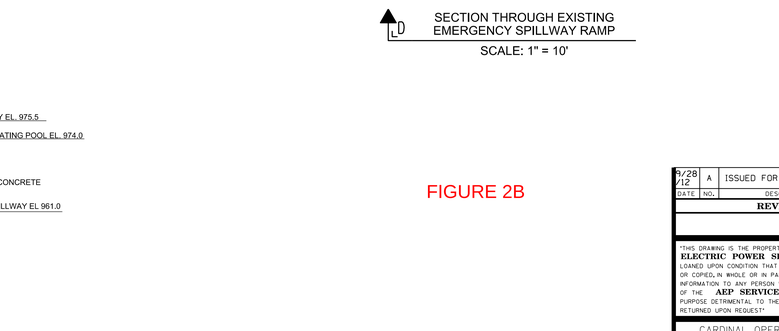
B2 SECTION THROUGH EXISTING EMERGENCY SPILLWAY RAMP
SCALE: 1" = 10'



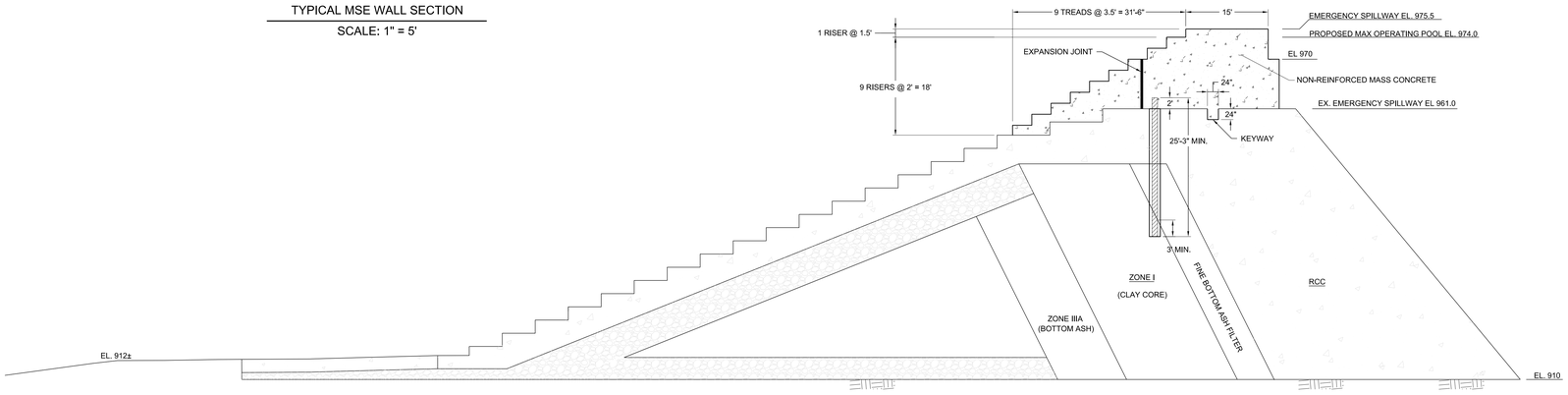
TYPICAL MSE WALL SECTION
SCALE: 1" = 5'



E SECTION E-E
SCALE: 1" = 10'



D SECTION THROUGH EXISTING EMERGENCY SPILLWAY RAMP
SCALE: 1" = 10'



C SECTION THROUGH EXISTING EMERGENCY SPILLWAY
SCALE: 1" = 10'

FIGURE 2B

S&ME, INC.
6190 ENTERPRISE COURT
DUBLIN, OH 43016
PHONE: 614-793-2226
FAX: 614-793-2410
www.smeinc.com

STATE OF OHIO · MICHAEL GILBERT ROWLAND · E-65559 · REGISTERED PROFESSIONAL ENGINEER

MICHAEL GILBERT ROWLAND | E-65559 NUMBER | SEPT 28, 2012 DATE

PROJECT NUMBER:	011-11497-042	DRAWN BY:	EDV
DRAWING DATE:	9/28/12	ENGINEER:	MTR
LAST UPDATED:	9/28/12	APPROVED BY:	MGR
		SCALE:	AS NOTED

S&ME

DATE	NO.	DESCRIPTION	APPD.
9/28/12	A	ISSUED FOR BID	SSB MGR

REVISIONS

CARDINAL OPERATING COMPANY

CARDINAL PLANT

BRILLIANT OHIO

DAM RAISING
FLY ASH RETENTION DAM II
DAM RAISING
TYPICAL SECTIONS

DWG. NO. 13-30087-A

ARCH — ELEC — MECH — STR

SCALE: AS SHOWN

DR:

CH:

QC:

DATE:

APPROVED BY:

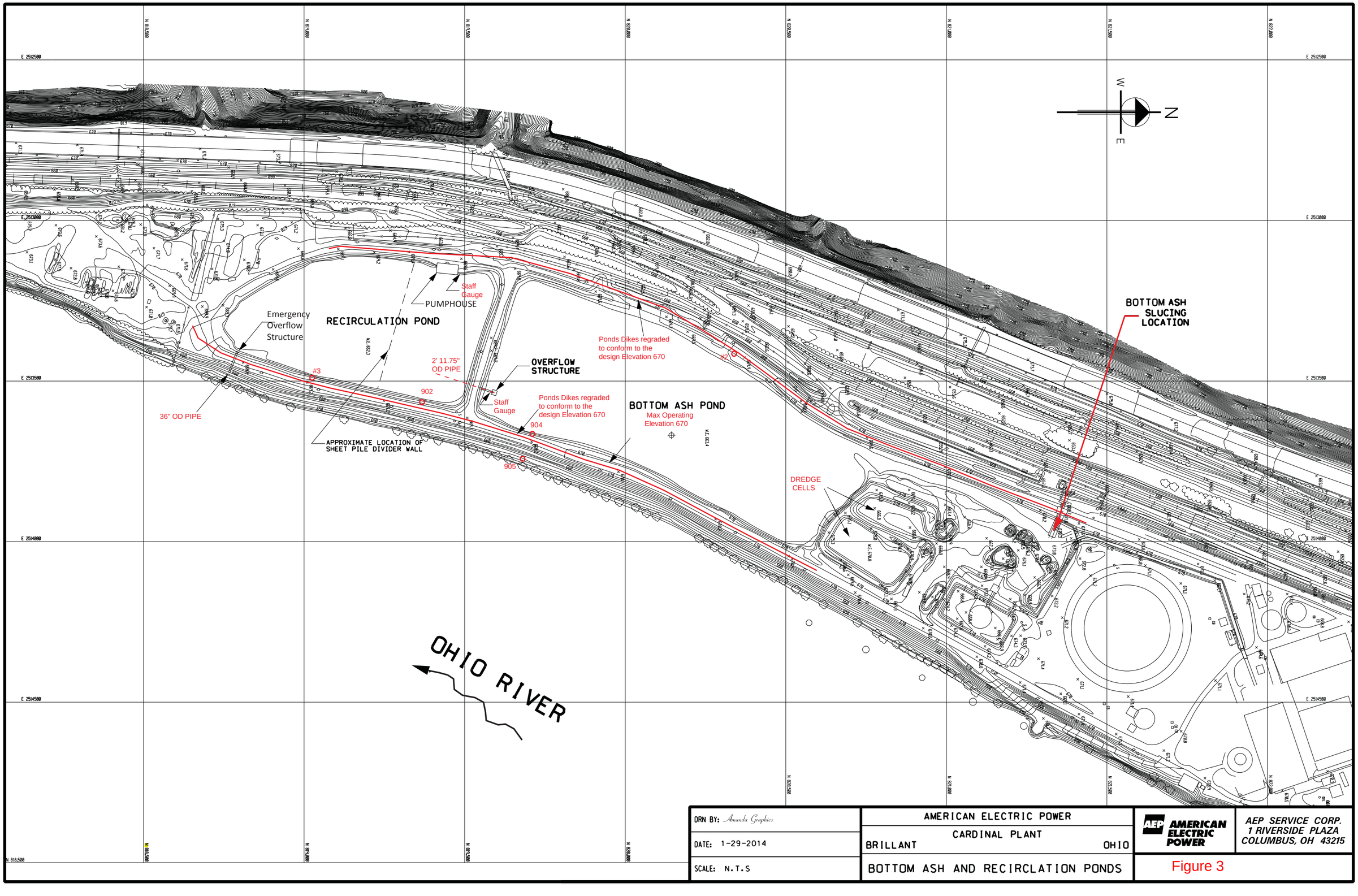
CIVIL ENGINEERING DIVISION

AMERICAN ELECTRIC POWER

1 RIVERSIDE PLAZA
COLUMBUS, OH 43215

IGSI092

SYSTEM DATE: DD-MMM-YYYY
SYSTEM TIME: HOURMINUTE
I54M FLR/CED



DRN BY: Amanda Graphics	AMERICAN ELECTRIC POWER CARDINAL PLANT BRILLANT OHIO	AEP AMERICAN ELECTRIC POWER AEP SERVICE CORP. 1 RIVERSIDE PLAZA COLUMBUS, OH 43215
DATE: 1-29-2014		
SCALE: N.T.S	BOTTOM ASH AND RECIRCLATION PONDS	Figure 3

Figure 4
Cardinal FAD 2

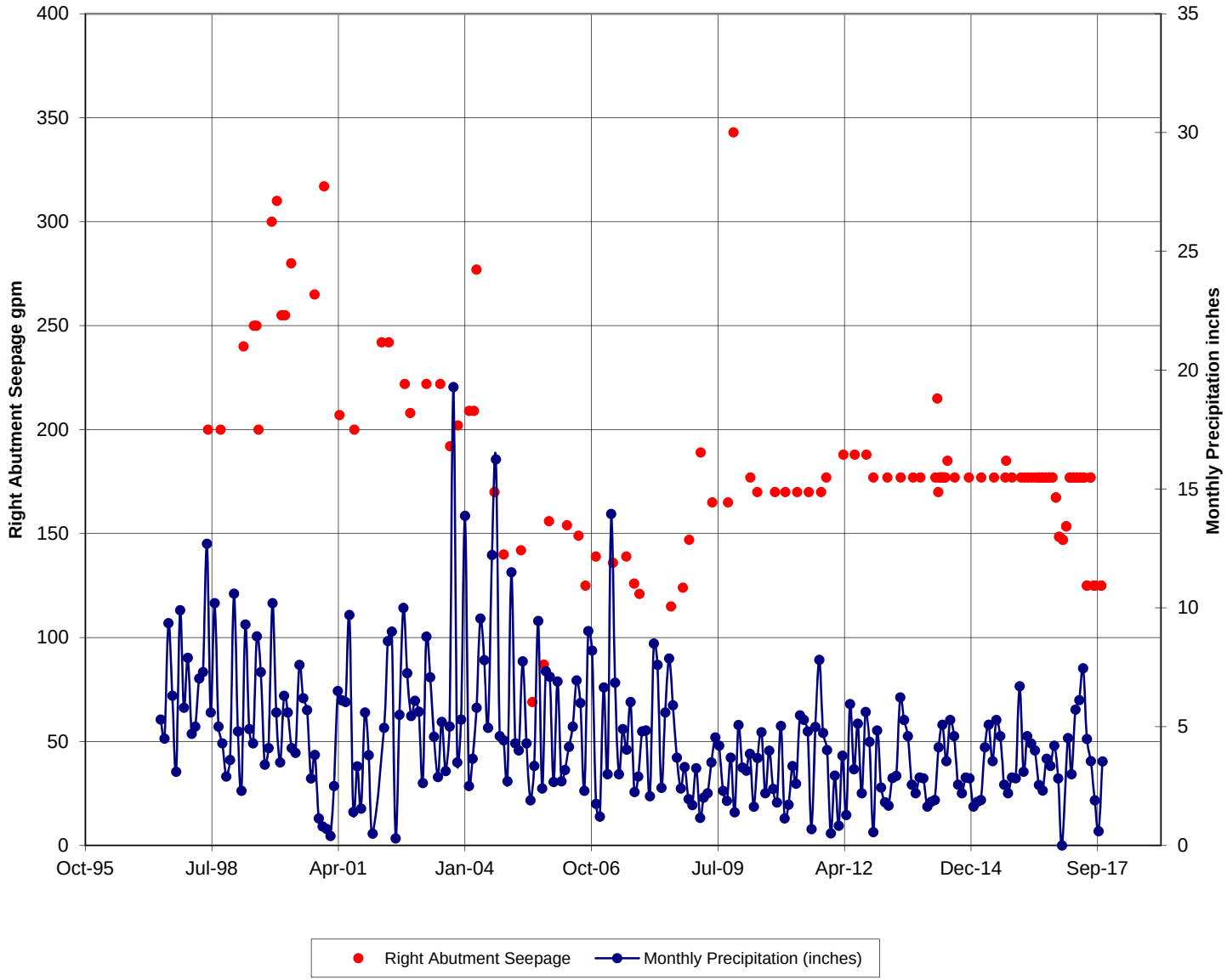


Figure 5a
Cardinal FAD 2

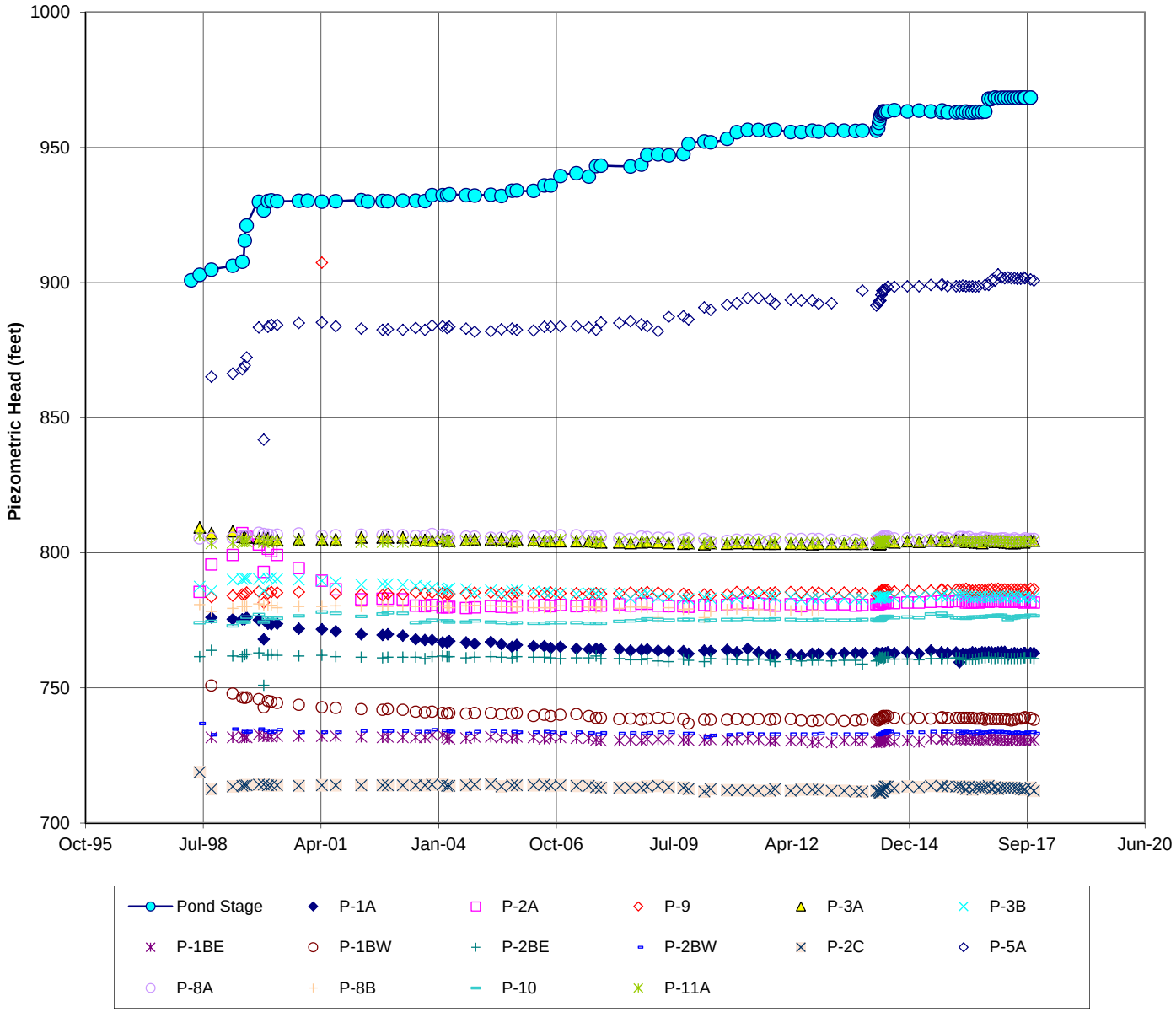


Figure 5b
Pool Stage verses Discharge
Cardinal FAD 2

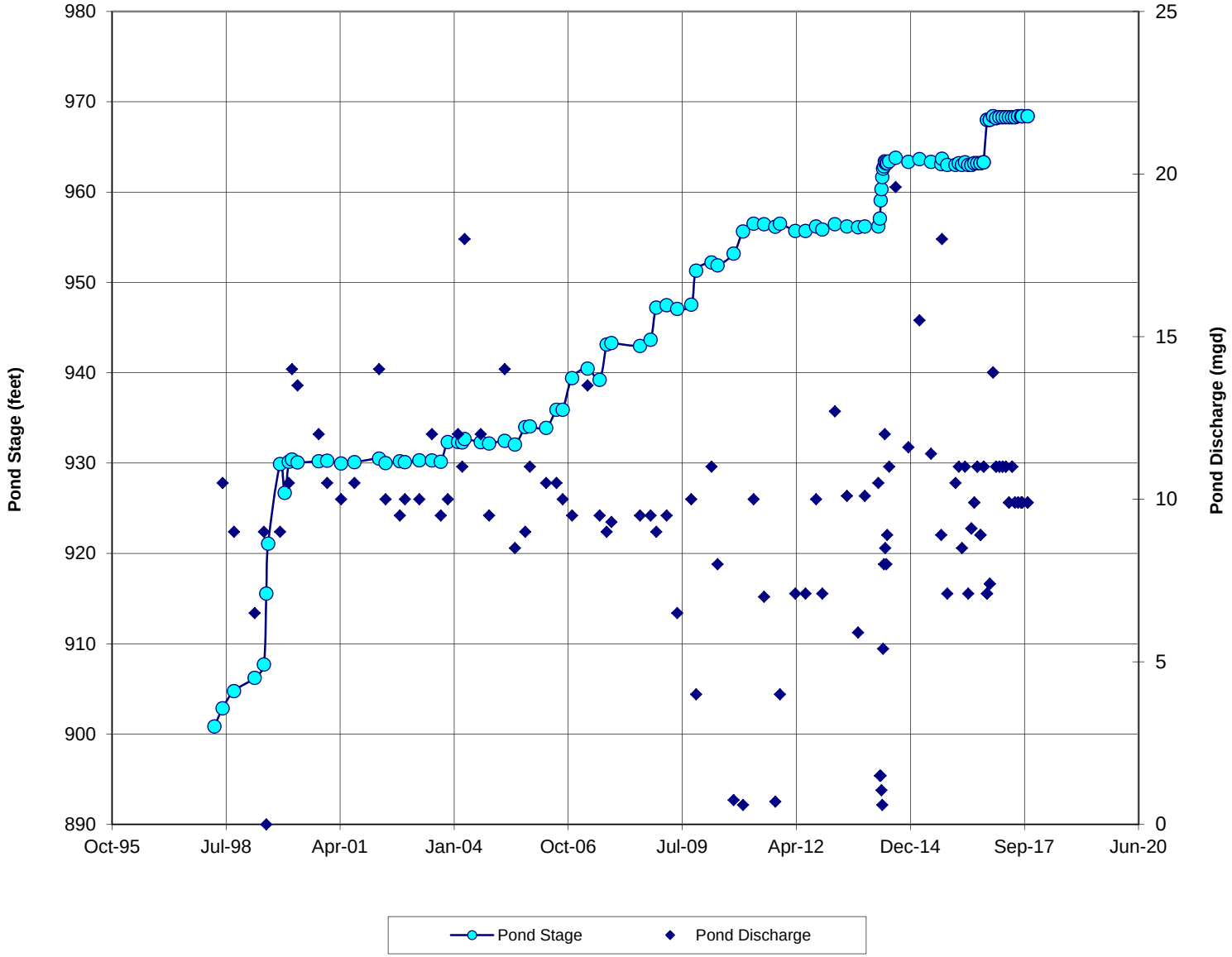


Figure 5c
Cardinal FAD 2
Right of Center
Foundation Piezometers

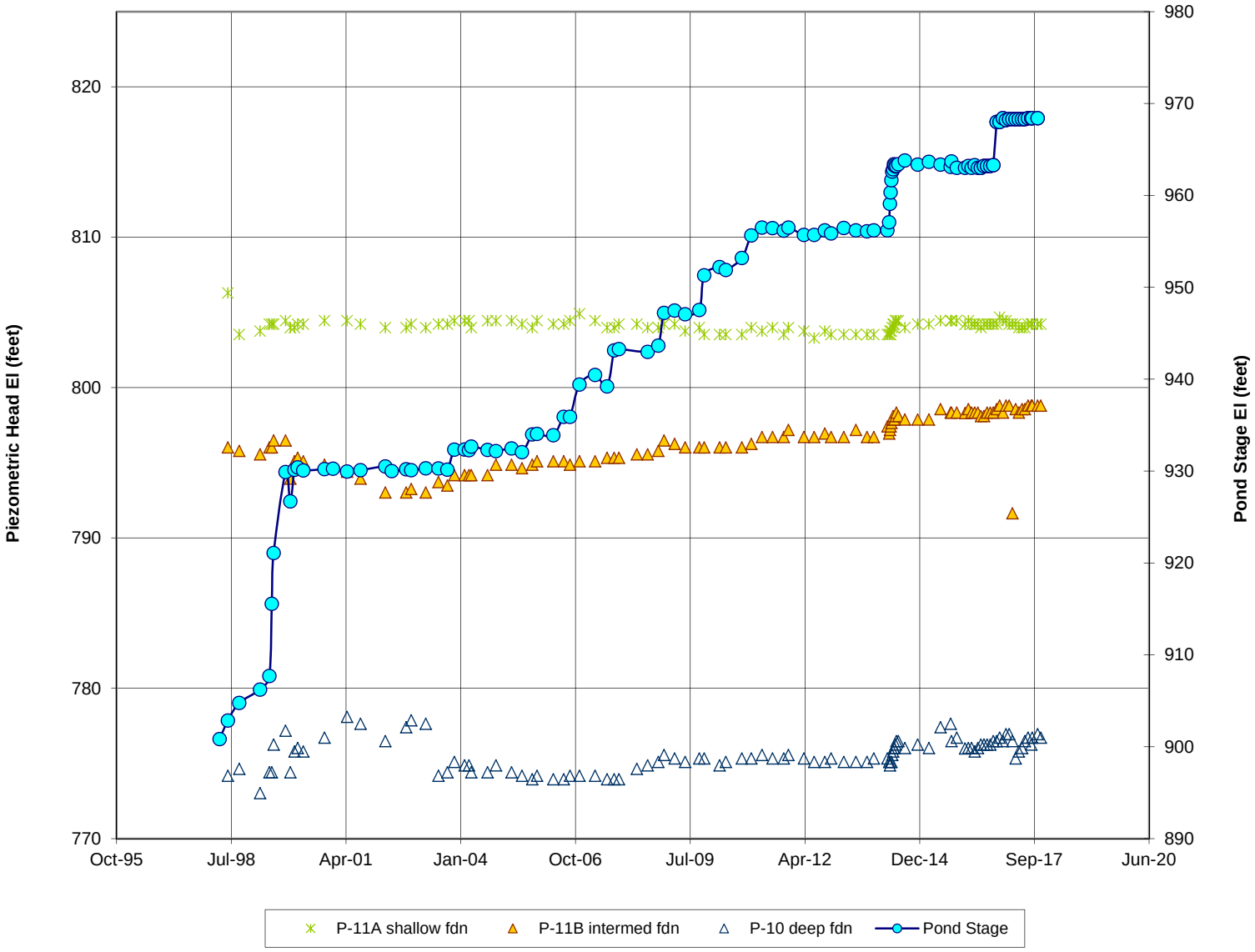


Figure 5d
Cardinal FAD 2
Left of Center
Foundation Piezometers

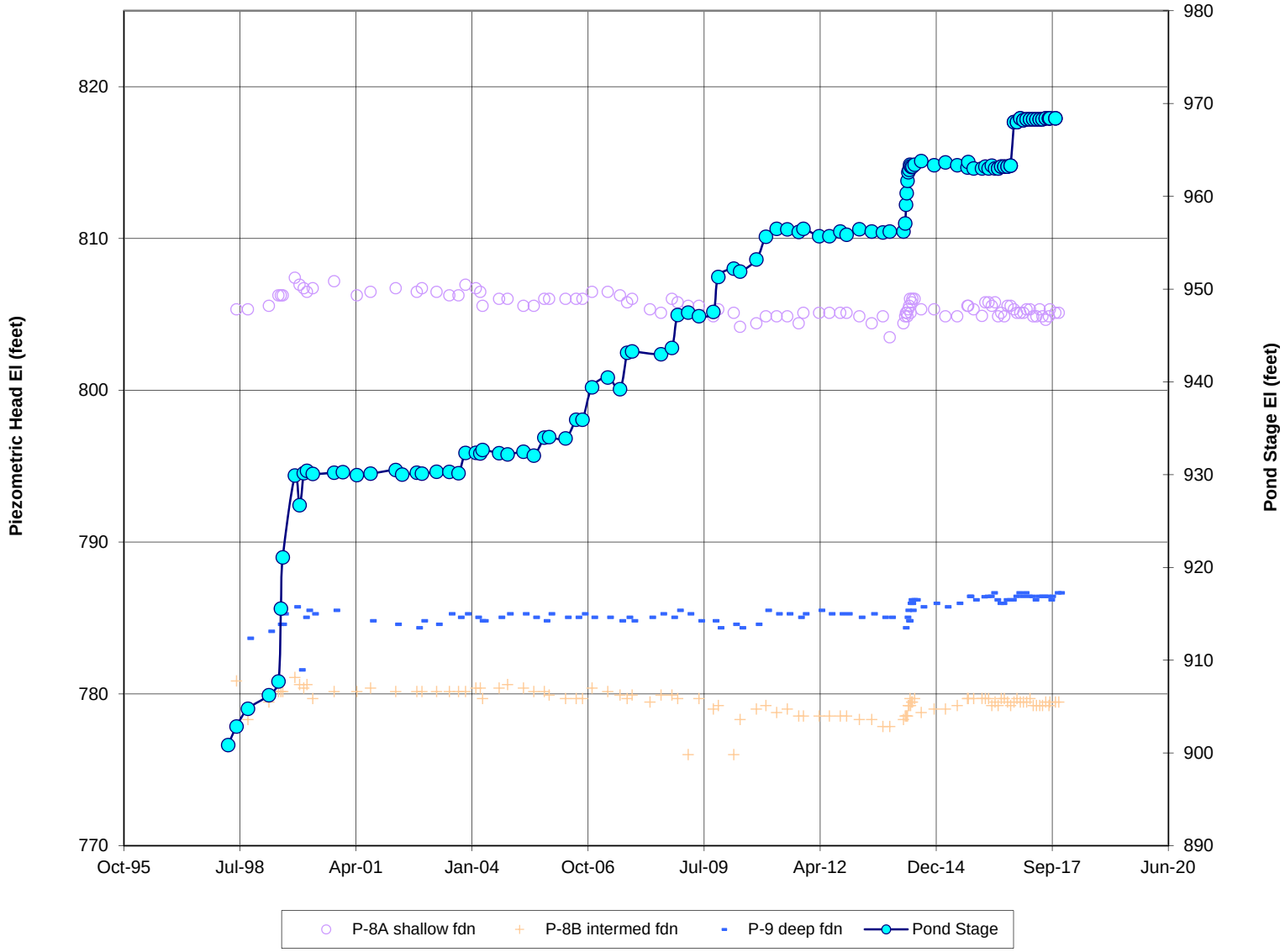


Figure 5e
Cardinal FAD 2
Centerline of Dam

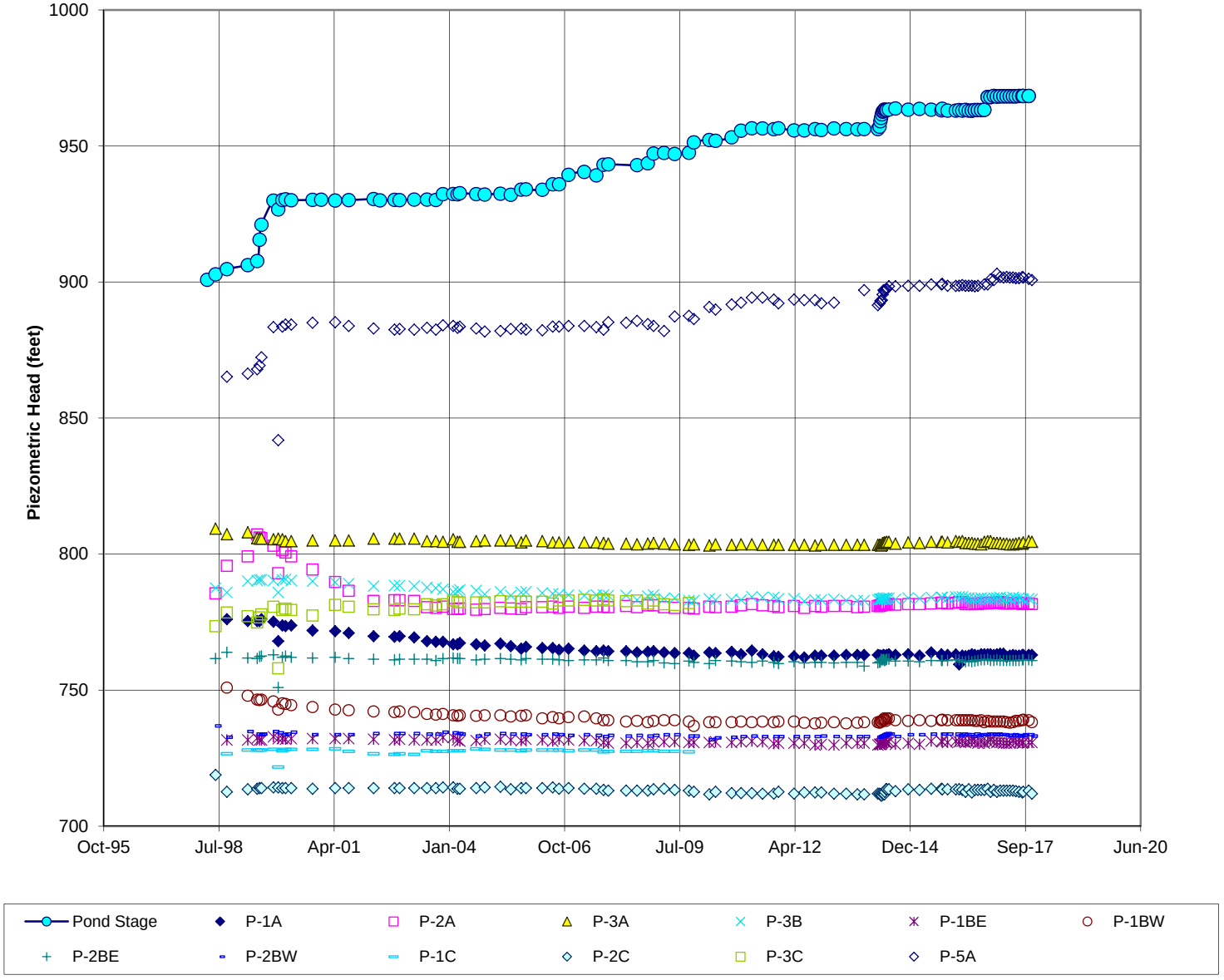


Figure 5f
Cardinal FAD 2
Centerline of Dam

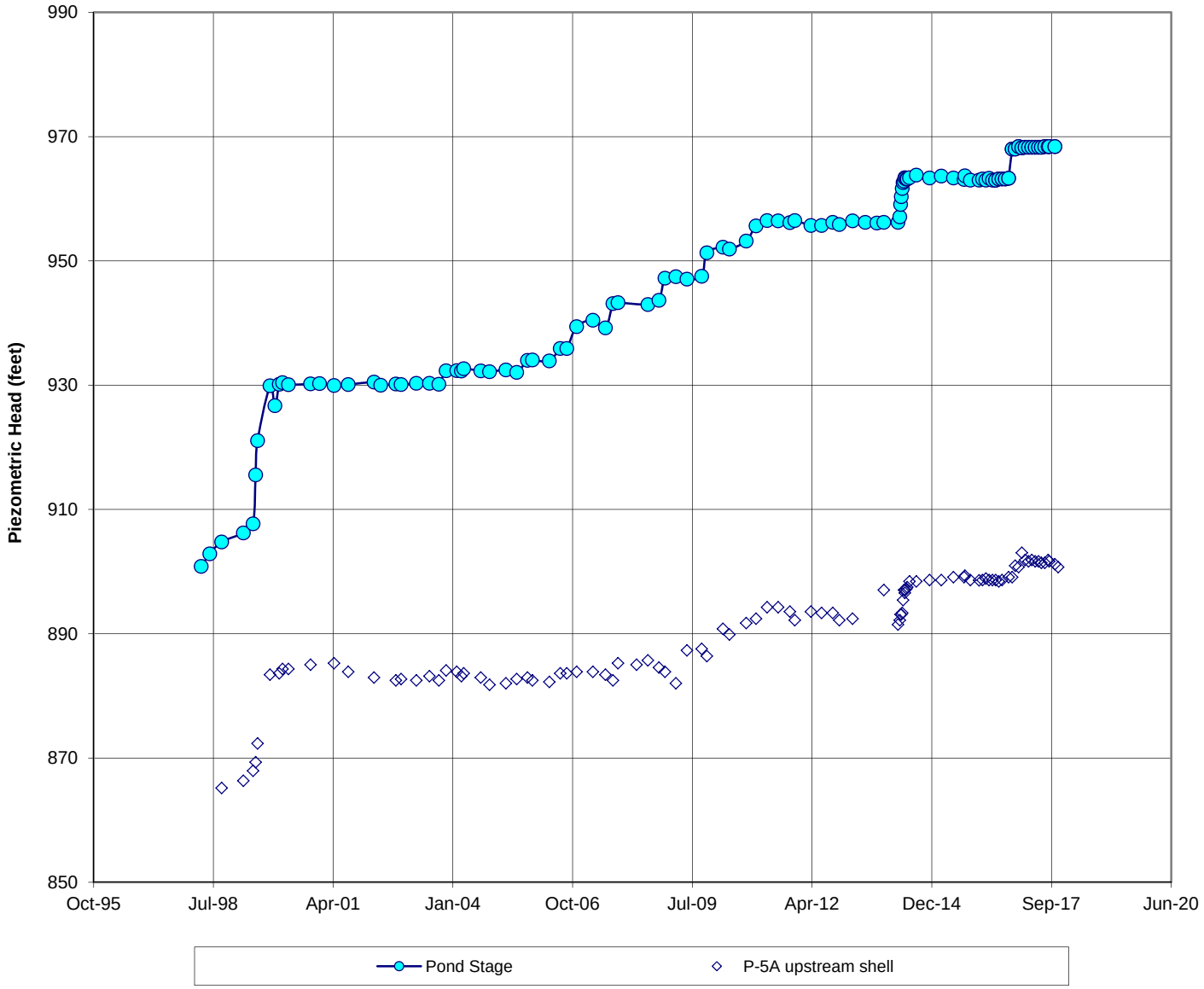


Figure 5g
Cardinal FAD 2
Centerline of Dam
Clustered Piezometer Site

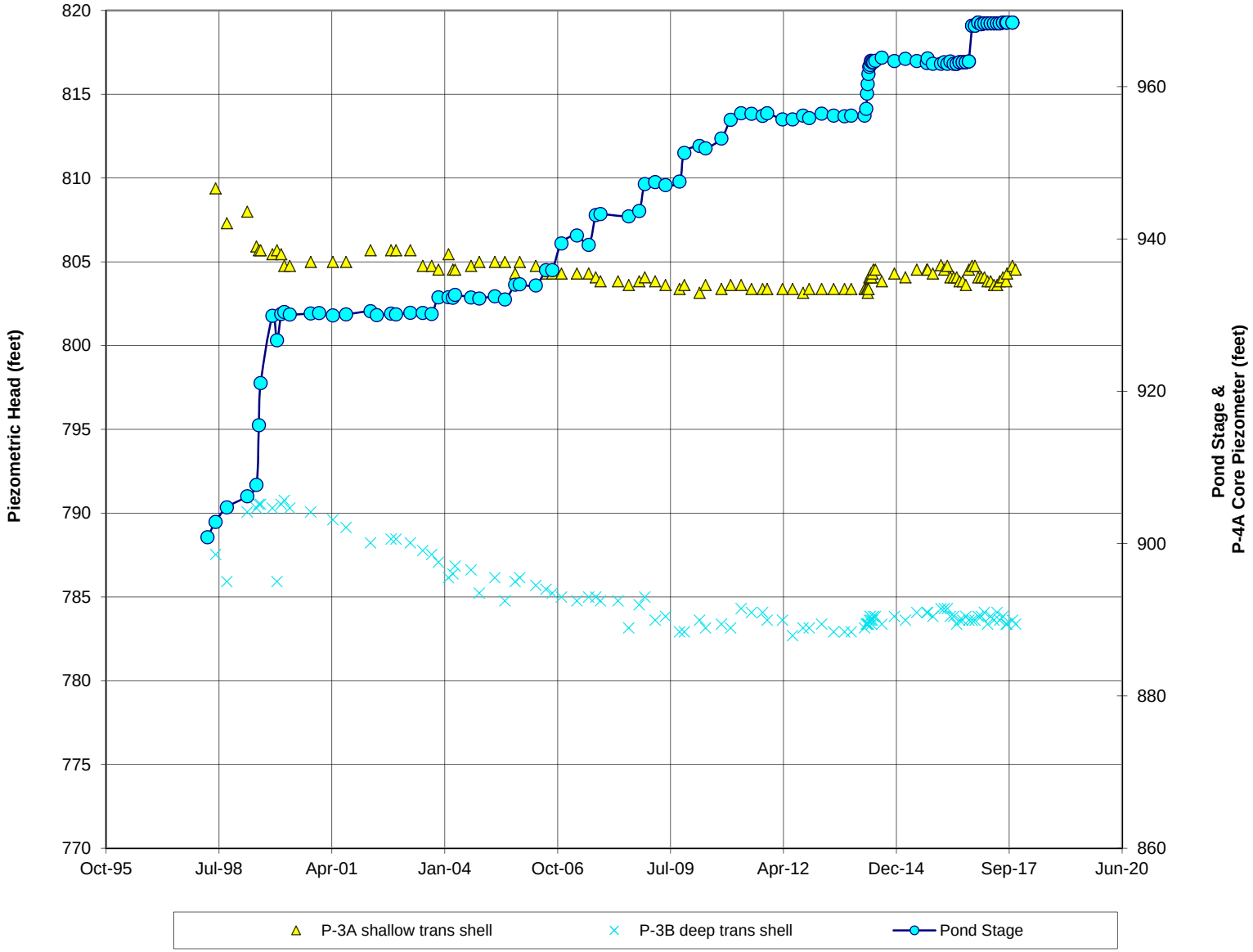


Figure 5h
Cardinal FAD 2
Centerline of Dam
Clustered Piezometer Site

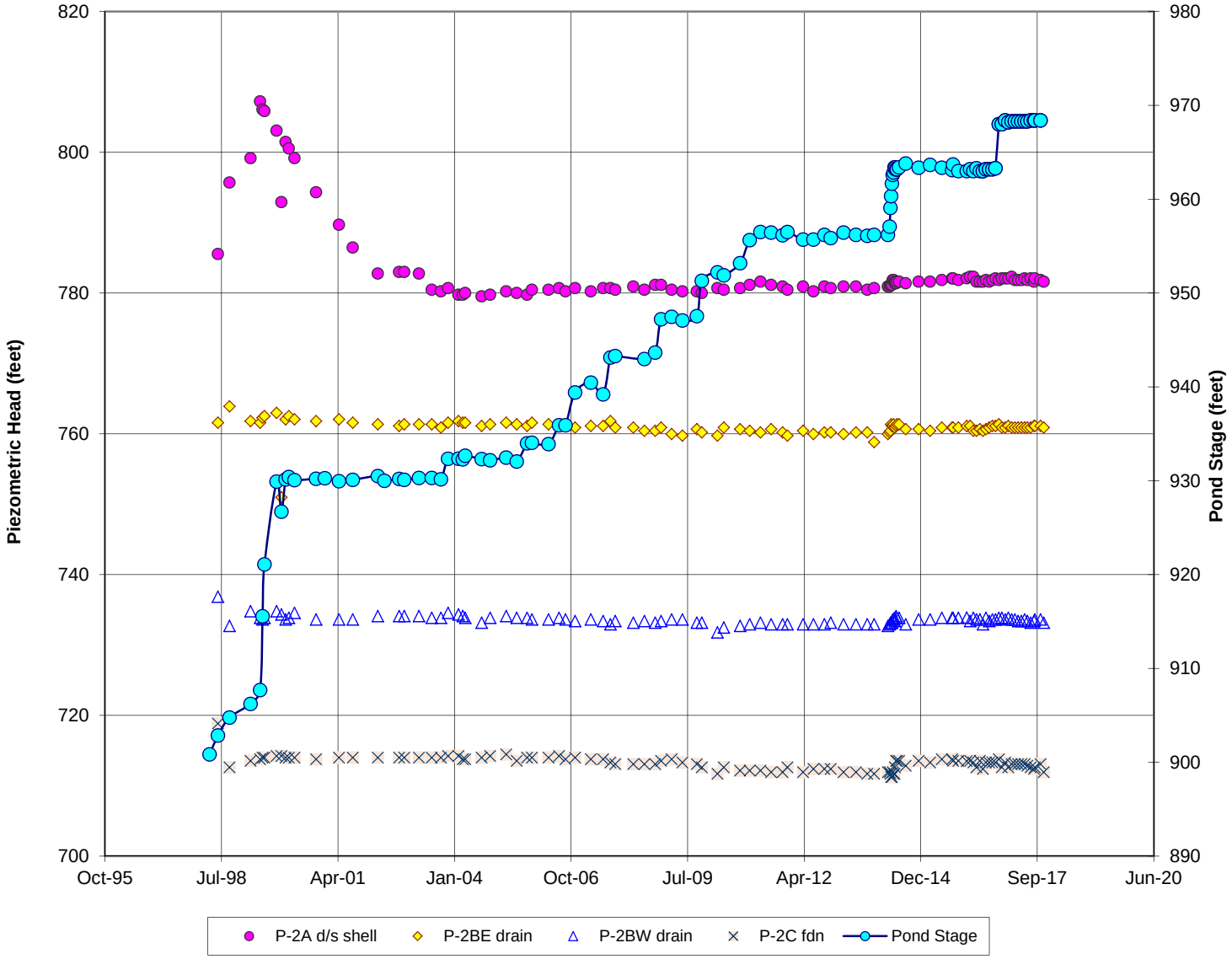


Figure 5i
Cardinal FAD 2
Centerline of Dam
Cluustered Piezometer Site

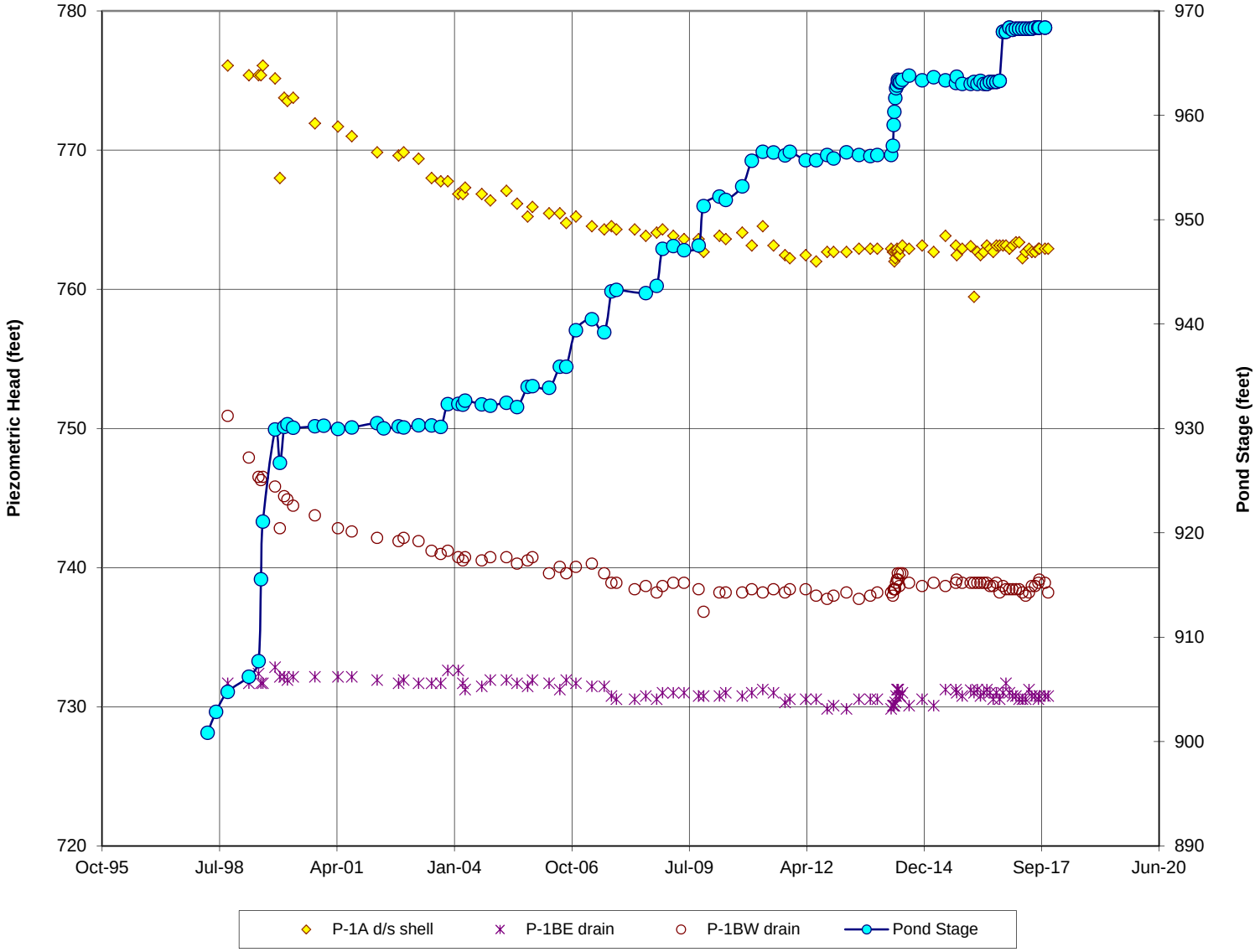


Figure 5j
Cardinal FAD 2
Centerline of Dam
Drain Piezometers

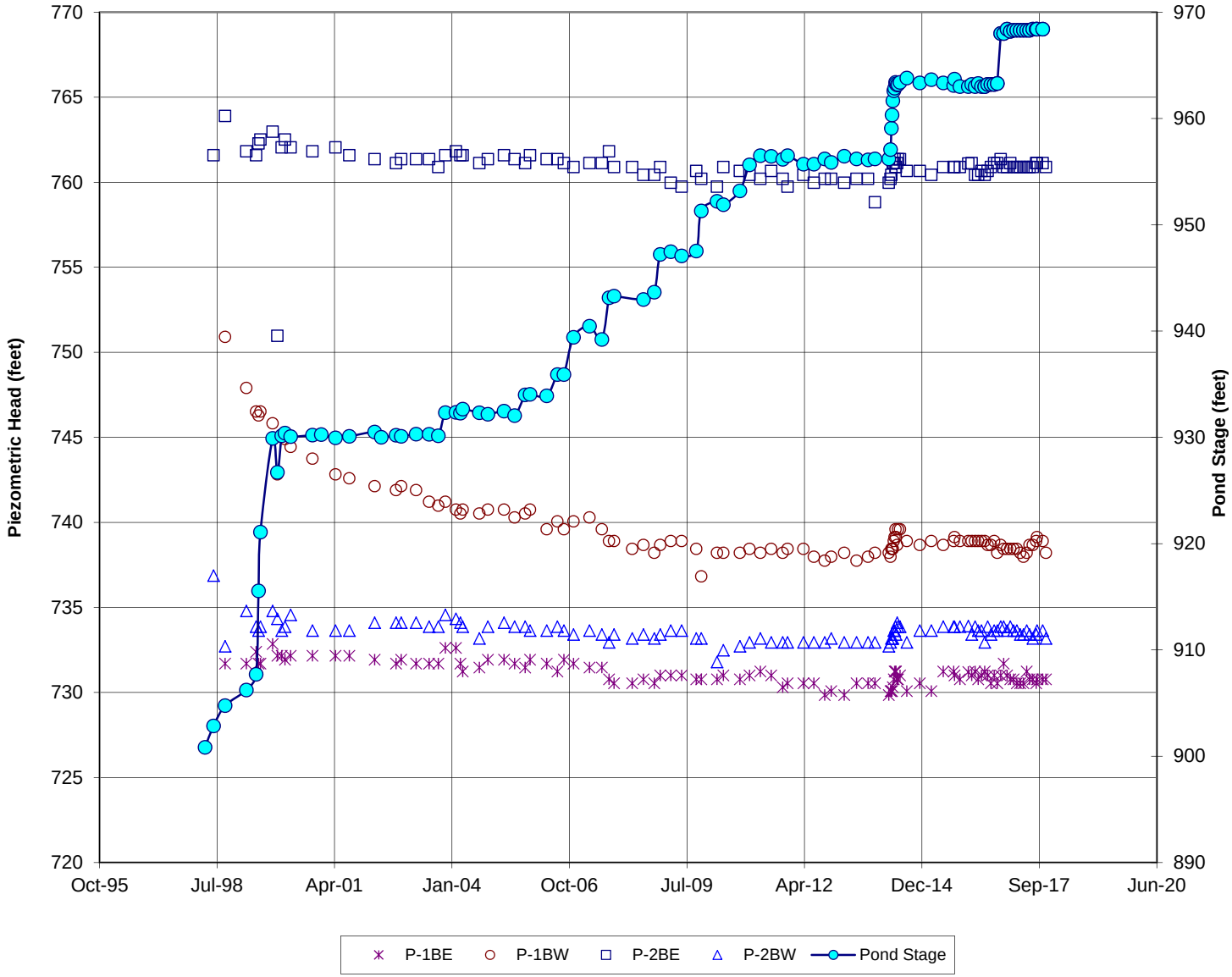


Figure 5k
Cardinal FAD 2
Centerline of Dam
Foundation Piezometers

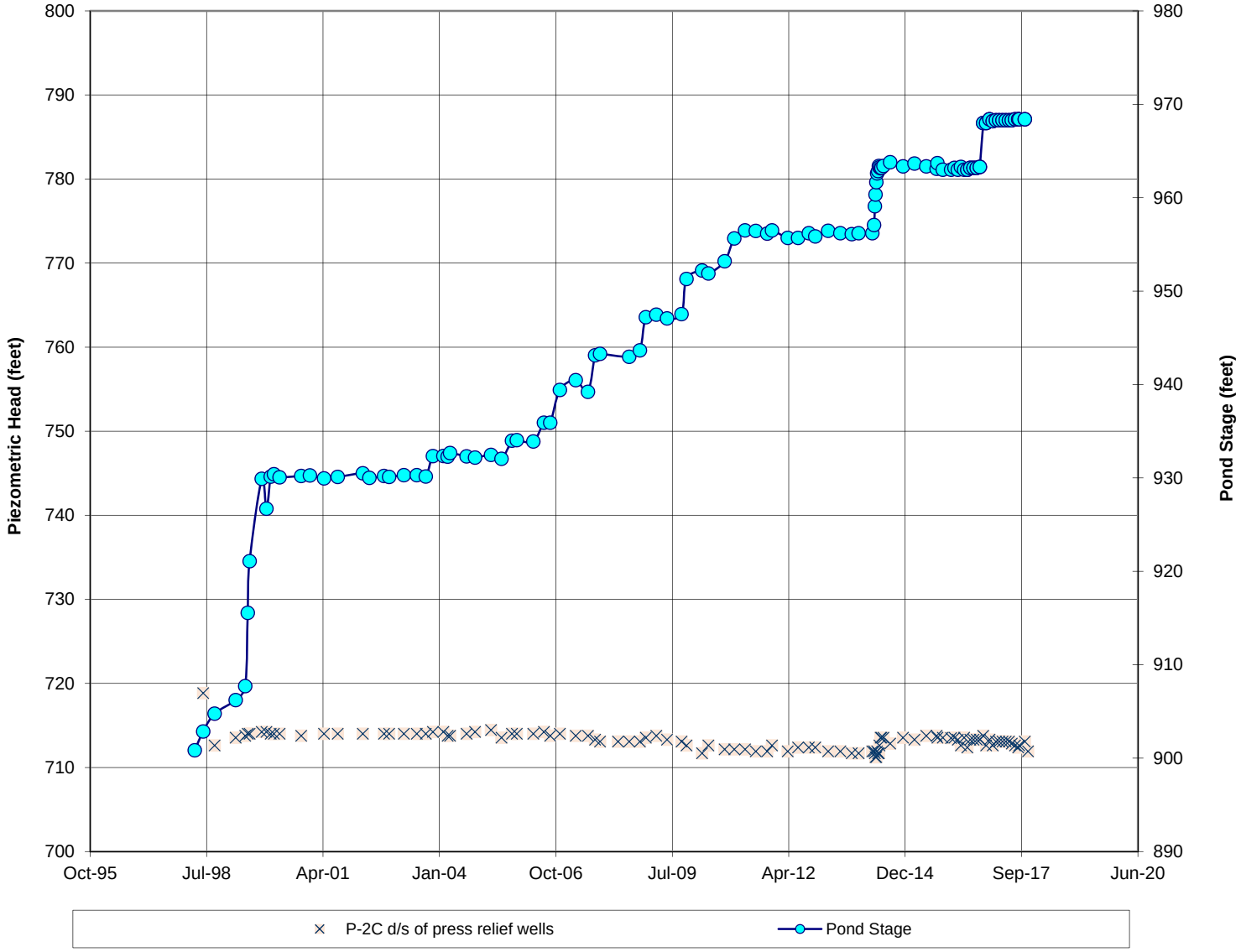


Figure 5l
Cardinal FAD 2
Centerline of Dam
Drain Piezometers & Discharge

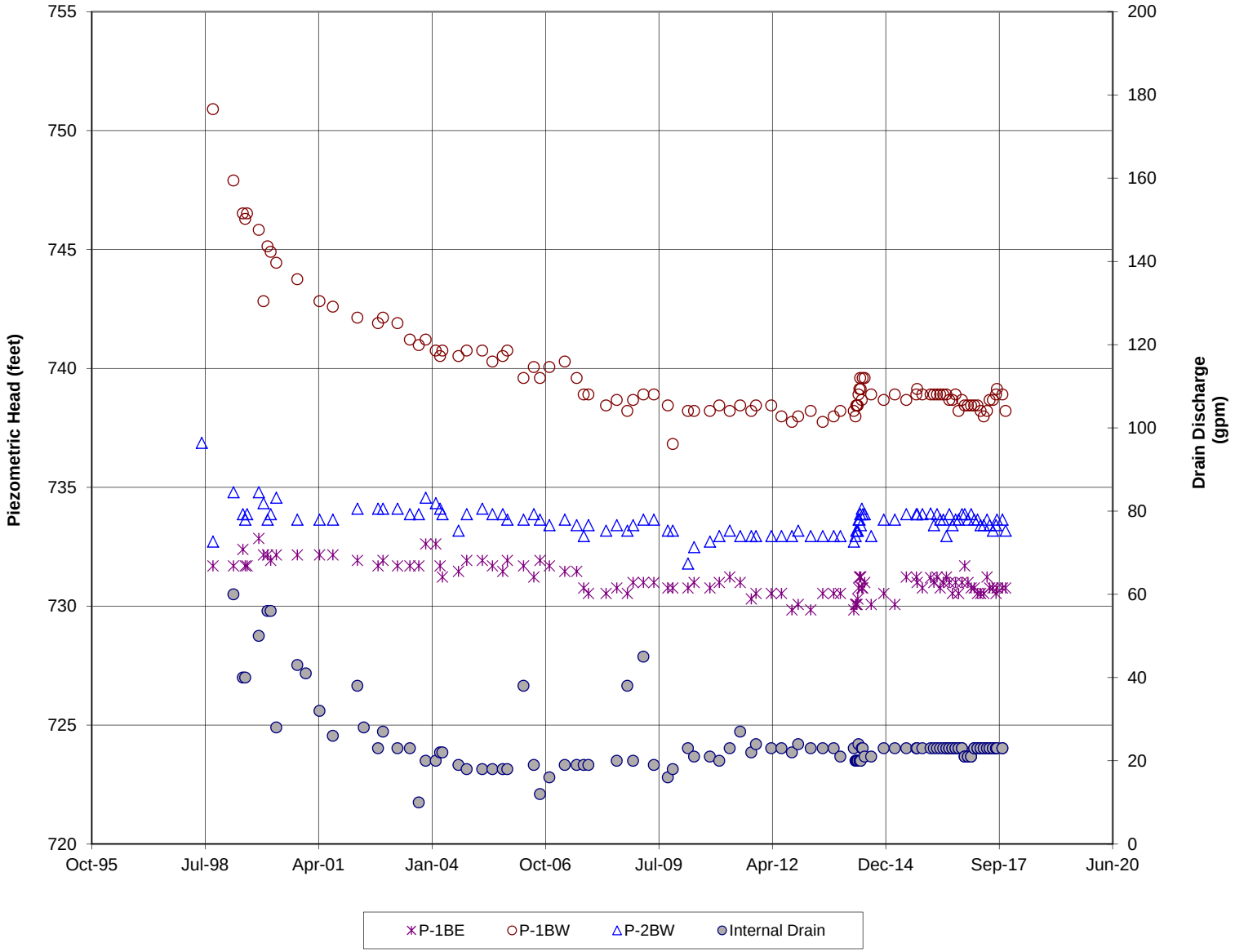


Figure 5m
Cardinal FAD 2
Centerline of Dam
Drain Piezometers & V-Notched Weir Discharge

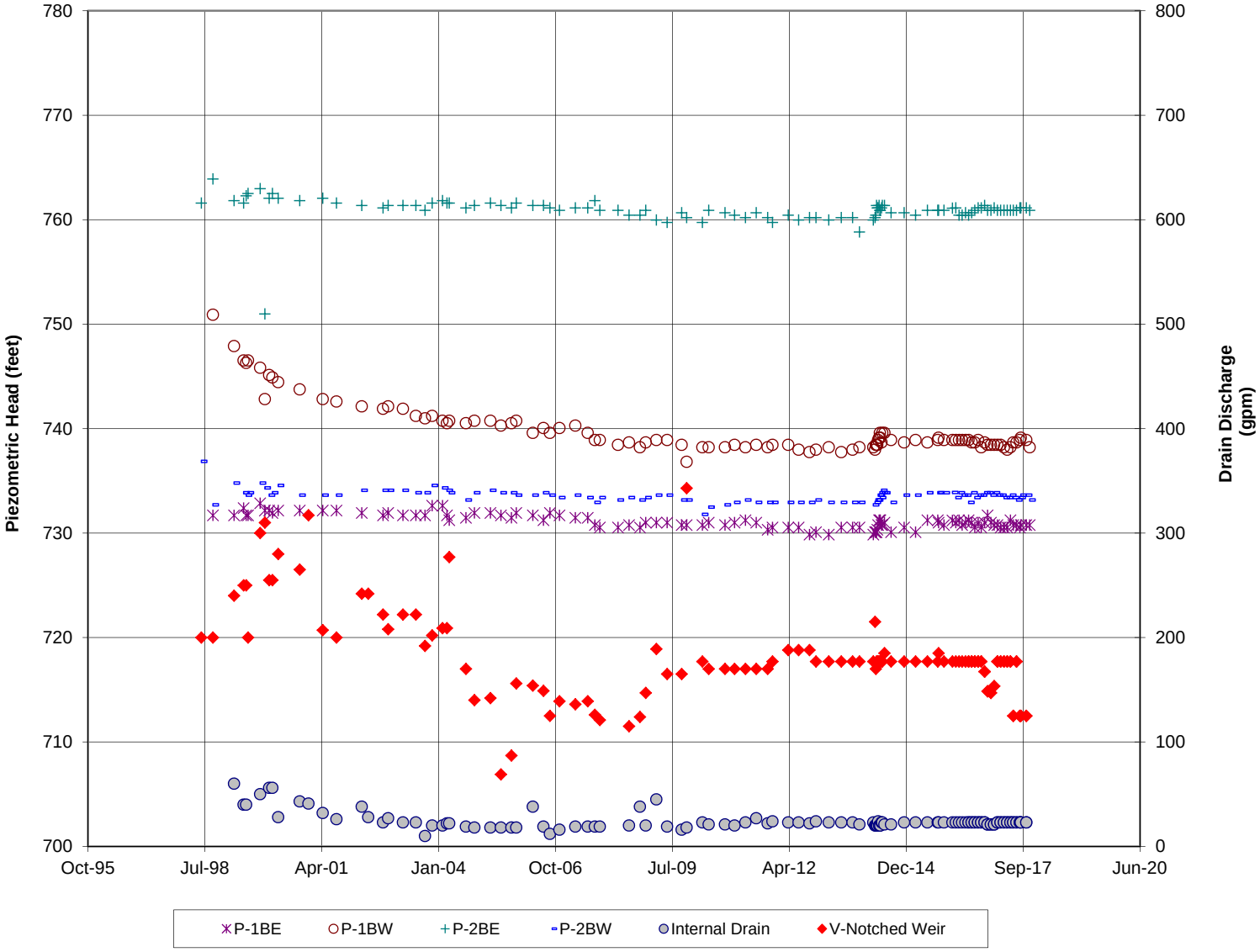


Figure 5n
Cardinal FAD 2
Centerline of Dam
Drain Piezometers & Right Abutment Piezometers

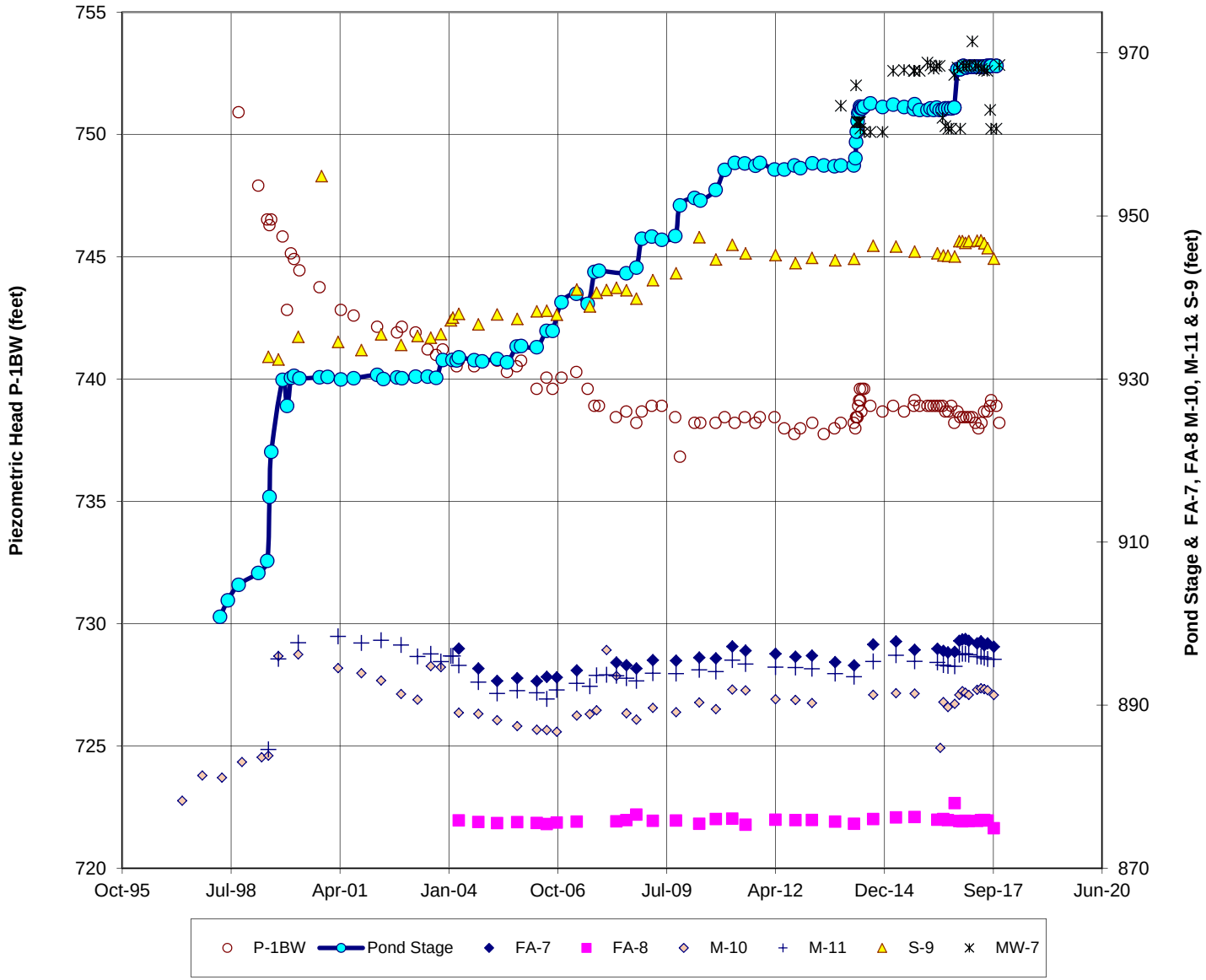


Figure 5p
Bottom Ash Pond Complex
Piezometers & Ponds Stages

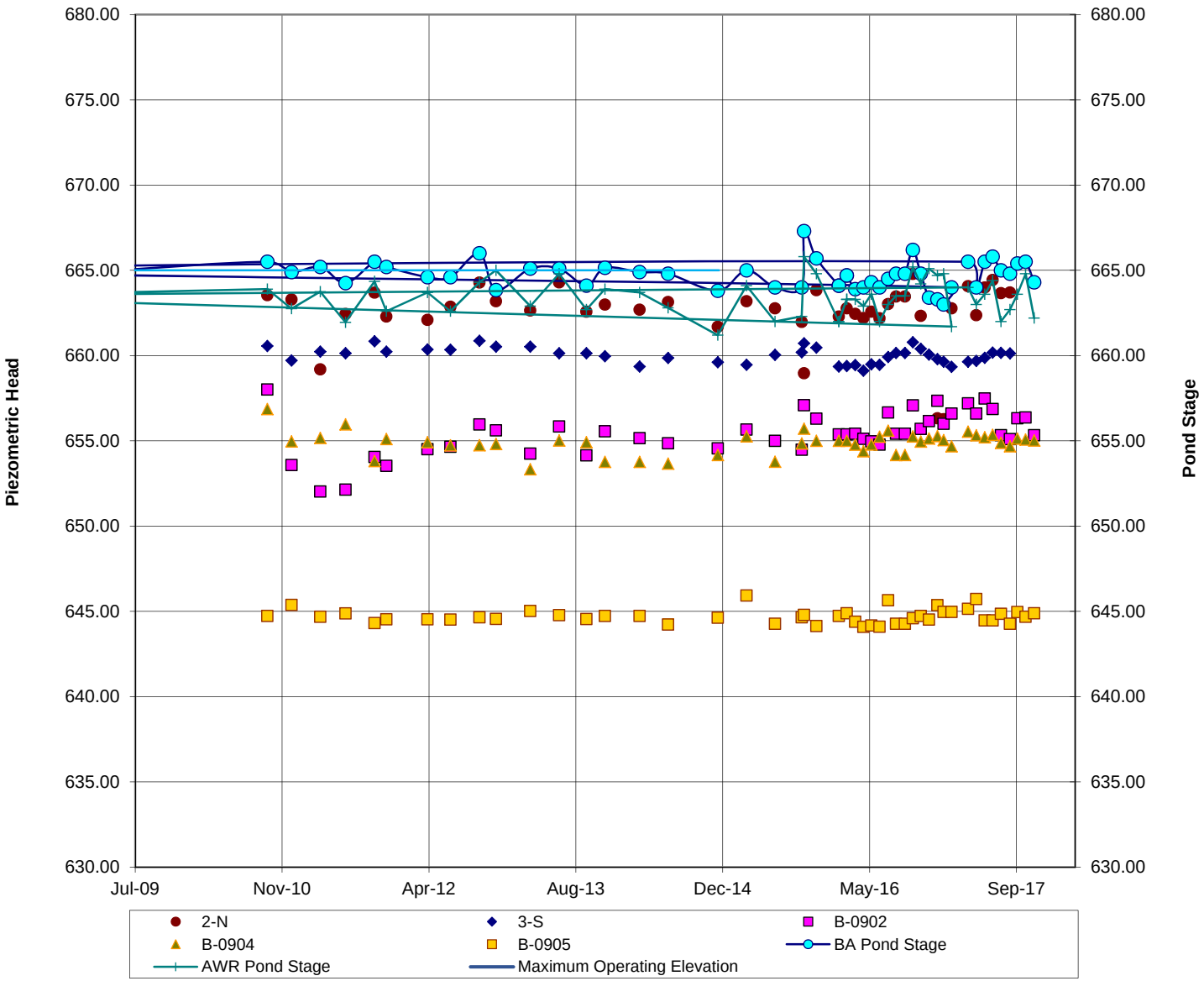
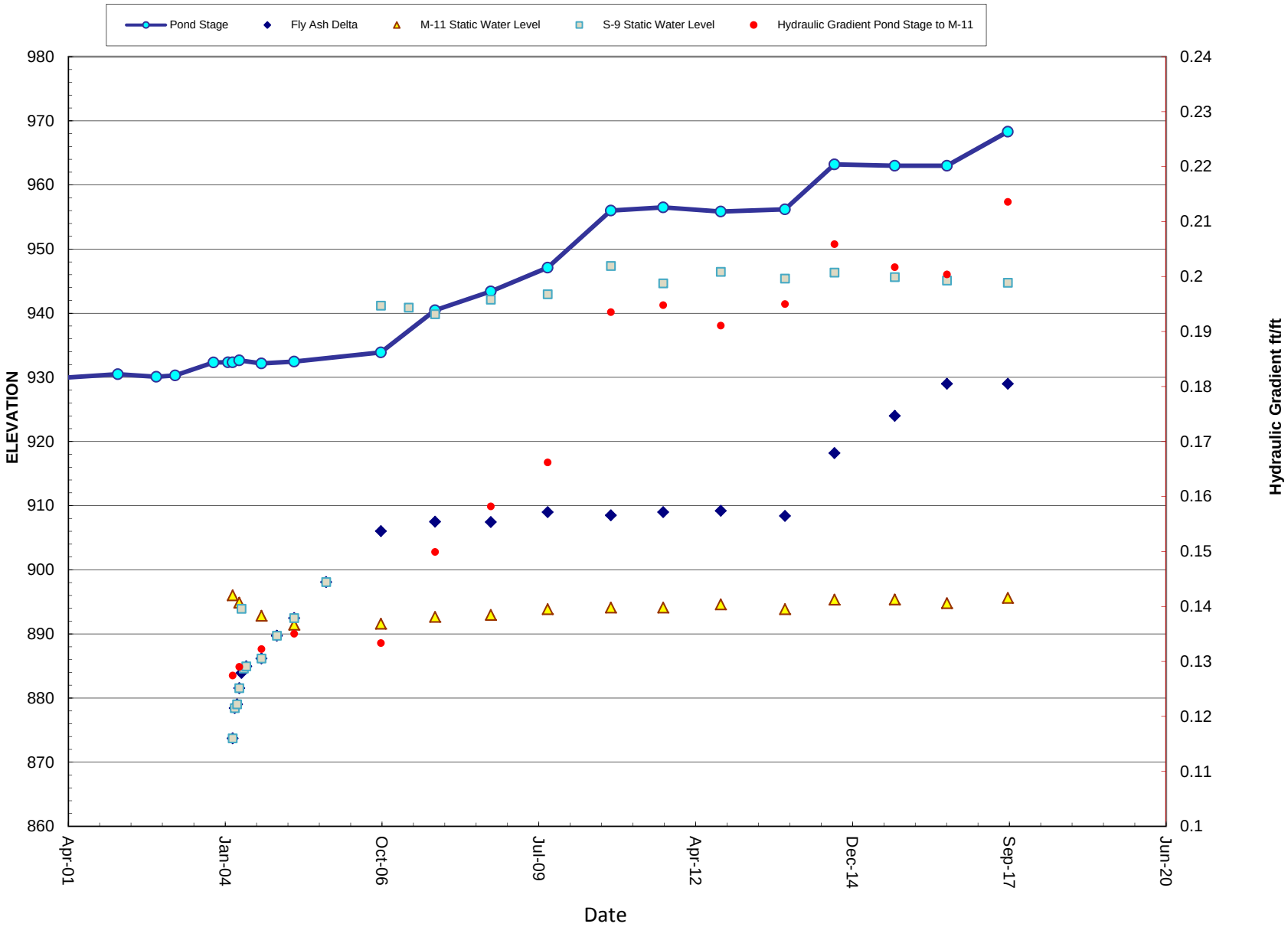
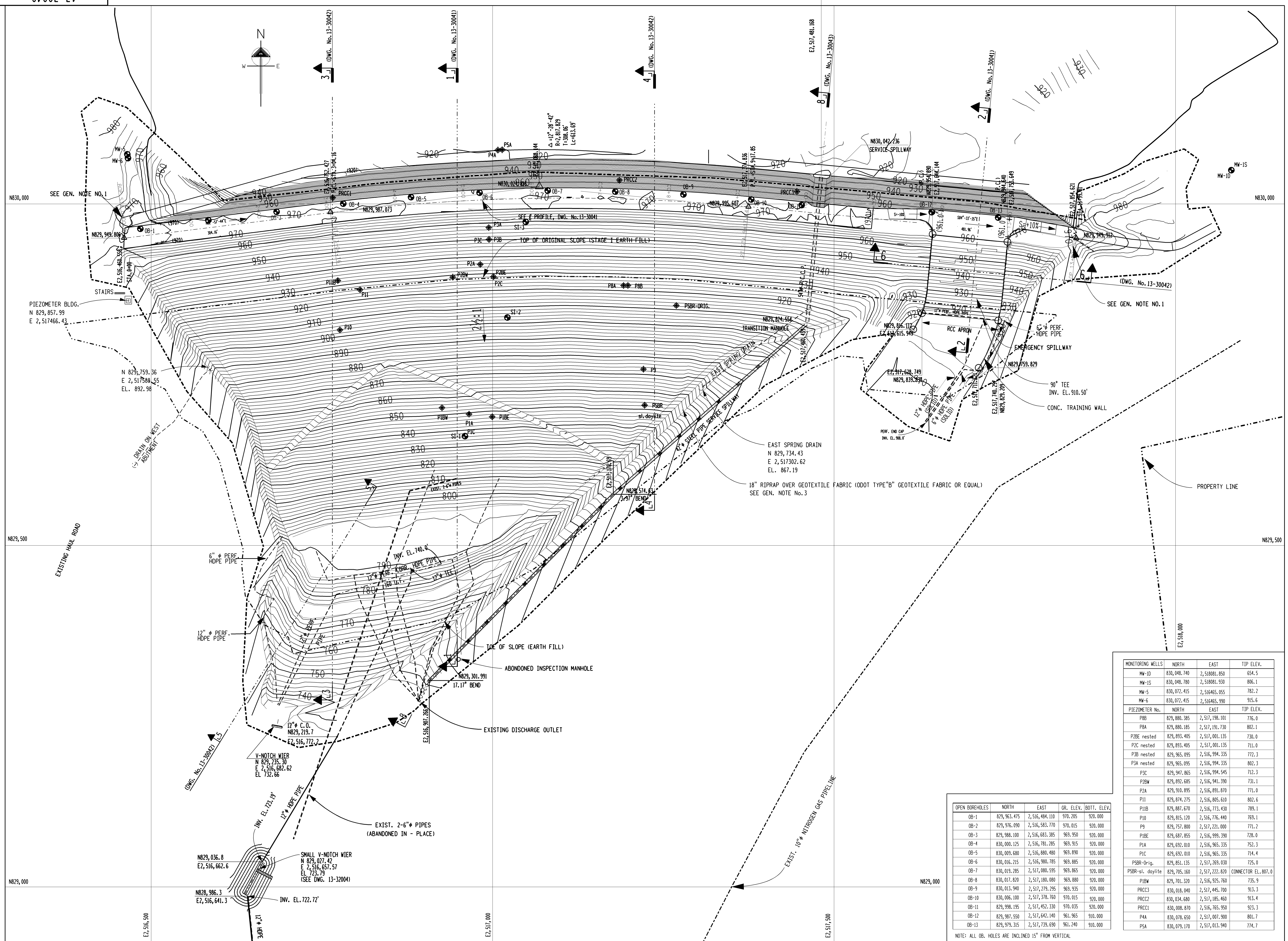


Figure 6
CARDINAL FAR 2
Fly Ash Deposition



DWG. NO. 13-30040



GENERAL NOTES

1.- EXCAVATE ROCK SURFACE TO ACHIEVE A RIGHT ANGLE CONTACT WITH THE RCC.
2.- THE SOIL OVERBURDEN ON BOTH THE RIGHT & LEFT ABUTMENTS SHALL BE STRIPPED. A 2' BOTTOM ASH DRAINAGE BLANKET SHALL BE PROVIDED OVER THE ENTIRE STRIPPED AREA. ANY SEEPAGE ZONES FOUND DURING STRIPPING SHALL BE DRAINED AS NECESSARY BY A FRENCH DRAIN DAYLIGHTING INTO GROIN DITCH.
3.- ADJUST LOCATION OF GROIN DITCH AS REQUIRED TO CLEAR PIPE SUPPORTS.

LEGEND - EXISTING

- 925.5 SPOT ELEVATION
- INTERMEDIATE CONTOUR
- INDEX CONTOUR
- DEPRESSION CONTOUR
- TREES AND TREELINE
- STRUCTURE AND BUILDING
- FENCE
- POLE
- ROADS
- EDGE OF WATER
- MANHOLES / CATCH BASIN
- POWER POLE
- PIPES
- TOWER

LEGEND - PROPOSED

- +(970.0') FIN. GRADE SPOT ELEV.
- 920 FIN. GRADE CONTOUR
- DRAINAGE DITCH
- INCLINED BORE HOLES
- VERTICAL BORE HOLES
- PIEZOMETER

REFERENCE DRAWINGS

13-30041 - FLY ASH DAM II RAISING PROFILE & SECTION.
13-30042 - FLY ASH DAM II RAISING SECTIONS & DETAILS SHT.1.
13-30043 - FLY ASH DAM II RAISING SECTIONS & DETAILS SHT.2.

OPEN BOREHOLES	NORTH	EAST	GR. ELEV.	BOTT. ELEV.
OB-1	829,963.475	2,516,484.110	970.205	920.000
OB-2	829,976.090	2,516,583.770	970.015	920.000
OB-3	829,988.100	2,516,683.385	969.950	920.000
OB-4	830,000.125	2,516,781.285	969.915	920.000
OB-5	830,009.680	2,516,880.480	969.890	920.000
OB-6	830,016.215	2,516,980.785	969.885	920.000
OB-7	830,019.285	2,517,080.595	969.865	920.000
OB-8	830,017.820	2,517,180.080	969.880	920.000
OB-9	830,013.940	2,517,279.295	969.935	920.000
OB-10	830,006.100	2,517,378.760	970.015	920.000
OB-11	829,998.195	2,517,452.330	970.035	920.000
OB-12	829,987.550	2,517,642.140	961.965	910.000
OB-13	829,979.315	2,517,739.690	961.240	910.000

NOTE: ALL OB. HOLES ARE INCLINED 15° FROM VERTICAL

MONITORING WELLS	NORTH	EAST	TIP ELEV.
MW-1D	830,048.740	2,518081.850	654.5
MW-1S	830,048.780	2,518081.930	806.1
MW-5	830,072.415	2,516465.055	782.2
MW-6	830,072.415	2,516465.990	915.6
PIEZOMETER No.	**NORTH**	**EAST**	**TIP ELEV.**
P8B	829,880.385	2,517,198.101	776.0
P8A	829,880.185	2,517,191.730	802.1
P2BE nested	829,893.405	2,517,001.135	730.0
P2C nested	829,893.405	2,517,001.135	711.0
P3B nested	829,965.095	2,516,994.335	772.3
P3A nested	829,965.095	2,516,994.335	802.3
P3C	829,947.865	2,516,994.545	712.3
P2BW	829,892.685	2,516,941.390	731.1
P2A	829,910.895	2,516,891.870	771.0
P11	829,874.275	2,516,805.610	802.6
P11B	829,887.670	2,516,773.430	789.1
P10	829,815.120	2,516,776.440	769.1
P9	829,757.800	2,517,221.000	771.2
P1BE	829,687.855	2,516,999.390	728.0
P1A	829,692.010	2,516,965.335	752.3
P1C	829,692.010	2,516,965.335	714.4
P5BR-Orig.	829,851.135	2,517,269.030	725.0
P5BR-sl. daylite	829,705.160	2,517,222.820	CONNECTOR EL.807.0
P1BW	829,701.320	2,516,925.760	735.9
PRCC3	830,018.040	2,517,445.700	913.3
PRCC2	830,034.680	2,517,185.460	913.4
PRCC1	830,008.870	2,516,765.950	923.3
P4A	830,078.650	2,517,007.900	801.7
P5A	830,079.170	2,517,013.940	774.7

PTS No. 55689

REVISIONS

DATE	NO.	DESCRIPTION	APPD.
3/31/00	5	REVISED TO REFLECT AS_BUILT CONDITIONS. FINAL SUBMITTAL TO STATE (Amanda Graphics)	BMK
5/21/99	4	AS_BUILT: REVISED TOPO, DRAIN PIPES , ADDED TABLES, PIEZOMETERS AND OPEN BORE HOLES. REMOVED MONITORING WELLS 4,3, 2D & 2S (AG)	HJB
6/22/98	3	REMOVED INTERMEDIATE CONTOURS. INDICATED CONCRETE TRAINING WALL & GEOTEXTILE FABRIC. (RGD)	HJB
5/20/98	2	DELETED DROP MANHOLE & REV. PIPE ALIGNMENT. (RGD)	HJB
4/23/98	1	REV. TOE OF DAM TO REFLECT SLIDE REPAIR. RELOCATED DROP MANHOLE & REV. PIPE BEND, 6°30' WAS 6°. ADDED UNDERDRAIN SYSTEM. (RGD)	HJB
4/21/97	0	ISSUED FOR CONSTRUCTION.	HJB

s:/cd/13/geo_hydro_site/30040.dgn

CARDINAL OPERATING COMPANY

CARDINAL PLANT

BRILLIANT OHIO

FLY ASH DAM II RAISING GRADING & DRAINAGE PLAN

DWG. NO. 13-30040-5

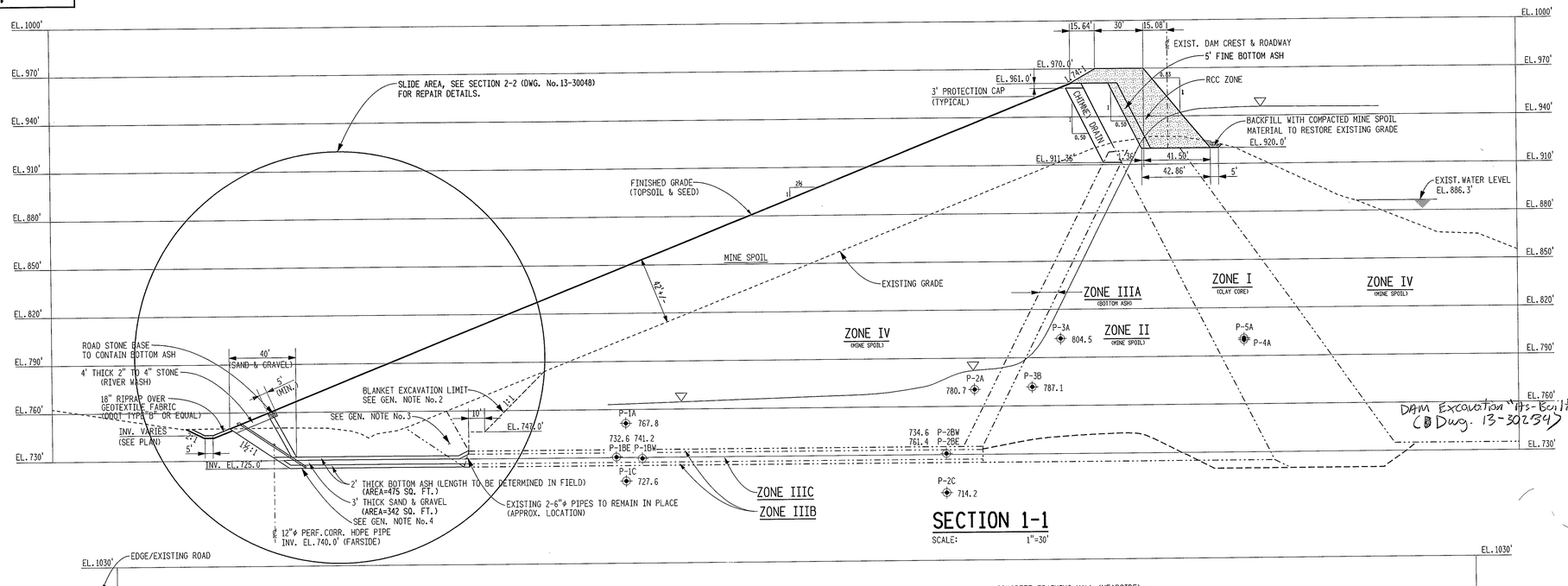
SCALE: 1"=50'
DR: RGD
CH: GJZ
ENGR. HJB
PROJ. ENGR.
DATE: 4/21/97

CIVIL ENGINEERING DIVISION

APPROVED BY H. Joseph Buhac

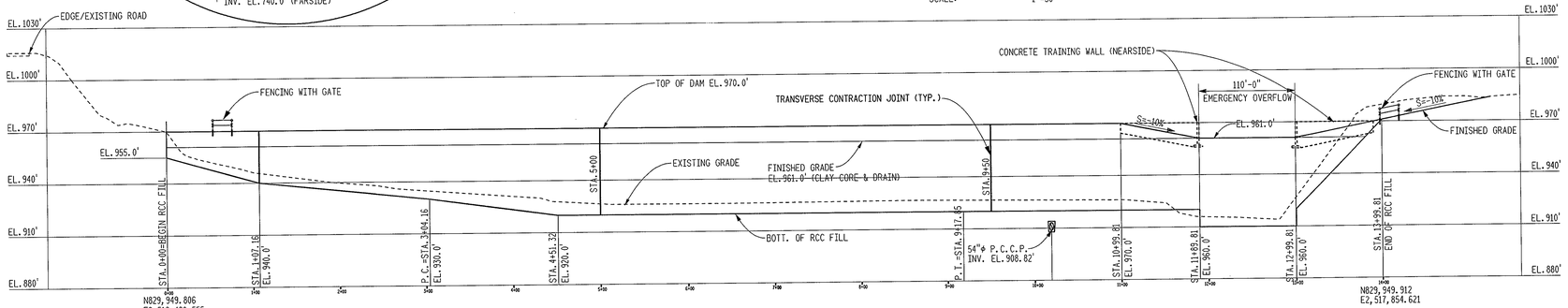
AMERICAN ELECTRIC POWER
1 RIVERSIDE PLAZA
COLUMBUS, OH 43215

DWG. NO. 13-30041



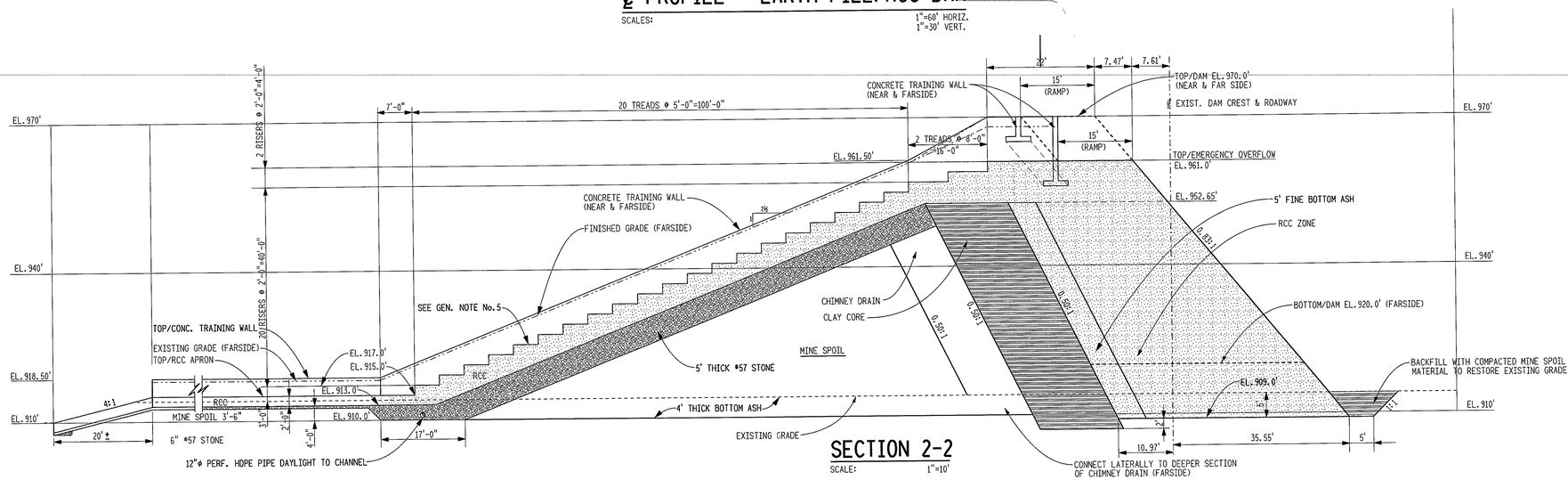
SECTION 1-1

SCALE: 1"=30'



℄ PROFILE - EARTH FILL/RCC DAM

SCALES: 1"=60' HORIZ. 1"=30' VERT.



SECTION 2-2

SCALE: 1"=10'

GENERAL NOTES

1. - FOR SECTIONS LOCATION, SEE DWG. No.13-30040.
2. - LIMIT WIDTH OF EXCAVATION SECTIONS ALONG THE TOE OF THE DAM TO 20 FEET. PROVIDE SOIL SUPPORT AS REQUIRED.
3. - REMOVE EXISTING 12"ϕ PIPE. STOCKPILE REMOVED SAND & GRAVEL MATERIAL AND RE-USE ONLY A CLEAN PORTION OF MATERIAL TO EXTEND DRAINAGE BLANKET.
4. - REMOVE SOIL OVERBURDEN & CLEAN THE SURFACE OF THE ROCK.
5. - SEAL JOINTS BETWEEN RCC AND TRAINING WALL WITH JOINT FILLER.

REFERENCE DRAWINGS

13-30040 - FLY ASH DAM II RAISING GRADING & DRAINAGE PLAN.

DATE	NO.	DESCRIPTION	APPD.
	6	REVISED TO SHOW INSTALLATION DEPTH OF PNEUMATIC PIEZOMETER. AND DAM "AS-BUILT" EXCAVATION GRADES.	
3/2000	5	REVISED TO REFLECT AS-BUILT CONDITIONS. FINAL SUBMITTAL TO STATE	AMK
5/1999	4	AS-BUILT: REVISED TOE AREA OF SECTION 2-2	AMK
6/23/98	3	EXTENDED CONC. TRAINING WALL REMOVED HIGHER & LOWER RCC STRENGTH FACING & ZONE, ADDED GEN. NOTE No.5. 2' DIM ON SECT."2-2" WAS 5'.	AMK
5/20/98	2	REV. SECT.2-2. INDICATED RCC APRON & BOTTOM ASH BLANKET DRAIN THICKNESS.	AMK
4/23/98	1	REV. SECT.1-1, SECT.2-2 & ℄ PROFILE.	AMK
4/2/97	0	ISSUED FOR CONSTRUCTION.	AMK

REVISIONS

s:/cd/13/geo_hydro_site/30041.dgn

CARDINAL OPERATING COMPANY

CARDINAL PLANT

BRILLIANT OHIO

FLY ASH DAM II RAISING PROFILE & SECTIONS

DWG. NO. 13-30041-6

SCALE: AS NOTED

DR: Amanda Gephart

CHI:

ENGR.

PROJ. ENGR.

DATE:

APPROVED BY

CIVIL ENGINEERING DIVISION

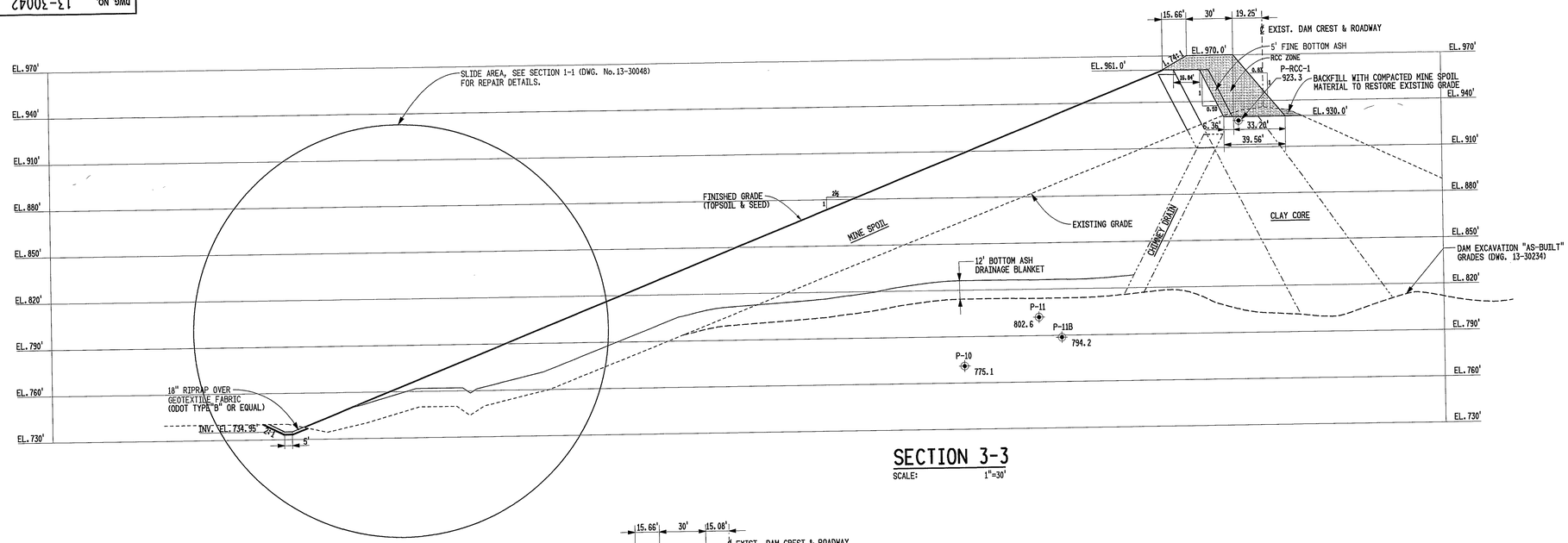
AEP AMERICAN ELECTRIC POWER

1 RIVERSIDE PLAZA COLUMBUS, OH 43215

PTS No. 55689

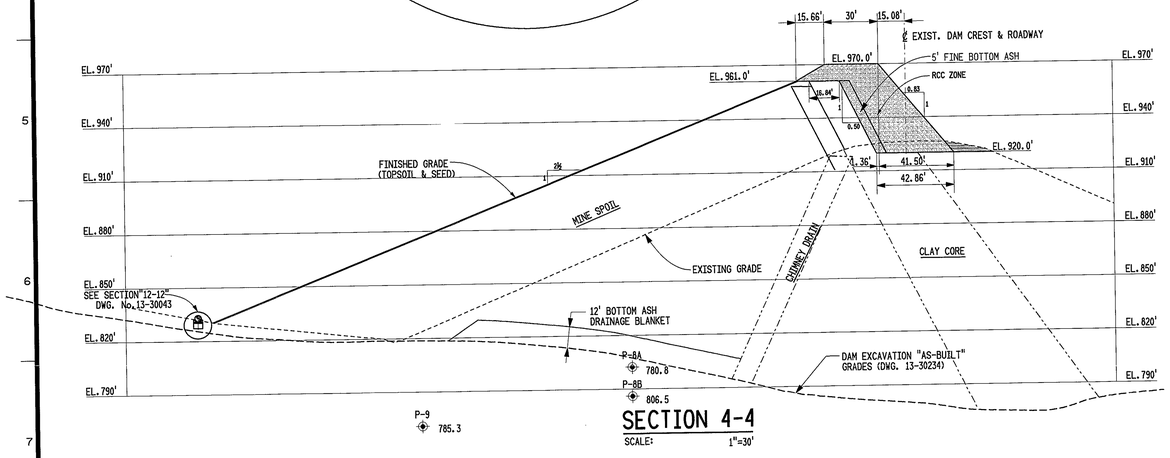
SYSTEM DATE-17 MAY 2004
SYSTEM TIME-09:40:56
15th FLR.-CED

DWG. NO. 13-30042



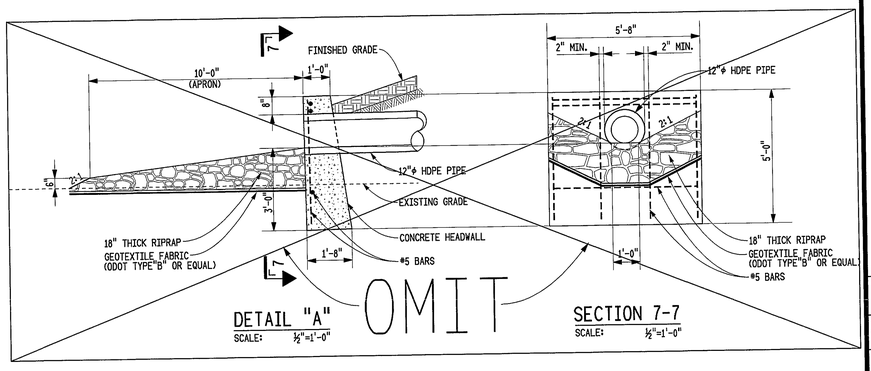
SECTION 3-3

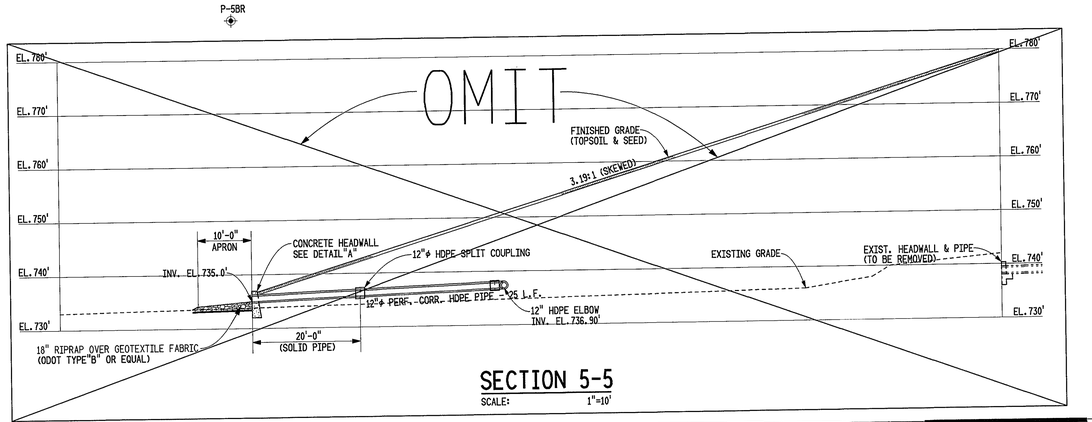
SCALE: 1"=30'



SECTION 4-4

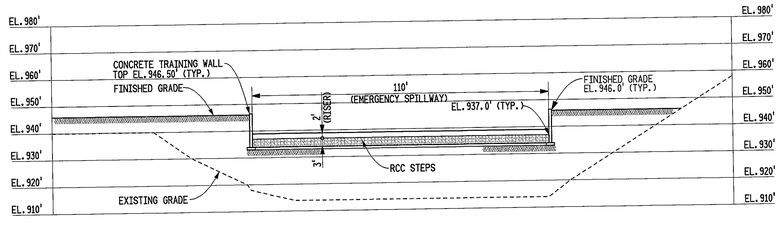
SCALE: 1"=30'





SECTION 5-5

SCALE: 1"=10'



SECTION 6-6

SCALE: 1"=20'

GENERAL NOTES

1.- FOR SECTIONS LOCATION, SEE DWG. No. 13-30040.

REFERENCE DRAWINGS

13-30040 - FLY ASH DAM II RAISING GRADING & DRAINAGE PLAN.

DATE	NO.	DESCRIPTION	APP'D
4/23/98	4	REVISED TO SHOW INSTALLATION DEPTH OF PNEUMATIC PIEZOMETER, AND DAM "AS-BUILT" EXCAVATION GRADES.	
3/2000	3	REVISED TO REFLECT AS-BUILT CONDITIONS. FINAL SUBMITTAL TO STATE.	BMK
4/22/98	2	REMOVED HIGHER & LOWER RCC FACING & ZONE.	MJB
4/23/98	1	REV. SECTS. "3-3" & "4-4" OMITTED SECT. "5-5", "7-7" AND DETAIL "A".	MJB
4/2/97	0	ISSUED FOR CONSTRUCTION.	MJB

REVISIONS

s:/cd/13/geo_hydro_site/30042.dgn

CARDINAL OPERATING COMPANY

CARDINAL PLANT

BRILLIANT OHIO

FLY ASH DAM II RAISING SECTIONS & DETAILS SHT.1

DWG. NO. 13-30042-4

SCALE: AS NOTED | CIVIL ENGINEERING DIVISION

ORI: Arnold Gryboski
CHI:
ENGR.:
PROJ. ENGR.:
DATE:
APPROVED BY:

AEP AMERICAN ELECTRIC POWER — 1 RIVERSIDE PLAZA COLUMBUS, OH 43215

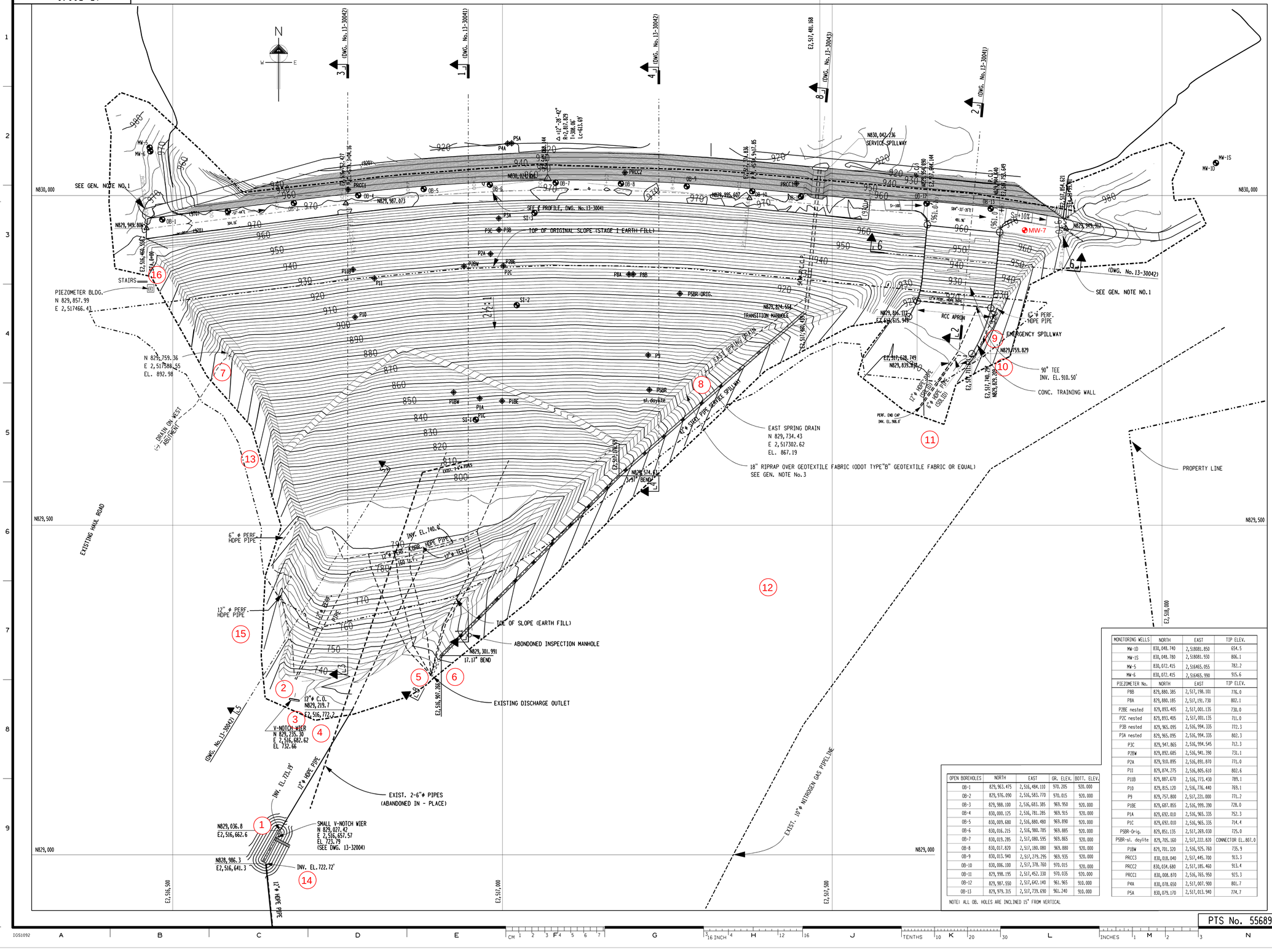
PTS No. 55689

IGS1092

SYSTEM DATE: 18 MAY 2004
SYSTEM TIME: 09:34:21
ISM: P:\0465

ATTACHMENT F:
Fly Ash Dam II
Seepage Collection Drains Location Plan & Table

DWG. NO. 13-30040



GENERAL NOTES

1. - EXCAVATE ROCK SURFACE TO ACHIEVE A RIGHT ANGLE CONTACT WITH THE RCC.
2. - THE SOIL OVERBURDEN ON BOTH THE RIGHT & LEFT ABUTMENTS SHALL BE STRIPPED. A 2' BOTTOM ASH DRAINAGE BLANKET SHALL BE PROVIDED OVER THE ENTIRE STRIPPED AREA. ANY SEEPAGE ZONES FOUND DURING STRIPPING SHALL BE DRAINED AS NECESSARY BY A FRENCH DRAIN DAYLIGHTING INTO GROIN DITCH.
3. - ADJUST LOCATION OF GROIN DITCH AS REQUIRED TO CLEAR PIPE SUPPORTS.

LEGEND - EXISTING

- ~926.6 — SPOT ELEVATION
- INTERMEDIATE CONTOUR
- INDEX CONTOUR
- DEPRESSION CONTOUR
- TREES AND TREELINE
- STRUCTURE AND BUILDING
- FENCE
- POLE
- ROADS
- EDGE OF WATER
- MANHOLES / CATCH BASIN
- POWER POLE
- PIPES
- TOWER

LEGEND - PROPOSED

- +(970.0') — FIN. GRADE SPOT ELEV.
- 920 — FIN. GRADE CONTOUR
- DRAINAGE DITCH
- INCLINED BORE HOLES
- VERTICAL BORE HOLES
- PIEZOMETER

REFERENCE DRAWINGS

13-30041 - FLY ASH DAM II RAISING PROFILE & SECTION.

13-30042 - FLY ASH DAM II RAISING SECTIONS & DETAILS SHT.1.

13-30043 - FLY ASH DAM II RAISING SECTIONS & DETAILS SHT.2.

OPEN BOREHOLES	NORTH	EAST	GR. ELEV.	BOTT. ELEV.
OB-1	829,963.475	2,516,484.110	970.205	920.000
OB-2	829,976.090	2,516,583.770	970.015	920.000
OB-3	829,988.100	2,516,683.385	969.950	920.000
OB-4	830,000.125	2,516,781.285	969.915	920.000
OB-5	830,009.680	2,516,880.460	969.890	920.000
OB-6	830,016.215	2,516,980.785	969.885	920.000
OB-7	830,019.285	2,517,080.595	969.865	920.000
OB-8	830,017.820	2,517,180.080	969.880	920.000
OB-9	830,013.940	2,517,279.295	969.935	920.000
OB-10	830,006.100	2,517,378.760	970.015	920.000
OB-11	829,998.195	2,517,452.330	970.035	920.000
OB-12	829,987.550	2,517,642.140	961.965	910.000
OB-13	829,979.315	2,517,739.690	961.240	910.000

NOTE: ALL OB. HOLES ARE INCLINED 15° FROM VERTICAL

MONITORING WELLS	NORTH	EAST	TIP ELEV.
MW-1D	830,048.740	2,518081.850	654.5
MW-1S	830,048.780	2,518081.930	806.1
MW-5	830,072.415	2,516465.055	782.2
MW-6	830,072.415	2,516465.990	915.6
PIEZOMETER No.	NORTH	EAST	TIP ELEV.
P8B	829,880.385	2,517,198.101	776.0
P8A	829,880.185	2,517,191.730	802.1
P2BE nested	829,893.405	2,517,001.135	730.0
P2C nested	829,893.405	2,517,001.135	711.0
P3B nested	829,965.095	2,516,994.335	772.3
P3A nested	829,965.095	2,516,994.335	802.3
P3C	829,947.865	2,516,994.545	712.3
P2BW	829,892.685	2,516,941.390	731.1
P2A	829,910.895	2,516,891.670	771.0
P11	829,874.275	2,516,805.610	802.6
P11B	829,887.670	2,516,773.430	789.1
P10	829,815.120	2,516,776.440	769.1
P9	829,757.800	2,517,221.000	771.2
P1BE	829,687.855	2,516,999.390	728.0
P1A	829,692.010	2,516,965.335	752.3
P1C	829,692.010	2,516,965.335	714.4
PSBR-Orig.	829,851.135	2,517,269.030	725.0
PSBR-sl. daylite	829,765.160	2,517,222.820	CONNECTOR EL.807.0
P1BW	829,701.320	2,516,925.760	735.9
PRCC3	830,018.040	2,517,445.700	913.3
PRCC2	830,034.680	2,517,185.460	913.4
PRCC1	830,008.870	2,516,765.950	923.3
P4A	830,078.650	2,517,007.900	801.7
P5A	830,079.170	2,517,013.940	774.7

REVISIONS

DATE	NO.	DESCRIPTION	APPD.
4/2197	0	ISSUED FOR CONSTRUCTION.	MJB
6/21/98	1	REV. TOE OF DAM TO REFLECT SLIDE REPAIR. RELOCATED DROP MANHOLE & REV. PIPE BEND, 6°30' WAS 6°. ADDED UNDERDRAIN SYSTEM. #CA	MJB
5/20/99	2	DELETED DROP MANHOLE & REV. PIPE ALIGNMENT. #CA	MJB
5/21/99	3	REMOVED INTERMEDIATE CONTOURS. INDICATED CONCRETE TRAINING WALL & GEOTEXTILE FABRIC. #CA	MJB
5/21/99	4	AS_BUILT: REVISED TOPO, DRAIN PIPES , ADDED TABLES, PIEZOMETERS AND OPEN BORE HOLES. REMOVED MONITORING WELLS 4,3, 2D & 2S #CA	MJB
3/30/00	5	REVISED TO REFLECT AS_BUILT CONDITIONS. FINAL SUBMITTAL TO STATE	BTBLK

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CARDINAL OPERATING COMPANY

CARDINAL PLANT

BRILLIANT OHIO

FLY ASH DAM II RAISING GRADING & DRAINAGE PLAN

DWG. NO. 13-30040-5

SCALE: 1"=50'

CIVIL ENGINEERING DIVISION

DR: MJB

CHI: GTC

ENGR.: MJB

PROJ. ENGR.:

DATE: 4/2197

APPROVED BY: H. Joseph Bubac

AEP AMERICAN ELECTRIC POWER

1 RIVERSIDE PLAZA COLUMBUS, OH 43215

PTS No. 55689

IGS1092

SYSTEM DATE: 26 JAN 2005
SYSTEM TIME: 14:08:29
15th FL

0465

Cardinal Fly Ash Dam II - Drains and Seepage Zones				
	Date of Inspection:	**11/17/2017**		
Drain Number & Location	**Drain Source**	**Outlet Size**	**Amount (GPM)**	**Clarity**
1. D/S Open Weir	Chimney / toe drain system	12" Dia.	23gpm	Clear
2. D/S Right Abutment	Right abutment valley	12" Dia.	105.3gpm	Clear
3. D/S Right Abutment	Slag Buttress / right abutment	12" Dia.	<1 gpm	Clear
4. D/S Right Abutment	Slag Buttress / Trench in Center	12" Dia.	<1gpm	Clear
5. Stilling Basin / Right Side	West side of stilling basin	6" dia.	1.3gpm	Clear
6. Stilling Basin / Left Side	East side of stilling basin	6" dia.	5.5gpm	Clear
7. Right Groin Ditch	West Bedrock abutment 900' elevation	12" Dia.	12gpm	Clear
8. Left Groin Ditch	East Tributary valley abutment 905"elevation	6" dia.	6.7gpm	Clear
9. Left D/S E/W	Emergency Spillway drainage blanket	12" Dia.	<1gpm	Clear
10. Left D/S E/W	E/S Left training wall	6" dia.	<1.5gpm	Clear
11. E/S 300' D/S Left	E/S Channel left 900" elevation	Seep Zone	<3gpm	Clear
12. E/S Outlet Channel	Total Seepage within Emergency Spillway	10: Dia.	12gpm	Clear
13. Right Abutment Hillside	Right Abutment Hillside near 920' elevation	Two - 6" dia.	<1gpm	Clear
14. D/S Channel / Parshall flume	Total Flow (spillway / seepage combination)	Open Channel	9.9MGD	Clear
15. Right Hillside Jules Verne Weir-3	Right Hillside Jules Verne near 770' elevation	V-Notch Weir	75gpm	Clear
16. Right Groin Pipe-2	right groin 6” pipe 930' elevation	6" pipe	0.48gpm	Clear