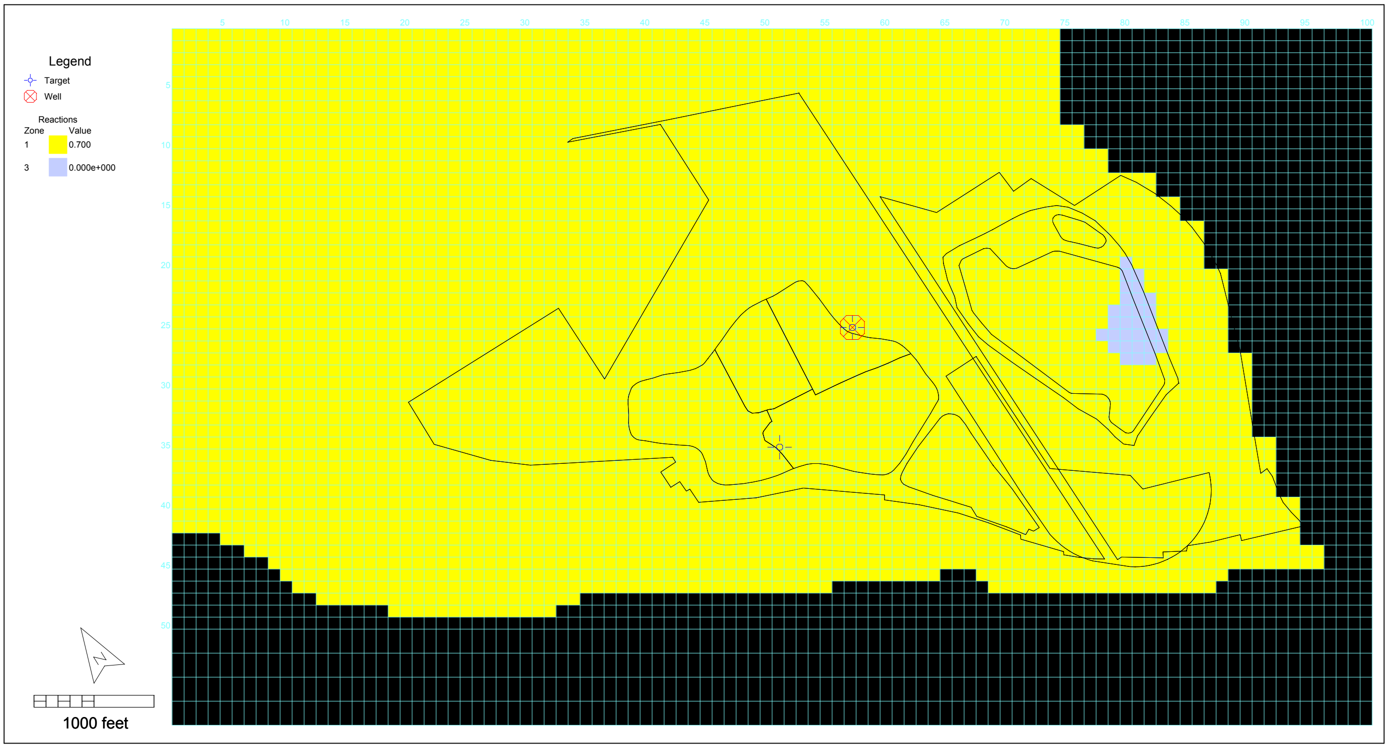


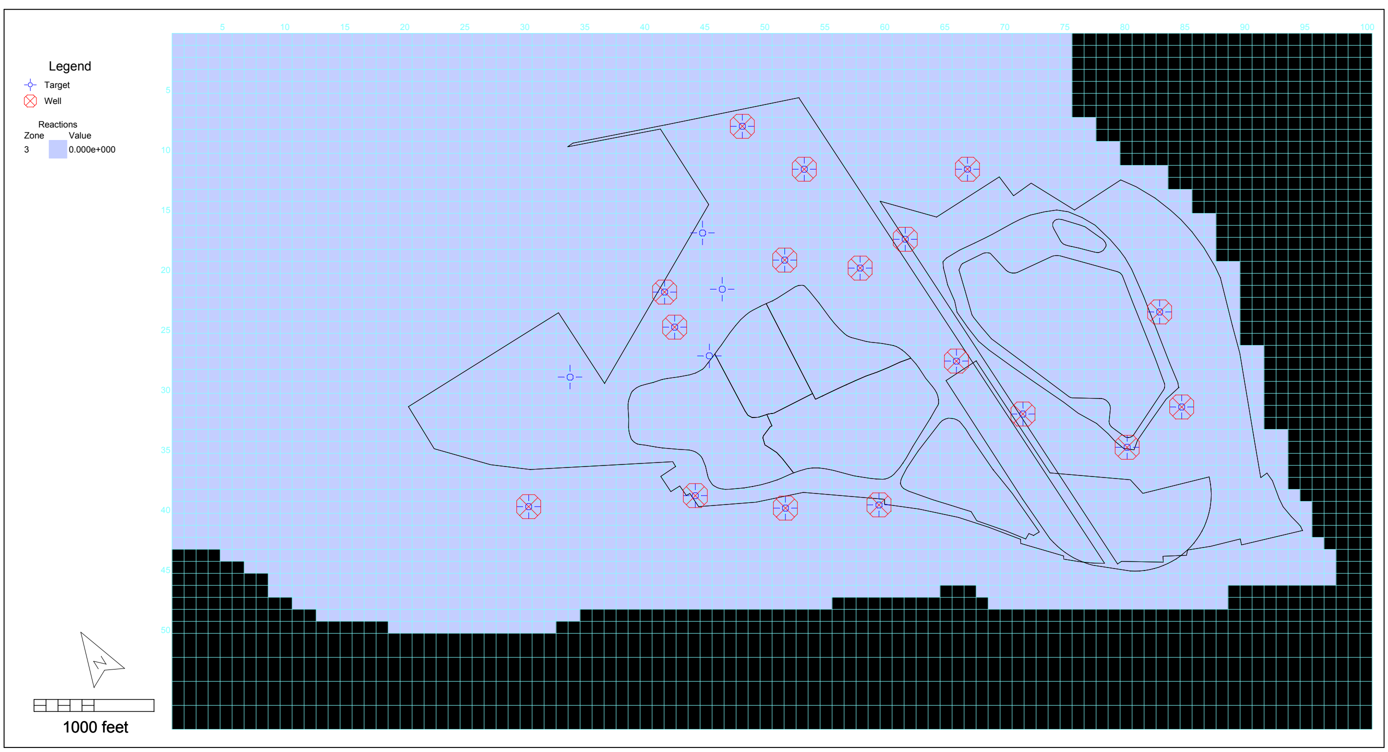


Figure 3-5. Reaction K_d (cm^3/g) for Layer 1 (top) and Layer 2 through Layer 8 (bottom).

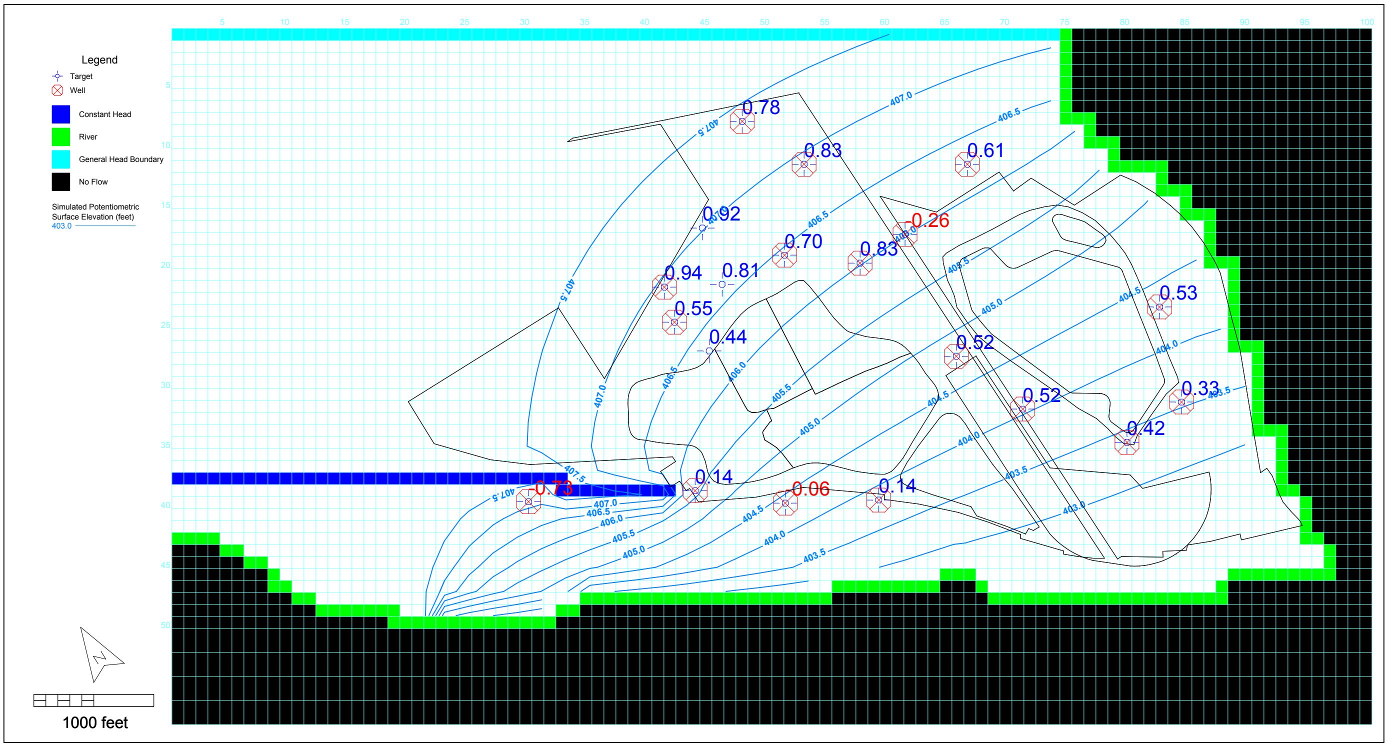


Figure 3-6. Comparison between Simulated Heads and Field Measurements for Layer 2.

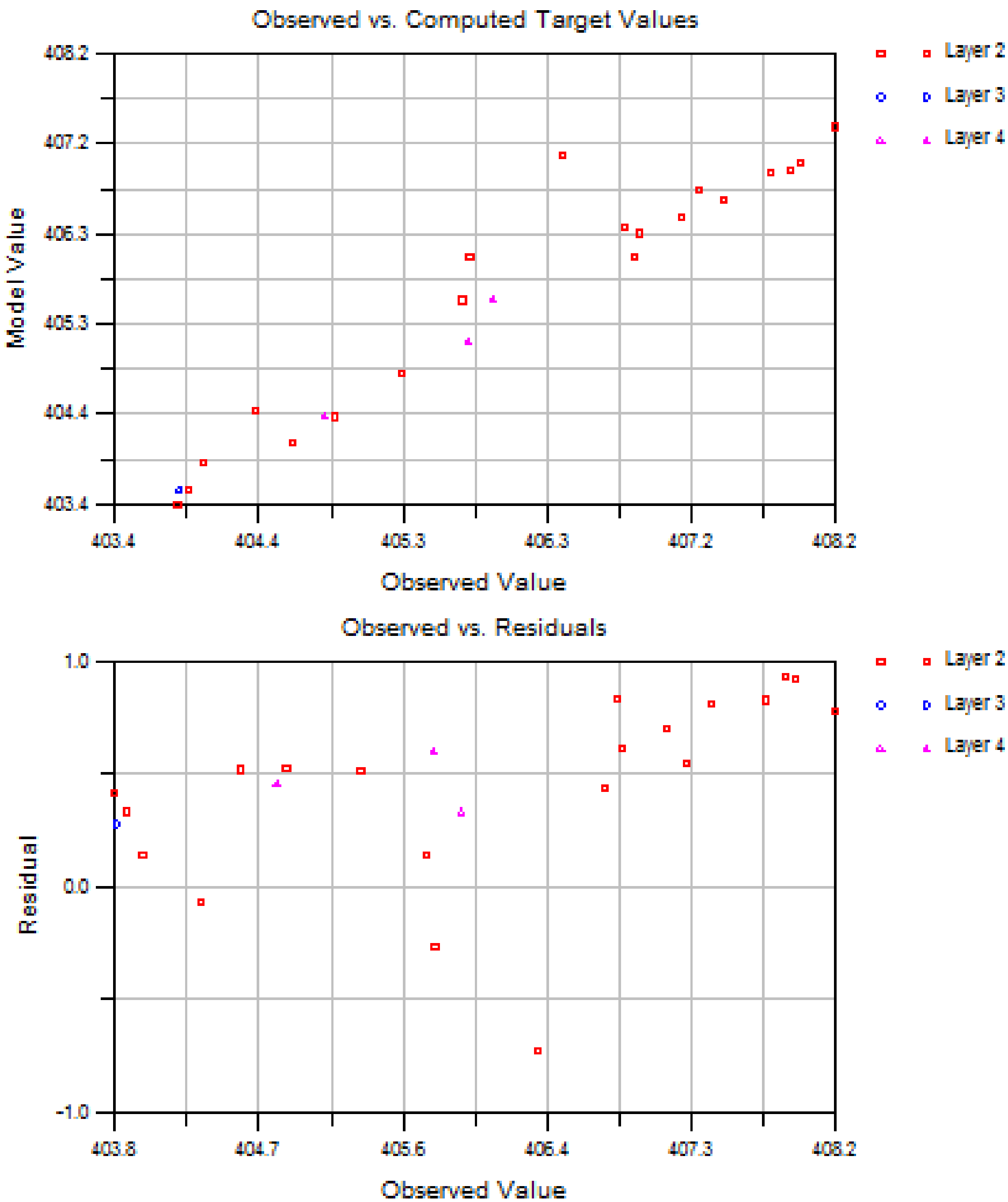


Figure 3-7. Steady-State MODFLOW Model Calibration Results.

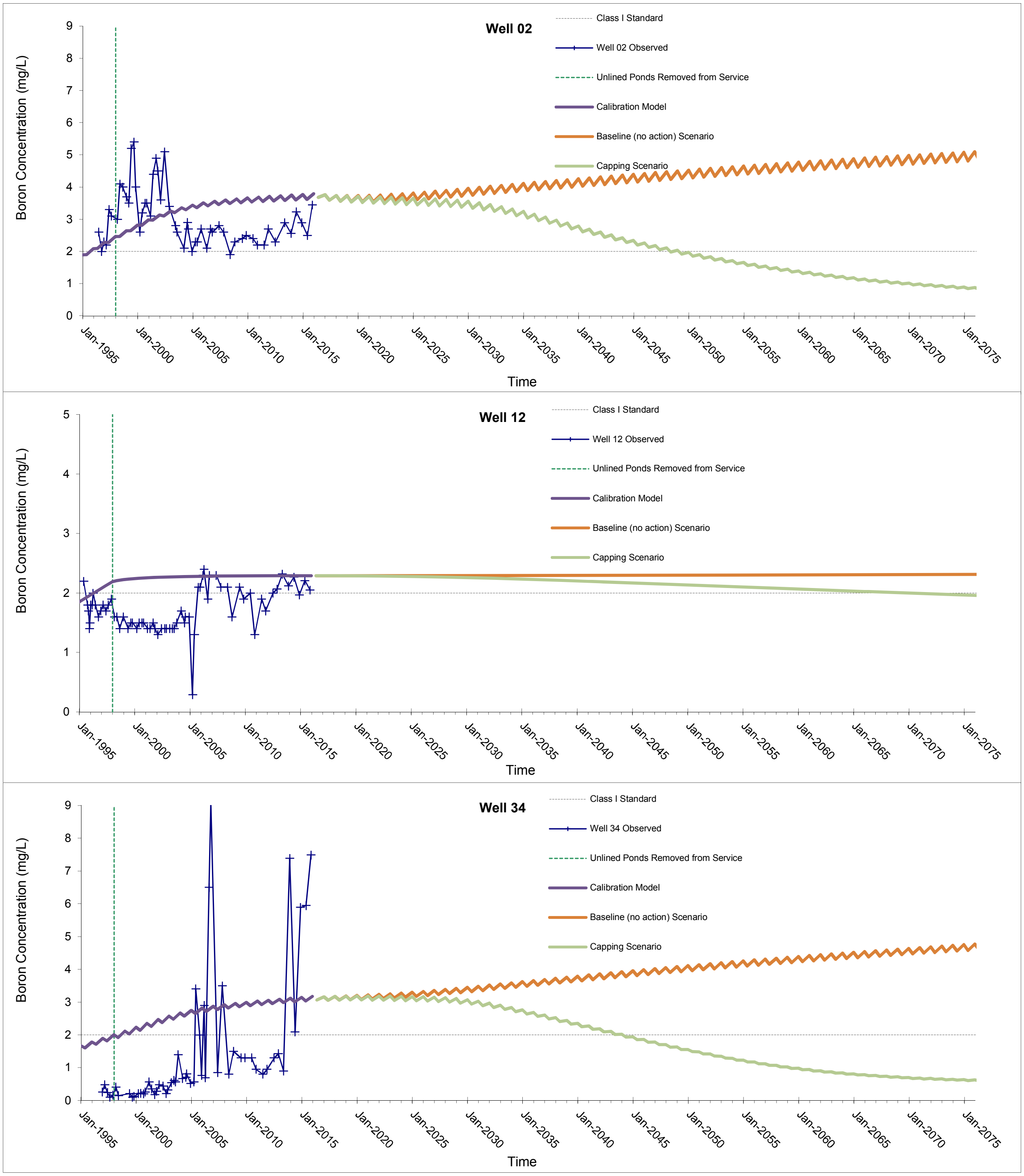


Figure 3-8. Predicted and observed boron concentrations (mg/L) (1995-2075)

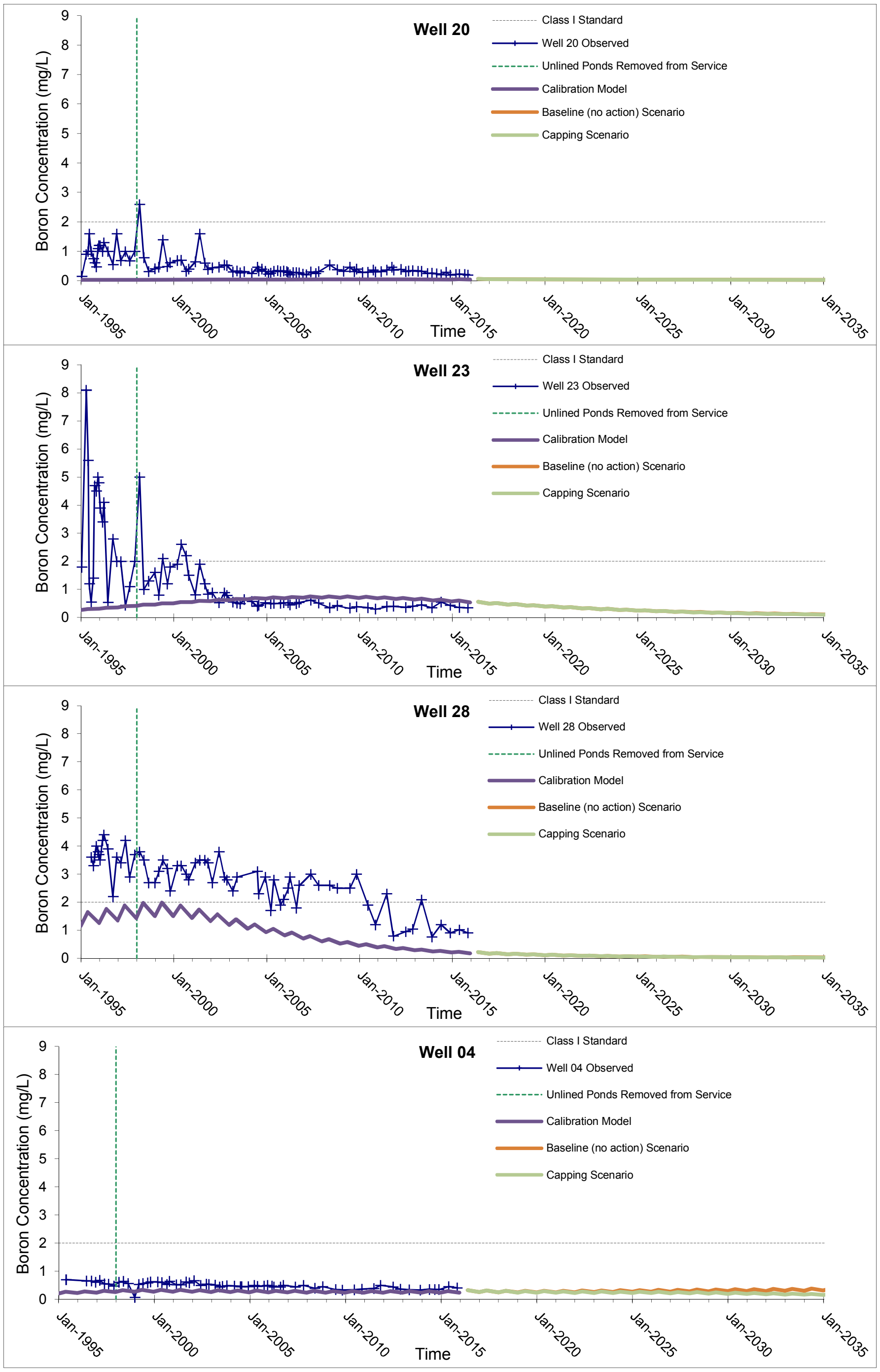


Figure 3-8 (cont'd). Predicted and observed boron concentrations (mg/L) (1995-2035)

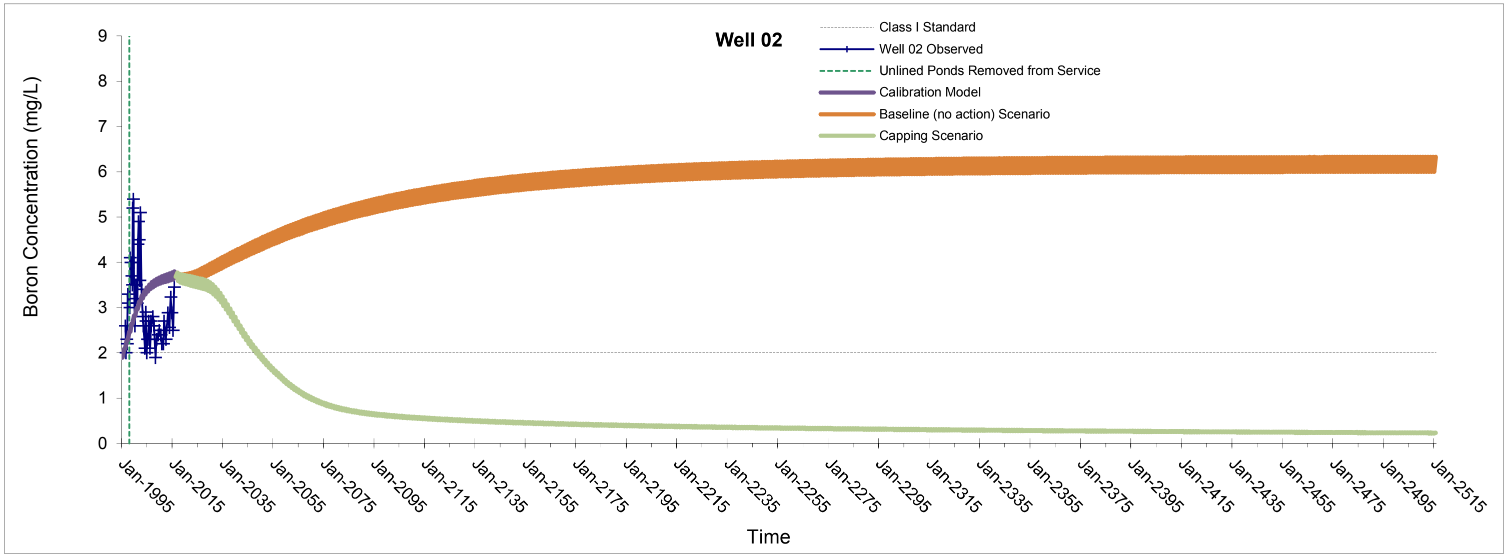


Figure 4-1. Predicted and observed boron concentrations (mg/L) (1995-2515)

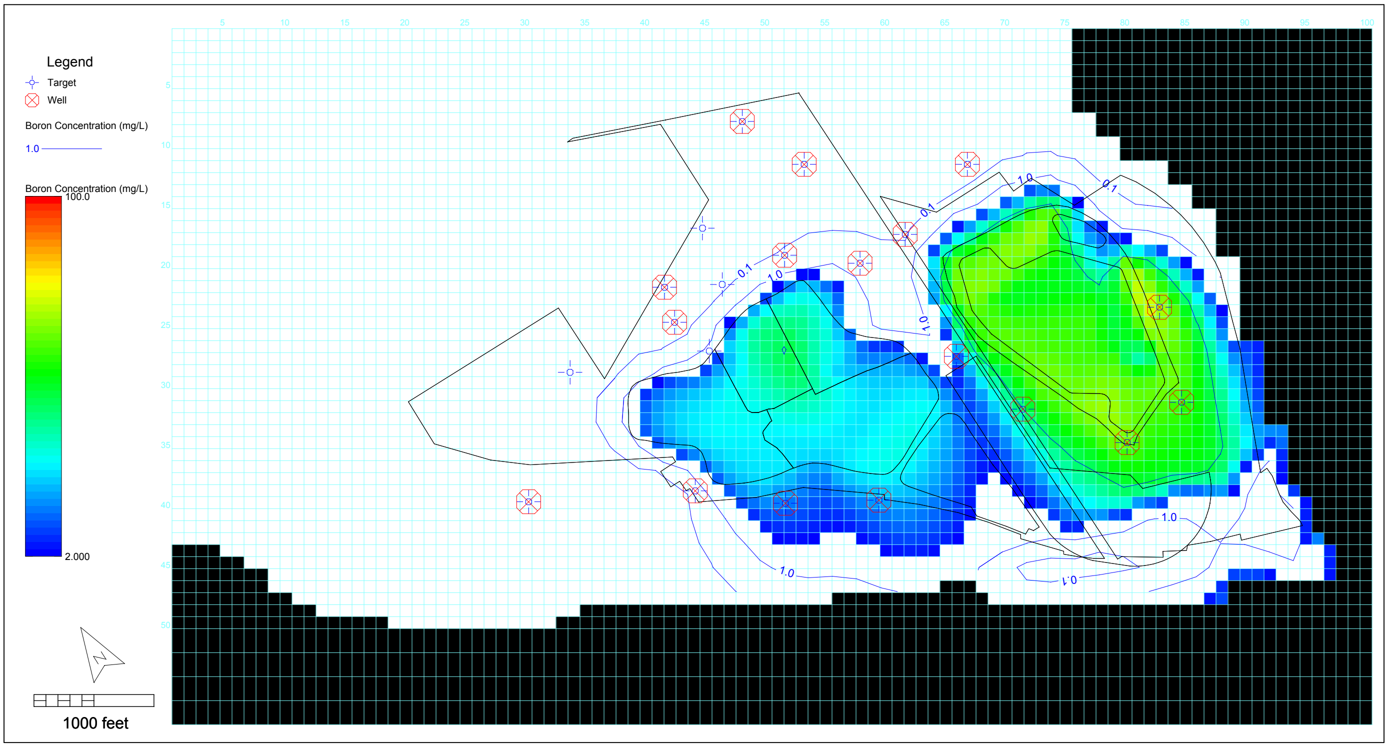


Figure 4-2. Predicted Maximum Extent of Boron Plume (2 mg/L) with Capping Scenario for Layer Layer 2 (Prediction Model, Capping Scenario, Stress Period 2, 365 days).

TABLES

Table 3-1. Flow Model Input Values (calibration and sensitivity)

Groundwater Model Report
Wood River West Ash Complex, Wood River Power Station
Dynegy Midwest Generation, LLC

NRT PROJECT NO.: 2376/2
BY: JJW CHKD BY: BGH
DATE: 8/26/16

Horizontal Hydraulic Conductivity	Property Zone ID	ft/d	cm/s	Sensitivity[1]
Silty Clay Units	1	6.80E-02	2.4E-05	High
Inter-Sand Window	7	33	1.2E-02	Negligible
Shallow Primary Sand Unit	3	33	1.2E-02	Low
Deep Primary Sand Unit	8	547	1.9E-01	Moderate - Moderately High
Vertical Hydraulic Conductivity		**ft/d**	**Kh/Kv**	**Sensitivity[1]**
Silty Clay Units	1	6.80E-04	100	High
Inter-Sand Window	7	6.6	5.0	Negligible
Shallow Primary Sand Unit	3	6.6	5.0	Moderate
Deep Primary Sand Unit	8	109	5.0	Negligible
Recharge[2]		**ft/d**	**in/yr**	**Sensitivity[1]**
Silty Clay Units	1	2.0E-04	0.9	Negligible
WAP 1	2	2.0E-03	8.8	High
WAP 2E	3	2.0E-03	8.8	High
WAP 2W	4	2.0E-04	0.9	Low
Pond 3	5	3.9E-07	0.0	Negligible
OEAP	6	1.0E-03	4.4	Negligible
OEAP	7	2.0E-04	0.9	Negligible
OEAP	8	4.1E-03	18.0	Negligible
OEAP	9	8.0E-04	3.5	Negligible
NEAP	10	1.2E-04	0.5	Negligible
NEAP	11	1.2E-04	0.5	Negligible

Notes:

1. Sensitivity Explanation, based on maximum change in Sum of Squared Residuals (SSR)
   - Negligible - SSR changed by less than 1%
   - Low - SSR change between 1% and 10%
   - Moderate - SSR change between 10% and 50%
   - Moderately High - SSR change between 50% and 100%
   - High - SSR change greater than 100%
2. See figures for delineation of model zones, for flow model calibration inputs see stress periods 123-134
3. WAP-West Ash Pond, OEAP-Old East Ash Pond, NEAP - New East Ash Pond

NATURAL RESOURCE TECHNOLOGY

Table 3-1 (cont'd). Flow Model Input Values (calibration and sensitivity)

Groundwater Model Report
Wood River West Ash Complex, Wood River Power Station
Dynegy Midwest Generation, LLC

NRT PROJECT NO.: 2376/2
BY: JJW CHKD BY: BGH
DATE: 8/26/16

River Parameters		
Mississippi River - Mel Price Dam Pool		**Sensitivity[1]**
Upstream Stage (ft) to Downstream Stage (ft)	418.5 - 418.5	Negligible
Bed Thickness (ft)	20	not tested
Hydraulic Conductivity (cm/s)	1.00E-05	not tested
Conductance (ft^2/d, normalized per ft^2 area)	~697	Negligible
River Width (ft)	5000	not tested
Length of River (ft)	~98	not tested
Mississippi River (base stage)		**Sensitivity[1]**
Upstream Stage (ft) to Downstream Stage (ft)	402.9 - 401.2	High
Bed Thickness (ft)	1	not tested
Hydraulic Conductivity (cm/s)	2.30E-03	not tested
Conductance (ft^2/d, normalized per ft^2 area)	3.30E+06	Negligible
River Width (ft)	5000	not tested
Length of River (ft)	100	not tested
Wood River		**Sensitivity[1]**
Upstream Stage (ft) to Downstream Stage (ft)	407.1 - 401.1	Negligible
Bed Thickness (ft)	1	not tested
Hydraulic Conductivity (cm/s)	3.50E-07	not tested
Conductance (ft^2/d, normalized per ft^2 area)	2	Negligible
River Width (ft)	20	not tested
Length of River (ft)	100	not tested
General Head Boundary Parameters (upgradient groundwater input)		**Sensitivity[1]**
Upstream Stage (ft) to Downstream Stage (ft)	409.2 - 407.1	High
Saturated Thickness (ft)	20	not tested
Hydraulic Conductivity (cm/s)	3.50E-02	not tested
Conductance (ft^2/d, normalized per ft^2 area)	2.00E+05	Negligible
Width (ft)	100	not tested
Distance to Head (ft)	1	not tested
Constant Head Boundary Parameters (controlled levee landside ponding)		**Sensitivity[1]**
Upstream Stage (ft) to Downstream Stage (ft)	409.0 - 408.0	Moderate

Notes:

1. Sensitivity Explanation, based on maximum change in Sum of Squared Residuals (SSR)
   - Negligible - SSR changed by less than 1%
   - Low - SSR change between 1% and 10%
   - Moderate - SSR change between 10% and 50%
   - Moderately High - SSR change between 50% and 100%
   - High - SSR change greater than 100%
2. See figures for delineation of model boundary conditions

Table 3-2. Transport Model Recharge and Concentration Input Values (calibration)

Groundwater Model Report
Wood River West Ash Complex, Wood River Power Station
Dynegy Midwest Generation, LLC

NRT PROJECT NO.: 2376/2
BY: JJW CHKD BY: BGH
DATE: 8/18/16

Silty Clay Units	Stress Periods	Dates	Concentration (mg/L)	Recharge (ft/day)	Recharge (in/yr)
Zone 1	1-134	1949-2015	0	2.0E-04	0.88
Old East Ash Pond	**Stress Periods**	**Dates**	**Concentration (mg/L)**	**Recharge (ft/day)**	**Recharge (in/yr)**
Zone 6	1-58	1949-1978	80	7.0E-03	30.66
Zone 7			50	2.0E-04	0.88
Zone 8			50	1.0E-02	43.80
Zone 9			50	7.0E-03	30.66
Old East Ash Pond	**Stress Periods**	**Dates**	**Concentration (mg/L)**	**Recharge (ft/day)**	**Recharge (in/yr)**
Zone 6	59-122	1979-2010	80	1.0E-03	4.38
Zone 7			50	2.0E-04	0.88
Zone 8			50	1.0E-02	43.80
Zone 9			50	8.0E-04	3.50
Old East Ash Pond	**Stress Periods**	**Dates**	**Concentration (mg/L)**	**Recharge (ft/day)**	**Recharge (in/yr)**
Zone 6	123-134	2011-2015	80	1.0E-03	4.38
Zone 7			50	2.0E-04	0.88
Zone 8			50	4.1E-03	17.96
Zone 9			50	8.0E-04	3.50
New East Ash Pond	**Stress Periods**	**Dates**	**Concentration (mg/L)**	**Recharge (ft/day)**	**Recharge (in/yr)**
Zone 10	115-134	2007-2015	50	1.2E-04	0.53
Zone 11			80	1.2E-04	0.53
West Ash Ponds	**Stress Periods**	**Dates**	**Concentration (mg/L)**	**Recharge (ft/day)**	**Recharge (in/yr)**
Zone 2 (WAP 1)	1-58	1949-1978	0	2.0E-04	0.88
Zone 3 (WAP 2W)			0	2.0E-04	0.88
Zone 4 (WAP 2E)			0	2.0E-04	0.88
Zone 5 (Pond 3)			0	2.0E-04	0.88
West Ash Ponds	**Stress Periods**	**Dates**	**Concentration (mg/L)**	**Recharge (ft/day)**	**Recharge (in/yr)**
Zone 2 (WAP 1)	59-98	1979-1998	15	2.0E-03	8.76
Zone 3 (WAP 2W)			10	7.0E-03	30.66
Zone 4 (WAP 2E)			20	2.0E-03	8.76
Zone 5 (Pond 3)			25	2.0E-03	8.76
Zone 12 (WAP 2E, Pond 3)			80	1.0E-02	43.80
West Ash Ponds	**Stress Periods**	**Dates**	**Concentration (mg/L)**	**Recharge (ft/day)**	**Recharge (in/yr)**
Zone 2 (WAP 1)	99-134	1999-2015	10	2.0E-03	8.76
Zone 3 (WAP 2W)			10	2.0E-03	8.76
Zone 4 (WAP 2E)			10	2.0E-04	0.88
Zone 5 (Pond 3)			10	3.9E-07	1.71E-03

Notes:

1. Sensitivity Explanation
    - Negligible - little effect on concentrations
    - Low - concentrations at two or more wells changed by 2 to 10 percent
    - Moderate - concentrations at two or more wells changed by 10 to 20 percent
    - High - concentration at two or more wells changed by more than 20 percent

Table 3-3. Mean Monthly Mississippi River Stage from 1990 through 2002

Groundwater Model Report

Wood River West Ash Complex, Wood River Power Station

Dynegy Midwest Generation, LLC

NRT PROJECT NO.: 2376/2

BY: JJW CHKD BY: PMH

DATE: 6/14/16

Mean Monthly Mississippi River Stage Data for March, April, May, June, and July 1990-2002 (Flood Stage).

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
March Mean Stage	408.8	406.2	407.37	412.92	409.23	404.85	403.6	414.55	413.15	406.68	402.72	411.3	403.29
April Mean Stage	404.55	412.64	408.96	421.94	412.21	411.39	406.86	416.57	420.07	413.1	401.78	413.28	406.91
May Mean Stage	414.06	414.83	405.9	421.78	412.61	423.49	418.41	413.15	412.16	419.32	403.05	418.01	419.57
June Mean Stage	416.4	412.64	400.65	417.36	406.64	421.02	419.03	408.41	413.26	415.9	409.86	417.93	411.83
July Mean Stage	411.09	404.86	406.06	431.47	405.71	410.23	409.77	406.5	413.46	410.25	408.49	406.78	403.56
Average Flood Stage	410.98	410.23	405.79	421.09	409.28	414.20	411.53	411.84	414.42	413.05	405.18	413.46	409.03

Mean Monthly Mississippi River Stage Data for August, September, October, November, December, January, and February 1990-2002 (Base stage).

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
August Mean Stage	407.02	400.86	404.47	428.16	401.73	406.81	404.79	404.47	405.06	405.37	401.13	401.31	402.11
September Mean Stage	402.77	399.81	403.87	421.96	401.08	402.56	401.39	403.17	402.04	401.19	399.65	400.71	400.68
October Mean Stage	400.61	399.82	401.27	413.90	401.96	403.14	402.20	402.91	408.24	400.69	399.22	401.50	401.74
November Mean Stage	400.24	403.23	408.20	407.78	403.82	405.05	405.95	403.26	409.78	400.13	400.51	400.73	399.83
December Mean Stage	401.79	405.62	410.87	404.92	403.17	401.02	404.08	403.81	404.76	400.08	398.45	401.70	398.30
January Mean Stage	nd	402.15	401.69	408.74	401.49	402.65	400.28	402.37	404.64	403.48	399.41	399.10	399.33
February Mean Stage	400.48	403.10	402.67	405.31	403.88	402.68	402.04	407.77	406.51	409.68	399.96	407.13	402.61
Average Base Stage	402.15	402.08	404.72	412.97	402.45	403.42	402.96	403.97	405.86	402.95	399.76	401.74	400.66

Notes:

1. All river stage data are in feet above mean sea level
2. All river stage elevations were recorded by the United States Army Corps of Engineers from the Mel Price Lock and Dam tailwater gauging station
3. All river stage data were copied from the United States Army Corps of Engineers historical data published on the web at http://mvs-wc.mvs.usace.army.mil/archive/mi/mi6t/

Table 3-3 (cont'd). Mean Monthly Mississippi River Stage from 2003 through 2014

Groundwater Model Report

Wood River West Ash Complex, Wood River Power Station

Dynegy Midwest Generation, LLC

Mean Monthly Mississippi River Stage Data for March, April, May, June, and July 2003-2014 (Flood Stage).

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
March Mean Stage	399.69	406.9	402.25	401.36	408.94	412.14	411.21	414	412.16	405	406.67	403.31
April Mean Stage	401.65	405.67	406.74	407.23	413.04	416.93	412.96	416.03	415.73	405.55	415.12	407.33
May Mean Stage	410.38	406.8	404.79	406.55	412.83	417.7	418.27	416.51	418.33	407.52	418.48	409.79
June Mean Stage	404.68	415.15	406.51	401.84	407.44	422.92	412.86	418.38	420.73	404.07	420.74	411.64
July Mean Stage	404.85	406.93	401.67	398.89	403.8	417.74	405.79	420.65	416.49	401.08	409.53	414.61
Average Flood Stage	404.25	408.29	404.39	403.17	409.21	417.49	412.22	417.11	416.69	404.64	414.11	409.34

Mean Monthly Mississippi River Stage Data for August, September, October, November, December, January, and February 2003-2014 (Base stage).

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
August Mean Stage	398.58	402.38	399.05	398.49	403.99	405.23	403.18	415.88	411.09	398.15	401.18	402.45
September Mean Stage	398.56	401.78	399.28	399.30	404.17	409.56	401.63	409.77	404.66	397.79	398.22	408.46
October Mean Stage	397.59	400.40	401.32	398.61	405.16	403.37	406.68	409.20	401.59	398.02	398.57	407.89
November Mean Stage	400.10	403.91	398.50	398.07	401.84	401.61	414.24	405.08	401.74	398.42	399.51	401.82
December Mean Stage	400.93	404.28	398.59	401.37	400.77	401.48	406.16	401.48	402.97	397.78	397.98	nd
January Mean Stage	397.37	399.98	408.11	399.75	402.50	403.33	403.72	406.74	401.98	400.36	397.71	398.28
February Mean Stage	397.66	399.39	407.45	399.48	400.86	405.57	403.74	405.14	405.62	401.71	400.46	399.88
Average Base Stage	398.68	401.73	401.76	399.30	402.76	404.31	405.62	407.61	404.24	398.89	399.09	403.13

Average Mean Monthly River Stage (Base stage, 1990-2014)	**402.91**	**Average Mean Monthly River Stage (Flood stage, 1990-2014)**	**410.84**

Notes:

1. All river stage data are in feet above mean sea level
2. All river stage elevations were recorded by the United States Army Corps of Engineers from the Mel Price Lock and Dam tailwater gauging station
3. All river stage data were copied from the United States Army Corps of Engineers historical data published on the web at http://mvs-wc.mvs.usace.army.mil/archive/mi/mi6t/

Table 3-4. Transport Model Input Values (calibration and sensitivity)

Groundwater Model Report
Wood River West Ash Complex, Wood River Power Station
Dynegy Midwest Generation, LLC

NRT PROJECT NO.: 2376/2
BY: JJW CHKD BY: BGH
DATE: 8/18/16

Specific Storage (ft^{-1})	Property Zone ID	Base Case	Alternatives	Sensitivity[1]
Silty Clay Units	1	3.00E-04	not tested	-
Inter-Sand Window, Shallow & Deep Primary Sand Units	5	3.00E-06	not tested	-
Specific Yield	**Property Zone ID**	**Base Case**	**Alternatives**	**Sensitivity[1]**
Silty Clay Units	1	0.10	not tested	-
Inter-Sand Window, Shallow & Deep Primary Sand Units	5	0.20	not tested	-
Effective Porosity	**Property Zone ID**	**Base Case**	**Alternatives**	**Sensitivity[1]**
Silty Clay Units	1	0.10	0.05, 0.15	Model failed to converge
Inter-Sand Window, Shallow & Deep Primary Sand Units	5	0.20	0.15, 0.25	Model failed to converge
Dispersivity (ft)	**Property Zone ID**	**Base Case**	**Alternatives**	**Sensitivity[1]**
Silty Clay Units / Inter-Sand Window, Shallow & Deep Primary Sand Units Longitudinal	4 / 2	1 / 10	3 * Base Case, 10 * Base Case	High, High
Silty Clay Units / Inter-Sand Window, Shallow & Deep Primary Sand Units Transverse	4 / 2	0.1 / 1		Low, High
Silty Clay Units / Inter-Sand Window, Shallow & Deep Primary Sand Units Vertical	4 / 2	0.01 / 0.1		High, High
Retardation	**Property Zone ID**	**Base Case**	**Alternatives**	**Sensitivity[1]**
Bulk Density (g/cm^3)	1, 3	1.57	not tested	-
Silty Clay Units	1	0.7	0.4, 1.1	High
Inter-Sand Window, Shallow & Deep Primary Sand Units	3	0	0.4	High

Notes:

1. Sensitivity Explanation
    - Negligible - little effect on concentrations
    - Low - concentrations at two or more wells changed by 2 to 10 percent
    - Moderate - concentrations at two or more wells changed by 10 to 20 percent
    - High - concentration at two or more wells changed by more than 20 percent

NATURAL RESOURCE TECHNOLOGY

Table 4-1. West Ash Ponds Transport Model Recharge Input Values (baseline and capping scenario prediction)

Groundwater Model Report
Wood River West Ash Complex, Wood River Power Station
Dynegy Midwest Generation, LLC

NRT PROJECT NO.: 2376/2
BY: JJW CHKD BY: BGH
DATE: 8/18/16

	Stress Periods	Simulation Year	Dates	Concentration (mg/L)	Recharge (ft/day)	Recharge (in/yr)
Zone 2 (WAP 1) Baseline	1-1000	1-500	2016-2515	10	**2.0E-03**	8.76
Zone 3 (WAP 2W) Baseline	1-1000	1-500	2016-2515	10	**2.0E-03**	8.76
Zone 4 (WAP 2E) Baseline	1-1000	1-500	2016-2515	10	**2.0E-04**	0.88
Zone 5 (Pond 3) Baseline	1-1000	1-500	2016-2515	10	**3.9E-07**	1.71E-03
	Stress Periods	**Simulation Year**	**Dates**	**Concentration (mg/L)**	**Recharge (ft/day)**	**Recharge (in/yr)**
Zone 2 (WAP 1) with CAP	1-20	1-10	2016-2025	10	**1.2E-03**	5.28
	21-62	11-31	2026-2046	10	**6.5E-05**	0.28
	63-1000	32-500	2047-2515	10	**4.9E-07**	0.002
Zone 3 (WAP 2W) with Cap	1-18	1-9	2016-2024	10	**1.2E-03**	5.24
	19-56	10-28	2025-2043	10	**6.3E-05**	0.28
	57-1000	29-500	2044-2515	10	**3.3E-07**	0.001
Zone 4 (WAP 2E) with Cap	1-1000	1-500	2016-2515	10	**7.6E-05**	0.33
Zone 5 (Pond 3) with Cap	1-1000	1-500	2016-2515	0	**3.9E-07**	1.71E-03

APPENDIX A

MODFLOW/MT3DMS MODEL FILES

(PROVIDED SEPARATELY)

Appendix E. Slope and Stability Calculations

Attorney Client Privileged

Attachment D.1
Geotechnical Analysis

This package summarizes the preliminary geotechnical analyses performed in support of the 30% West Ash Complex Closure Design submittal, for the Dynegy Wood River Plant. The following information and analyses are presented herein:

- Summary of Subsurface Investigation
- Summary of Subsurface Conditions
- Cap Settlement Analyses
- Dike Slope Stability Analyses

Figures, calculations and computer program outputs are provided as attachments and are referenced herein.

I. Summary of Subsurface Investigation

A subsurface exploration was performed at the west ash complex, including 15 soil borings, installation of 9 geotechnical piezometers to monitor groundwater, and a program of 11 cone-penetration test (CPT) soundings, with seismic wave velocity measurements and pore pressure dissipation testing. The borings were drilled by AECOM's subcontractor Terracon Consultants, Inc. of St. Louis, MO, under the full-time supervision of AECOM geotechnical personnel. Terracon used an All-Terrain Vehicle-mounted drill rig, in conjunction with 3-¼ inch inner diameter hollow stem augers and wash rotary methods to drill the borings. CPT soundings were performed by AECOM's subcontractor ConeTec, Inc., again with full-time oversight by AECOM personnel.

Boring depths varied from 30 to 70 ft and CPT depths varied from 30 to 50 ft below existing grades. Boring and CPT sounding locations are depicted in **Figure 1**.

Representative soil samples were collected from each of the borings for classification and/or testing. The soil samples were obtained by Standard Penetration Testing (SPT) with a split-spoon sampler, in general accordance with ASTM D 1586. Undisturbed samples of fly ash and/or fine-grained soils were obtained using 3-inch outside diameter steel (Shelby) tubes, either conventionally pushed in accordance with ASTM D 1587 or by utilizing a piston sampler in accordance with ASTM D 6519 (in ash and very soft soils).

The field investigation was complimented by a comprehensive laboratory testing program. The program was designed to establish the index and engineering properties of the soils encountered at the site, with a focus on establishing the parameters pertinent to the pond closure design (including shear strength of the soils for use in slope stability analyses, and compressibility of the ashes and soft soils underlying the site, for use in cap settlement analyses). The program included the following tests:

Index Tests:

- Moisture Content
- Atterberg Limits
- Grain Size Analyses

Compressibility:

- One-Dimensional Consolidation Testing

Strength Tests:

- Consolidated-Undrained Triaxial Testing
- Direct Simple Shear Testing
- Cyclic Direct Simple Shear Testing

At the time of this 30% design submittal, approximately 75% of the assigned testing has been received, but some tests are still in progress. Of particular note is that the cyclic testing on ash and clay samples has not been completed (which results could influence the seismic slope stability analyses presented herein). Furthermore, while several consolidation test results are available and have been incorporated, additional tests are still in progress. The complete data set may influence the settlement analyses presented herein. Therefore, some adjustments to the analyses and conclusions as a result of forthcoming data may be warranted, and will be appropriately incorporated at later design stages.

In addition to our investigation, AECOM reviewed historical geotechnical information that was available in Dynegy's files. This information included boring location map and boring logs for the subsurface investigation performed by Sargeant and Lundy (dating to 1977) to support the original design of the pond system. This information included 19 borings drilled to depths up to 85 ft below the pre-existing (pre-pond construction) grades. The historical information includes boring profile and SPT information, but no laboratory testing. The subsurface profile revealed by the historical borings was similar to that encountered by AECOM in the current investigation, and the historical borings were therefore used to supplement the current data in our evaluations.

II. Summary of Subsurface Conditions

The borings encountered the following generalized soil profile at the site (soil layers are listed from highest elevation to lowest):

Fine-Grained Dike Fill Materials: The perimeter dikes at Ponds 2W, 2E, and 3 are largely comprised of fine-grained soil fills classified as lean clay (CL) and fat clay (CH). The clays generally had a stiff to hard consistency and appeared to be well-compacted materials. The Pond 1 dikes were raised in the early 1990s, from an original elevation around 432 ft to the current elevation around 445 ft. Based on our borings, the material used to raise these dikes consists of a silty sand (SM) to sandy silt (ML). These fills were medium dense in the borings, and appeared to be well compacted.

Ponded Ash Materials: Sluiced ash materials were encountered in the borings drilled in Pond 2W and Pond 1. The material was generally classified as a silt (ML - fly ash). Above the residual pond water table, the ash was loose to medium dense. Below the water level, the ash became loose to very loose and saturated.

Native Alluvial Clay: Most of the west ash complex is underlain by a native clay of alluvial origin. The stratum was typically classified as fat clay (CH), with some zones lean clay (CL) occasionally identified. At the west complex, the clay consistency varied from soft to stiff, generally improving from east to west. The clay thickness generally thins from east to west.

Native Sand: Native sand materials, anticipated to be of alluvial origin, were encountered in all borings drilled at the west ash complex. In most cases, the sands were encountered below the alluvial clay, but in some instances were encountered directly below the dike fills or ponded ash. In general, the sands were medium dense, but some zones of looser material were also encountered at several borings. The sands were typically saturated, and were relatively clean (fines content typically in the range of 5 to 20%).

Groundwater Table: Based on preliminary data from the piezometers, the static groundwater table exists in the range of El. 400 to 410 across the complex, which corresponds to the native clay or sand deposits. A perched (residual) water table is also present within the ponds themselves. Generally, this perched water table exists within 10 ft of the existing ash surface in the ponds.

A geologic cross-section cut across the pond system (Section 1-1), providing a snapshot of the various strata described above is provided in **Figure 2.**

III. <u>Cap Settlement Analysis</u>

The proposed crown fill and cap materials (which are to be up to 25 ft thick in some areas) will surcharge the ash and native soil materials that they are placed over. Some of these soils (the ash and alluvial clays) have moderate to high compressibility. Long-term settlement of the crown will alter the as-constructed surface slopes, and short-term settlement (during construction) will affect the quantity of fill materials that are necessary to build the crown.

Settlements were calculated along a representative cross-section across the cap. The section is depicted on Figure 1. The section was selected to represent the conditions that exist in Pond 2W.

The following points summarize the methodology employed in the settlement analysis:

- The source of the surcharge that will induce settlement is the weight of the crown fill and surface cap soil. The crown fill will consist of bottom ash excavated from the adjacent East Ash Pond system. The surface cap will be constructed of suitable borrow materials obtained from on-site or imported. Bottom ash materials were conservatively assumed to have a total unit weight of 105 pcf, and cap soil was assumed to have 130 pcf. The surcharge loading at any point from each material was taken as the unit weight of the material times its thickness above existing grades.

- Classical settlement theory was used herein to estimate settlements of each stratum. For ash and clay materials, the following equation applies:

$$s_i = \frac{H_i C_c}{1+e_0} \log \frac{\sigma_0' + \Delta\sigma}{\sigma_p'}$$

For the native sand, the empirical Hough's Method was applied, using the following equation:

$$s_i = \frac{H_i}{C'} \log \frac{\sigma_0' + \Delta\sigma}{\sigma_p'}$$

Where,

H_i = Thickness of layer
C_c = Compression Index of layer
e_0 = Initial void ratio at layer
σ_0' = Effective overburden pressure at layer center
σ_p' = Effective preconsolidation pressure
$\Delta\sigma$ = Surcharge pressure at layer center, γz
C' = A compressibility index based on SPT results for sands

- The various compressibility parameters were selected on the basis of laboratory consolidation testing available at this time, the results of the field borings, and using engineering judgment. Based on the test results, the ponded ash and native clay layers are considered to be lightly overconsolidated soils. An overconsolidation ratio of 1.25 was used in the calculations (the preconsolidation pressure parameter was assumed equal to 125% of the overburden pressure for these materials). **Table E-1** below summarizes the parameters used in the calculations.

Table E-1: Compressibility Parameters Used In Settlement Analyses

Layer	γ(pcf)	e_0	C_r	C_c
Ponded Ash (above water table)	90	1.35	0.016	0.06
Ponded Ash (below water table)	90	1.35	0.016	0.12
Native Alluvial Clay	119	0.75	0.04	0.35
Native Sand Alluvium	115	--	C' Index based on SPT values from borings	

- Settlements were calculated for a number of points along the reference Cross-Section 1-1, and a settlement profile was so developed.

- Time rate of settlement analyses have not yet been performed at this 30% design stage. Herein, we have assumed that the sluiced fly ash materials within the ponds and the underlying native sand materials in the profile (both of which are non-plastic materials) will consolidate relatively rapidly, and a majority of the settlement in these layers will occur during the course of crown and cap construction. Therefore, while the settlement of these layers will necessitate additional fill placement (to "recover" the grade lost to settlement), they will not contribute to long term reduction of slope grades of the surface cap. It is assumed that the alluvial clay deposit will experience slow consolidation, and the settlement from this stratum will contribute to long-term slope changes of the surface cap.

Results of Settlement Analysis

Table E-2 summarizes the results of the settlement calculations at each analysis point along Section 1-1. The results and conclusions of the settlement analysis are summarized as follows:

- Predicted long-term settlements in the alluvial clays vary from 2-in to 10-in across the section. These magnitudes indicate that nominal loss of surface slope could occur long-term.

- Short-term settlements in the ponded fly ash and alluvial sand materials is predicted to vary between about 4 and 16-inches, with an average of about 10-inches.

- As the intent of the design is to maintain a minimum 2% surface slope for drainage, the 30% grading plan has been configured at a constructed slope of 2.5% within Ponds 2W and 2E (where the majority of net crown fill is to be placed) to account for loss due to settlement. This will address the issues summarized above (loss of slope due to long term settlement, and account of additional volume of fill required to recover short-term settlement), in a preliminary fashion. The surface grading will be optimized in subsequent submittals.

AECOM

Job	Dynegy Wood River	Project No.	60440115	Sheet	7 of 11
Description	Geotechnical Calculations	Computed by	CAD	Date	11/11/15
	West Ash Complex 30% Closure Design	Checked by	VKG	Date	11/12/15

Table E-2: Summary Results of Settlement Analyses

INPUT PARAMETERS					*Analysis Results*		
Point	Cross Section Analysis Location (STA.)	Proposed Crown Fill Thickness (ft)	Proposed Cap and Cover Thickness (ft)	Total Proposed Fill Thickness* (feet)	Total Settlement (inches)	Short-Term Settlement (Inches)	Long-Term Settlement (inches)
1	1+00	0	0	0	0	0	0
2	1+22	0	0	0	0	0	0
3	1+50	6	2	8	5.4	4.5	0.9
4	1+75	16	2	18	9.2	6.9	2.3
5	2+00	17.6	2	19.6	11.2	8.5	2.7
6	2+50	17	2	19	11.5	8.6	2.9
7	2+90	17	2	19	11.6	8.6	3
8	3+50	22	2	24	17	11.1	5.9
9	4+06	22	2	24	19.1	12.6	6.5
10	5+00	23	2	25	25.3	15.8	9.5
11	5+52	21.2	2	23.2	21.3	11.6	9.7
12	6+00	22.2	2	24.2	21.9	12	9.9
13	6+50	21.5	2	23.5	19	10.2	8.8
14	6+62	19.5	2	21.5	16.8	9.1	7.7
15	6+84	8	2	10	9.5	3.6	5.9
16	7+08	0	0	-	0	0	0
17	7+13	0	0	-	0	0	0
18	7+25				0	0	0

IV. Dike Slope Stability Analyses

For the 30% design submittal, limit-equilibrium slope stability analyses have been performed at four representative cross-sections, L-L, M-M, K-K, and G-G. The section locations are provided in **Figure 1**.

Analyses were performed using Spencer's Method which is a limit equilibrium slope stability analysis procedure. The computer program SLOPE/W 2007 by Geo-Slope International was utilized. The program analyzes a large number of potential slip surface geometries and identifies the geometry that results in a critical (i.e. lowest) factor of safety (FS). Additional information on the program is available at http://www.geo-slope.com/.

Each section was analyzed for the following cases:

Static Operating Case: This case models the closed ponds under static, long-term conditions. Drained (effective stress) shear strength parameters were used for all materials, and phreatic conditions were estimated based on the available piezometer data. The Programmatic target for post-earthquake analysis is a factor of safety greater than 1.5.

Post-Earthquake Case: This case models the closed ponds under conditions that are anticipated to exist following the design earthquake event. The design earthquake is an event with 2% probability of exceedance in 50 years (recurrence interval of approximately 2500 years). The purpose of the post-earthquake stability analysis is to assess stability conditions immediately following a seismic event. No horizontal seismic coefficient is included in these analyses, but selection of strength parameters for the analyses takes into account the potential for softening/ weakening of the soils as a result of pore pressures generated by the earthquake shaking. The Programmatic target for post-earthquake analysis is a factor of safety greater than 1.2.

Preliminary liquefaction screening analysis was performed for each section, to ascertain potential zones of liquefaction for use in the post-earthquake analyses. Reduced strengths of materials anticipated to liquefy or soften during the design earthquake were input to the post-earthquake analyses.

Models were established based on the following methodology:

- ***Surface Geometry:*** Surface topography corresponded to the proposed grades, as depicted in the 30% plans. For areas where grade changes are not proposed (such as at the perimeter dike slopes), topography is based on County LIDAR surveys.
- ***Subsurface Stratigraphy:*** Stratigraphy for each cross-section was based on the pertinent borings (both new AECOM borings and high-quality historical borings) that are in the vicinity of each cross-section. Groundwater tables were modeled as piezometric lines in

SLOPE/W, with elevations and configuration of the lines primarily established based on the recently installed piezometers. **Table E-3** summarizes the borings used to construct each section.

Table E-3: Borings Used To Develop Subsurface Stratigraphy

Cross-Section	Borings Utilized
G-G	WOR-B008 and D-9 (1977 Historic Boring)
K-K	WOR-B015, WOR-B016, D-15 (1977 Historic Boring)
L-L	WOR-B017 and WOR-B018
M-M	WOR-B020 and D-4 (1977 Historic Boring)

- ***Liquefaction Screening Analysis:*** Preliminary liquefaction screening analysis has been performed as part of this 30% submittal. Liquefaction screening was performed using SPT and CPT data obtained during the AECOM exploration, for borings pertinent to each analysis cross-section (as described in **Table E-3**). The screening procedure was based on the methodology by Idriss and Boulanger (2008, 2014). The procedure considers a stress-based approach to evaluate the potential for liquefaction triggering, and compares calculated earthquake-induced cyclic stress ratios (CSR) with the estimated cyclic resistance ratios (CRR) of the soil to establish the factor of safety against liquefaction triggering.

  The design earthquake for the screening procedure was the same as used for the post-seismic slope stability analysis (2500 year event). As the site-specific Probabilistic Seismic Hazard Analysis is still in progress at the time of this submittal, ground motions for the screening analysis were based on USGS seismic hazard data, corrected for Seismic Site Class D conditions assumed for the site. Site-specific information will be incorporated at later submittals.

  This methodology is considered to be a screening-level procedure. Adverse results from the screening procedure are generally considered to be grounds for more rigorous evaluation to be performed at a later phase of the project.

  The screening analysis indicates that there is potential for liquefaction of the ponded fly ash materials as well as the upper portions of the native sand alluvium deposit. The analyses also indicate that cyclic softening of the native alluvial clay may occur as a result of the design earthquake. These results were carried forward to the post-earthquake cases of the slope stability analyses.

- ***Material Properties:*** Unit weight and shear strength parameters were established on the basis of available laboratory testing and on field test results from the borings. For the post-earthquake cases, soils that are anticipated to liquefy or soften were assigned reduced strengths. **Table E-4** summarizes the shear strength parameters used in the slope stability analyses.

Table E-4: Soil Parameters Used In Slope Stability Analyses

Layer	γ(pcf)	*Properties For Static Operating Case*		*Properties For Post-Seismic Case*	
		ϕ' (deg)	*c' (psf)*	*ϕ (deg)*	*c (psf)*
Dike Fill (Clay)	130	30	200	30	200
Dike Fill (Sand)	120	33	0	33	0
Ponded Ash	100	27	0	$s_u/\sigma'_v = 0.06$ (See Note)	
Native Alluvial Clay	130	30	0	$s_u/\sigma'_v = 0.20$ (See Note)	
Native Sand Alluvium	120	32	0	$s_u/\sigma'_v = 0.20$ to 0.25 (See Note)	

Note: Materials that are anticipated to soften or liquefy during the design earthquake were modeled using undrained shear strengths that vary as a function of the overburden pressure. The alluvial clay was modeled with 80% of the anticipated static undrained strength (from lab testing). Strength of ponded ash was selected based on previous experience with ash materials (cyclic tests in fly ash are not yet available for Wood River). The alluvial sands were assigned residual strengths based on field test data (SPT N and CPT results), using procedures give in Idriss and Boulanger (2008, 2014).

Results of Stability Analysis

Table E-5 summarizes the results of the stability analyses for each section, and output figures from the slope models are provided at the back of this document.

Table E-5 – Results of Slope Stability Analysis

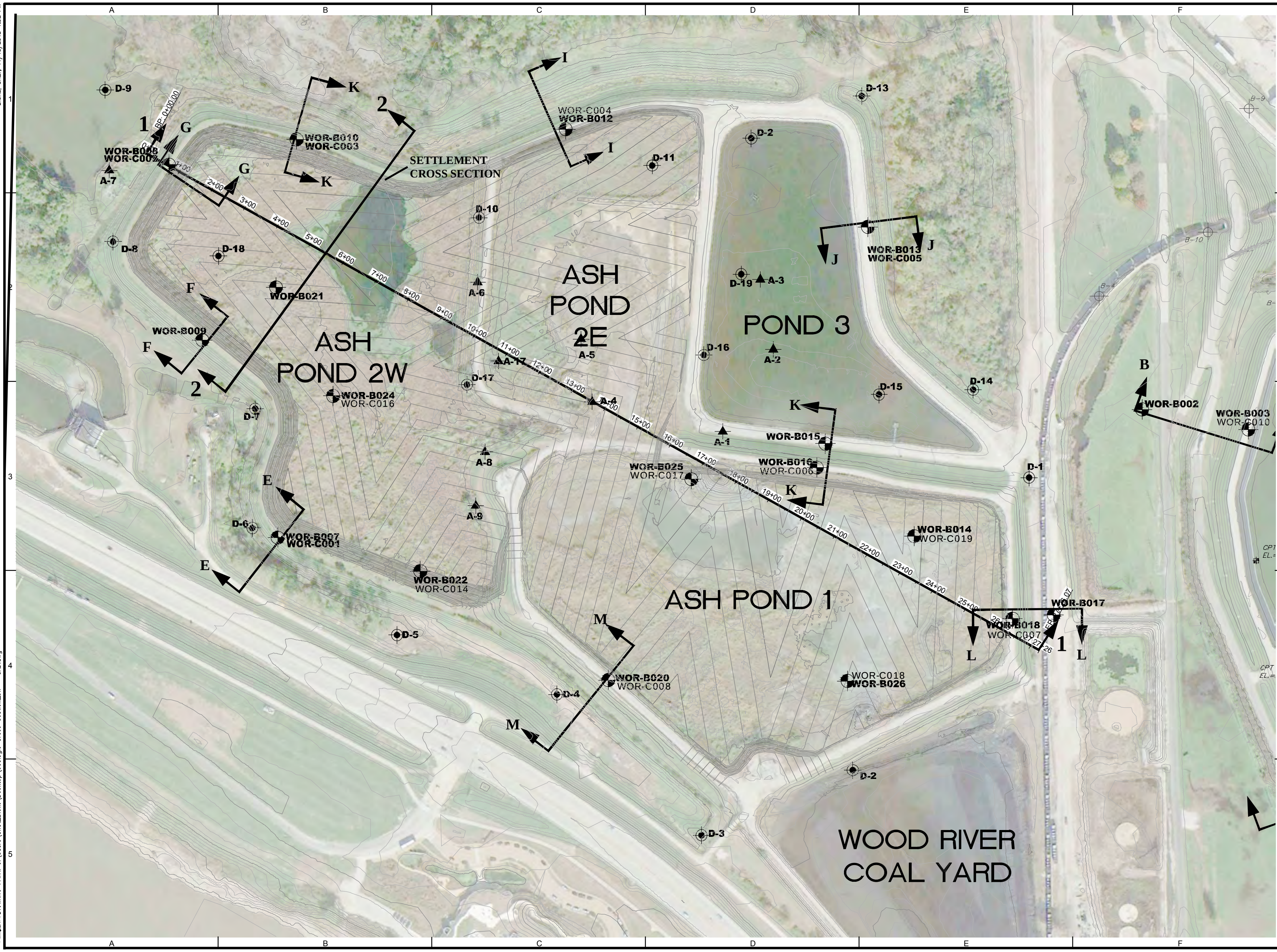
Loading Case	Program Criteria	Cross Section G-G	Cross Section K-K	Cross Section L-L	Cross Section M-M
Static, Operating	FS ≥ 1.5	2.55	3.26	3.45	3.23
Post-Earthquake	FS ≥ 1.2	1.29	2.37	2.50	1.98

The results indicate that all sections have acceptable factors of safety for all cases. Therefore, at the present design stage, we anticipate that slope stabilization measures will not be required for the closure design, and such measures are not depicted in the 30% plans. We do note that the post-earthquake factors of safety at some sections are relatively close to the programmatic minimum values. More definitive results await the PSHA and seismic site response analyses for the site, which are forthcoming. Furthermore, once these tests are received, additional cyclic lab testing in the alluvial clays and ponded ash will be assigned. Subsequent submittals will incorporate the results of these studies, including any changes to the design details, should they become necessary.

V. References

1. Idriss, I.M., and Boulanger, R. W. (2008). “SPT-Based Liquefaction Triggering Procedures”, Report No. UCD/CGM-10-02, Center for Geotechnical Modeling, Department of Civil and Environmental Engineering, University of California, Davis, CA.

2. Idriss, I.M., and Boulanger, R.W. (2014). “CPT and SPT Based Liquefaction Triggering Procedures”, Report No. UCD/CGM-14-01, Center for Geotechnical Modeling, Department of Civil and Environmental Engineering, University of California, Davis, CA.



AECOM
564 White Pond Dr.
Akron, OH 44320
330-836-9111 (phone)
330-836-9115 (fax)

DYNEGY
Dynegy Inc.
1500 East Port Plaza Drive
Collinsville, IL 62234

WEST ASH COMPLEX CLOSURE

WOOD RIVER POWER PLANT
ALTON, IL

ISSUED FOR BIDDING ______ DATE BY

ISSUED FOR CONSTRUCTION ______ DATE BY

REVISIONS

NO.	DESCRIPTION	DATE
1	30% DESIGN	2015-11-13

AECOM PROJECT NO:	60440115
DRAWN BY:	JSW
DESIGNED BY:	CAD
CHECKED BY:	VKG
DATE CREATED:	2015-10-13
PLOT DATE:	2015-10-13
SCALE:	1" = 120'
ACAD VER:	2015

SHEET TITLE

GEOTECHNICAL SITE PLAN

FIGURE 1

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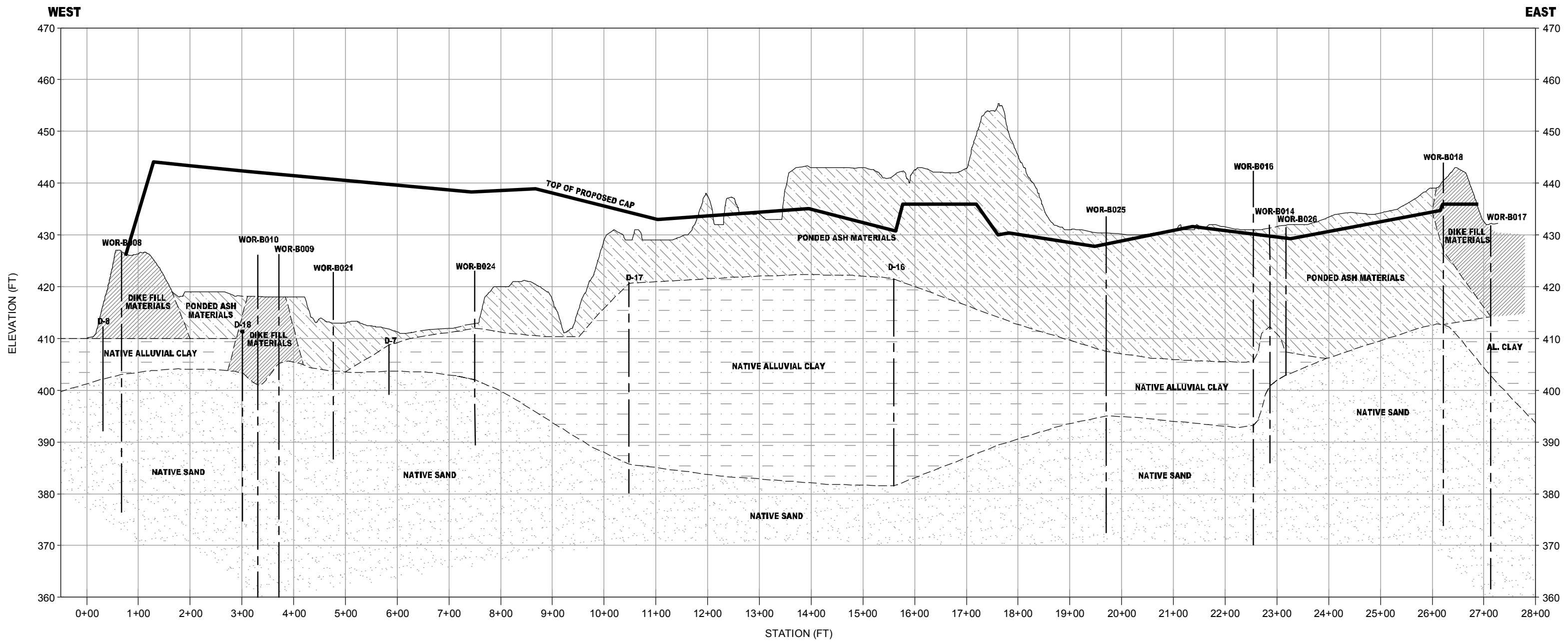
DICKE, CHET, 11/13/2015 12:51 PM



CROSS SECTION 1-1

LEGEND:

Dike Fill Materials: Soil fills were most often classified as lean clay (CL) and fat clay (CH). The clays generally had a stiff to hard consistency and appeared to be well-compacted materials. Pond raise dike materials at Pond 1 (circa 1990) were silty sand (SM) to sandy silt (ML). These fills were medium dense in the borings, and appeared to be well compacted.

Ponded Ash Materials: Sluiced ash materials consisted of brown to gray fly ash and had classification of silt (ML). Above the residual pond water table, the ash was loose to medium dense. Below the water level, the ash became loose to very loose and saturated.

Native Alluvial Clay: The stratum, anticipated to be of alluvial origin, was typically classified as a fat clay (CH), with some zones of lean clay (CL) occasionally identified. The clay consistency varied from soft to stiff, generally improving from east to west. Layers of loose silty sand (SM) and silt (ML) were occasionally interbedded in the clay deposits.

Native Sand: Native sand materials, anticipated to be of alluvial origin, were typically classified as poorly graded sand (SP). Layers of clay or silty sand (generally less than 5 ft thick) were occasionally interbedded in the sand. In general, the sands were medium dense, but some zones of looser material were also encountered at several borings. The sands were typically saturated.

0 120 240 360
HORIZONTAL SCALE IN FEET

0 12 24 36
VERTICAL SCALE IN FEET

AECOM
564 White Pond Dr.
Akron, OH 44320
330-836-9111 (phone)
330-836-9115 (fax)

DYNEGY
Dynegy Inc.
1500 East Port Plaza Drive
Collinsville, IL 62234

WEST ASH COMPLEX CLOSURE

WOOD RIVER POWER PLANT
ALTON, IL

ISSUED FOR BIDDING — DATE BY

ISSUED FOR CONSTRUCTION — DATE BY

REVISIONS

NO.	DESCRIPTION	DATE
△	30% DESIGN	2015-11-1
△		
△		
△		
△		

AECOM PROJECT NO:	60440115
DRAWN BY:	JSW
DESIGNED BY:	CAD
CHECKED BY:	VKG
DATE CREATED:	2015-10-13
PLOT DATE:	2015-10-13
SCALE:	H:1" = 120'; V:1"=12'
ACAD VER:	2015

SHEET TITLE

TYPICAL GEOLOGIC PROFILE

FIGURE 2

AECOM DRAWING PATH: E:\Temporary\witzberger\Geologic Cross Section_JW - Copy.dwg

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AECOM PROJECT NO. : 60440115
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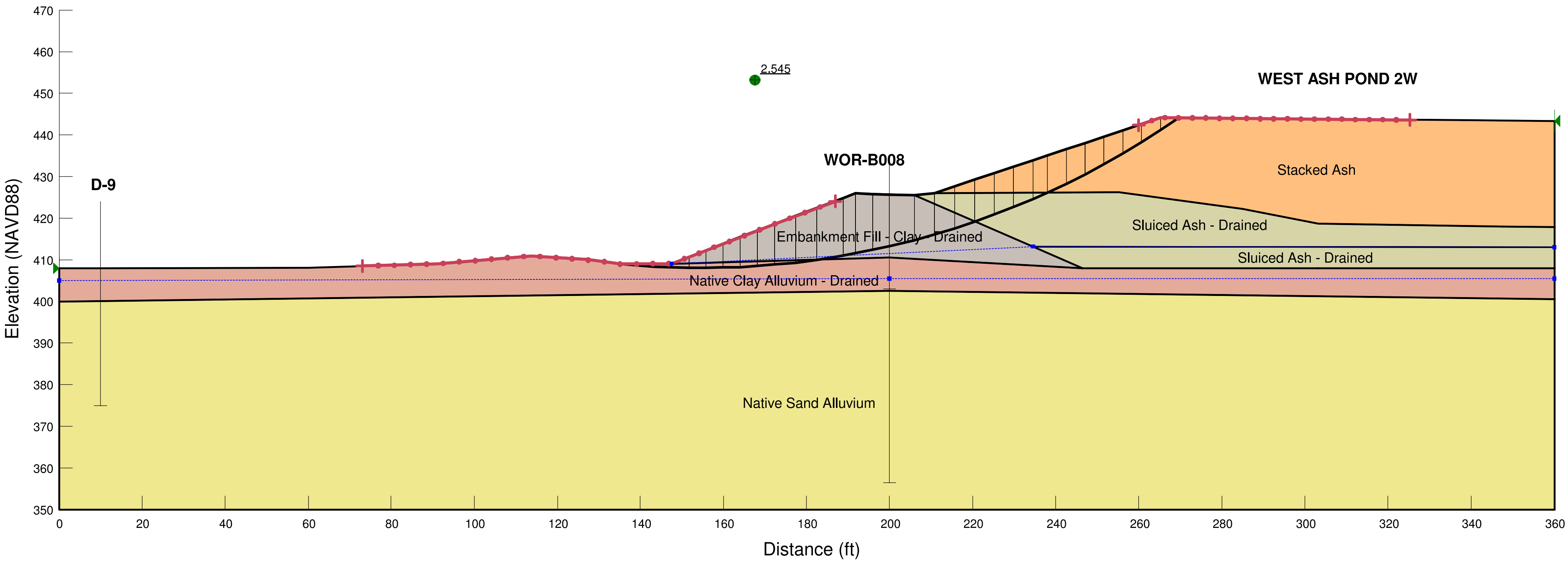
ANALYSIS: Static (Rotational), Operating Case
SEISMIC LOAD: 0 g



MATERIAL PROPERTIES

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Unit Weight: 130 pcf
Cohesion: 100 psf
Phi: 30 °

Name: Sluiced Ash - Drained
Unit Weight: 100 pcf
Cohesion: 0 psf
Phi: 27 °

Name: Stacked Ash
Unit Weight: 95 pcf
Cohesion: 0 psf
Phi: 34 °

Name: Native Clay Alluvium - Drained
Unit Weight: 130 pcf
Cohesion: 0 psf
Phi: 30 °

Name: Native Sand Alluvium
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 32 °

Name: Sluiced Ash - Drained
Unit Weight: 100 pcf
Cohesion: 0 psf
Phi: 27 °

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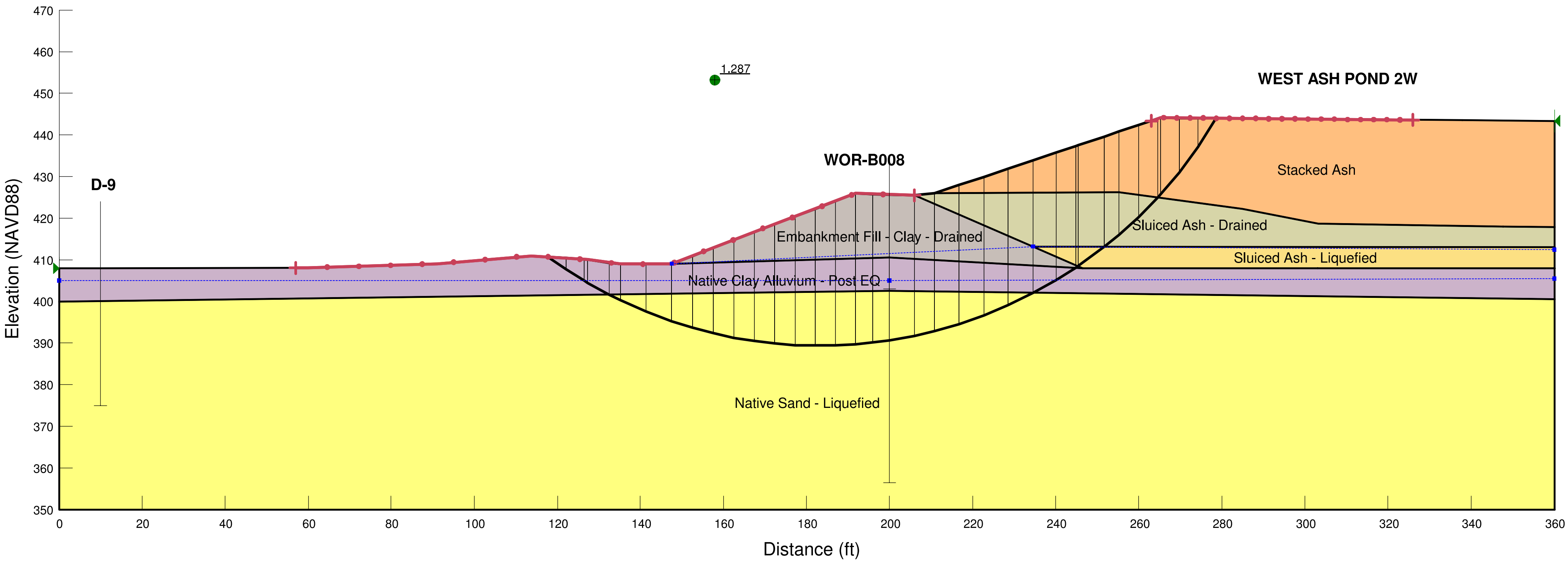
PROJECT LOCATION: ALTON, IL
AECOM PROJECT NO. : 60440115
CROSS SECTION: G-G (PROPOSED CLOSURE)
ANALYSIS: Post-Earthquake Condition - Rotational
SEISMIC LOAD: 0 g



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Cohesion: 0 psf
Phi: 27 °

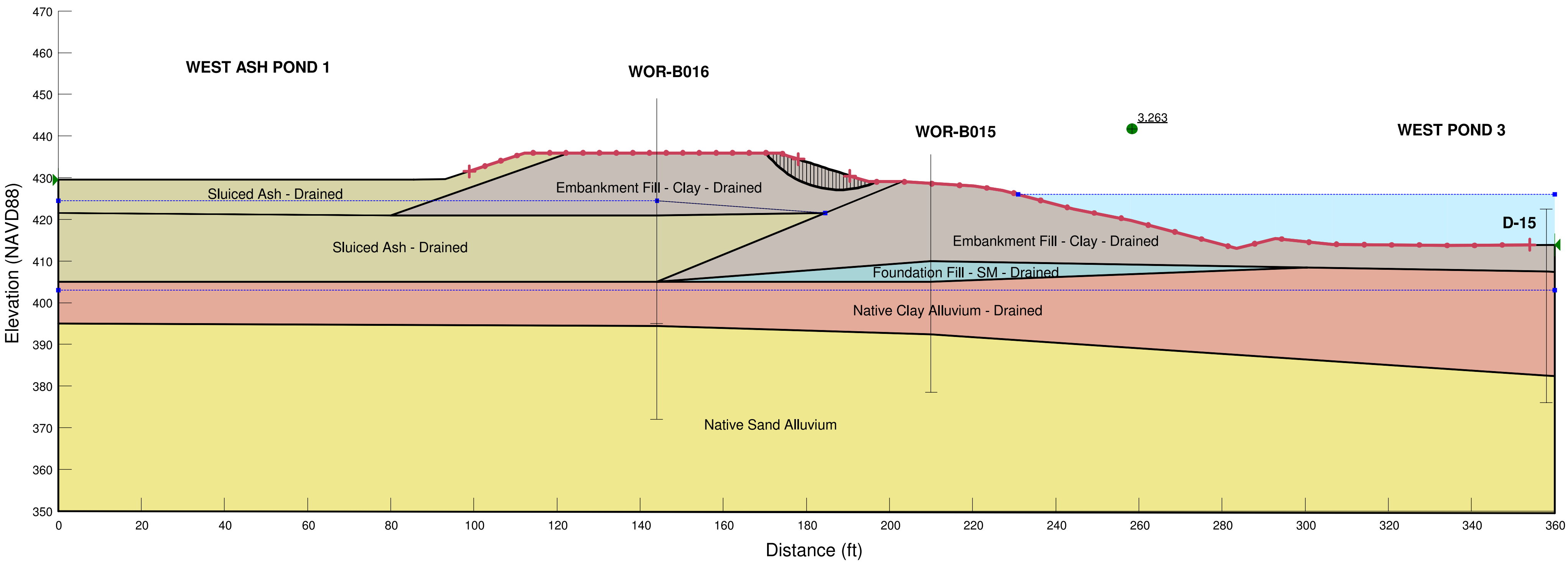
Name: Stacked Ash
Unit Weight: 95 pcf
Cohesion: 0 psf
Phi: 34 °

Name: Native Clay Alluvium - Post EQ
Unit Weight: 120 pcf
Tau/Sigma Ratio: 0.2
Minimum Strength: 0

Name: Native Sand - Liquefied
Unit Weight: 115 pcf
Tau/Sigma Ratio: 0.25
Minimum Strength: 0

Name: Sluiced Ash - Liquefied
Unit Weight: 100 pcf
Tau/Sigma Ratio: 0.06
Minimum Strength: 0

PROJECT: DYNEGY - WOOD RIVER POWER STATION
PROJECT LOCATION: ALTON, IL
AECOM PROJECT NO. : 60440115
CROSS SECTION: K-K (PROPOSED CLOSURE)
ANALYSIS: Static (Rotational), Operating Case
SEISMIC LOAD: 0 g



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Unit Weight: 130 pcf
Cohesion: 100 psf
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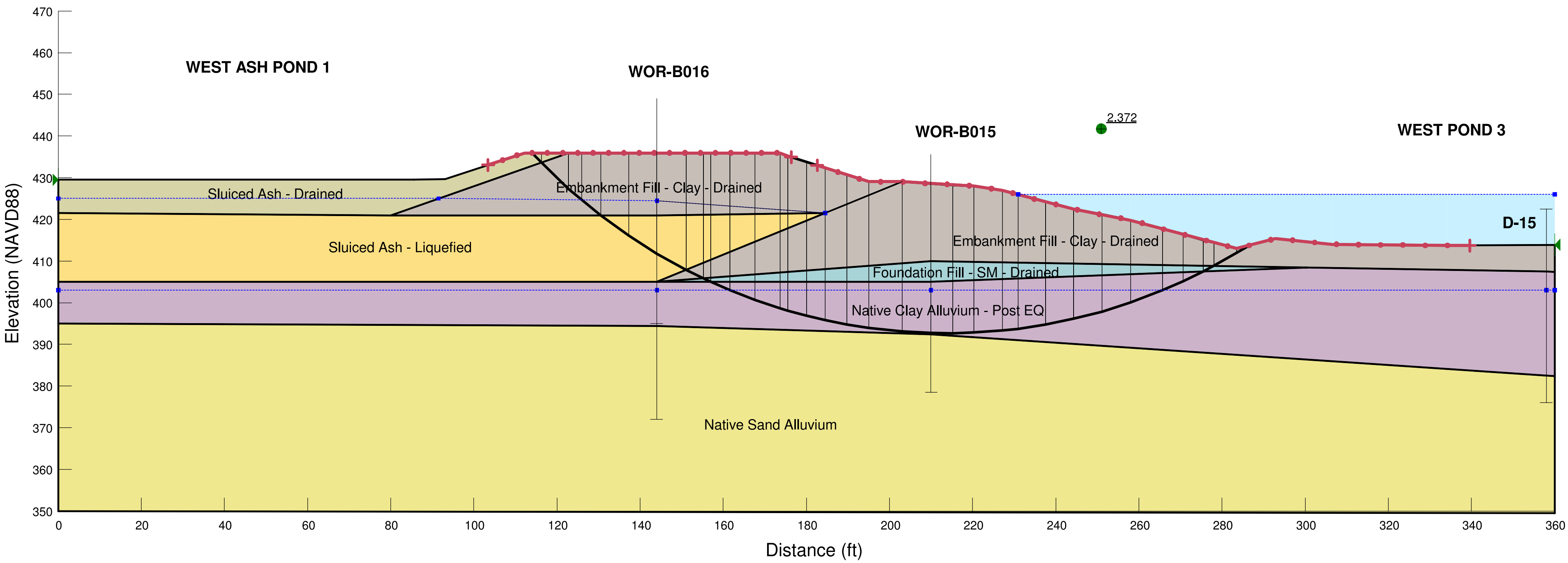
Unit Weight: 130 pcf
Cohesion: 100 psf
Phi: 30 °

Name: Native Clay Alluvium - Drained
Unit Weight: 130 pcf
Cohesion: 0 psf
Phi: 30 °

Name: Native Sand Alluvium
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 32 °

Name: Foundation Fill - SM - Drained
Unit Weight: 115 pcf
Cohesion: 0 psf
Phi: 28 °

PROJECT: DYNEGY - WOOD RIVER POWER STATION
PROJECT LOCATION: ALTON, IL
AECOM PROJECT NO. : 60440115
CROSS SECTION: K-K (PROPOSED CLOSURE)
ANALYSIS: Post-Earthquake Condition - Rotational
SEISMIC LOAD: 0 g



MATERIAL PROPERTIES

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Name: Sluiced Ash - Liquefied
Unit Weight: 100 pcf
Tau/Sigma Ratio: 0.06
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Name: Native Clay Alluvium - Post EQ
Unit Weight: 120 pcf
Tau/Sigma Ratio: 0.2
Minimum Strength: 0

Name: Native Sand Alluvium
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 32 °

Name: Foundation Fill - SM - Drained
Unit Weight: 115 pcf
Cohesion: 0 psf
Phi: 28 °

PROJECT: DYNEGY - WOOD RIVER POWER STATION
PROJECT LOCATION: ALTON, IL
AECOM PROJECT NO. : 60440115
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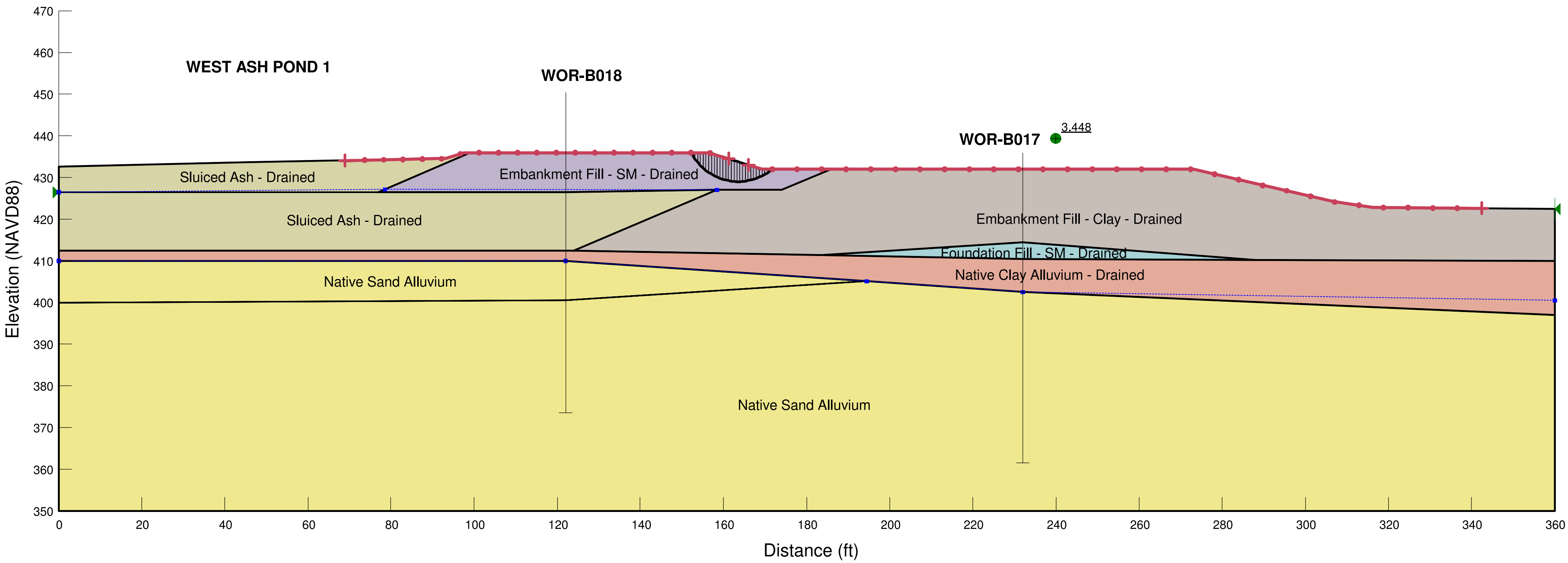
ANALYSIS: Static (Rotational), Operating Case
SEISMIC LOAD: 0 g



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Phi: 27 °
Piezometric Line: 2

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Phi: 32 °

Name: Native Clay Alluvium - Drained
Unit Weight: 130 pcf
Cohesion: 0 psf
Phi: 30 °

Name: Embankment Fill - Clay - Drained
Unit Weight: 130 pcf
Cohesion: 100 psf
Phi: 30 °

Name: Foundation Fill - SM - Drained
Unit Weight: 115 pcf
Cohesion: 0 psf
Phi: 28 °

Name: Native Sand Alluvium
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 32 °
Piezometric Line: 1

Name: Native Sand Alluvium
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 32 °

PROJECT: DYNEGY - WOOD RIVER POWER STATION
PROJECT LOCATION: ALTON, IL
AECOM PROJECT NO. : 60440115
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ANALYSIS: Post-Earthquake Condition - Rotational
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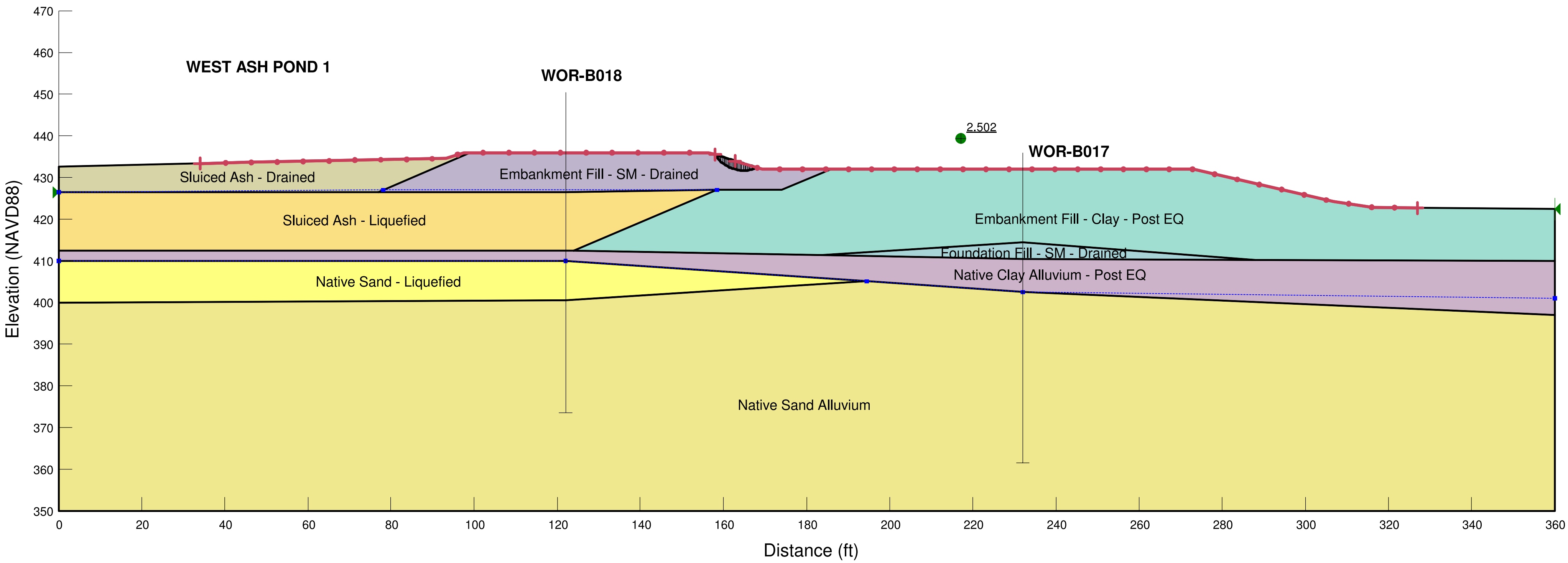

MATERIAL PROPERTIES

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Tau/Sigma Ratio: 0.06
Minimum Strength: 0
Piezometric Line: 2

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Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 32 °

Name: Native Clay Alluvium - Post EQ
Unit Weight: 120 pcf
Tau/Sigma Ratio: 0.2
Minimum Strength: 0

Name: Embankment Fill - Clay - Post EQ
Unit Weight: 130 pcf
Tau/Sigma Ratio: 0.35
Minimum Strength: 0

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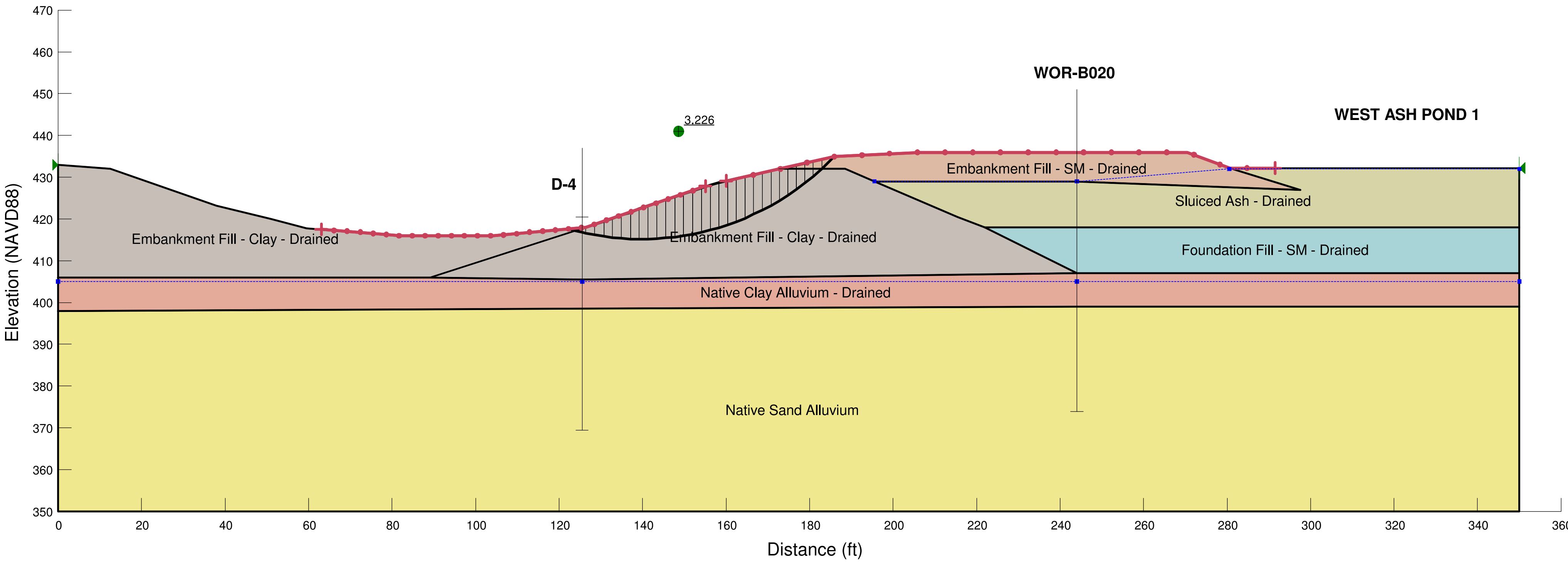
Cohesion: 0 psf
Phi: 28 °

Name: Native Sand Alluvium
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 32 °
Piezometric Line: 1

Name: Native Sand - Liquefied
Unit Weight: 115 pcf
Tau/Sigma Ratio: 0.2
Minimum Strength: 0

PROJECT: DYNEGY - WOOD RIVER POWER STATION
PROJECT LOCATION: ALTON, IL
AECOM PROJECT NO. : 60440115
CROSS SECTION: M-M (PROPOSED CLOSURE)
ANALYSIS: Static (Rotational), Operating Case
SEISMIC LOAD: 0 g



MATERIAL PROPERTIES

Name: Embankment Fill - Clay - Drained
Unit Weight: 130 pcf
Cohesion: 200 psf
Phi: 30 °

Name: Embankment Fill - SM - Drained
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 33 °

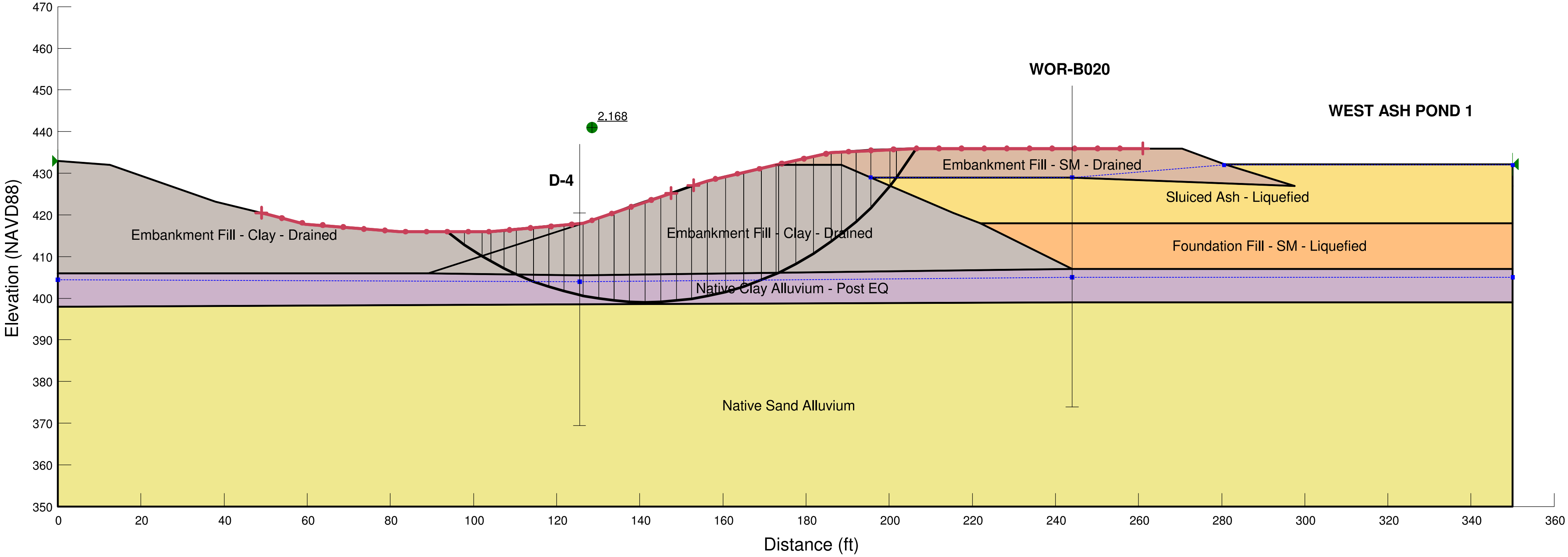
Name: Native Clay Alluvium - Drained
Unit Weight: 130 pcf
Cohesion: 0 psf
Phi: 30 °

Name: Foundation Fill - SM - Drained
Unit Weight: 115 pcf
Cohesion: 0 psf
Phi: 28 °

Name: Sluiced Ash - Drained
Unit Weight: 100 pcf
Cohesion: 0 psf
Phi: 27 °

Name: Native Sand Alluvium
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 32 °

PROJECT: DYNEGY - WOOD RIVER POWER STATION
PROJECT LOCATION: ALTON, IL
AECOM PROJECT NO. : 60440115
CROSS SECTION: M-M (PROPOSED CLOSURE)
ANALYSIS: Post-Earthquake Condition - Rotational
SEISMIC LOAD: 0 g



MATERIAL PROPERTIES

Name: Embankment Fill - Clay - Drained
Unit Weight: 130 pcf
Cohesion: 200 psf
Phi: 30 °

Name: Embankment Fill - SM - Drained
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 33 °

Name: Native Clay Alluvium - Post EQ
Unit Weight: 130 pcf
Tau/Sigma Ratio: 0.2
Minimum Strength: 0

Name: Foundation Fill - SM - Liquefied
Unit Weight: 115 pcf
Tau/Sigma Ratio: 0.08
Minimum Strength: 0

Name: Sluiced Ash - Liquefied
Unit Weight: 100 pcf
Tau/Sigma Ratio: 0.06
Minimum Strength: 0

Name: Native Sand Alluvium
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 32 °

Attorney Client Privileged

Attachment D.2
Hydrology and Hydraulics Analysis

<u>**Objective**</u>: **This analysis describes the independent investigation and design calculations and considerations of the on-site hydrology and hydraulics for closure of the West Ash Pond Complex as required by the Environmental Protection Agency's (EPA's) Final Coal Combustion Residuals (CCR) Rule. In particular, the analysis investigates the performance of the existing spillways and outlet structures for the West Ash Pond Complex during the 100-year/24-hour storm event as required by Illinois Department of Natural Resources regulations, as well as for a 100-year/24 hour storm for proposed conditions for the 30% closure design. AECOM evaluated how the onsite hydraulics will be affected by the proposed closure plan of the West Ash Pond Complex. AECOM also investigated the East Ash Ponds as they relate to concerns affecting the West Ash Pond Complex. In addition, the analyses evaluate how large flows from off-site affect the Station operations.**

I. <u>Overview</u>

Dynegy Wood River Power Station (WRPS) is located in Madison County and approximately 5 miles west of Alton, Illinois. The WRPS is effectively hydraulically divided into two sections, west and east, by the railroad east of Ponds 1 and 3.

The West Ash Pond Complex is a 50 acre inactive complex consisting of three CCR ponds, West Ash Ponds 1, 2E and 2W, separated by splitter dikes. Pond 3 acts as a stormwater polishing pond. All three CCR ponds will be closed in place using a combination of a conventional earth soil cover system and an alternative geosynthetic cover system. Pond 3 will remain operational after the closure of the West Ash Complex ash ponds.

West Ash Ponds 1, 2W, and 2E were all originally hydraulically linked as one pond, but have since been separated by previous projects completed in the 1990s. Currently, Ponds 1 and 2W are both hydraulically isolated from of the rest of the West Ash Pond Complex as they have no outlets and are completely surrounded by clay dikes. In addition, they both are no longer receiving ash. The only inflow into either pond comes from rain falling directly into them. Both ponds along with Pond 2E are to be capped and closed as a separate scope of this project.

Pond 2E and Pond 3 are hydraulically linked and are still active. Pond 2E receives both stormwater and plant process flows and Pond 3 receives only decanted water and stormwater. Plant flows into Pond 2E (approximately equal to 20.1 cubic feet per second (CFS)) travel from the southwest corner of Pond 2E where it settles, and decanted water flows into Pond 3 through a weir controlled catch basin at the northeast corner of Pond 2E. Pond 3 was originally separated into two sections, A and B, but they have since been connected into one lined pond. Pond 3 now polishes received water before it discharges into a riser and through a 24-inch HDPE pipe at the south end of the pond. The riser pipe discharges to a ditch east of the railroad track separating the west systems from the east. This discharge enters a series of ditches separated by culverts that runs along the north side of the East Ash Ponds and discharges into Wood River through a 72-inch culvert. The plant process water pipes will be rerouted to Pond 3 by others. Once Pond 1, 2W, and 2E are closed and capped, Pond 3 will receive plant process flows, stormwater runoff from these ponds (as well as the adjacent coal pile), and direct rainfall into the pond.

The East Ash Ponds consist of the Primary East Ash Pond and the Secondary East Ash Polishing Pond. The Primary East Ash Pond historically received sluiced ash and process flows from the plant aside from the flow that is pumped into the West Ash Pond Complex.

The perimeter dikes for all CCR surface impoundments on site have a "Significant" hazard rating as described in the EPA's Final Coal Combustion Residuals (CCR) Rule and by the Illinois Department of Natural Resources Title 17 Regulations.

Pond 3 is a polishing stormwater pond and not a CCR pond. Since it has a storage volume less than 1000 acre-feet it is considered to be a small Class II (Significant) dam according to IDNR Title 17 Regulations. The selected design storm under the proposed closure design shall be the 100-year/24-hour flood.

The engineering scope associated with this purpose is listed below:

- AECOM developed an existing and proposed H&H model for the west portion of the WRPS with the HydroCAD modeling program utilizing existing data, as built design drawings, and data from both an aerial survey and a ground survey performed in October 2015 (**Reference 2**). This data was supplemented with topographical LIDAR data obtained from the State. The topographical information was used to determine the offsite drainage areas. This offsite drainage area does not flow into the West Ash Pond Complex or East Ash Ponds, but it is necessary to analyze site tailwater conditions. The existing and proposed layouts of the modeling are shown in Figures 1 and 2 in **Attachment 1**. The modeling results are incorporated into this analysis with conclusions.
- HydroCAD modeling was used to estimate floods up to the 100-year flood for on-site flooding conditions, and to evaluate if off site flooding could impact the WRPS site.
- The East Ash Ponds and the West Ash Pond Complex were incorporated into the existing and proposed HydroCAD models for the entire site.
- On-site drainage was estimated from design drawings, reports, site visits, surveys and other available information and was one model included both the western and eastern systems.

- The West Ash Pond Complex consists of Pond 1, 2W, 2E, and is hydraulically connected to Pond 3. It also includes the series of ditches and culverts north of the East Ash Ponds. During large enough floods it is possible that the West Ash Pond Complex affects the flooding around the east ponds. Flooding in these areas is also a function of whether the levee is open or closed. Once the levee is closed, the low-lying area above the discharge pipe would tend to flood due to on site drainage not being able to leave the site, which is exacerbated due to discharges from Pond 3.
- The site modeling includes all impoundments, their drainage areas, and their control structures and includes all areas of the site that will act as additional storage during large floods.

II. Selected Methods:

- HydroCAD 10.00-12 was used to model the routing, storage, and conveyance of stormwater and process water flow through the ponds and ditches, and into Wood River.
- Within the HydroCAD program, runoff was calculated using the SCS TR-20 method and the routing was completed using the Dynamic Storage-Indication method, where the stage-discharge and storage-indication curves are re-evaluated at each time step, based on the current elevation of any downstream nodes. This allows the routing to respond to ongoing tailwater changes, rather than assuming static tailwater conditions. This results in a more accurate representation of controls on the system throughout a flood event.
- Drainage areas, volumes, and other site geometry were calculated using the AutoCAD 2014 Civil 3D software package.

III. Design Criteria

- Acceptance criteria for the closure design are based on whether Pond 3 and the proposed closure design for West Ash Pond Complex can pass the 100-year, 24- hour storm event without overtopping its embankments.
- All storm calculations are to include the anticipated tailwater conditions during high (100-year flood) flows on the Mississippi River and Wood River. It is assumed that during high flows on Wood River, the outlet through the levee will be closed off.
- All plant process flows along with stormwater flows from the coal pile will be routed to Pond 3.

IV. Data & Assumptions

The following is a list of assumptions and determining factors used for the HydroCAD modeling effort:

- All elevations are converted to the North American Vertical Datum of 1988 (NAVD88) from the National Geodetic Vertical Datum of 1929 (NGVD 29) which is about 1.5 inches lower than the NAVD88 datum.
- The storage areas north of the West Ash Pond Complex and the East Ash Ponds were derived from LIDAR information data. (**Reference 1**).
- There are no emergency spillways for the western or eastern stormwater systems at the site.
- The normal operating water surface elevations of the interior ponds, on-site berm elevations, control structure inverts, and other relevant hydraulic controls are taken from a site survey performed October, 2015 (**Reference 2**), from design drawings, and LIDAR information. The normal operating pool for Pond 3 was derived from the modeled steady-state condition using an estimated base flow of 20.1 cfs. This was estimated from the Wastewater Flow Diagram (**Reference 8**).
- Offsite drainage areas were estimated from the Alton Quadrangle and the Columbia Bottom Quadrangle topo from The National map **(References 3 and 4)**.
- The Mississippi River and Wood River 100-year flood elevation, as determined by the FEMA Flood Profile as shown in **Attachment 3**, was used for the worst-case tailwater condition (**References 5 and 6**).
- The maximum 100-year water surface elevation for Wood River at the discharge point of the final 72-inch CMP is due to Mississippi River backwater and is taken from the FEMA Flood Profile (**Reference 6**) for Wood River located in the Madison County Flood Insurance Study (**Reference 7**). The 100-year water surface elevation for Wood River and the Mississippi River is 437.0 ft.
- There is a large offsite storage area northwest of Pond 2W that collects the western portion of the offsite drainage area. This drainage area lies just north of the US Army Corps of Engineers pump station and stores stormwater up to an elevation of roughly 413.0 ft with a maximum surface area of about 31 acres.
- The expected maximum volume of process flows being discharged into Pond 3 is approximately 20.1 CFS (**Reference 8**).

V. Hydrology

The analysis of the West Pond Complex consists of estimating the watershed hydrology, the onsite storage area, the drainage control parameters, and the Wood River tailwater conditions. The on-site analysis consists of estimating the on-site drainage areas, storage area of the ash ponds and the capacity of the conveyance structures.

Pond storage areas were calculated by using AutoCAD Civil 3D and used as inputs into the HydroCAD model. Weirs and other control structure dimensions and elevations were taken from design plans, surveys, LIDAR data, and existing reports.

The description of what was used in the analysis is as follows:

West Pond Complex Drainage System

Proposed Conditions

Proposed Drainage Area – Survey and USGS

The proposed conditions include installation of a graded cap installed over Pond 2W, 2E and Pond 1. The cap that will be installed over Ponds 2W and 2E will have 2 channels graded into it that each flow into Pond 3 through a 24-inch pipe. The southern ditch has an approximate drainage area of 14.99 acres and the northern ditch has an approximate drainage area of 10.07 acres. The cap that will be installed over Pond 1 will have 3 channels graded into it that each flow into Pond 3 through a 24-inch pipe. The westernmost channel has an approximate drainage area of 7.32 acres. The middle channel has an approximate drainage area of 7.66 acres. The easternmost channel has an approximate drainage area of 5.73 acres. The drainage areas for proposed Pond 1 and Ponds 2E and 2W are confined to the area within their perimeter berms as shown on the clip below of the proposed Western Pond Complex.

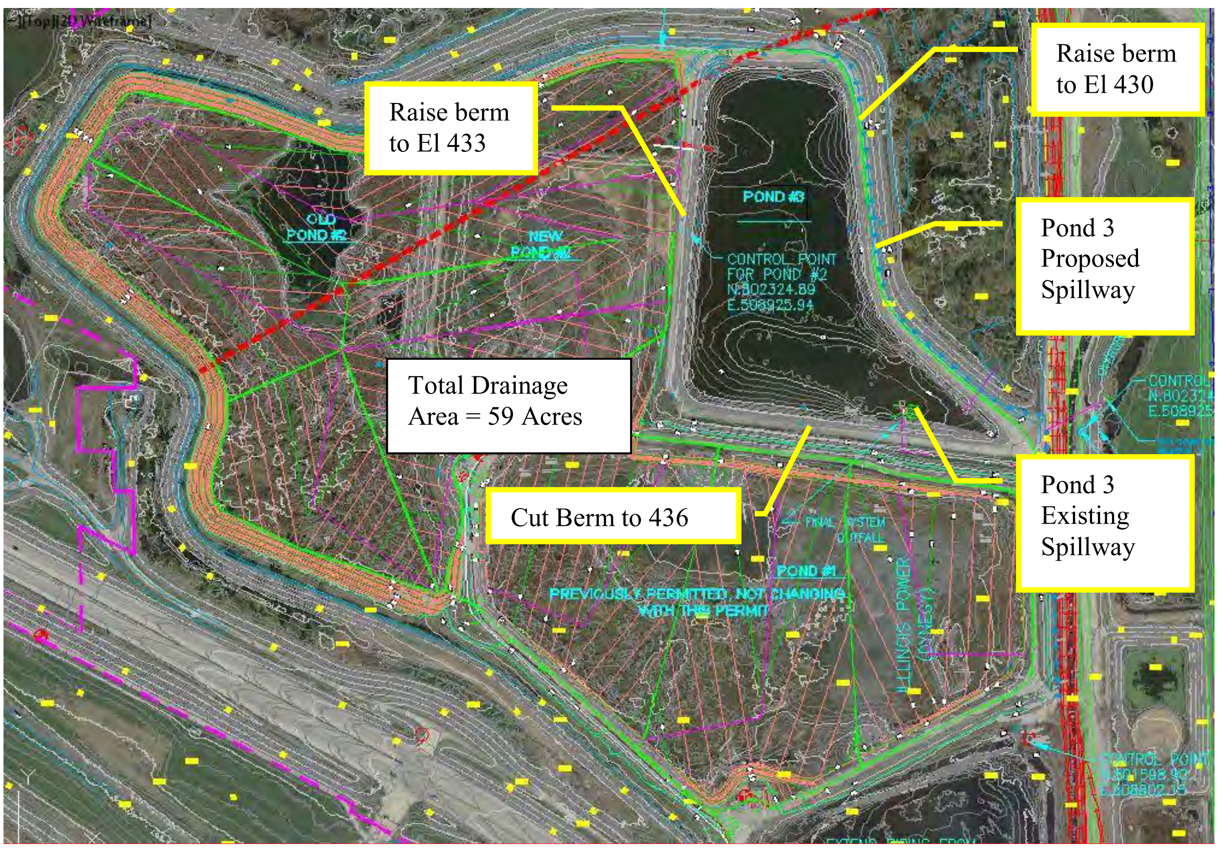
The proposed drainage area for the total watershed in the Western Pond Complex was estimated to be 59 acres. The digital elevation model (DEM) developed from LIDAR data was developed from the site survey performed October, 2015 (**Reference 2**).

AECOM developed the DEM of the site and the surrounding area with a 5-foot grid size to estimate the drainage area, pond storage areas and flow patterns as shown in the clip below. In this manner, the most accurate available information for the area was used to confirm that the watershed divide are accurately estimated. Based on the surveys, DEM, and USGS quadrangle, AECOM estimated the watershed drainage area to be 59 acres.

Proposed Watershed Data – CN, Flow Length, Land Use, Tc

AECOM used information from the site survey to calculate storage. For the drainage area to the northern ditch of the Pond 2E and 2W cap, a CN of 84 and a time of concentration of 11.4 minutes were used. For the drainage area to the southern ditch of the Pond 2E and 2W cap, a CN of 84 and a time of concentration of 12.1 minutes were used. For the drainage area to the western ditch of the Pond 1 cap, a CN of 84 and a time of concentration of 12.2 minutes were used. For the drainage area to the middle ditch of the Pond 1 cap, a CN of 84 and a time of concentration of 13.6 minutes were used. For the drainage area to the eastern ditch of the Pond 1 cap, a CN of 84 and a time of concentration of 12.1 minutes were used. The curve number of 84 was used for all flow over the cap system.

As part of the closure, the embankment around Pond 3 will need be raised to elevation of 430.0 ft is sufficient to allow 0.5 feet of freeboard during the 100-year flood. The embankment between Pond 2E and Pond 3 will need to be raised to an elevation of 433.0 ft and the embankment between Pond 1 and Pond 3 will be lowered to an elevation of 436.0 ft. As a result of these configurations around the perimeter of Pond 3, all of the access roads surrounding the pond will drain into it. This added drainage area is estimated to be 4.63 acres with a CN of 84 and a time of concentration of 2.2 minutes.



Clip of AutoCAD Civil 3-D showing West Pond Complex Drainage Areas

Proposed Storage Areas

AECOM used information from the proposed surfaces to calculate proposed storage areas for the analysis, which included all the ponded areas above Pond 3. Existing storages that will not change in the proposed conditions model were not revised. Original storage areas were used for the area east of the railroad near the West Ash Pond Complex, where stormwater discharges from Pond 3.

To calculate all of the storage areas, AECOM used the AutoCAD Civil 3D to determine stage storage relationships from the proposed surface data. In this manner, accurate estimated stage-storage relationships are used to calculate storage. AECOM used the cumulative storage at each stage as input in HydroCAD to calculate how much the storage attenuates flood discharges.

Using the stage-storage relationships for the pond system, the flood peak attenuation due to storage was estimated for the proposed cap system, as was the maximum water surface in Pond 3. Water surface elevations in each basin were calculated to determine if raising of the embankments are required due to lack of capacity. Flooding impacts were evaluated to develop flood improvement alternatives for the West Ash Pond Complex.

The clip on the previous page depicts the locations of the West Ash Pond Complex units and depiction of the proposed HydroCAD modeling that shows the drainage areas and storage areas that will convey flows to Pond 3 which will discharge from the existing spillway. It also depicts the East Ash Ponds which discharge to Wood River.

The top of the eastern embankment is set to 430.0 ft to have a minimum of 0.5 feet of freeboard during the design storm and to allow for dewatering of the pond to prevent subsequent storms from overtopping the pond.

Western Pond Complex Drainage System

Rainfall Information and Distributions

The rainfall information used in the HydroCAD modeling was based on the NOAA Atlas 14, Volume 8, Version 2 (**Reference 10**) which provides rainfall data for storm events with average recurrence intervals ranging from 1 to 1,000 years and durations ranging from 5 minutes to 60 days. The data obtained from the NOAA website is presented in **Attachment 2** and the NOAA depths used for the AECOM modeling are provided below. The maximum estimated rainfall depths were used in the modeling to be conservative.

The following chart shows the rainfall depths and recurrence intervals for the storms modeled, in addition to the distributions applied to the rainfall depth.

Return Period (Years)	Rainfall Depth (Inches)	Duration (Hours)	Rainfall Distribution
10-year	5.47	24	SCS Type II
25-year	6.95	24	SCS Type II
50-year	8.06	24	SCS Type II
100-year	9.38	24	SCS Type II

The SCS Type II storm, 24-hour rainfall distribution used by AECOM is appropriate to use for storms up to the 100-year flood at the project site.

In addition to the 100-year storm, AECOM estimated the smaller storms for comparison and to allow for only pipe full conditions during the 25-year storm in the ponded areas upstream of Pond 3. The rainfall depths used in the analysis are dependent on the return period of the storm, but their distribution is not.

Wood River/Mississippi River Water Levels

The final outfall of the West Pond Complex is through a 72-inch pipe controlled by the Wood River Drainage and Levee District (WRDLD) that discharges into Wood River. The WRDLD controls when the pipe through the levee will be closed and monitors high water conditions of Wood River and the Mississippi River. Since the 72-inch CMP discharge directly into Wood River, high water surface elevations in the river will submerge the pipe and reduce its capacity. The 72-inch pipe was assumed to be closed during high water levels on the river to determine tailwater effects on the Pond 3 spillway performance.

The maximum 100-year water surface elevation of Mississippi River was used to model high tailwater conditions as a worst case scenario. In this condition, the 72-inch discharge pipe through the levee was considered closed. For the high water level, the FEMA Flood Insurance Study Flood Profile (**Reference 7**) was used to estimate the water surface elevation at the outlet point of the 72-inch pipe. The 100-year water surface elevation that AECOM calculated off of the Flood Insurance Rate maps is 437.0 ft, which was used in the AECOM HydroCAD modeling for high tailwater conditions. For low water conditions, the river level was assumed to be below the culvert outlet invert elevations and the culverts remain inlet controlled. Low flow conditions on the river do not influence the culverts' performance and the culverts' outlets are in free discharge conditions. AECOM used a low flow river elevation of 395.5 ft (**Reference 12**) in the models.

The required drawdown for the site is based on the Programmatic Document which requires that the ash ponds shall be drained to normal pool within 3 days after the design storm. None of the West Ash Pond Complex ponds are controlled by high water elevation of Wood River or the Mississippi River.

In addition, TR-60 Guidelines suggests that the required drawdown at a critical facility shall be 85% of the inflow volume released within 10-days. To drain 85% of the design inflow volume in the current pond system, if the Mississippi River was at low or high stage, it would take approximately 1 day to drain Pond 3.

The Pond 3 primary spillway acts as a drawdown structure to drain 85% of the proposed design inflow volume from the pond within the required time. Drawdown calculations are provided in in the HydroCAD output in **Attachment 4**.

VI. Hydraulics

All hydraulic modeling was done on HydroCAD using information from the aforementioned LIDAR data, site survey, and as-built drawings provided by Dynegy. Storage areas were calculated based on the most recent topography while inverts and other details for outlet structures were taken from surveys and as built drawings.

Manning's Roughness Coefficient (n-value)

Manning's values were selected on HydroCAD based on the material of each conveyance structure. Each 24-inch pipe draining the ditches on the proposed caps used a Manning's number of 0.012.

Headwall Inlet Losses

The AECOM HydroCAD model incorporated the same head loss coefficient for each outlet. Unless otherwise specified, a square edged concrete headwall was selected in the HydroCAD model. This is the most conservative approach.

Road Weir Length, Geometry, and Weir Coefficients

- Discharges over roads are most accurately modeled using the broad-crested weir equation. The HydroCAD modeling included broad crested weirs at the perimeters of each pond and each miscellaneous drainage area.

$$Q = C \times L \times H^{1.5}$$

Where Q = Flow over weirs,

L = Crest length

H = Head above invert elevation

C = Weir coefficient, variable based on head and breadth of weir

	Weir Breadth--(ft)										
Head	0.50	0.75	1.00	1.50	2.00	2.50	3.00	4.00	5.00	10.0	15.0
0.2	2.80	2.75	2.69	2.62	2.54	2.48	2.44	2.38	2.34	2.49	2.68
0.4	2.92	2.80	2.72	2.64	2.61	2.60	2.58	2.54	2.50	2.56	2.70
0.6	3.08	2.89	2.75	2.64	2.61	2.60	2.68	2.69	2.70	2.70	2.70
0.8	3.30	3.04	2.85	2.68	2.60	2.60	2.67	2.68	2.68	2.69	2.64
1.0	3.32	3.14	2.98	2.75	2.66	2.64	2.65	2.67	2.68	2.68	2.63
1.2	3.32	3.20	3.08	2.86	2.70	2.65	2.64	2.67	2.66	2.69	2.64
1.4	3.32	3.26	3.20	2.92	2.77	2.68	2.64	2.65	2.65	2.67	2.64
1.6	3.32	3.29	3.28	3.07	2.89	2.75	2.68	2.66	2.65	2.64	2.63
1.8	3.32	3.32	3.31	3.07	2.88	2.74	2.68	2.66	2.65	2.64	2.63
2.0	3.32	3.31	3.30	3.03	2.85	2.76	2.72	2.68	2.65	2.64	2.63
2.5	3.32	3.32	3.31	3.28	3.07	2.89	2.81	2.72	2.67	2.64	2.63
3.0	3.32	3.32	3.32	3.32	3.20	3.05	2.92	2.73	2.66	2.64	2.63
3.5	3.32	3.32	3.32	3.32	3.32	3.19	2.97	2.76	2.68	2.64	2.63
4.0	3.32	3.32	3.32	3.32	3.32	3.32	3.07	2.79	2.70	2.64	2.63
4.5	3.32	3.32	3.32	3.32	3.32	3.32	3.32	2.88	2.74	2.64	2.63
5.0	3.32	3.32	3.32	3.32	3.32	3.32	3.32	3.07	2.79	2.64	2.63
5.5	3.32	3.32	3.32	3.32	3.32	3.32	3.32	3.32	2.88	2.64	2.63

Broad Crested Weir Coefficients

- The weir lengths estimated for each elevation are not fixed, but vary based upon depth of flow and the surveyed topography. The flow lengths are dynamically calculated in HydroCAD based upon the depth of flow at each time interval.
- The overtopping weir lengths were taken from the road information developed in the LIDAR survey, as it was considered the most accurate information. The weir lengths were calculated in AutoCAD Civil 3D. The survey was used to estimate inverts (low points on the crown of the roads/top of railroad tracks) for the broad crested overtopping weirs.
- The broad crested weir coefficient is a function of depth of flow, and the weir geometry controls depth. The overtopping width of the road weir is over 15-feet and the weir coefficient is expected to range from 2.63 to 2.70. A weir coefficient of 2.70 was used to model the road weirs to be conservative. The railroad track control width is approximately 7 ft and the weir coefficient is expected to range from 2.40 to 2.68 based on the anticipated maximum depth of 1 ft. A weir coefficient of 2.68 was used to model the railroad track weirs as they are less efficient, and to be conservative.

VII. Results

HydroCAD H&H Model Output –Proposed Conditions

Table 1 below summarizes the results of AECOM's HydroCAD model for the proposed site conditions. Refer to **Attachment 4** for the associated detailed HydroCAD output reports.

Table 1 - Flooding Scenarios for Proposed conditions

Storage Area	Flood Event	Qpeak in (cfs)	Qpeak out (cfs)	Storage[1] (acre-feet)	Max WSE(ft)
Pond 1 cap west ditch	100-yr/24-hr	126	21	1.91	431.20
Pond 1 cap middle ditch	100-yr/24-hr	93	23	2.96	430.72
Pond 1 cap east ditch	100-yr/24-hr	57	17	1.06	430.51
Pond 2 cap North Ditch	100-yr/24-hr	104	29	1.64	431.88
Pond 2 cap South Ditch	100-yr/24-hr	142	29	1.65	431.91
Pond 3	100-yr/24-hr	276.9	97.3	42.4	429.6

[1] The storage is the amount of water stored in the area upstream of the outlet structure

It should be noted that **Table 1** represents the proposed conditions "worst-case" scenario for the 100-yr/24-hr storm with the outlet to Wood River closed off. The top of the adjacent road is verified by the surveyed low point on each road and is the overtopping control elevation. The weir lengths were also taken from the aerial survey and weir coefficients are estimated based on flow depth.

Pond 2W and 2E

- Ponds 2W and 2E will be regraded and capped. There will be two ditches, north and south, that convey the stormwater runoff from each of their respective drainage areas.
- Both ponds have a 24-inch culvert to convey their stormwater into Pond 3. Culverts were designed to pass the 25-year storm at pipe full conditions, and attenuate the 100-year storm.
- The only inflow into these ditches is the rainfall that falls directly onto the cap, as there is no run-on to the cap system. The northern ditch has a storage area of 4 acre-feet. The southern ditch has a storage area of 3.36 acre-feet.

- The road between Pond 2E and Pond 3 will need to be raised to an elevation of 433.0 ft to avoid overtopping during the 100-year flood. In addition, the liner for the pond must be at or above an elevation of 427.0 ft.

Pond 1

- Pond 1 will be regraded and capped. There will be three ditches, east, middle, and west, that convey the stormwater runoff from each of their respective drainage areas.
- All three ditches will have a 24-inch culvert to convey the stormwater into Pond 3. Culverts were designed to pass the 25-year storm at pipe full conditions, and attenuate the 100-year storm.
- The only inflow into these ditches is the rainfall that falls directly onto the cap, as there is no run-on to the cap system. The western ditch has a storage area of 6.51 acre-feet. The middle ditch has a storage area of 12.06 acre-feet. The eastern ditch has a storage area of 7.34 acre-feet.
- The road between Pond 1 and Pond 3 is to be lowered to an elevation of 436.0 ft to minimize elevation differences in the access road. The liner for Pond 3 should be at or above an elevation of 427.0 ft.

Pond 3

- Pond 3 will be hydraulically connected to Ponds 2E, 2W, and 1.Pond 3 will also receive rainwater that falls directly onto Pond 3 and its surrounding embankments.
- It is estimated that Pond 3 will receive approximately 20.1 CFS of plant process flows. This was estimated from the Wastewater Flow Diagram (**Reference 8**).
- The pond has a live storage volume of 49.1 acre-feet.
- The Pond 3 existing spillway will not be modified in the proposed conditions, however an emergency spillway will need to be constructed.
- The proposed emergency spillway will have a bottom width of 15 feet with 10H:1V side slopes to allow for vehicle traffic. It has an invert elevation of 428.5 feet and shall be lined with a minimum of 30 inches thick of grouted IDOT RR 7 Stone with 12 inches of bedding. The relevant calculations can be found in **Attachment 5**.
- With the updated LIDAR survey data, the elevation of the lowest portions of the access road around Pond 3 was shown to be 428.0 ft. With all of the new inflows from plant process water, Ponds 2W, 2E and 1 the maximum water surface elevation of Pond 3 gets to 429.6 ft. To maintain 0.5 feet of freeboard during the 100-year flood, it will be necessary to the access road at an elevation of at least 430.0 ft.

- The water that leaves Pond 3 through the original outlet structure still travels through a series of ditches and culverts north of the East Ash Ponds before finally reaching the 72-inch CMP that drains into Wood River.
- The 100-year inflow into the pond is 276 cfs , with a discharge of 97.3 cfs and a peak elevation of 429.6 ft.
- With AECOM's proposed design, there is no overtopping from the 100-year flood.
- The inlet and outlet inverts for the 72-inch CMP are below the 100-year water surface of Mississippi River. The Pond 3 primary spillway discharge is a function of the downstream tailwater. The 72-inch CMP would need to be closed to prevent the site from being submerged by the Mississippi River during its 100-year peak. Closure of the 72-inch CMP due to high water levels on Mississippi River would affect the tailwater condition of the Pond 3 primary spillway.

VIII. Conclusions/Recommendations

The following conclusions and recommendations are based on the Existing Conditions HydroCAD model of the West Ash Pond Complex.

Conclusions

- There is no anticipated overtopping of the West Ash Pond Complex or the East Ash Ponds during the 100-year flood in the existing conditions.
- West Ash Ponds 1, 2W, 2E, and 3 have no overtopping during the 100-year/24-hr flood that is required per the IDNR regulations.
- The 72-inch CMP that outlets into Wood River will need to be closed during semi-recurrent intervals due to backwater from the Wood River and Mississippi River to prevent flooding of the site. The 100-year flood elevation of the Mississippi River is 437.0 ft.
- All on-site and off-site drainage areas are able to contain the 100-year/24-hr flood within the site without overtopping and potentially failing ash pond embankments.
- The extent of the ponded water upstream of the 72-inch CMP remains within the property boundaries during the 100-year flood with Wood River at its normal pool elevation.
- Existing West Ash Ponds 1, 2W, 2E, and Pond 3 all have 0.5 ft of freeboard during the 100-year/24-hr flood.

Recommendations

The following recommendations were developed based on the results of the hydrologic and hydraulic analysis of the existing on-site drainage conditions and are based on the Existing and Proposed Conditions HydroCAD models of the West Ash Pond Complex.

- It is recommended that each ditch in the Pond West Ash 2E, 2W, and 1 cap drains into a separate 24-inch culvert that drains into Pond 3. The inverts will vary and are provided as part of the HydroCAD output in **Attachment 4.**
- It is recommended that the road between West Ash Pond 2E and Pond 3 is raised to an elevation no less than 433.0 ft to avoid overtopping into Pond 3. In addition, it is recommended that the road between Pond 1 and Pond 3 be lowered to an elevation no more than 436.0 ft to minimize grade changes on the access road.
- It is recommended that a minimum of 0.5 ft of freeboard is maintained on the ponds during the 100-year flood. The north and eastern portions of the access road surrounding Pond 3 should be raised to an elevation of 430.0 ft due to the peak

100-year water surface elevation of 429.6 ft. The access road between Pond 2 and Pond 3 should be maintained at a constant elevation of 433.0 ft due to the peak 100-year water surface elevation of 432.0 ft in Pond 2E.

IX. References

1) LIDAR Survey, Illinois Geospatial Data Clearinghouse, Prairie Research Institute, 2014.

2) Topographical Survey, Weaver Consulting Group, October 2015.

3) Alton Quadrangle,7.5-minute series , Alton, Illinois, U.S. Topo, The National Map, U.S. Geological Survey, United States Department of the Interior, 2015.

4) Columbia Bottom Quadrangle,7.5-minute series , Alton, Illinois, U.S. Topo, The National Map, U.S. Geological Survey, United States Department of the Interior, 2015.

5) Flood Profile, Mississippi River, FEMA Flood Insurance Study page 24, Madison County, Illinois, Effective January, 1980.

6) Flood Profile, Wood River, FEMA Flood Insurance Study page 25, Madison County, Illinois, Effective January, 1980.

7) FEMA Flood Insurance Study, Madison County, Illinois, Effective January, 1980.

8) Wastewater Flow Diagram Wood River Power Station, Illinois Power Company, Plotted 8-18-1988.

9) Technical Release 55 (TR-55), Urban Hydrology for Small Watersheds, United States Department of Agriculture (USDA), 1986.

10) NOAA Atlas 14, Precipitation-Frequency Atlas of the United States, Volume 8, Version 2, 2013. http://hdsc.nws.noaa.gov/hdsc/pfds/index.html.

11) NOAA Hydrometeorological Report No. 51 (HMR-51) "Probable Maximum Precipitation Estimates, United State East of the 105th Meridian", dated June, 1978.

12) River and Reservoir Daily Report, U.S Army Corps of Engineers, St. Louis District, Dated November 11, 2015.

13) Design Drawings, East Ash Pond, Wood River Power Station, URS Corp., 2006.

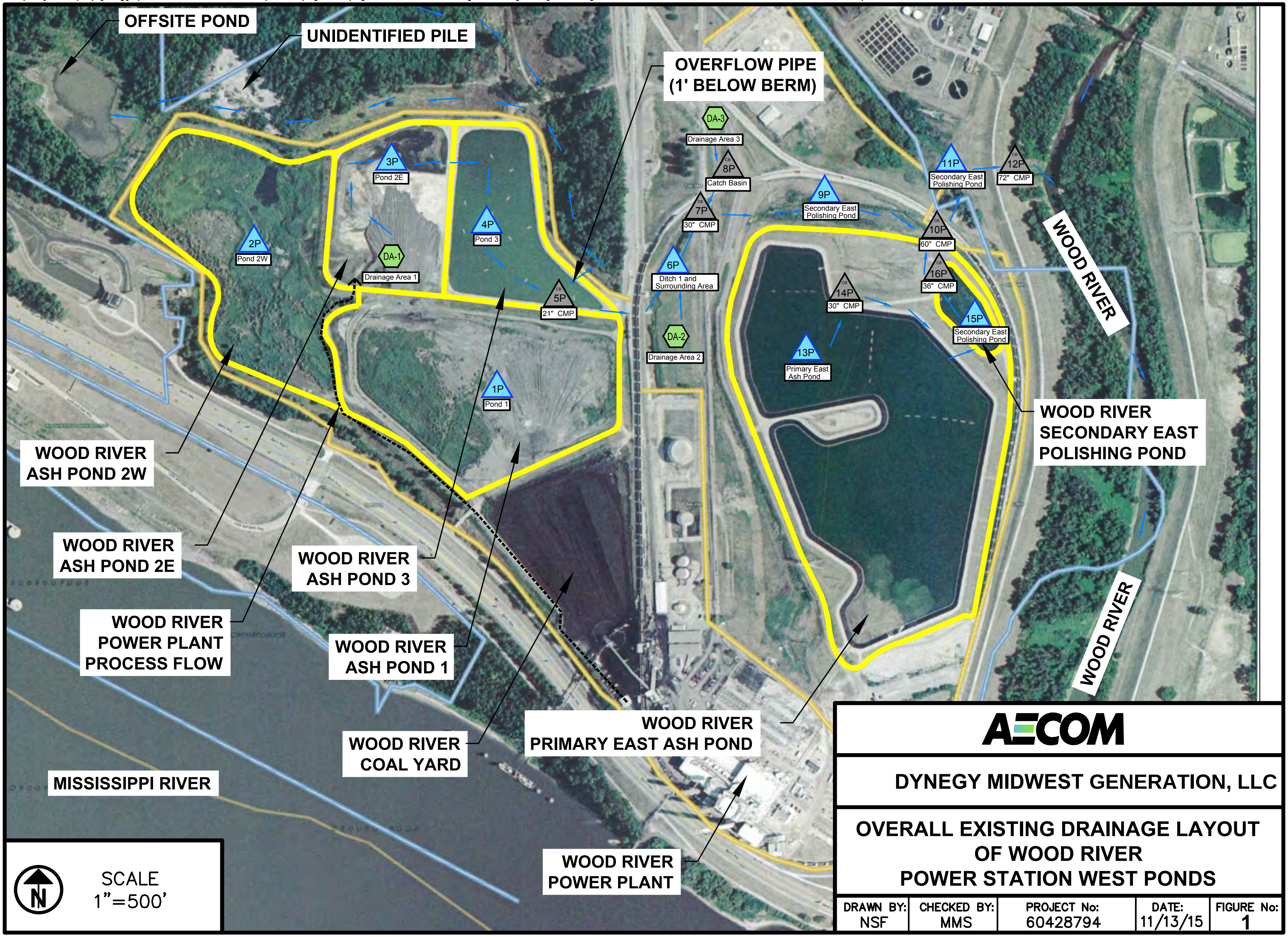
List of Figures

List of Attachments

ATTACHMENT 1

AUTOCAD FIGURES

K:\Projects\D\Dynegy\60428794_WoodRiver\DWGs\Figures\Fig 1_Overall Existing Drainage Layout.dwg User: michael_shore Nov 11, 2015 – 6:01pm



AECOM

DYNEGY MIDWEST GENERATION, LLC

OVERALL EXISTING DRAINAGE LAYOUT OF WOOD RIVER POWER STATION WEST PONDS

DRAWN BY:	CHECKED BY:	PROJECT No:	DATE:	FIGURE No:
NSF	MMS	60428794	11/13/15	1

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AECOM

DYNEGY MIDWEST GENERATION, LLC.

OVERALL PROPOSED DRAINAGE LAYOUT OF WOOD RIVER POWER STATION WEST POND COMPLEX

DRAWN BY:	CHECKED BY:	PROJECT No:	DATE:	FIGURE No:
NSF	MMS	60428794	11/13/15	2

AECOM

ATTACHMENT 2

WOOD RIVER, ILLINOIS, US, POINT PRECIPITATION FREQUENCY ESTIMATES

NOAA Atlas 14, Volume 8, Version 2
Location name: Wood River, Illinois, US*
Latitude: 38.8587°, Longitude: -90.1131°
Elevation: 425 ft*
* source: Google Maps

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Deborah Martin, Sandra Pavlovic, Ishani Roy, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Michael Yekta, Geoffery Bonnin

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.369 (0.293-0.464)	0.433 (0.344-0.544)	0.536 (0.425-0.676)	0.621 (0.490-0.785)	0.737 (0.563-0.948)	0.825 (0.619-1.07)	0.913 (0.665-1.20)	1.00 (0.704-1.34)	1.11 (0.758-1.52)	1.20 (0.800-1.66)
10-min	0.540 (0.429-0.679)	0.634 (0.503-0.797)	0.785 (0.622-0.990)	0.910 (0.717-1.15)	1.08 (0.825-1.39)	1.21 (0.906-1.57)	1.34 (0.974-1.76)	1.46 (1.03-1.97)	1.63 (1.11-2.23)	1.76 (1.17-2.43)
15-min	0.658 (0.523-0.828)	0.773 (0.614-0.972)	0.958 (0.759-1.21)	1.11 (0.875-1.40)	1.32 (1.01-1.69)	1.47 (1.10-1.91)	1.63 (1.19-2.15)	1.79 (1.26-2.40)	1.99 (1.35-2.72)	2.14 (1.43-2.97)
30-min	0.939 (0.747-1.18)	1.11 (0.879-1.39)	1.38 (1.09-1.73)	1.60 (1.26-2.02)	1.89 (1.44-2.43)	2.12 (1.59-2.75)	2.34 (1.70-3.08)	2.56 (1.80-3.43)	2.84 (1.93-3.88)	3.05 (2.03-4.22)
60-min	1.22 (0.968-1.53)	1.43 (1.13-1.79)	1.77 (1.40-2.23)	2.05 (1.62-2.59)	2.45 (1.87-3.16)	2.75 (2.07-3.58)	3.06 (2.23-4.05)	3.38 (2.38-4.54)	3.80 (2.59-5.21)	4.12 (2.75-5.70)
2-hr	1.50 (1.20-1.86)	1.75 (1.40-2.17)	2.16 (1.73-2.69)	2.51 (2.00-3.14)	3.00 (2.33-3.85)	3.39 (2.58-4.38)	3.79 (2.79-4.98)	4.20 (2.99-5.62)	4.76 (3.27-6.49)	5.19 (3.48-7.14)
3-hr	1.67 (1.35-2.06)	1.93 (1.56-2.39)	2.38 (1.92-2.95)	2.77 (2.22-3.44)	3.33 (2.61-4.26)	3.79 (2.90-4.88)	4.26 (3.17-5.59)	4.76 (3.41-6.36)	5.46 (3.77-7.42)	6.00 (4.04-8.23)
6-hr	1.99 (1.63-2.43)	2.28 (1.87-2.79)	2.80 (2.29-3.43)	3.27 (2.65-4.02)	3.97 (3.15-5.05)	4.55 (3.53-5.83)	5.17 (3.88-6.74)	5.83 (4.22-7.75)	6.77 (4.72-9.17)	7.52 (5.11-10.2)
12-hr	2.35 (1.95-2.84)	2.69 (2.23-3.26)	3.31 (2.73-4.01)	3.88 (3.18-4.71)	4.72 (3.79-5.97)	5.44 (4.26-6.92)	6.21 (4.71-8.04)	7.04 (5.14-9.29)	8.22 (5.78-11.1)	9.18 (6.27-12.4)
24-hr	2.75 (2.30-3.28)	3.16 (2.64-3.77)	3.89 (3.24-4.66)	4.55 (3.78-5.47)	5.56 (4.51-6.95)	6.41 (5.07-8.06)	7.31 (5.60-9.38)	8.29 (6.10-10.9)	9.69 (6.87-13.0)	10.8 (7.44-14.5)
2-day	3.18 (2.70-3.76)	3.67 (3.11-4.34)	4.54 (3.83-5.37)	5.31 (4.46-6.31)	6.47 (5.30-7.98)	7.43 (5.93-9.25)	8.45 (6.52-10.7)	9.55 (7.08-12.4)	11.1 (7.92-14.7)	12.3 (8.55-16.5)
3-day	3.49 (2.98-4.09)	4.04 (3.44-4.74)	4.99 (4.24-5.87)	5.83 (4.93-6.89)	7.08 (5.82-8.66)	8.10 (6.50-10.0)	9.17 (7.12-11.6)	10.3 (7.68-13.3)	11.9 (8.54-15.7)	13.2 (9.19-17.6)
4-day	3.75 (3.22-4.38)	4.34 (3.72-5.07)	5.35 (4.57-6.26)	6.23 (5.29-7.32)	7.52 (6.21-9.15)	8.57 (6.90-10.5)	9.66 (7.52-12.1)	10.8 (8.08-13.9)	12.4 (8.93-16.3)	13.7 (9.57-18.2)
7-day	4.46 (3.86-5.15)	5.09 (4.41-5.89)	6.17 (5.32-7.15)	7.09 (6.08-8.26)	8.42 (6.99-10.1)	9.47 (7.68-11.5)	10.6 (8.27-13.1)	11.7 (8.79-14.9)	13.3 (9.57-17.3)	14.5 (10.2-19.1)
10-day	5.08 (4.43-5.84)	5.76 (5.02-6.62)	6.89 (5.98-7.94)	7.85 (6.77-9.08)	9.20 (7.68-11.0)	10.3 (8.36-12.4)	11.4 (8.93-14.0)	12.5 (9.40-15.8)	14.0 (10.1-18.2)	15.2 (10.7-20.0)
20-day	6.86 (6.05-7.79)	7.70 (6.79-8.74)	9.06 (7.96-10.3)	10.2 (8.89-11.6)	11.7 (9.87-13.8)	12.9 (10.6-15.3)	14.1 (11.2-17.1)	15.2 (11.6-19.1)	16.8 (12.2-21.6)	17.9 (12.7-23.4)
30-day	8.33 (7.40-9.39)	9.33 (8.28-10.5)	10.9 (9.68-12.4)	12.2 (10.8-13.9)	14.0 (11.8-16.3)	15.3 (12.6-18.0)	16.6 (13.2-20.0)	17.8 (13.6-22.1)	19.4 (14.2-24.8)	20.6 (14.7-26.8)
45-day	10.2 (9.12-11.4)	11.4 (10.2-12.8)	13.4 (11.9-15.0)	14.9 (13.2-16.8)	17.0 (14.4-19.5)	18.4 (15.3-21.6)	19.9 (15.9-23.8)	21.2 (16.2-26.2)	22.9 (16.8-29.1)	24.1 (17.3-31.3)
60-day	11.8 (10.6-13.1)	13.2 (11.9-14.7)	15.5 (13.9-17.3)	17.2 (15.3-19.3)	19.5 (16.7-22.4)	21.2 (17.7-24.7)	22.7 (18.3-27.1)	24.2 (18.6-29.7)	26.0 (19.1-32.8)	27.2 (19.5-35.2)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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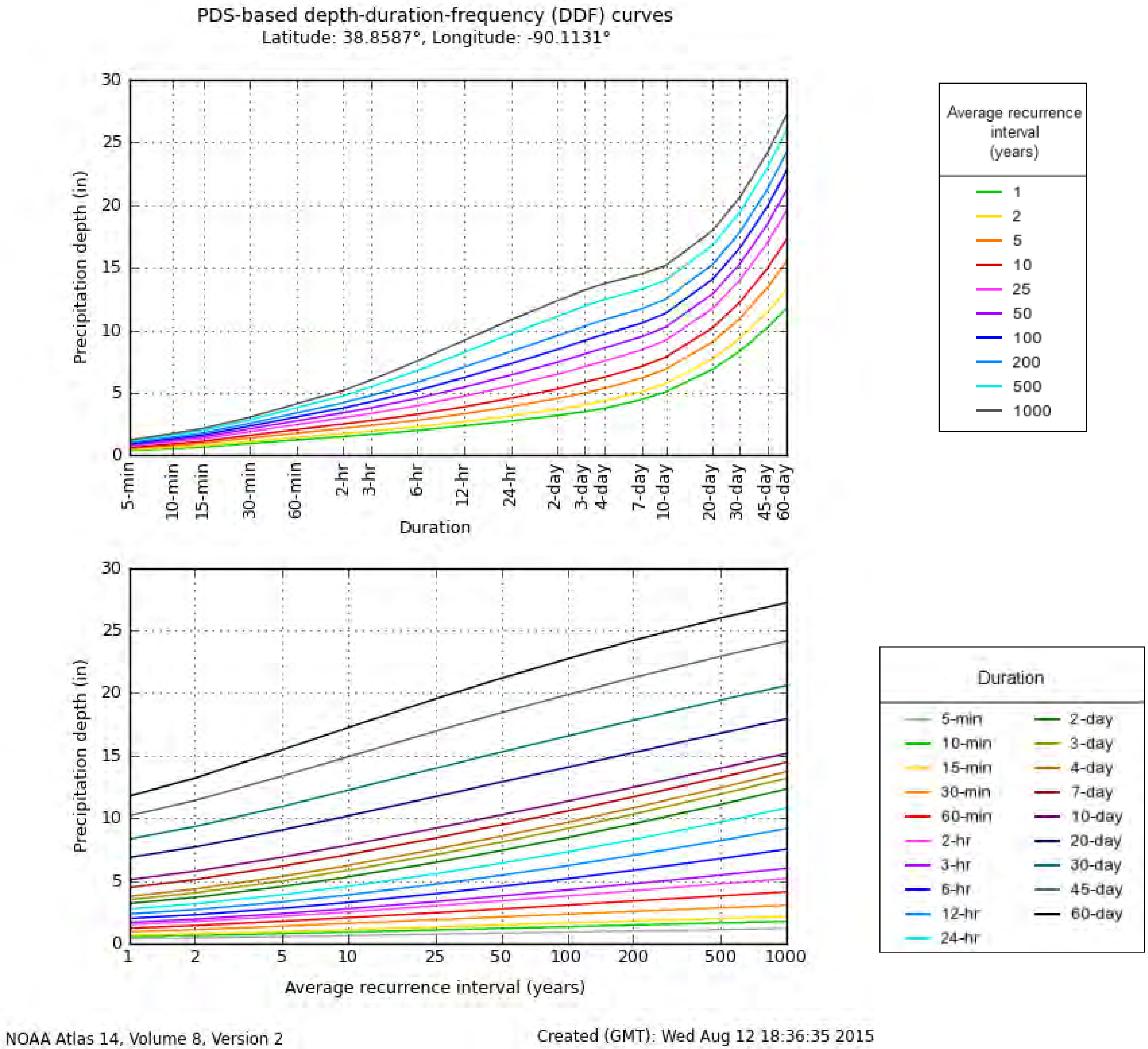
PF graphical



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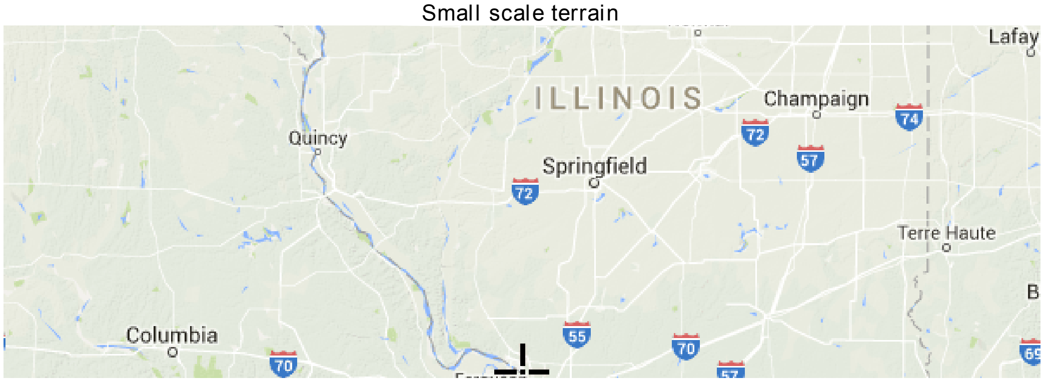
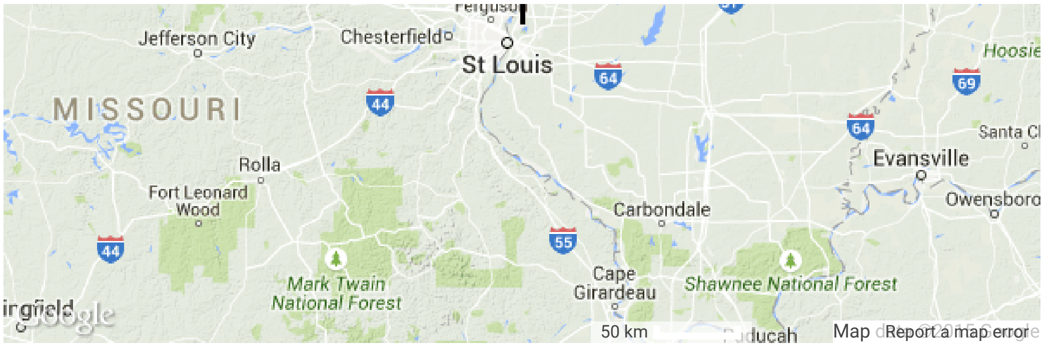
Maps & aerials

Small scale terrain





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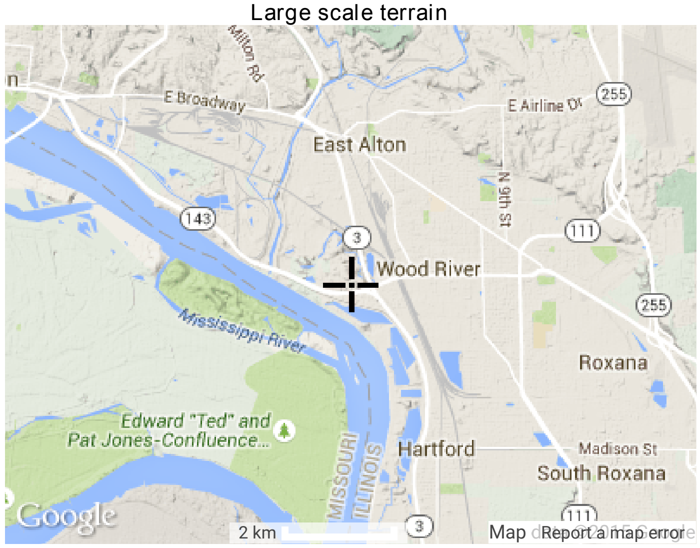
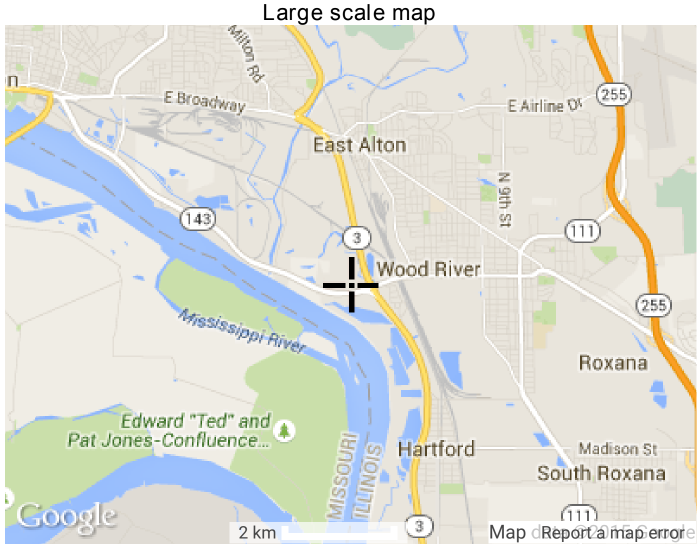


Large scale map



Large scale aerial